CHAPTER 1

GENERAL INFORMATION

1.1. Introduction to MIST

The necessity of establishing a technical institute for the Bangladesh Armed Forces was felt in the late eighties. In the absence of such an institution, officers of Bangladesh Armed Forces had been graduating from Bangladesh University of Engineering and Technology (BUET), Bangladesh Institute of Technology (BIT) and other foreign institutions of science and technology. With a view to meeting the increasing demand for the development and dissemination of engineering and technological knowledge, Bangladesh Armed Forces established the Military Institute of Science and Technology (MIST) that promises to provide facilities for higher technical education both for the officers of Bangladesh Armed Forces as well as for civil students from home and abroad. The motto of MIST is ―Technology for Advancement. Founded on 19 April 1998, MIST started its journey on 31 January 1999 by offering a four- year bachelor's degree on Civil Engineering. Bachelor degree on Computer Science Engineering course started on 2001**.** Bachelor courses on Electrical, Electronic & Communication Engineering and Mechanical Engineering started its journey from 2003. Bachelor of Science program on Aeronautical Engineering (AE) and Naval Architecture and Marine Engineering (NAME) program were started from 2008-2009 and 2012-2013 respectively. Besides, four new departments started their academic session from 2014-2015 i.e. Nuclear Science & Engineering (NSE), Biomedical Engineering (BME), Architecture (Arch) and Environmental, Water Resources & Coastal Engineering (EWCE). Industrial and Production Engineering (IPE) and Petroleum and Mining Engineering (PME) departments started their academic session from 2015-2016.

1.2 Vision and Mission of MIST

Vision:

To be a centre of excellence for providing advanced quality education in the field of scientific, engineering and technology advanced to create diverse quality leaders and professionals and conduct innovative research to meet the national and global needs and challenges.

Mission

MIST is working on following missions:

a. To develop as a Centre of Excellence for providing comprehensive education and conducting creative and innovative research in diverse disciplines of engineering, technology, science, management and related fields.

b. To produce technologically advanced intellectual leaders and professionals with high moral and ethical values to meet the national and global needs for sustainable socio- economic development.

c. To provide consultancy, advisory and testing services to government, industrial, educational and other organizations to render technical support for widening practical knowledge and to contribute in sustainable socio-economic advancement.

d. To extend collaborative and research activities with national and international communities for life-long learning and long term interaction with the academician and industry.

1.3 Motto and Values of MIST

Motto:
As an Institution without gender biasness, MIST is steadily upholding its motto "**Technology for Advancement**" and remains committed to contribute to the wider spectrum of national educational arena, play a significant role in the development of human resources and gradually pursuing its goal to grow into a '**Centre of Excellence**'.

Values:

a. **Integrity and Respect-** We embrace honesty, inclusivity, and equity in all that we do.
b. **Honesty and Accountability-** Our actions reflect our values, and we are accountable for both.
c. **Dedication to Quality and Intellectual Rigour-** We strive for excellence with energy, commitment and passion.
d. **Pursuit of Innovation-** We cultivate creativity, adaptability and flexibility in our students, faculty and staff.

1.4 Eligibility of Students for Admission in MIST

The students must fulfill the following requirements:

a. **Bangladeshi Students:** Minimum qualifications to take part in the admission test are as follows:

(1) The applicant must have passed SSC/equivalent examination in Science Group obtaining GPA 4.00 (without fourth subject) in the scale of 5.0 and in HSC/Equivalent examination from Board of Intermediate and Secondary Education/ Madrasa Education Board/Technical Education Board in science group the applicant must have obtained minimum 'A+' (Plus) in any TWO(2) subjects out of FIVE (5) subjects including Mathematics, Physics, Chemistry, English, and Bengali and 'A' in rest THREE (3) subjects.

(2) The applicant must have qualified in minimum five subjects including Mathematics, Physics, Chemistry and English Language with minimum 'B' in average in GCE 'O' Level and in 'A' level he/she must have obta ined minimum 'A' in ONE subject out of three subjects including Mathematics, Physics, and Chemistry with and minimum 'B' in rest TWO subjects.

(3) Applicants who have passed HSC or Equivalent examination in the current year or one year before the notification for admission can apply.

(4) Sex: Male and Female.

b. **Foreign Students:** Maximum 3% of overall vacancies available will be kept reserved for the foreign students and will be offered to foreign countries through AFD of the Government of the People's Republic of Bangladesh. Applicants must fulfill the following requirements:

(1) Educational qualifications as applicable for Bangladeshi civil students or equivalent.

(2) Must have security clearance from respective Embassy/High Commission in Bangladesh.

(3) Sex: Male and Female.

In the event of non-availability of foreign students, Bangladeshi civil candidates will fill up the vacancies.

1.5 Number of Seats

The highest number of seats for 04(Four) years Bachelor Degree in Engineering programs (Unit– A) and 5 (Five) years Bachelor Degree of Architecture programs are as follows:

Allocation of Seats

Ser	Unit	**Department**	**Seats**
1	**A**	Civil Engineering (CE)	60
2		Computer Science and Engineering (CSE)	60
3		Electrical, Electronic and Communication Engineering (EECE)	60
4		Mechanical Engineering (ME)	60
5		Aeronautical Engineering (AE)	50
6		Naval Architecture and Marine Engineering (NAME)	40
7		Biomedical Engineering (BME)	40
8		Nuclear Science and Engineering (NSE)	40
9		Environmental, Water Resources & Coastal Engineering (EWCE)	60
10		Industrial and Production Engineering (IPE)	50
11		Petroleum and Mining Engineering (PME)	25
12	**B**	Architecture (Arch)	25
		Total	570

The total number is 570. In general, about 50% seats will be allocated to military officers. However, in case of the requirement of military students vacancy is less in any particular year, the deficient vacancy will be filled up by civil students. MIST also maintains quota as mentioned below:

Ser	**Quota Allocation**	**Seats**
1	General Candidates	54%
2	Children of Military Personnel	40%
3	Children of Freedom Fighters	2%
4	Tribal Citizen	1%
5	International Students	3%
	Total	100%

1.6 Admission Procedure

1.6.1 Syllabus for Admission Test: Admission test will be conducted on the basis of the syllabus of Mathematics, Physics, Chemistry and English (comprehension and functional) subjects of HSC examinations of all boards of secondary and higher secondary school certificates. Admission test will be conducted out of 200 marks and the distribution of marks is given below:

Ser.	Subjects	Marks
a.	Mathematics	60
b.	Physics	60
c.	Chemistry	60
d.	English	20
	Total	200

1.6.2 **Final Selection:** Students will be selected on the basis of results of the admission test. Individual choice for selection of departments will be given preference as far as possible. In case of tie in the result of admission test, difference will be judged on the basis of marks obtained in Mathematics, Physics, Chemistry and English respectively in admission test.

1.6.3 **Medical Check Up:** Civil candidates selected through admission test will go for medical checkup in MIST/ CMH. If the medical authority considers any candidate unfit for study in MIST due to critical/contagious/mental diseases as shown in medical policy of MIST will be declared unsuitable for admission.

1.7 Students Withdrawal Policy

1.7.1 For Poor Academic Performance:

The under graduate (B.Sc.) Engineering programs for all engineering disciplines are planned for 04 regular levels, comprising of 08 regular terms, for Architecture program it is planned for 3 regular levels, comprising of 10 regular terms. It is expected that all students will earn degree by clearing all the offered courses in the stipulated time. In case of failure the following policies will be adopted:

a. Students failing in any course/ subject will have to clear/pass the said course/subject by appearing it in supplementary/ self study (for graduating student) examination as per examination policy.

b. Students may also retake the failed subject/ course in regular term/short term as per examination policy.

c. Maximum grading for supplementary/ self study examination etc. of failed subjects will be B+ as per examination policy.

d. One student can retake/reappear in a failed subject/ course only twice. However, With the Permission of Academic Council of MIST, a student may be allowed for third time as last chance.

e. In case of sickness, which leads to missing of more than 40% classes or miss term final examination (supported by requisite medical documents), students may be allowed to withdraw temporarily from that term and repeat the whole level with the regular level in the next academic session, subject to the approval of Academic Council , MIST. However, he/she has to complete the whole undergraduate program within 06 (six) academic years (for Architecture 07 academic years) from the date of his/her registration.

f. Minimum credit requirement for the award of bachelor's degree in Engineering (B.Sc. Engg.) and Architecture (B. Arch) will be decided by the respective department as per existing rules. However the minimum CGPA requirement for obtaining a bachelor degree in engineering and Architecture is 2.20.

g. Whatever may be the cases, students have to complete the whole undergraduate program within 06 (six) academic years from the date of registration.

h. All other terms and conditions of MIST Examination Policy remain valid.

1.7.2 <u>Withdrawal on Disciplinary Ground</u>

a. **<u>Unfair Means:</u>** Adoption of unfair means may result in expulsion of a student from the program and so from the Institution. The Academic Council will authorize such expulsion on the basis of recommendation of the Disciplinary Committee, MIST and as per policy approved by the affiliating university. Following would be considered as unfair means adopted during examinations and other contexts:

(1) Communicating with fellow students for obtaining help in the examination.

(2) Copying from another student's script/ report/paper.

(3) Copying from desk or palm of a hand or from other incrimination documents.

(4) Possession of any incriminating document whether used or not.

b. **<u>Influencing Grades:</u>** Academic Council may expel/withdraw any student for approaching directly or indirectly in any form to influence a teacher or MIST authority for grades.

c. **<u>Other Indiscipline Behaviors</u>:** Academic Council may withdraw/expel any student on disciplinary ground if any form of indiscipline or unruly behavior is seen in him/her which may disrupt the academic environment/ program or is considered detrimental to MIST's image.

d. **Immediate Action by the Disciplinary Committee of MIST:** The Disciplinary Committee, MIST may take immediate disciplinary action against any student of the institution. In case of withdrawal/ expulsion, the matter will be referred to the Academic Council, MIST for post- facto approval.

1.7.3 Withdrawal on Own Accord

a. **Permanent Withdrawal:** A student who has already completed some courses and has not performed satisfactorily may apply for a withdrawal.

b. **Temporary Withdrawal:** A student, if he/she applies, may be allowed to withdraw temporarily from the program/ subject by the approval of Academic Council of MIST, but he/she has to complete the whole program within 06 (six) academic years (for Architecture 07 academic years) from the date of his/her registration.

CHAPTER 2

RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAM AT MIST

2.1 Introduction

MIST has introduced course system for undergraduate studies from the academic session 2017-18. Therefore, the rules and regulations mentioned in this paper will be applicable to students for administering undergraduate curriculum through the Course System. This will be introduced with an aim of creating a continuous, even and consistent workload throughout the term for the students.

2.2 The Course System

2.2.1 The salient features of the Course System are as follows:

a. Number of theory courses will be generally 5 in each term. However, with the recommendation of course coordinator and Head of the Department, Commandant MIST may allow relaxation in this regard. This relaxation is to be reported to Academic Council of MIST.

b. Students will not face any level repeat for failing.

c. Students will get scope to improve their grading.

d. Introduction of more optional courses to enable the students to select courses according to their individual needs and preferences.

e. Continuous evaluation of students' performance.

f. Promotion of student-teacher interaction and contact.

2.2.2 Beside the professional courses pertaining to each discipline, the undergraduate curriculum gives a strong emphasis on acquiring thorough knowledge in the basic sciences of mathematics, physics and chemistry. Due importance is also given on the study of several subjects in humanities and social sciences.

2.2.3 The first two years of bachelor's programs generally consist of courses on basic engineering, general science and humanities subjects; while the third and subsequent years focus on specific disciplines.

2.3 Number of Terms in a Year

2.3.1 There will be two terms (Spring and Fall) in an academic year. In addition to these two regular terms there will be a short term after the Fall Term of each academic session. During the short term, students can take only failed courses to cover up the credit deficiencies.

2.3.2 Respective departments will take the decisions about courses to be offered during each short term depending upon the availability of course teachers and number of students willing to take a particular course.

2.4 Duration of Terms

2.4.1 The duration of each of Term I(Spring) and Term II(Fall) (maximum 22 weeks) may be as under:

Ser	Events	Durations
1.	Classes before Mid Term	7 weeks
2.	Mid Term Vacation	1 week
3.	Classes after Mid Term	7 weeks
4.	Makeup Classes and Preparatory leave	2/3 weeks
5.	Term Final Examination	2/3 weeks
6.	Term End Vacation	1/2 week

2..4.2 The duration of a Short Term will be around 7 weeks of which about 6 weeks will be spent for class lectures and one week for Term Final Examination. The duration for Short Term and Examination will be as under:

Ser	Events	Durations
1.	Classes	6 weeks
2.	Final Examination	1 week
Total		**7 Weeks**

2.5 Course Pattern and Credit Structure

The undergraduate program is covered by a set of theoretical courses along with a set of laboratory (sessional) courses to support them.

2.6 Course Designation System

2.6.1 Each course is designated by a maximum of four letter code identifying the department offering the course followed by a three-digit number having the following interpretation:

a. The left most digit corresponds to the year in which the course is normally taken by the students. The second digit is reserved for departmental use. It usually identifies a specific area/group of study within the department.
b. The right most digit is an odd number for theoretical courses and an even number for sessional courses.

2.6.2 The course designation system is illustrated as Follows:

AEAS 101 — **Introduction to Aeronautical Engineering**

- Course Title
- Odd digit designates a theoretical course
- Reserved for departmental use
- Signifies 1st Year/ 1st Level course
- Department Identification (Aerospace Discipline)

AEAS 206 — **Mechanics of Solids Sessional**

- Course Title
- Even digit designates a sessional course
- Reserved for departmental use
- Signifies 2nd Year/ 2nd Level course
- Department Identification (Aerospace Discipline)

AEAV 101 — **Electrical Circuit Analysis – I**

- Course Title
- Odd digit designates a theoretical course
- Reserved for departmental use
- Signifies 1st Year/ 1st Level course
- Department Identification (Avionics Discipline)

AEAV 202 — **Electrical Circuit Analysis – II Sessional**

- Course Title
- Even digit designates a sessional course
- Reserved for departmental use
- Signifies 2nd Year/ 2nd Level course
- Department Identification (Avionics Discipline)

2.7 Assignment of Credits

The assignment of credits to a theoretical course follows a different rule from that of a sessional course.

a. Theoretical Courses: One lecture per week per term is equivalent to one credit.

b. Sessional Courses: Credits for sessional courses is half of the class hours per week per term.

Credits are also assigned to project and thesis work taken by the students. The amount of credits assigned to such work varies from one discipline to another.

2.8 Types of Courses

The types of courses included in the undergraduate curriculum are divided into the following groups:

a. **Core Courses:** In each discipline, a number of courses are identified as core courses, which form the nucleus of the respective bachelor's degree program. A student has to complete all the designated core courses of his/her discipline.

b. **Pre-requisite Courses:** Some of the core courses are identified as prerequisite courses for a specific subject.

c. **Optional Courses:** Apart from the core courses, the students can choose from a set of optional courses. A required number of optional courses from a specified group have to be chosen.

2.9 Course Offering and Instruction

2.9.1 The courses to be offered in a particular term are announced and published in the Course Catalog along with the tentative Term Schedule before the end of the previous term. The courses to be offered in any term will be decided by Board of Undergraduate Studies (BUGS) of the respective department.

2.9.2 Each course is conducted by a course teacher who is responsible for maintaining the expected standard of the course and for the assessment of students' performance. Depending on the strength of registered students (i.e. on the number of students) enrolled for the course, the teacher concerned might have course associates and Teaching Assistants (TA) to aid in teaching and assessment.

2.10 Teacher Student Interaction

The new course system encourages students to come in close contact with the teachers. For promotion of a high level of teacher-student interaction, each student is assigned to an adviser and the student is free to discuss all academic matters with his/her adviser. Students are also encouraged to meet any time with other teachers for help and guidance in academic matters. However, students are not allowed to interact with teachers after the moderation of questions.

2.11 Student Adviser

2.11.1 One adviser is normally appointed for a group of students by the BUGS of the concerned department. The adviser advises each student about the courses to be taken in each term by discussing the academic program of that particular term with the student.

2.11.2 However, it is also the student's responsibility to keep regular contact with his/her adviser who will review and eventually approve the student's specific plan of study and monitor subsequent progress of the student.

2.11.3 For a student of second and subsequent terms, the number and nature of courses for which he/she can register is decided on the basis of academic performance during the previous term. The adviser may permit the student to drop one or more courses based on previous academic performance.

2.12 Course Registration

2.12.1 Any student who uses classroom, laboratory facilities or faculty-time is required to register formally. Upon admission to the MIST, students are assigned to advisers. These advisers guide the students in choosing and registering courses.

2.12.2 **Registration Procedure:** At the commencement of each term, each student has to register for courses in consultation with and under the guidance of his/her adviser. The date, time and venue of registration are announced in advance by the Registrar's Office. Counseling and advising are accomplished at this time. It is absolutely essential that all the students be present for registration at the specified time.

2.12.3 **Pre-conditions for Registration**

a. For first year students, department-wise enrolment/ admission is mandatory prior to registration. At the beginning of the first term, an orientation program will be conducted for them where they are handed over with the registration package on submission of the enrolment slip.

b. Any student, other than the new batch, with outstanding dues to the MIST or a hall of residence is not permitted to register. Each student must clear their dues and obtain a clearance certificate, upon production of which, he/she will be given necessary Course Registration Forms to perform course registration.

c. A student is allowed to register in a particular course subject to the class capacity constraints and satisfaction of pre-requisite courses. However, even if a student fails in a pre-requisite course in any term, the concerned department (BUGS) may allow him/her to register for a course which depends upon the pre-requisite course provided that his/her attendance and performance in the continuous assessment of the mentioned pre-requisite course is found to be satisfactory.

2.12.4 **Registration Deadline:** Each student must register for the courses to be taken before the commencement of each term. Late registration is permitted only during the first week of classes. Late registration after this date will not be accepted unless the student submits a written application to the registrar through the concerned Head of the department explaining the reasons for delay. Acceptable reasons may be medical problems with supporting documents from the Medical Officer of MIST or some other academic commitments that prohibit enrollment prior to the last date of registration.

2.12.5 Penalty for Late Registration: Students who fail to register during the designated dates for registration are charged a late registration fee of Tk. 100.00 (One hundred only) per credit hours. Penalty for late registration will not be waived.

2.12.6 Limits on the Credit Hours to be taken

A student should be enrolled for at least 15 credit hours and is allowed to take a maximum of 24 credit hours. Relaxation on minimum credit hours may be allowed. A student must enroll for the sessional courses prescribed in a particular term within the allowable credit hour limits.

In special cases where it is not possible to allot the minimum required 15 credit hours to a student, the concerned department (BUGS) may permit with the approval of the Commandant, a lesser number of credit hours to suit individual requirements. Such cases are also applicable to students of Level 4 requiring less than 15 credit hours for graduation.

2.12.7 Course Add/ Drop

A student has some limited options to add or drop courses from the registration list. Addition of courses is allowed only within the first two weeks of a regular term and only during the first week of a short term. Dropping a course is permitted within the first four weeks of a regular term and two weeks of a short term.

Any student willing to add or drop courses has to fill up a Course Adjustment Form. This also has to be done in consultation with and under the guidance of the student's respective adviser. The original copy of the Course Adjustment Form has to be submitted to the Registrar's Office, where the required numbers of photocopies are made for distribution to the concerned adviser, Head, Dean, Controller of Examinations and the student.

All changes must be approved by the adviser and the Head of the concerned department. The Course Adjustment Form has to be submitted after being signed by the concerned persons.

2.12.8 Withdrawal from a Term

If a student is unable to complete the Term Final Examination due to serious illness or serious accident, he/she may apply to the Head of the degree awarding department for total withdrawal from the term before commencement of term final examination.
However, application may be considered during term final examination in special case. The application must be supported by a medical certificate from the Medical Officer of MIST. The concerned student may opt for retaining the sessional courses of the term. The

Academic Council will take the final decision about such applications. However, the total duration for graduation will not exceed 6 academic years.

2.13 The Grading System

The total performance of a student in a given course is based on a scheme of continuous assessment, for theory courses this continuous assessment is made through a set of quizzes, class tests, class evaluation, class participation, homework assignment and a term final examination. The assessments for sessional courses are made by evaluating performance of the student at work during the class, viva-voce during laboratory hours and quizzes. Besides that, at the end there will be a final lab test. Each course has a certain number of credits, which describes its corresponding weightages. A student's performance is measured by the number of credits completed satisfactorily and by the weighted average of the grade points earned. A minimum grade point average (GPA) is essential for satisfactory progress. A minimum number of earned credits also have to be acquired in order to qualify for the degree. Letter grades and corresponding grade points will be given as follows:

Numerical Markings	Grade	Grade Points
80% and above	A+	4.00
75% to below 80%	A	3.75
70% to below 75%	A-	3.50
65% to below 70%	B+	3.25
60% to below 65%	B	3.00
55% to below 60%	B-	2.75
50% to below 55%	C+	2.50
45% to below 50%	C	2.25
40% to below 45%	D	2.00
below 40%	F*	0.00
Incomplete	I	-
Withdrawal	W	-
Project/ Thesis continuation	X	-

* Subject in which the student gets F grade shall not be regarded as earned credit hours for the calculation of Grade Point Average (GPA).

2.14 Distribution of Marks

2.14.1 Theory: Thirty percent (30%) of marks of a theoretical course shall be allotted for continuous assessment, i.e. quizzes, home assignments, class tests, observations/ class participation and class attendance. These marks must be submitted to Office of the Controller of Examinations before commencement of final exam. The rest of the marks will be allotted to the Term Final Examination. The duration of final examination will be three (03) hours. The scheme of continuous assessment that a particular teacher would follow for a course will be announced on the first day of the classes.

Distribution of marks for a given course per credit is as follows:

Class Participation/ Observation	5%
Class Attendance	5%
Homework assignment/ Quizzes/ CTs	20%
Final Examination (Section A & B)	70%
Total	100

2.14.2 **<u>Sessional/Practical Examinations:</u>** Sessional courses are designed and conducted by the concerned departments. Examination on sessional/practical subjects will be conducted by the respective department before the commencement of term final examination. The date of practical examination will be fixed by the respective department. Students will be evaluated in the sessional courses on the basis of the followings (all or as decided by the Examination Sub-Committee):

Class Attendance	-
Class performance/observation	-
Lab Test/Report Writing/project work/Assignment	-
Quiz Test	-
Viva Voce	-
Total	100%

2.14.3 **<u>Sessional Course in English</u>**. The distribution will be as under:

Class Attendance	-
Class performance/observation	-
Written Assignment	-
Oral Performance	-
Listening Skill	-
Group Presentation	-
Viva Voce	-
Total	100%

2.15 <u>Basis for awarding marks for class attendance:</u>

This will be as follows:

Attendance	Marks
90% and above	100%
85% to less than 90%	80%
80% to less than 85%	60%
75% to less than 80%	40%
Below 75%	0%

2.16 Collegiate and Non-collegiate

Students having class attendance of 90% or above in individual subject will be treated as collegiate and less than 90% and up to 75% will be treated as non-collegiate in that subject. The non-collegiate student(s) may be allowed to appear in the examination subject to payment of non-collegiate fee/fine of an amount fixed by MIST/BUP. Students having class attendance below 75% will be treated as dis-collegiate and will not be allowed to appear in the examination and treated as fail. But in a special case such students may be allowed to appear in the examination with the permission of Commandant and it must be approved by the Academic Council.

2.17 Calculation of GPA

Grade Point Average (GPA) is the weighted average of the grade points obtained of all the courses passed/completed by a student. For example, if a student passes/completes *n* courses in a term having credits of $C_1, C_2, \dots, C_n$ and his grade points in these courses are $G_1, G_2, \dots, G_n$ respectively then

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

The Cumulative Grade Point Average (CGPA) is the weighted average of the GPA obtained in all the terms passed/completed by a student. For example, if a student passes/ completes n terms having total credits of $TC_1, TC_2, \dots, TC_n$ and his GPA in these terms are GPA_1, GPA_2, GPA_n respectively then

$$CGPA = \frac{\sum_{i=1}^{n} TC_i GPA_i}{\sum_{i=1}^{n} TC_i}$$

2.17.1 Numerical Example

Suppose a student has completed eight courses in a term and obtained the following grades:

Course	Credits, C_i	Grade	Grade G_i	Points, $C_I * G_i$
AEAS 110	1.50	A-	3.50	5.250
AEAS 101	3.00	A+	4.00	12.000

CHEM 105	3.00	A	3.75	11.250
MATH 121	3.00	B	3.00	9.000
HUM 111	3.00	B-	2.75	8.250
HUM 103	3.00	B	3.00	9.000
PHY 115	3.00	A+	4.00	12.000
CSE112	1.50	A	3.75	5.625
Total	21.00			72.375

GPA = 72.375/ 21.00 = 3.45

Suppose a student has completed four terms and obtained the following GPA.

Level	Term	Credit Earned, TC_i	Hours GPA Earned, GPA_i	GPA_i*TC_i
1	1	21.00	3.73	78.330
1	2	20.50	3.93	80.565
2	1	19.75	3.96	78.210
2	2	20.25	4.00	81.000
Total		**81.50**		**318.105**

CGPA = 318.105/81.50 = 3.90

2.18 Minimum Earned Credit and GPA Requirement for Obtaining Degree

Minimum credit hour requirements for the award of bachelor degree in engineering (B.Sc. Engineering) and other discipline will be decided as per existing rules. The minimum CGPA requirement for obtaining a Bachelor degree in engineering and other discipline is 2.20.

2.19 Minimum Earned Credit and GPA Requirement for Obtaining Degree

Minimum credit hour requirements for the award of bachelor degree in engineering (B.Sc. Engineering) and other discipline will be decided as per existing rules. The minimum GPA requirement for obtaining a Bachelor's degree in Engineering and Architecture is 2.20.

2.20 Impacts of Grade Earned

a. The courses in which a student has earned a ‘D’ or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained an ‘F’ grade will not be counted towards his/her earned credits or GPA calculation. However, the ‘F’ grade will remain permanently on the Grade Sheet and the Transcript.

b. A student who obtains an ‘F’ grade in a core course will have to repeat that particular course. However, if a student gets an ‘F’ in an optional course, he/she may choose to repeat that course or take a substitute course if available. When a student will repeat a course in which he/she has previously obtained an 'F', he/she will not be eligible to get a grade better than 'B+' in that repeated course.

c. If a student obtains a grade lower than 'B+' in a particular course he/she will be allowed to repeat the course only once for the purpose of grade improvement. However, he/she will not be eligible to get a grade better than 'B+' for an improvement course.

d. A student will be permitted to repeat for grade improvement purposes a maximum of 6 courses in B.Sc. Engineering programs and a maximum of 7 courses in B. Arch. program.

e. If a student obtains a 'B+' or a better grade in any course he/she will not be allowed to repeat the course for the purpose of grade improvement.

2.21 Classification of Students

2.21.1 At MIST, regular students are classified according to the number of credit hours completed/ earned towards a degree. The following classification applies to all the students:

Level	Credit Hours Earned	
	Engineering	Architecture
Level 1	0.0 to 36.0	0.0 to 34.0
Level 2	More than 36.0 to 72.0	More than 34.0 to 72.0
Level 3	More than 72.0 to 108.0	More than 72.0 to 110.0
Level 4	More than 108.0	More than 110.0 to 147.0
Level 5		More than 147.0

2.21.2 However, before the commencement of each term all students other than new batch are classified into three categories:

Category 1: This category consists of students who have passed all the courses described for the term. A student belonging to this category will be eligible to register for all courses prescribed for the upcoming term.

Category 2: This category consists of students who have earned a minimum of 15 credits but do not belong to category 1. A student belonging to this category is advised to take at least one course less since he might have to register for one or more backlog courses as prescribed by his/her adviser.

Category 3: This category consists of students who have failed to earn the minimum required 15 credits in the previous term. A student belonging to this category is advised to take at least two courses less than a category 1 student subject to the constraint of registering at least 15 credits. However, he will also be required to register for backlog courses as prescribed by the adviser.

2.21.3 **Definition of Graduating Student:** Graduating students are those students who will have ≤ 24 credit hour for completing the degree requirement.

2.22 Performance Evaluation

i. The performance of a student will be evaluated in terms of two indices, viz. Term Grade Point Average and Cumulative Grade Point Average which is the grade average for all the terms completed.

ii. Students will be considered to be making normal progress toward a degree if their Cumulative Grade Point Average (CGPA) for all work attempted is 2.20 or higher. Students who regularly maintain a term GPA of 2.20 or better are making good progress toward the degrees and are in good standing with MIST. Students who fail to maintain this minimum rate of progress will not be in good standing. This can happen when any one of the following conditions exists.

   a. The term GPA falls below 2.20.

   b. The Cumulative Grade Point Average (CGPA) falls below 2.20.

   c. The earned number of credits falls below 15 times the number of terms attended.

iii. All such students can make up their deficiencies in GPA and credit requirements by completing courses in the subsequent term(s) and backlog courses, if there are any, with better grades. When the minimum GPA and credit requirements are achieved the student is again returned to good standing.

2.23 Application for Graduation and Award of Degree

A student who has fulfilled all the academic requirements for Bachelor's degree will have to apply to the Controller of Examinations through his/her Adviser for graduation. Provisional Degree will be awarded by BUP on completion of credit and GPA requirements.

2.24 Time Limits for Completion of Bachelor's Degree

A student must complete his studies within a maximum period of six years for engineering and seven years for architecture.

2.25 Attendance, Conduct and Discipline

MIST has strict rules regarding the issues of attendance in class and discipline.

Attendance: All students are expected to attend classes regularly. The university believes that attendance is necessary for effective learning. The first responsibility of a student is to attend classes regularly and one is required to attend the classes as per MIST rules.

Conduct and Discipline: During their stay in MIST all students are required to abide by the existing rules, regulations and code of conduct. Students are strictly forbidden to form or be members of student organization or political party, club, society etc., other than those set up by MIST authority in order to enhance student's physical, intellectual, moral and ethical development. Zero tolerance in regards of sexual abuse and harassment in any forms and drug abuse and addiction are strictly observed in the campus.

2.26 Teacher-Student Interaction

The academic system in MIST encourages students to come in close contact with the teachers. For promotion of high level of teacher-student's interaction, a course coordinator (CC) is assigned to each course. Students are free to discuss with CC about all academic matters. Students are also encouraged to meet other teachers any time for help and guidance for academic matters. Heads of the departments, Director of Administration, Director of Students Welfare (DSW), Dean and Commandant address the students at some intervals. More so, monthly Commandant's Parade is organized in MIST where all faculty members, staff and students are formed up, thereby increasing teacher-student interaction.

2.27 Absence during a Term

A student should not be absent from quizzes, tests, etc. during the term. Such absence will naturally lead to reduction in points/marks, which count towards the final grade. Absence in the Term Final Examination will result in an F grade in the corresponding course. A student who has been absent for short periods, up to a maximum of three weeks due to illness, should approach the course teacher(s) or the course coordinator(s) for make-up quizzes or assignments immediately upon return to classes. Such request has to be supported by medical certificate from competent authority (e.g. CMH/MIST Medical Officer).

2.28 Recognition of Performance

As recognition of performance and ensure continued studies MIST awards medals, scholarships and stipends will be given as per existing rules and practices.

2.29 Types of Different Examination

Following different types of final Examinations will be conducted in MIST to evaluate the students of Undergraduate Programs:

a. **Term Final Examination:** At the end of each normal term (after 22wk or so), term final examination will be held. Students will appear in the term final examination for all the theory courses they have taken in the term.

b. **Short Term Examination:** Short Term may be conducted after one week completion of Term 2 final examination. Students will be allowed to take maximum three theoretical courses in the Short Term. Examination will be conducted at the end of Short Term (6^{th} week class). However, Head of concerned department with the approval of Commandant may decide to take Supplementary examination instead of Short Term. No Laboratory/ Sessional Courses can be taken in short term.

c. **Supplementary Examination:** It will take place once in a year, after each term-I final break. It should be completed within first 3 weeks of a new term. Students will be allowed to appear this examination for one subject at a time. Graduating students will be allowed to appear maximum two subjects during supplementary examination in their last Term. However, Head of the concerned department with the approval of Commandant may decide to take another Supplementary Examination instead of Short Term. In that case, a student will be allowed to take only one failed course in the particular Supplementary Examination. This examination will be conducted in the previous week of the beginning of Term I. Highest achieved grade for all courses of Supplementary Examination will be B+.

d. **Improvement Examination:** It will be taken during supplementary and short term examination. Questions will be same as the question of the regular examination of that Short Term Final Examination (if any). Student can take two subject at a time and maximum 6 subjects in the whole academic duration. If a student obtains a grade lower than 'B+' in a course, he/she will be allowed to repeat the course only once for grade improvement. However, he/she will not be eligible to get a grade better then 'B+' for an improvement course. Among the previous result and improvement examination result, best one will be considered as final result for an individual student. However, performance of all examination i.e. previous to improvement examination, shall be reflected in the transcript.

e. **Self-Study Course Examination:** Only graduating students (level-4) will be allowed to appear at Self Study course examination. It will be taken with Term Final Examination. No regular class will be arranged for this, but teachers will be assigned for supervising and guiding the students for study, conducting class test/quiz and regular assessment for 30% marks. Maximum two theory courses may be taken as self-study course by a student. Highest achieved grade for these courses will be B+. In that case a student will be allowed to take maximum 24 credits instead of 15 in the last Term of his/her graduation.

f. **Special Referred Examination:** Since course system will start from 1st Term of 2018, for all casualty cases like referred, backlog, failed courses, level repeat students will be given chance to clear their respective all failed courses by appearing in this examination. It will be held after the confirmation of the result of Term-II Final Examination of 2017 and before starting of the class of the Term-I of 2018. Students of all levels, failed in any courses even after appearing in Special Referred Examination-1, will be allowed to re-appear again in the failed courses during Special Referred Examination-2 to be held during Mid Term break of Term-1 of 2018. Student of Level-4 of 2017, failed in any courses even after appearing in these two referred examinations, will be allowed to clear failed courses as a last chance, during Term-1 final examination of 2018 (as a Special Referred Examination-3). Students of other levels, failed in any courses even after appearing in two Special Referred Examinations, will be allowed to clear these failed courses as per normal rules of course system (either by retaking these courses or appearing at the supplementary Examination). Highest grade for courses in all these examinations will be 'B+'.

2.30 Rules of Different Examinations

2.30.1 Term Final Examination: Following rules to be followed:

a. Registration to be completed before commencement of the class. A student has to register his desired courses paying registration, examination fee and other related fees.
b. Late registration will be allowed without penalty within first one week of the term.
c. Within 1st two weeks of a term a student can Add/Drop course/courses. To add a course, in the 3rd week, one has to register the course by paying additional fees. To drop a course, one has to apply within three weeks and paid fees will be adjusted/ refunded. If anyone wants to drop a course after three weeks and within 4 weeks, that will be permitted but paid fees will not be refunded in that case.
d. Registrar office will finalize registration of all courses within 7 (seven) weeks, issue registration slip and that will be followed by issuing Admit Card.

e. Term Final Examination to be conducted in the 18-20th week of the term as per approved Academic Calendar.

2.30.2 Short Term Examination: Following rules to be followed:
a. Short Term for period of 6 weeks may be offered by a department after one week of completion of Term II Final Examination.
b. Short Term Final Examination is to be conducted on 7th week of Short Term.
c. Only repeat course can be offered, not any fresh course.
d. Classes will be arranged for the students who register a failed course in the Short Term.
e. After 6 (six) weeks of class, in the 7th week short Term Examination will be held. Academic calendar for this Short Term will be declared by the Department during the Mid-Term break of Term-II.
f. One student can take only three (failed/improvement) courses at a time in the Short Term.
g. Students will have to complete registration of course for Short Term by paying all the fees, before starting of the Term-II final Exam.
h. Graduating students may register for Short Term examinations after finalization of result of T 2 final examination.
i. Maximum grading will be 'B+'.
j. Question Setting, Moderation, Result Publication will be done following the same rules of Term Final Exam as per Exam Policy. Separate Tabulation sheet will be made for this examination.
k. However, Head of concerned department with the approval of Commandant may decide to take Supplementary Examination instead of Short Term.

2.30.3 Supplementary Examination: Following rules to be followed:

a. After the final break of every Term-I, Supplementary Examination will be held (once in a year).
b. Examination will be taken on 70% marks like Term Final examination. Remaining 30% marks on continuous assessment earned previously in that particular course will be counted. If a student fails in a course more than once in regular terms, then best one of all continuous assessment marks will be counted.

c. A student will be allowed to take one course at a time for each supplementary examination, but in the graduating Term one student can take two courses if required.
d. Highest grade of supplementary examination will be ‘B+’.
e. Registration for supplementary courses to be done during the mid-term break of Term 1, paying the required fees.
f. Examination will be completed after Term I End break within three weeks of Term II.
g. If any student fails in a course, he can clear the course retaking it 2^{nd} time or, he can clear the examination appearing at the supplementary examination as well. But anyone fails twice in a course consecutively, he has to take approval of Academic Council of MIST for appearing third/last time in a course and need to pay extra financial penalty.
h. If anyone fails in the sessional course, that course cannot be cleared in the supplementary examination.
i. Question setting, Moderation, Result Publication will be done following the same rules of Term Final Examination as per Examination Policy.
j. However, Head of the concerned department with the approval of Commandant may decide to take another Supplementary Examination instead of Short Term. In that case, a student will be allowed to take only one failed course in that particular Supplementary Examination. This examination will be conducted in the previous week of the beginning of Term 1. Registration of that Supplementary Examination should be completed during registration of Short Term course.

2.30.4 **<u>Improvement Examination:</u>** Following rules to be followed:

a. Any student gets a grading below ‘B+’ and desires to improve that course, he will be allowed to appear the improvement examination for that particular course.
b. Highest grade of Improvement examination will be ‘B+’.
c. One student is allowed to appear at Improvement exam in 6 (six) courses in his whole graduation period taking maximum two courses at a time.
d. For Improvement examination, registration is to be done before Term 2 Final Examination with the Short Term Courses or, during the registration of Supplementary Courses by paying all the fees.
e. Improvement examination to be taken during the supplementary and short term examinations.
f. Choice of Improvement course is restricted within the offered courses of that Short Term by the Departments and in two courses at a time.
g. Question Setting, Moderation and Result Publication to be done with courses of regular Term Final Examination.

2.30.5 **<u>Self-Study Course and Examination:</u>** Following Rules to be followed:

a. An irregular student for completion of his graduation can take maximum two repeat courses as self-study course in the graduating Term if he desires and is accepted by department.
b. One student can take maximum 24 credit hours course in the graduating Term to complete his graduation.
c. Registration for self-study course by paying all fees must be completed with other course of regular Term.

d. To run the self-study course, concerned Department will assign one teacher each for every self-study course offered. No regular theory class will be held, but that assigned teacher will take necessary class Tests, Quiz Test and give attendance and observation marks to give 30% marks at the end of the Term. For remaining 70% marks written examination will be taken with the Term Final Examination.
e. Assigned teacher for self-study examination will be responsible for setting questions of 70% marks and other examination formalities.
f. Question Setting, Moderation, and Result Publication to be done with courses of Term Final Examination.
g. Grading of Self Study course and examination will be maximum 'B+'.

2.30.6 **Special Referred Examination:** Following rules will be followed:

a. Immediately after the finalization of result of Term-2 final exam of 2017, for all failed/leftover courses, special referred examination will be arranged and students will have to register the courses for the examination by paying required fees and charges. Following the registration, Admit Card will be issued.
b. Examination will be held before commencement of Term-1 of 2018.
c. One student can appear at all of his failed courses (Referred/Backlog) in the Referred Examination including present level-repeat students.
d. Highest grade for all courses in this Examination will be 'B+'.
e. Question Setting, Moderation and Result Publication will be done following the same rules of Term Final Examination as per Examination Policy.
f. Separate Tabulation Sheet will be made for this special referred examination.

2.31 Irregular Graduation

If any graduating student clears his/her failed course in Term-1 and his graduation requirements are fulfilled, his graduation will be effective from the result publication date of Term-1 and that student will be allowed to apply for provisional certificate.

CHAPTER 3

DEPARTMENT OF PETROLEUM AND MINING ENGINEERING (PME)

3.1 Introduction to the program

The Department of Petroleum and Mining Engineering (PME) offers Bachelor of Science in Petroleum and Mining engineering which is one the top university level programs among the engineering universities in Bangladesh. The Department of Petroleum & Mining Engineering has planned to start its academic work in the year 2016 with the objective to produce qualified personnel in the field of Petroleum & Mining Engineering, skilled enough to quantify the oil, gas and mineral resources and to develop those resources for proper exploitation. The program is designed to prepare graduates for national and international field of Petroleum and Mining Engineering.

Petroleum and Mining Engineering plays a vital role in all fields of modern human activities. It has established itself as one of the most important branches of engineering. The Petroleum and Mining Engineering undergraduate program provides an excellent technical background for persons who want to work in the fields of Reservoir, Drilling, Production, Refining, LNG, LPG, and Mining. In addition to lectures and practical sessions in the class room, the undergraduate program also includes industrial/educational visits to different reputed industries/places both home and abroad. The new generation of Petroleum and Mining engineers is encouraged to undertake research and development activities in the above areas and this department is committed to the study and analysis of fundamental as well as applied problems. Problems of military and national importance have consequently received great emphasis in the activities of this department.

In addition to the above there is opportunity for postgraduate studies and research leading to higher degrees i.e. M. Sc. (Engg), M. Engg, and Ph.D.

3.2 <u>Vision and Mission of the Program</u>

Vision:

The department of Petroleum and Mining Engineering intends to be nationally recognized through education and research programs in both petroleum and mining discipline. The vision is to see the energy industry of the country to be transformed through our graduates and researchers by translating fundamental scientific discovery into applied industry applications.

Mission:

1. To guide all efforts aiming to build, sustain, incorporate, convey and apply petroleum and mining engineering knowledge, and to augment the human resources of these disciplines and thus to help ensuring the nation an energy-secure future that balances environmental impact and affordable energy supply.
2. To foster an environment in which students learn to think, conduct research, apply knowledge and achieve success in a diverse and changing global economy.
3. To guide the students develop themselves as professionals with high ethical and moral values.

3.3 Program Objectives

The Graduates of Petroleum and Mining Engineering department will be able:

1. To solve critical technical problems related to Petroleum and Mining Engineering.

2. To build up successful professional careers in oil, gas and minerals industries.

3. To pursue continuous learning through professional development, practical training and specialized certifications.

4. To undertake post graduate and doctorate and excel in academic and research careers.

5. To positively contribute in national and global socio economic development.

3.4 Learning Outcomes

Based on the suggestion of Board of Accreditation for Engineering and Technical Education (BAETE), Bangladesh, the Bachelor in Petroleum and Mining Engineering (PME) program will have following learning outcomes:

1) Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2) Problem analysis: Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.

3) Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.

4) Investigation: Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

5) Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6) The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

7) Environment and sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

8) Ethics: Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.

9) Individual work and teamwork: Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

10) Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

11) Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments.

12) Life-long learning: Recognize the need for and have the preparation and ability to engage in independent, life- long learning in the broadest context of technological change.

3.5 Generic Skills

1. Apply the principles and theory of Petroleum and Mining Engineering knowledge to the requirements, design and development of different oil, gas and minerals recovery systems with appropriate understanding.

2. Define and use appropriate research methods and modern tools to conduct a specific project.

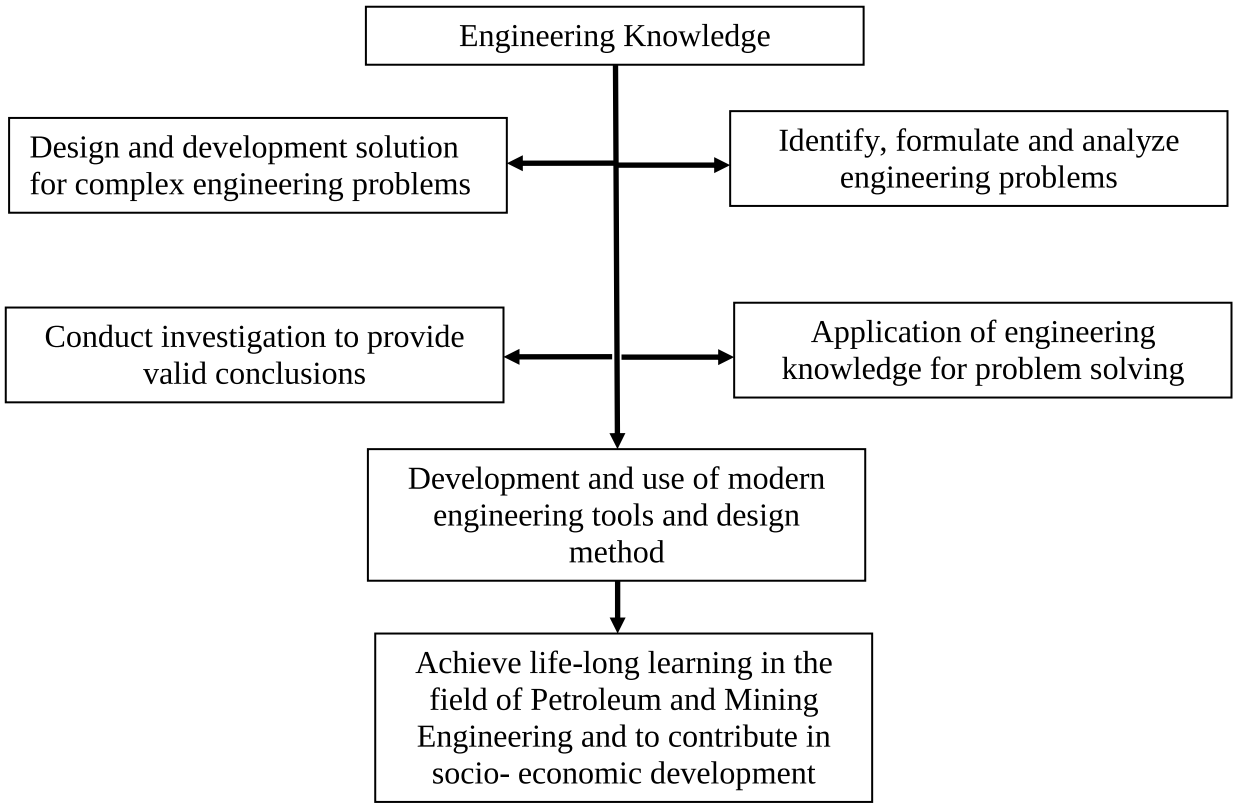
3. Learn independently, be self- aware and self- manage their time and workload.

4. Apply critical thinking to solve complex engineering problems.

5. Analyze real time problems and justify the appropriate use of technology.

6. Work effectively with others and exhibit social responsibility.

3.6 Curriculum/ Skill Mapping



CHAPTER 4

COURSE CURRICULUM OF BACHELOR IN PETROLEUM AND MINING ENGINEERING

4.1 Course Schedule

Keeping the above mentioned program outcome, the course schedule for the undergraduate students of the Department of Petroleum and Mining Engineering (PME) is given below:

Distribution of Credits among Major Fields

Level/ Term	Humanities	Math	Basic Science (Phy, Chem)	Other Engg. (ME, CSE, EECE)	Dept. Engg. Courses	Total
1-I	2.00+1.00=3.00	3.00	3.00	1.50+1.50 =3.00	3.00+3.00+1.50=7.50	19.50
1-II	3.00	3.00	3.00+3.00 +1.50+1.50=9.00	-	3.00+1.50=4.5	19.50
2-I		4.00		3.00+1.50= 4.50	3.00+3.00+3.00+1.5+0.75 =11.25	19.75
2-II	2.00			2.00+0.75+ 3.00+0.75= 6.50	2.00+3.00+3.00+1.5+1.5=11.00	19.50
3-I					19.50	19.50
3-II					21.75	21.75
4-1					20.50	20.50
4-II					21.50	21.50
% Of Total Course	4.95	6.19	7.43	8.67	72.76	100
Total Credit Hour	8.00	10.00	12.00	14.00	117.50	161.50

4.2 Distribution of Contact Hours and Credit Hours in Eight Terms

Level/Term	Theory Contact Hours	Sessional Contact Hours	Theory Credit Hours	Sessional Credit Hours	Total Contact Hours	Total Credit Hours
1/I	14	11	14	5.5	25	19.50
1/II	15	9	15	4.5	24	19.50
2/I	16	7.5	16	3.75	23.5	19.75
2/II	15	9	15	4.5	24	19.50
3/I	15	9	15	4.5	24	19.50
3/II	18	6.00+4 weeks	18	3.75	24.00+ 4 weeks	21.75
4/I	15	11	15	5.5	26	20.50
4/II	16	11	16	5.5	27	21.50
	124.00	73.50+4 weeks	124.00	37.50	197.50+4 weeks	161.50

4.3 Final Year Project/Thesis

Project/thesis will have to be undertaken by students under a supervisor in partial fulfillment of the requirement of his/her degree. Credits allotted to the project/thesis will be 4.5 corresponding to 9 contact hours.

4.4 Distribution of Courses in Levels and Terms

Level-1, Term-1

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	Chem 171	Basic Chemistry	3	3
2	Hum 171	Fundamental English	2	2
3	Math 171	Differential Calculus, Integral Calculus and Matrices	3	3
4	PME 111	Geology for Petroleum and Mining Engineers	3	3
5	PME 113	Introduction to Petroleum and Mining Engineering	3	3
SESSIONAL/LABORATORY				
1	ME 178	Engineering Drawing and CAD	3	1.5
2	ME 176	Workshop Practice	3	1.5
3	PME 112	Geology Laboratory	3	1.5
4	Hum 172	Developing English Language Skills	2	1
			25.00	19.50

Contact Hours: 14 (Theo) + 11.00 (Lab) = 25 hours/week   No of Theory Courses = 5
Total Credits = 19.50   No of Laboratory Courses = 4

Level-1, Term-2

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	Chem173	Petroleum Chemistry	3	3
2	Hum 173	Economics and Accounting	3	3
3	Math 173	Vector Analysis, Geometry and Engineering Statistics	3	3
4	Phy 171	Physics	3	3
5	PME 123	Reservoir Rock and Fluid Properties	3	3
SESSIONAL/LABORATORY				
1	Chem 172	Chemistry Laboratory	3	1.5
2	Phy 172	Physics Laboratory	3	1.5
3	PME 124	Reservoir Rock and Fluid Properties Laboratory	3	1.5
			24.00	19.50

Contact Hours: 15 (Theo) + 9.00 (Lab) = 24 hours/week   No of Theory Courses = 5
Total Credits = 19.50   No of Laboratory Courses = 3

Level-2, Term-1

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	EECE 271	Fundamentals of Electrical and Electronic Engineering	3	3
2	Math 271	Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis	4	4
3	PME 211	Engineering Mechanics	3	3
4	PME 213	Petroleum Engineering Thermodynamics	3	3
5	PME 215	Rock Mechanics for Mining and Petroleum Engineers	3	3
SESSIONAL/LABORATORY				
1	EECE 272	Electrical and Electronic Engineering Laboratory	3	1.5
2	PME 216	Rock Mechanics Laboratory	3	1.5
3	PME 218	Drilling Fluid Laboratory	1.5	0.75
			23.50	19.75

Contact Hours: 16 (Theo) + 7.50 (Lab) = 23.5 hours/week   No of Theory Courses = 5
Total Credits = 19.75   No of Laboratory Courses = 3

Level-2, Term-2

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	CSE 271	Introduction to Computer Programming	2	2
2	PME 223	Exploration Geophysics	2	2
3	ME 271	Fluid Mechanics	3	3
4	PME 227	Mining system	3	3
5	PME 229	Strength of Materials	3	3
6	Hum 271	Sociology	2	2
SESSIONAL/LABORATORY				
1	CSE 272	Computer Programming Sessional	1.5	0.75
2	PME 224	Exploration Geophysics Laboratory	3	1.5
3	PME228	Mining System Laboratory	3	1.5
4	ME 272	Fluid Mechanics Laboratory	1.5	0.75
			24.00	19.5

Contact Hours: 15 (Theo) + 9.00 (Lab) = 24 hours/week   No of Theory Courses = 6
Total Credits = 19.50   No of Laboratory Courses = 4

Level-3, Term-1

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	PME 311	Mine Instrumentation and Machinery	3	3
2	PME 313	Shaft Sinking and Tunneling	3	3
3	PME 315	Well Logging and Formation Evaluation	3	3
4	PME 317	Drilling Engineering	3	3
5	PME 319	Heat Transfer and Mass Transfer	3	3
SESSIONAL/LABORATORY				
1	PME 312	Mine Instrumentation and Machineries Laboratory	3	1.5
2	PME 316	Well Logging and Formation Evaluation Laboratory	3	1.5
3	PME 318	Rig Floor Simulation Laboratory	3	1.5
			24.00	19.50

Contact Hours: 15 (Theo) + 9.00 (Lab) = 24 hours/week   No of Theory Courses = 5
Total Credits = 19.50   No of Laboratory Courses = 3

Level-3, Term-2

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	PME 321	Petroleum Production Engineering	3	3
2	PME 323	Natural Gas Processing and LNG Technology	3	3
3	PME 325	Reservoir Engineering	4	4
4	PME 327	Mine Survey	3	3
5	PME 329	Health, Safety and Environment in Petroleum and Mining Industries	2	2
6	PME 3211	Rock Blasting and Explosive Technology	3	3
SESSIONAL/LABORATORY				
1	PME 324	Natural Gas Processing and LPG Laboratory	3	1.50
2	PME 328	Mining Survey Laboratory	3	1.50
3	PME 320	Industrial Training	4 weeks	0.75
			24.00	21.75

Contact Hours: 18 (Theo) + 6.00 (Lab) = 24 hours/week   No of Theory Courses = 6
Total Credits = 21.75   No of Laboratory Courses = 3

Level-4, Term-1

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	PME 411	Well Test Analysis	3	3
2	PME 413	Reservoir Modeling and Simulation	3	3
3	PME 415	Mine Ventilation and Environmental Engineering	3	3
4	PME 417	Petroleum Refining and LPG Technology	4	4
5	PME 419	Professional Practices and Communication	2	2
SESSIONAL/LABORATORY				
1	PME 400	Project / Thesis- Part: I	3	1.5
2	PME 412	Integrated Design Project- Part: I	2	1
3	PME 414	Reservoir Modeling and Simulation Sessional	3	1.5
4	PME 416	Mine Ventilation and Environmental Engineering Laboratory	3	1.5
			26.00	20.50

Contact Hours: 15 (Theo) + 11.00 (Lab) = 26 hours/week   No of Theory Courses = 5
Total Credits = 20.50   No of Laboratory Courses = 4

Level-4, Term-2

Sl No	Course No	Course Title	Contact hour/week	Credits
THEORY				
1	PME 421	Evaluation and Management of Petroleum and Mining Projects	3	3
2	PME 423	Transmission and Distribution of Natural Gas	3	3
3	PME 425	Enhanced Oil and Gas Recovery Techniques	2	2
4	PME 427	Minerals Processing	3	3
5	PME 429	Ground Water Managements in Mining	2	2
6	PME 4211	Mine Planning and Design	3	3
SESSIONAL/LABORATORY				
1	PME 400	Project / Thesis- Part: II	6	3
2	PME 412	Integrated Design Project- Part: II	2	1
3	PME 428	Minerals Processing Laboratory	3	1.5
			27.00	21.50

Contact Hours: 16 (Theo) + 11.0 (Lab) = 27.00 hours/week   No of Theory Courses = 6
Total Credits = 21.50   No of Laboratory Courses = 3

CHAPTER 5

DETAIL OUTLINE OF UNDERGRADUATE COURSES

Level-1, Term-1

Chem 171: Basic Chemistry

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Chemistry is the molecular science. Chemists believe that the best understanding of the properties of matter comes from study at the molecular level. Chemistry provides the basic principles that govern the structure (and therefore the behavior and reactivity) of molecules.

Objective:

1. General familiarity with the following areas in chemistry: analytical, inorganic, organic and physical.
2. The basic analytical and technical skills to work al and technical skills to work effectively in the various fields of chemistry.
3. The ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.
4. The ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.
5. The ability to use information technology tools such as the Internet and computer-based literature searches as well as printed literature resources to locate and retrieve scientific information needed for laboratory or theoretical work.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Chemistry founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Chemistry demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development

4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Chemistry uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize reaction rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Atomic Structure: The structure of atom, Nuclear charge and atomic number, Rutherford's nuclear model of atom, Bohr's model, Quantum number, Electronic configuration of elements, Pauli's exclusion principle, Hund's rule.

Periodic Classification of Elements: Periodic Table, Modern Periodic law, Ionization potential, Electron affinity, Electro negativity, Position of hydrogen, Inert gases, Lanthanides and Actinides in the Periodic table, Properties of different types of elements in the light of electronic configuration.

Chemical Bonds: Electronic theory of valances, Different types of bonds, Ionic bonds, Covalent bonds, Co-ordination bonds, Metallic bonds and Hydrogen bonds, Hybridization, Hybridization of atomic orbital.

Acids and Bases: Arrhenius concept, Bronsted-Lowery concept, Lewis concept, dissociation constant, pH, buffer solution etc., Acid-base indicators.

Chemical Equilibrium and Kinetics: Chemical equilibrium and Equilibrium Constants, Law of mass-action, Units of equilibrium constants, Application of law of mass-action to Homogeneous and Heterogeneous Equilibrium, Le-Chotelier Principle, Determinations of Kp, Kc, Rate of reaction, Order and Molecular of reactions, Rate Equations for First, Second and Third order reactions, Chain reactions, Determination of order and rate constant of reaction, Collision theory of reaction rates, Theory of animalcular reactions.

Oxidation and Reduction Reactions: Definitions, Oxidation state and Oxidation number, Balancing of oxidation reduction equation, Equivalent weight of oxidizing and reducing agents.

Electrochemistry: Electrochemical cell, Electrode potential, Oxidation-reduction potential e.g. of cell, Reversible and Irreversible cell, Reversible electrodes, Application, Measurements, Concentration cell, Determination of activity and activity coefficient.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation

- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Chemistry on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Chemistry demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of chemicals and data management validated against national or international standards				√								
5.	Perform, analyze and optimize reaction rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Atomic Structure**: The structure of atom, Nuclear charge and atomic number, Rutherford's nuclear model of atom	
Lecture-2	Bohr's model	
Lecture-3	Quantum number	
Week-2		
Lecture-4	Electronic configuration of elements	
Lecture-5	Pauli's exclusion principle	
Lecture-6	Hund's rule.	
Week-3		
Lecture-7	**Periodic Classification of Elements**: Periodic Table, Modern Periodic law, Ionization potential, Electron affinity	
Lecture-8	Electro negativity	
Lecture-9	Position of hydrogen	
Week-4		
Lecture-10	Inert gases	
Lecture-11	Lanthanides and Actinides in the Periodic table	
Lecture-12	Properties of different types of elements in the light of electronic configuration	
Week-5		CT-2
Lecture-13	**Chemical Bonds**: Electronic theory of valances, Different types of bonds, Ionic bonds	
Lecture-14	Covalent bonds	
Lecture-15	Co-ordination bonds	
Week-6		
Lecture-16	Metallic bonds and Hydrogen bonds	
Lecture-17	Hybridization	
Lecture-18	Hybridization of atomic orbital	
Week-7		
Lecture-19	**Acids and Bases**: Arrhenius concept, Bronsted-Lowery concept, Lewis concept, dissociation constant	
Lecture-20	pH, buffer solution etc	
Lecture-21	Acid-base indicators	
Week-8		
Lecture-22	**Chemical Equilibrium and Kinetics**: Chemical equilibrium and Equilibrium Constants, Law of mass-action,	
Lecture-23	Units of equilibrium constants	
Lecture-24	Application of law of mass-action to Homogeneous and Heterogeneous Equilibrium	
Week-9		
Lecture-25	Application of law of mass-action to Homogeneous and	

	Heterogeneous Equilibrium	CT-3
Lecture-26	Le-Chotelier Principle	
Lecture-27	Determinations of Kp, Kc, Rate of reaction	
Week-10		
Lecture-28	Order and Molecular of reactions	
Lecture-29	Rate Equations for First, Second and Third order reactions,	
Lecture-30	Chain reactions	
Week-11		
Lecture-31	Determination of order and rate constant of reaction	
Lecture-32	Collision theory of reaction rates	
Lecture-33	Theory of animalcular reactions	
Week-12		
Lecture-34	**Oxidation and Reduction Reactions**: Definitions, Oxidation state and Oxidation number	
Lecture-35	Balancing of oxidation reduction equation	
Lecture-36	Equivalent weight of oxidizing and reducing agents	
Week-13		CT-4
Lecture-37	**Electrochemistry**: Electrochemical cell, Electrode potential,	
Lecture-38	Oxidation-reduction potential e.g. of cell, Reversible and	
Lecture-39	Irreversible cell	
Week-14		
Lecture-40	Reversible electrodes	
Lecture-41	Application, Measurements, Concentration cell	
Lecture-42	Determination of activity and activity coefficient.	

Text and Reference Books:

1. Basic Chemistry, Books a la Carte Edition by Karen C. Timberlake and William Timberlake
2. Understanding Basic Chemistry Through Problem Solving: The Learner's Approach by Jeanne Tan and Kim Seng Chan
3. Understand Basic Chemistry Concepts: The Periodic Table, Chemical Bonds,by Chris McMulen
4. Introductory Chemistry by Nivaldo J. Tro
5. Basic Chemistry Concepts and Exercises by John Kenkel

Hum 171: Fundamental English

2.00 Contact Hour; 2.00 Credit Hour

Pre-requisite: None

Rationale:

Through the study of English in Stage 6 students continue to develop their capacity to understand and use the English language for a variety of purposes and in various textual forms. Students engage with and explore a variety of texts that include widely acknowledged quality literature of past and contemporary societies. Through their responding and composing of both critical and creative texts, students develop an understanding of themselves and of diverse human experiences and cultures. The study of English in Stage 6 provides students with opportunities to experiment with ideas and expression, to become innovative, active, independent learners, to collaborate and to reflect on their learning.

Objective:

1. These objectives involve the four language skills (speaking, listening, reading, and writing), but they can also include: the language functions related to the topic of the lesson (e.g., justify, hypothesize) vocabulary essential to a student being able to fully participate in the lesson (e.g., axis, locate, graph)

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
2) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of data management validated against national or international standards

Course Contents:

Introduction: importance and mastering various approaches to learning English;

Phonetics: Phonetic system, correct English pronunciation; Grammar: Construction of sentences, grammatical problems, grammar and usages, precise writing;

Communication: approaches to communication, communication today, business communication;

Writing Methods: Business letter, tenders and quotations, resumes and job letters. Comprehension, Paragraph writing, Amplification;

Report Writing: Purpose of a report, classification of reports, organizing a report, writing short report, preparing complete analytical report, analysis and illustration of a report, problems in writing reports, journal articles, technical and scientific presentation,

Research study: definition and purpose, research methodology, data analysis, thesis presentation. Short stories written by some well-known classic writers.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
2.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Enhanced Oil and Gas Recovery uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Introduction:** importance and mastering various approaches to learning English	
Lecture-2	**Phonetics:** Phonetic system, correct English pronunciation; Grammar	
Week-2		
Lecture-3	Construction of sentences, grammatical problems	
Lecture-4	grammar and usages, precise writing	
Week-3		
Lecture-5	**Communication:** approaches to communication,	
Lecture-6	communication today	
Week-4		
Lecture-7	business communication	
Lecture-8	business communication	
Week-5		
Lecture-9	**Writing Methods:** Business letter, tenders and quotations,	
Lecture-10	resumes	
Week-6		
Lecture-11	job letters	CT-2
Lecture-12	Comprehension	
Week-7		
Lecture-13	Paragraph writing	
Lecture-14	Amplification	
Week-8		
Lecture-15	**Report Writing:** Purpose of a report, classification of reports	
Lecture-16	organizing a report	
Week-9		
Lecture-17	writing short report	
Lecture-18	preparing complete analytical report	
Week-10		
Lecture-19	analysis and illustration of a report	
Lecture-20	problems in writing reports	
Week-11		
Lecture-21	journal articles	
Lecture-22	technical and scientific presentation,	CT-3
Week-12		
Lecture-23	**Research study:** definition and purpose	
Lecture-24	research methodology	
Week-13		
Lecture-25	data analysis	
Lecture-26	data analysis	
Week-14		

Lecture-27	Thesis presentation	
Lecture-28	Short stories written by some well-known classic writers.	

Text and Reference Books:

1. Understanding and Using English Grammar by Betty Azar
2. Fundamental English by p.b. ballard

Math 171: Differential and Integral Calculus, Matrices

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The aim of the Differential and Integral Calculus, Matrices is that learners should be provided with a conceptual background which empowers them to make rational sense of elementary Differential and Integral Calculus, Matrices.

Objective:

1. To explain the characteristics of Differential Calculus and Integral Calculus, Matrices
2. To provide a physical interpretation of the Differential Calculus and Integral Calculus, Matrices
3. To apply Differential Calculus and Integral Calculus, Matrices in solving engineering problems
4. To use integral operations for simplification of complex problems

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Petroleum and Minerals Processing founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum and Minerals Processing demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum and Minerals Processing uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Petroleum and Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Differential Calculus: Limit, Continuity and differentiability, Differentiation, Successive differentiation, Leibnitz's theorem. Taylor's theorem. Indeterminate form, Partial derivatives Euler's theorem of homogeneous functions, Maxima and minima of functions of several variables, Tangent and normal, Curvature.

Integral Calculus: Various types of indefinite integral, Definite integral properties of definite integral, Beta and Gamma functions, Reduction and More reduction formula, Computation of area, Multiple integrals.

Matrix: Solution of system of linear equations, Rank and nullity of matrix, Eigenvalues and eigenvectors, Cayley-Hamilton theorem for inverse matrix.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Petroleum and Minerals Processing founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum and Minerals Processing demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice			√									

	skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development												
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum and Minerals Processing and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Petroleum and Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		
Lecture-1	**Differential Calculus :** Limit	
Lecture-2	Continuity and differentiability	
Lecture-3	Continuity and differentiability	
Week-2		
Lecture-4	Continuity and differentiability	
Lecture-5	Differentiation,	
Lecture-6	Successive differentiation	
Week-3		CT-1
Lecture-7	Leibnitz's theorem	
Lecture-8	Taylor's theorem	
Lecture-9	Indeterminate form	
Week-4		
Lecture-10	Partial derivatives	
Lecture-11	Euler's theorem of homogeneous functions,	
Lecture-12	Maxima and minima of functions of several variables	
Week-5		
Lecture-13	Tangent and normal	
Lecture-14	Curvature	
Lecture-15	**Integral Calculus :** Various types of indefinite integral,	CT-2
Week-6		
Lecture-16	Various types of indefinite integral	

Lecture-17	Various types of indefinite integral	
Lecture-18	Various types of indefinite integral	
Week-7		
Lecture-19	Definite integral properties of definite integral	
Lecture-20	Definite integral properties of definite integral	
Lecture-21	Definite integral properties of definite integral	
Week-8		
Lecture-22	Beta and Gamma functions	
Lecture-23	Beta and Gamma functions	
Lecture-24	Beta and Gamma functions	
Week-9		CT-3
Lecture-25	Reduction and More reduction formula	
Lecture-26	Reduction and More reduction formula	
Lecture-27	Computation of area	
Week-10		
Lecture-28	Multiple integrals	
Lecture-29	**Matrix:** Solution of system of linear equations,	
Lecture-30	Solution of system of linear equations	
Week-11		
Lecture-31	Rank and nullity of matrix	
Lecture-32	Rank and nullity of matrix	
Lecture-33	Rank and nullity of matrix	
Week-12		
Lecture-34	Eigenvalues and eigenvectors	
Lecture-35	Eigenvalues and eigenvectors	
Lecture-36	Eigenvalues and eigenvectors	
Week-13		CT-4
Lecture-37	Cayley-Hamilton theorem for inverse matrix	
Lecture-38	Cayley-Hamilton theorem for inverse matrix	
Lecture-39	Cayley-Hamilton theorem for inverse matrix	
Week-14		
Lecture-40	Cayley-Hamilton theorem for inverse matrix	
Lecture-41	Cayley-Hamilton theorem for inverse matrix	
Lecture-42	Cayley-Hamilton theorem for inverse matrix	

Text and Reference Books:

1. Calculus, by Haward Anton, Stephen Davis
2. Differential and Integral Calculus by Matin Chakraborty
3. A Text Book on Integral Calculus, Mohammad, Bhattacharjee & Latif
4. Differential and Integral Calculus, Das and Mukherjee.
5. Matrices, Frand Ayres, JR.
6. Matrices and Linear Transformations, Mohammad Iman Ali.

PME 111: Geology for Petroleum and Mining Engineers

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The course is one of several core courses that build an essential basic working knowledge of geological skills. The course provides the tools necessary for advancement into courses/fields including facies analysis and sequence stratigraphy, petroleum geology, hydrogeology, geological mapping, and research projects.

Objective:

1. Make inferences about Earth systems from observations of the natural world
2. Readily solve problems, especially those requiring spatial and temporal interpretation
3. Work with uncertainty, non-uniqueness, incompleteness, ambiguity, and indirect observations
4. Integrate information from different disciplines and apply systems thinking
5. Have strong field skills
6. Have strong computational skills for managing and analyzing multi-component datasets
7. Be able to collect, illustrate, and analyze spatial data

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Geology founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Geology demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Geological uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize geomodel by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Introduction: Introduction to geology, and petroleum and mining geology; Classification of geology; Petroleum system; Source of petroleum; Petroleum formation.

Regional Geology: Structure of earth, Plate tectonic theory and plate boundaries; Geologic time; Faults and Anticlines; Overview of geologic features on a regional to global scale incorporating data and concepts from plate tectonics, Stratigraphy, Palaeontology; Igneous, Metamorphic and sedimentary petrology. Synthesis of the geologic history of a large area.

Rocks: Classification of rock; Igneous rock; Sedimentary rock; Clastic sedimentary rocks, Conglomerate, Shale, Clays, Bentonite, Chemical sedimentary rocks, Organic sedimentary; Metamorphic rock; Rock cycle; Kerogen types and their significance; Maturity indicators; Reservoir Rocks; Traps; Seals; Trap types. Sedimentary geology of reservoir rocks; Salt domes.

Mineral Deposit: Origin of minerals, Classifications, Physical and chemical properties of minerals; Mode of occurrence, Distribution, Genesis, Evaluation and exploration for metallic and industrial mineral deposits.

Surface Processes: Erosion, Running and underground water, Transportation, Deposition. Geological work of wind, running water, subsurface water, oceans and seas etc.; Earthquakes; River flooding; Coastal hazards; Mineral resources and environment; Energy and environment.

Exploration Methods: Subsurface geological cross sections and maps; Seismology and seismic surveying; Gravity and magnetic surveying; Origin, composition and distribution of coal deposits. Methods of coal exploration.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Geology founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Geology demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Geological and data management validated against national or international standards				√								
5.	Perform, analyze and optimize geomodels by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Introduction:** Introduction to geology, and petroleum and mining geology; Classification of geology	
Lecture-2	Petroleum system; Source of petroleum	
Lecture-3	Petroleum formation	
Week-2		
Lecture-4	**Regional Geology:** Structure of earth Plate tectonic theory and plate boundaries	
Lecture-5	Geologic time	
Lecture-6	Faults and Anticlines	
Week-3		
Lecture-7	Overview of geologic features on a regional to global scale incorporating data	
Lecture-8	concepts from plate tectonics	
Lecture-9	Stratigraphy	
Week-4		
Lecture-10	Palaeontology; Igneous	
Lecture-11	Metamorphic and sedimentary petrology	
Lecture-12	Synthesis of the geologic history of a large area	
Week-5		CT-2
Lecture-13	**Rocks:** Classification of rock; Igneous rock; Sedimentary rock; Clastic sedimentary rocks, Conglomerate, Shale, Clays, Bentonite	
Lecture-14	Chemical sedimentary rocks	
Lecture-15	Organic sedimentary	
Week-6		
Lecture-16	Metamorphic rock; Rock cycle	
Lecture-17	Kerogen types and their significance	
Lecture-18	Maturity indicators	
Week-7		
Lecture-19	Reservoir Rocks	
Lecture-20	Traps	
Lecture-21	Seals	
Week-8		
Lecture-22	Trap types	
Lecture-23	Sedimentary geology of reservoir rocks	
Lecture-24	Salt domes	
Week-9		CT-3
Lecture-25	**Mineral Deposit:** Origin of minerals, Classifications	
Lecture-26	Physical and chemical properties of minerals	
Lecture-27	Mode of occurrence	
Week-10		
Lecture-28	Distribution	
Lecture-29	Genesis	
Lecture-30	Evaluation and exploration for metallic and industrial mineral	

	deposits	
Week-11		
Lecture-31	**Surface Processes:** Erosion, Running and underground water, Transportation, Deposition.	
Lecture-32	Geological work of wind, running water, subsurface water, oceans and seas etc.; Earthquakes	
Lecture-33	River flooding	
Week-12		
Lecture-34	Coastal hazards	
Lecture-35	Mineral resources and environment	
Lecture-36	Energy and environment	
Week-13		CT-4
Lecture-37	**Exploration Methods:** Subsurface geological cross sections and	
Lecture-38	maps	
Lecture-39	Seismology and seismic surveying	
Week-14		
Lecture-40	Gravity and magnetic surveying	
Lecture-41	Origin, composition and distribution of coal deposits	
Lecture-42	Methods of coal exploration	

Text and Reference Books:

1. Earth An Introduction to Physical Geology by EDWARD J. TARBUCK FREDERICK K. LUTGENS
2. Physical Geology by Leet, L.D. et. al.
3. Basic Petroleum Geology by Peter K. Link
4. Energy Resources of Bangladesh by Dr. Badrul Imam

PME 113: Introduction to Petroleum and Mining Engineering

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The aim of the course is to provide students with a broad overview of introduction to petroleum and mining engineering in order that advanced courses in subsequent years can be understood within broader petroleum and mining engineering context. It also provides an introduction to decision-making and the petroleum and mining business environment.

Objective:

1. Be competent to handle complex petroleum and mining engineering tasks requiring multifaceted skills.
2. Be recognized for their ability to pursue innovative solutions through creative integration of best practices.
3. Demonstrate career advancement and exhibit the habits and personal attributes to handle management and leadership roles.
4. Exhibit commitment to the wellbeing of the community and the environment in pursuant of relevant solutions.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Petroleum and Mining Engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum and Mining Engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum and Mining Engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Petroleum Exploration: Introduction to petroleum system; History of petroleum; Gravimetric survey; Magnetic survey; Seismic Survey; Exploration well drilling.

Drilling Engineering: Wellbore configuration; Types of wells; Onshore and Offshore Drilling Rig and its components; Classification of Drilling Rigs; Drilling Rig Specification; Power system; Hoisting system; Rotary system; Drill Bit; Drilling Fluid Circulating system; The principal components in mud preparation, injection, cleaning & treatment system.

Reservoir Engineering: Introduction to different types of petroleum reservoir; Reservoir fluid properties; Reservoir rock properties; Fundamentals of reservoir fluid flow.

Production Engineering: Introduction to petroleum production system**;** Overview of surface and subsurface equipment, tools, devices, hardware; Properties of produced fluids.

Mining Engineering: Roles and responsibility of mining engineers. Basic understanding of underground and open-pit mining methods. Interaction of mining with the environment. Basic of mine ventilation, explosives, blasting etc. Safety and risk management of the mine.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Petroleum and Mining Engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											

2.	Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum and Mining Engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum and Mining Engineering uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		CT-1
Lecture-1	**Petroleum Exploration:** Introduction to petroleum system; History of petroleum	
Lecture-2	Gravimetric survey; Magnetic survey; Seismic Survey	
Lecture-3	Exploration well drilling	
Week-2		
Lecture-4	**Drilling Engineering:** Wellbore configuration; Types of wells	
Lecture-5	Onshore and Offshore Drilling Rig and its components	
Lecture-6	Classification of Drilling Rigs	
Week-3		
Lecture-7	Drilling Rig Specification; Power system	
Lecture-8	Hoisting system; Rotary system	
Lecture-9	Drill Bit	
Week-4		
Lecture-10	Circulating system	

Lecture-11	Drilling Fluid	
Lecture-12	The principal components in mud preparation, injection, cleaning & treatment system.	
Week-5		CT-2
Lecture-13	**Reservoir Engineering:** Introduction to different types of petroleum reservoir	
Lecture-14	Reservoir fluid properties	
Lecture-15	Reservoir fluid properties	
Week-6		
Lecture-16	Reservoir rock properties	
Lecture-17	Reservoir rock properties	
Lecture-18	Fundamentals of reservoir fluid flow	
Week-7		
Lecture-19	**Production Engineering:** Introduction to petroleum production system	
Lecture-20	Overview of surface and subsurface equipment, tools, devices, hardware	
Lecture-21	Properties of produced fluids	
Week-8		
Lecture-22	**Mining Engineering:** Roles and responsibility of mining engineers.	
Lecture-23	Basic understanding of underground and open-pit mining methods.	
Lecture-24	Basic understanding of underground and open-pit mining methods.	
Week-9		CT-3
Lecture-25	Basic understanding of underground and open-pit mining methods.	
Lecture-26	Basic understanding of underground and open-pit mining methods.	
Lecture-27	Basic understanding of underground and open-pit mining methods.	
Week-10		
Lecture-28	Basic understanding of underground and open-pit mining methods.	
Lecture-29	Basic understanding of underground and open-pit mining methods.	
Lecture-30	Basic understanding of underground and open-pit mining methods.	
Week-11		
Lecture-31	Interaction of mining with the environment	
Lecture-32	Interaction of mining with the environment	
Lecture-33	Interaction of mining with the environment	
Week-12		
Lecture-34	Interaction of mining with the environment	
Lecture-35	Basic of mine ventilation, explosives, blasting etc.	
Lecture-36	Basic of mine ventilation, explosives, blasting etc.	
Week-13		CT-4
Lecture-37	Basic of mine ventilation, explosives, blasting etc.	
Lecture-38	Basic of mine ventilation, explosives, blasting etc.	
Lecture-39	Basic of mine ventilation, explosives, blasting etc.	
Week-14		
Lecture-40	Safety and risk management of the mine.	
Lecture-41	Safety and risk management of the mine.	
Lecture-42	Safety and risk management of the mine.	

Text and Reference Books:

1. Introductory Mining Engineering by H. L. Hartman
2. Applied Drilling Engineering by A.T. Bourgoyne Jr, K.K. Millheim, M.E. Chenevert & F.S. Young Jr
3. Elements of Mining by R. S. Lewis and Clark
4. Drilling Fluids Tom S. Carter by SME Mining Engineering Handbook SME

ME 178: Engineering Drawing and CAD

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

An engineering drawing, a type of technical drawing, is used to fully and clearly define objects. This is the biggest reason why the conventions of engineering drawing have evolved over the decades toward a very precise, unambiguous state. Since the advent of computer-aided design (CAD), engineering drawing has been advanced so far.

Objective:

1. Learn sketching and taking field dimensions.
2. Take data and transform it into graphic drawings.
3. Learn basic engineering drawing formats.
4. Learn basic CAD skills.
5. Learn who draw 2D and 3D drawings in CAD.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Engineering Drawing and CAD founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Engineering Drawing and CAD demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Engineering Drawing and CAD data management validated against national or international standards
5) Perform, analyze and optimize design by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Fundamental Concepts: Views; Projections: First angle, Third angle; Generation of views of solid bodies in different planes, Sectional views, Auxiliary views, Isometric views, Dimensioning, Basic concept of working drawing.

AutoCAD: Importance to design and drafting, Setting up a drawing: starting AutoCAD, menu, planning for a drawing, basic commands, making a simple 2-D drawing, layers, object snap, poly lines and other features, file handling and display control, editing and dimensioning.

Computer Aided Design: Introduction to computer usage; introduction to CAD packages and computer aided drafting: drawing editing and dimensioning of simple objects; plan, elevations and sections of multi-storied buildings; reinforcement details of beams, slabs, stairs etc; plan and section of septic tank; detailed drawings of roof trusses; plans, elevations and sections of culverts, bridges and other hydraulic structures; drawings of building services.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Engineering Drawing and CAD founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Engineering Drawing and CAD demonstrated through appropriate and relevant assessment		√										

3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Engineering Drawing and CAD data management validated against national or international standards				√								
5.	Perform, analyze and optimize design by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Experiments
Week-1	Views; Projections: First angle, Third angle
Week-2	Generation of views of solid bodies in different planes
Week-3	Sectional views, Auxiliary views
Week-4	Isometric views
Week-5	Dimensioning
Week-6	Basic concept of working drawing.
Week-7	Quiz
Week-8	**AutoCAD**: Importance to design and drafting, Setting up a drawing: starting AutoCAD, menu, planning for a drawing, basic commands
Week-9	Making a simple 2-D drawing, layers, object snap, poly lines and other features
Week-10	File handling and display control, editing and dimensioning.
Week-11	**Computer Aided Design**: Introduction to computer usage; introduction to CAD packages and computer aided drafting
Week-12	drawing editing and dimensioning of simple objects; plan, elevations and sections of multi-storied buildings; reinforcement details of beams, slabs, stairs etc
Week-13	Plan and section of septic tank; detailed drawings of roof trusses; plans, elevations and sections of culverts, bridges and other hydraulic structures; drawings of building services
Week-14	Quiz

Text and Reference Books:

1. Engineering Drawing and Design by David Madsen
2. Manual of Engineering Drawing: Technical Product Specification and Documentation to British and International Standards by Colin H. Simmons and Dennis E. Maguir
3. Technical Drawing 101 with AutoCAD 2016 by Antonio Ramirez, Ashleigh Fuller, and Douglas Smith
4. Fundamentals of Modern Drafting by Paul Ross Wallach

ME 176: Workshop Practice

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Workshop is a place where students acquire knowledge on the operation of various processes involved in manufacturing and production. The workshop practical courses make students competent in handling practical work in engineering environment.

Objective:

1. To know about Foundry Shop: Study of Foundry Shop: Patterns, Molds, Cores.
2. To create molding by using molding sand.
3. To analyze metal melting and Casting inspection of casting and casting defects.
4. To know about Electric arc welding and analyze the procedure of arc welding.
5. To know about Gas welding and analyze the procedure of Gas welding.
6. To know about Metal Inert Gas (MIG) welding and Tungsten Inert Gas (TIG) welding and analyze the procedure of these both.
7. Impart knowledge to students in the latest technological topics on Production and Industrial Engineering and to provide them with opportunities in taking up advanced topics in the field of study.
8. Create a congenial environment that promotes learning, growth and imparts ability to work with multi-disciplinary groups in professional, industry and research organizations.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Workshop Practice founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Workshop Practice demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Workshop Practice uncertainty and data management validated against national or international standards

Course Contents:

Sheet Metal: Shop safety practice, Identification of different types of sheets/plates, e.g. CI, GI, MS, GP sheet etc. with commercial specification. Acquaintance with sheet metal working tools, machines and measuring instruments. Practice jobs on sheet metal (development of cones, bends, ducts etc.,

Machine and Fitting Shop: Shop safety practices, Acquaintance with tools used in fitting shop, e.g. Marking, Holding, Chiseling, Filing, Sawing etc. Tools, Practical jobs on the use of tools, Use of taps and dies. Acquaintance with different cutting tools and machine tools, Operation and maintenance of different machine tools, Practical jobs on: plain and taper turning, thread cutting, doing jobs by using shaper, milling, drilling and grinding machines.

Welding: Shop safety practice, Acquaintance with arc and gas welding tools, machines, electrodes, gas cylinders, their identification, types of gas flames, job preparation for welding. Practice on gas, arc welding and gas cutting of MS sheets and plates, soldering and brazing practices, study of welding defects.

Foundry: Shop safety practice, Acquaintance with foundry tools and equipments, introduction on foundry: molding, casting, pattern, core, bench, practice on simple bench or floor molding with solid and split pattern in green sand with and without cores, preparation of molding sand and core, preparation of mold, casting, study of defects in casting.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Workshop Practice founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Workshop Practice demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Workshop Practice uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Experiments
Week-1	Development of cones by metal sheets
Week-2	Development of bends by metal sheets
Week-3	Development of ducts by metal sheets
Week-4	Practical jobs on plain turning by using shaper machines
Week-5	Practical jobs on taper turning by using shaper machines
Week-6	Practical jobs on thread cutting by using shaper, milling, drilling and grinding machines
Week-7	Quiz
Week-8	Practice on arc welding of MS sheets and plates, soldering and brazing practices
Week-9	Practice on gas welding and gas cutting of MS sheets and plates
Week-10	Study of welding defects
Week-11	Preparation of molding sand and core, preparation of mold, casting, study of defects in casting.

Week-12	Preparation of molding sand and core, preparation of mold, casting, study of defects in casting
Week-13	Preparation of molding sand and core, preparation of mold, casting, study of defects in casting
Week-14	Quiz

Text and Reference Books:

1. Machine Shop Practice – James Anderson; W. A. Chapman.
2. Shop Theory –Anderson & Tatro.

PME 112: Geology Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

The course is one of several core courses that build an essential basic working knowledge of geological skills. The course provides the tools necessary for advancement into courses/fields including facies analysis and sequence stratigraphy, petroleum geology, hydrogeology, geological mapping, and research projects.

Objective:

1. Make inferences about Earth systems from observations of the natural world
2. Readily solve problems, especially those requiring spatial and temporal interpretation
3. Work with uncertainty, non-uniqueness, incompleteness, ambiguity, and indirect observations
4. Integrate information from different disciplines and apply systems thinking
5. Have strong field skills
6. Have strong computational skills for managing and analyzing multi-component datasets
7. Be able to collect, illustrate, and analyze spatial data

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Geology founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Geology demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Geological uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize geomodels by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

1. Hand-specimen study of common igneous, sedimentary and metamorphic rocks
2. Preparation of microscope slide of rock sample
3. Identification of pore space and grain by microscope in a rock sample
4. Identification of minerals by microscope in a rock sample
5. Study the petroleum reservoir rock by scanning electron microscope (SEM) to provide qualitative information about pore geometry, locating and identifying of minerals, particularly clay minerals.
6. Determination of total organic content (TOC) in rock sample for petroleum exploration
7. Study surface geological mapping and map projection, geological map scale and their computation
8. Study subsurface geological mapping, structure contour map, isopach map, facies map
9. Analysis of geological structure, fold, fault, joint, unconformity
10. Build simple and complex earth models, perform volume calculations, plot accurate maps
11. Analysis of regional geology, sequence stratigraphy, tectono stratigraphic history and associated resource potential.
12. Systematic study of stratigraphy, structure, lithology and sedimentology of the exposed rock in a suitable area (Field Work)

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Geology founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Geology demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Geological and data management validated against national or international standards				√								
5.	Perform, analyze and optimize geomodel by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Experiments
Week-1	Hand-specimen study of common igneous, sedimentary and metamorphic rocks
Week-2	Preparation of microscope slide of rock sample
Week-3	Identification of pore space and grain by microscope in a rock sample
Week-4	Identification of minerals by microscope in a rock sample
Week-5	Study the petroleum reservoir rock by scanning electron microscope (SEM) to provide qualitative information about pore geometry, locating and identifying of minerals, particularly clay minerals
Week-6	Determination of total organic content (TOC) in rock sample for petroleum exploration

Week-7	Quiz
Week-8	Study surface geological mapping and map projection, geological map scale and their computation
Week-9	Study subsurface geological mapping, structure contour map, isopach map, facies map
Week-10	Analysis of geological structure, fold, fault, joint, unconformity
Week-11	Build simple and complex earth models, perform volume calculations, plot accurate maps
Week-12	Analysis of regional geology, sequence stratigraphy, tectonostratigraphic history and associated resource potential
Week-13	Systematic study of stratigraphy, structure, lithology and sedimentology of the exposed rock in a suitable area (Field Work)
Week-14	Quiz

Text and Reference Books:

1. Earth An Introduction to Physical Geology by EDWARD J. TARBUCK FREDERICK K. LUTGENS
2. Physical Geology by Leet, L.D. et. al.
3. Basic Petroleum Geology by Peter K. Link
4. Energy Resources of Bangladesh by Dr. Badrul Imam

Hum 172: Developing English Language Skills

2.00 Contact Hour; 1.00 Credit Hour

Pre-requisite: None

Rationale:

Through the study of English in Stage 6 students continue to develop their capacity to understand and use the English language for a variety of purposes and in various textual forms. Students engage with and explore a variety of texts that include widely acknowledged quality literature of past and contemporary societies. Through their responding and composing of both critical and creative texts, students develop an understanding of themselves and of diverse human experiences and cultures. The study of English in Stage 6 provides students with opportunities to experiment with ideas and expression, to become innovative, active, independent learners, to collaborate and to reflect on their learning.

Objective:

1. These objectives involve the four language skills (speaking, listening, reading, and writing), but they can also include: the language functions related to the topic of the lesson (e.g., justify, hypothesize) vocabulary essential to a student being able to fully participate in the lesson (e.g., axis, locate, graph)

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
2) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of data management validated against national or international standards

Course Contents:

Reading skill: skimming, scanning, predicting, inferring; analysis and interpretation of texts; comprehension from literary and non-literary texts.

Writing skill: product approach, process approach: brain storming, self-evaluation, peer evaluation, revision/rewriting, teacher’s evaluation; techniques of writing: comparison and contrast, problem and solution, cause and effect, classification, illustration; writing paragraph, essay and report.

Listening skill: listening to recorded texts; learning to take useful notes and answering questions.

Speaking skill: dialogue in peer work; participation in discussion and debate; extempore speech; narrating events; story telling; presentation.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Written Assignment	15
Oral Performance	25
Listening Skill	10
Group Presentation	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
2.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Enhanced Oil and Gas Recovery uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Experiments
Week-1	**Reading skill**: skimming, scanning
Week-2	predicting, inferring
Week-3	Analysis and interpretation of texts
Week-4	comprehension from literary and non-literary texts
Week-5	**Writing skill**: product approach, process approach: brain storming, self-evaluation, peer evaluation, revision/rewriting, teacher's evaluation
Week-6	techniques of writing: comparison and contrast, problem and solution
Week-7	, cause and effect, classification, illustration
Week-8	writing paragraph, essay and report
Week-9	**Listening skill**: listening to recorded texts
Week-10	learning to take useful notes
Week-11	Answering questions
Week-12	**Speaking skill**: dialogue in peer work; participation in discussion and debate; extempore speech; narrating events
Week-13	story telling
Week-14	presentation

Text and Reference Books:

1. Understanding and Using English Grammar by Betty Azar
2. Fundamental English by p.b. ballard

Level-1, Term-2

Chem 173: Petroleum Chemistry

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

This course introduces candidates to organic chemistry as practiced in the petrochemical industries. In addition it covers general discussions on fossil fuels, gas and petroleum exploratory, petroleum refining and up-grading processes and industrial chemical conversion of primary petrochemicals to chemicals and products that dominate our everyday life. The mechanism of some industrial chemical processes will also be covered

Objective:

1. Present petroleum as a source of energy and industrial organic raw materials
2. Improve our knowledge of oil and gas industry: extraction and refinery operations; up-grading and conversion processes
3. Present molecular composition of crude petroleum as the chemical basis of refinery operations
4. Expose students to quality control protocols associated with the oil industry
5. Explain the processes by which fuel oil, diesel oil, lub oil, and asphalt are stripped from crude petroleum
6. Connect class room organic chemistry with industrial organic chemistry by showing how primary petrochemicals are converted to selected products that dominate our daily life.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Petroleum Chemistry founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum Chemistry demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum Chemistry uncertainty and data management validated against national or international standards

5) Perform, analyze and optimize oil and gas processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Aliphatic Compounds: Alkanes, Alkenes, Alkynes, Aliphatic halides, Alcohols, Thioalcohols, Ether and epoxides, Carbonyl compounds, Carboxylic acid and their derivatives, Amines, Amides and keto acids.

Alicyclic Compounds: Nomenclature, Preparation, Properties, Stability, Conformations of cyclohexanes and its derivatives, Factors affection the stability of conformations, Conformations of ethane, propane, n-butane cyclohexane and their derivatives.

Aromatic Compounds: Introduction, Nomenclature and classification of aromatic compounds, Source of aromatic compounds, Structure of benzene, Aromatic electrophilic and nucleophilic substitution, Reaction, Orientation in aromatic disubstitution; General chemistry of aromatic halides, sulphuric acids, amines amides and nitro compounds; Phenols and carboxylic and carbonyl compounds and Polynuclear aromatic compounds.

Petroleum: Origin, Occurrence, Composition and classification of crude petroleum, Exploration and production theory and technology of primary and secondary petroleum refining process and distillation of crude oil; Products from petroleum distillations, their characterization and uses, Cracking of petroleum, Gasoline, Diesel, Kerosene, Antiknock motor fuels, Aviation fuel, Lubricating fuel. Octane number and octane number of liquid fuels, Production of high octane fuel by alkylation’s Chemical treatment given to petroleum products, Purification of petroleum products, additives for petroleum fraction, Petroleum wax and petroleum coke, their manufacture and uses.

Clay chemistry: Structure of Montmorillonite; Interaction between clay particles

Polymer chemistry: Fundamental structure of polymers; Classification of polymers; Mechanisms of selected organic, bio-organic, polymerization and catalytic reactions.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Petroleum Chemistry founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum Chemistry demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of oil and gas processing and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil and gas rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Aliphatic Compounds**: Alkanes, Alkenes	
Lecture-2	Alkynes, Aliphatic halides, Alcohols, Thioalcohols	
Lecture-3	Ether and epoxides	
Week-2		
Lecture-4	Carbonyl compounds	
Lecture-5	Carboxylic acid and their derivatives	
Lecture-6	Amines, Amides and keto acids	
Week-3		
Lecture-7	**Aromatic Compounds**: Introduction, Nomenclature and classification of aromatic compounds	
Lecture-8	Source of aromatic compounds, Structure of benzene	
Lecture-9	Aromatic electrophilic and nucleophilic substitution, Reaction	
Week-4		
Lecture-10	Orientation in aromatic disubstitution	
Lecture-11	General chemistry of aromatic halides, sulphuric acids, amines amides and nitro compounds	
Lecture-12	Phenols and carboxylic and carbonyl compounds and Polynuclear aromatic compounds	
Week-5		CT-2
Lecture-13	**Alicyclic Compounds**: Nomenclature, Preparation	
Lecture-14	Properties, Stability	
Lecture-15	Conformations of cyclohexanes and its derivatives	
Week-6		
Lecture-16	Factors affection the stability of conformations	
Lecture-17	Conformations of ethane, propane	
Lecture-18	n-butane cyclohexane and their derivatives	
Week-7		
Lecture-19	**Petroleum**: Origin, Occurrence	
Lecture-20	Composition and classification of crude petroleum	
Lecture-21	Composition and classification of crude petroleum	
Week-8		
Lecture-22	Exploration and production theory and technology of primary and secondary petroleum refining process and distillation of crude oil	
Lecture-23	Exploration and production theory and technology of primary and secondary petroleum refining process and distillation of crude oil	
Lecture-24	Exploration and production theory and technology of primary and secondary petroleum refining process and distillation of crude oil	
Week-9		CT-3
Lecture-25	Products from petroleum distillations, their characterization and uses	
Lecture-26	Products from petroleum distillations, their characterization and	

	uses	
Lecture-27	Products from petroleum distillations, their characterization and uses	
Week-10		
Lecture-28	Cracking of petroleum	
Lecture-29	Gasoline, Diesel, Kerosene	
Lecture-30	Antiknock motor fuels, Aviation fuel, Lubricating fuel	
Week-11		
Lecture-31	Octane number and octane number of liquid fuels	
Lecture-32	Production of high octane fuel by alkylation's	
Lecture-33	Chemical treatment given to petroleum products	
Week-12		
Lecture-34	Purification of petroleum products	
Lecture-35	Additives for petroleum fraction	
Lecture-36	Petroleum wax and petroleum coke, their manufacture and uses	
Week-13		CT-4
Lecture-37	**Clay chemistry:** Structure of Montmorillonite	
Lecture-38	Interaction between clay particles	
Lecture-39	Interaction between clay particles	
Week-14		
Lecture-40	**Polymer chemistry:** Fundamental structure of polymers; Classification of polymers	
Lecture-41	Mechanisms of selected organic, bio-organic	
Lecture-42	polymerization and catalytic reactions	

Text and Reference Books:

1. Petroleum Chemistry and Refining by James G. Speight
2. Industrial Organic chemistry by Klaus Weissermel

Hum 173: Economics and Accounting

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Economics is the cornerstone subject in any financial, commerce or business related study. All businesses operate within an economic environment. Accounting enables students to develop the knowledge and skills to manage the financial affairs of individuals, communities, and businesses.

Objective:

1. To give the students the tools to make real life financial decisions in a constantly changing and uncertain world
2. To give the students the tools of process of preparing and communicating financial information to a wide range of users
3. To enhance financial literacy
4. To help individuals and organizations to be accountable to stakeholders for their actions

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Economics and Accounting founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Economics and Accounting demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Economics and Accounting uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Economics conditions by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Basic: Definition and scope of economics, Market economy and mixed economy, Demand and supply and their elasticity, Market equilibrium. Consumer behavior and producer behavior, Cost and revenue theory. Price theory under different marker structure. GNP, GDP, Investment, Inflation, Unemployment, Monetary policy and Fiscal policy. Development problems related to agriculture, industry and population of Bangladesh.

Resource Economics: Introduction, A resource taxonomy, Efficient inter-temporal allocations, The allocation over N periods, Transition to a renewable substitution, Exploration and technological progress, Market allocations, Appropriate property rights structures, Environmental costs.

Energy: Introduction, Natural Gas: Price control; Oil: The Cartel problem; Price elasticity of demand, Income elasticity of demand, Non OPEC suppliers-Compatibility of member interests, Fuels: Environmental problems, Conversion and load management, The long run issues.

Accounting:

Financial accounting: objectives and importance of accounting; accounting as an information system; basic accounting principles; accounting equation; recording system; accounting cycle; journal, ledger, trial balance; preparation of financial statements considering adjusting entries; financial statement analysis and interpretation.

Cost accounting: cost concepts and classification; cost-volume-profit analysis; contribution margin approach and its application, break-even analysis, target profit analysis, operating leverage; absorption costing vs variable costing; job order costing; capital budgeting; long run planning and control.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Economics and Accounting founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Economics and Accounting demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Economics and Accounting uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize economic conditions by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Basic**: Definition and scope of economics, Market economy and mixed economy, Demand and supply and their elasticity	
Lecture-2	Market equilibrium	
Lecture-3	. Consumer behavior and producer behavior	
Week-2		
Lecture-4	Cost and revenue theory	
Lecture-5	Price theory under different marker structure. GNP, GDP	
Lecture-6	Investment, Inflation, Unemployment	
Week-3		
Lecture-7	Monetary policy and Fiscal policy	
Lecture-8	Development problems related to agriculture	
Lecture-9	Industry and population of Bangladesh	
Week-4		
Lecture-10	**Resource Economics**: Introduction, A resource taxonomy, Efficient inter-temporal allocations, The allocation over N periods	
Lecture-11	Transition to a renewable substitution	
Lecture-12	Exploration and technological progress	
Week-5		CT-2
Lecture-13	Market allocations	
Lecture-14	Appropriate property rights structures	
Lecture-15	Environmental costs	
Week-6		
Lecture-16	**Energy**: Introduction, Natural Gas: Price control; Oil: The Cartel problem	
Lecture-17	Price elasticity of demand, Income elasticity of demand	
Lecture-18	Non OPEC suppliers-Compatibility of member interests, Fuels	
Week-7		
Lecture-19	Environmental problems	
Lecture-20	Conversion and load management	
Lecture-21	The long run issues	
Week-8		
Lecture-22	Financial accounting: objectives and importance of accounting; accounting as an information system; basic accounting principles	
Lecture-23	accounting equation	
Lecture-24	recording system; accounting cycle	
Week-9		CT-3
Lecture-25	journal, ledger, trial balance	
Lecture-26	journal, ledger, trial balance	
Lecture-27	Preparation of financial statements considering adjusting entries	
Week-10		
Lecture-28	preparation of financial statements considering adjusting entries	
Lecture-29	financial statement analysis and interpretation	

Lecture-30	financial statement analysis and interpretation	
Week-11		
Lecture-31	Cost accounting: cost concepts and classification	
Lecture-32	Cost-volume-profit analysis	
Lecture-33	Contribution margin approach and its application	
Week-12		
Lecture-34	Contribution margin approach and its application	
Lecture-35	Contribution margin approach and its application	
Lecture-36	Break-even analysis	
Week-13		CT-4
Lecture-37	Target profit analysis	
Lecture-38	Operating leverage	
Lecture-39	Absorption costing vs variable costing	
Week-14		
Lecture-40	Job order costing	
Lecture-41	Capital budgeting	
Lecture-42	Long run planning and control	

Text and Reference Books:

1. The General Theory of Employment, Interest and Money by John Maynard Keynes
2. Economics by Paul Samuelson and William Nordhaus
3. Oil & Gas Accounting by Steven M. Bragg
4. The Accounting Procedures Guidebook by Steven M. Bragg

Math 173: Vector Analysis, Geometry and Engineering Statistics

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The aim of the Vector Analysis, Geometry and Engineering Statistics is that learners should be provided with a conceptual background which empowers them to make rational sense of elementary Vector Analysis, Geometry and Engineering Statistics.

Objective:

1. To explain the characteristics of Vector Analysis, Geometry and Engineering Statistics
2. To provide a physical interpretation of the Vector Analysis, Geometry and Engineering Statistics
3. To apply Vector Analysis, Geometry and Engineering Statistics in solving engineering problems
4. To use integral operations for simplification of complex problems

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Vector Analysis, Geometry and Engineering Statistics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Vector Analysis, Geometry and Engineering Statistics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Vector Analysis, Geometry and Engineering Statistics uncertainty and data management validated against national or international standards

Course Contents:

Section-A

Vector: Scalar and vector fields, gradient of a scalar field, divergence and curl of a vector field, Vector differentiation, Line, Surface and Volume integrals, Green's theorem (for a plane), stokes theorem, Gauss's theorem of divergence.

Geometry (3D): Rectangular co-ordinates: Distance between two points, Direction cosines, Direction ratios, Angle between two lines. The plane - angle between two planes, Condition for perpendicularity and parallelism of two planes. The Straight line.

<u>Section-B</u>

<u>Statistics</u>

Correlation: Scatter diagrams, Correlation co-efficient, Rank correlation, Correlation ratio, Theorems on correlations.

Regression Analysis: Linear regression, Equation of the line of regression, Regression co-efficient, Curve fitting, Method of least square.

Probability: Mathematical and statistical definitions, Additive and multiplicative rule of probability, Conditional probability, Baye's theorem.

Random Variables: Discrete and continuous random variables, Probability mass function, Probability density function, Cumulative distribution functions, Mathematical expectation.

Discrete Probability Distribution: Binomial distribution, Negative binomial distribution, Geometric distribution, Poisson's distribution.

Continuous Probability Distribution: Normal distribution, Exponential distribution, Chi-square distribution, t and F- distributions.

Sampling Distribution: Population, Sample mean, Sample variance, Central limit theorem, Sampling distribution from a normal population.

Test of Hypothesis: Statistical hypothesis, Level of significance, Type I and Type II error, One tailed and two tailed tests, Tests for proportions.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Vector Analysis, Geometry and Engineering Statistics founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Vector Analysis, Geometry and Engineering Statistics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Vector Analysis, Geometry and Engineering Statistics uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		CT-1
Lecture-1	**Vector:** Scalar and vector fields, gradient of a scalar field	
Lecture-2	divergence and curl of a vector field	
Lecture-3	divergence and curl of a vector field	
Week-2		
Lecture-4	Vector differentiation, Line	
Lecture-5	Surface and Volume integrals, Green's theorem (for a plane), stokes theorem	
Lecture-6	Surface and Volume integrals, Green's theorem (for a plane), stokes theorem	
Week-3		
Lecture-7	Surface and Volume integrals, Green's theorem (for a plane), stokes theorem	
Lecture-8	Gauss's theorem of divergence	
Lecture-9	Gauss's theorem of divergence	
Week-4		
Lecture-10	Gauss's theorem of divergence	
Lecture-11	**Geometry(3D):** Rectangular co-ordinates: Distance between two points, Direction cosines	
Lecture-12	Direction ratios, Angle between two lines	
Week-5		CT-2
Lecture-13	Direction cosines, Direction ratios, Angle between two lines	
Lecture-14	Direction cosines, Direction ratios, Angle between two lines	
Lecture-15	Direction cosines, Direction ratios, Angle between two lines	
Week-6		
Lecture-16	The plane - angle between two planes	
Lecture-17	The plane - angle between two planes	
Lecture-18	The plane - angle between two planes	
Week-7		
Lecture-19	Condition for perpendicularity and parallelism of two planes	
Lecture-20	Condition for perpendicularity and parallelism of two planes	
Lecture-21	The Straight line	
Week-8		
Lecture-22	**Statistics** **Correlation**: Scatter diagrams, Correlation co-efficient	
Lecture-23	Rank correlation, Correlation ratio, Theorems on correlations	
Lecture-24	**Regression Analysis**: Linear regression, Equation of the line of regression, Regression co-efficient, Curve fitting, Method of least square	
Week-9		CT-3
Lecture-25	**Probability:** Mathematical and statistical definitions	
Lecture-26	Additive and multiplicative rule of probability	
Lecture-27	Conditional probability, Baye's theorem	
Week-10		

Lecture-28	**Random Variables:** Discrete and continuous random variables, Probability mass function, Probability density function	
Lecture-29	Cumulative distribution functions	
Lecture-30	Mathematical expectation	
Week-11		
Lecture-31	**Discrete Probability Distribution:** Binomial distribution, Negative binomial distribution	
Lecture-32	Geometric distribution	
Lecture-33	Poisson's distribution	
Week-12		
Lecture-34	**Continuous Probability Distribution**: Normal distribution, Exponential distribution	
Lecture-35	Chi-square distribution	
Lecture-36	t and F- distributions	
Week-13		
Lecture-37	**Sampling Distribution**: Population, Sample mean, Sample variance	
Lecture-38	Central limit theorem	
Lecture-39	Sampling distribution from a normal population.	CT-4
Week-14		
Lecture-40	**Test of Hypothesis**: Statistical hypothesis, Level of significance, Type I and Type II error	
Lecture-41	One tailed and two tailed tests	
Lecture-42	Tests for proportions	

Text and Reference Books:

1. Vector Analysis, Schaum's outlines, Murray R. Spiegel.
2. Elementary Linear Algebra, Howard Anton and Chris Rorres.
3. A Text Book on Co-ordinate Geometry with Vector Analysis, Rahman & Bhattacharjee.
4. College Linear Algebra, Prof Abdur Rahman
5. Mathematical Physics, B D Gupta.
6. Probability and Statistics for Engineers, Scheaffer & McClave.
7. Statistics and Random Processes, B. Praba, Aruna Chalam and Sujatha.
8. Quality Planning and Analysis, J. M. Juran& F. M. Gryna.
9. Business Statistics, Gupta and Gupta.

Phy 171: Physics

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Physics is a fundamental science that endeavors to explain all the natural phenomena that occur in the universe. Physics uses qualitative and quantitative models and theories based on physical laws to visualize, explain and predict physical phenomena.

Objective:

1. To learn Solve for the solutions and describe the behavior of a damped and driven harmonic oscillator in both time and frequency domains
2. Understand and implement Fourier series.
3. Understand the general motion of a particle in two dimensions so that, given functions x(t) and y(t) which describe this motion, they can determine the components, magnitude, and direction of the particle’s velocity and acceleration as functions of time
4. To understand the basic working principle of various energy storage devices like capacitors, inductors and resistors.
5. Analyze under what circumstances an object will start to slip, or to calculate the magnitude of the force of static friction.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Physics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Physics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Physics uncertainty and data management validated against national or international standards

Course Contents:

Waves & Oscillations:

Differential equation of Simple harmonic motion (SHM), Solution of Differential equation of SHM, total energy and average energy of SHM, spring-mass system, Two body oscillations, reduced mass, Combination of Simple harmonic motions with Lissajous figures, Simple, Compound & torsional pendulum, Differential equation of damped oscillations, Differential equation of forced oscillation, resonance, differential equation of a progressive wave, Relation between particle and wave velocity, Energy of a progressive wave, stationary waves, sound waves, interference of sound waves.

Crystallography:

Classification of solids, Crystalline and non-crystalline solids, single Crystal and polycrystalline solids, lattice, unit cell, basis & translation vector, crystal system, packing fraction and its calculations for different crystal structure, NaCl & CsCl crystal structure, Zinc Blende crystal structure, crystal planes & directions, interplaner spacing, Miller indices, relation between interplaner spacing and Miller indices, Bragg's law, X-ray diffraction, Defects in Crystals, different types of bonds in solids, Inter atomic distances and forces of equilibrium.

Physical Optics:

Huygens's principle and construction, Interference of light, Conditions of interference, Young's double slit experiment, theory of interference fringes, Fresnel bi-prism, Interference in thin films, Newton's rings, Interferometers, diffraction by single slit, diffraction by double slits and N-slits, diffraction gratings, diffraction at a circular aperture, Resolving power of a telescope, Resolving power of a microscope, relation between magnifying power and resolving power, polarization of light, production and analysis of polarized light, Brewster's law, Malus law, polarization by double refraction Nicole prism, optical activity, specific rotation, polarimeters.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Physics founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Physics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Physics uncertainty and data management validated against national or international standards				√								

Lecture Schedule: Lecture Topic

Lecture		Class Test (CT)
Week-1		CT-1
Lecture-1	**Waves & Oscillations:** Differential equation of Simple harmonic motion (SHM), Solution of Differential equation of SHM	
Lecture-2	total energy and average energy of SHM	
Lecture-3	spring-mass system	
Week-2		
Lecture-4	Two body oscillations, reduced mass	
Lecture-5	Combination of Simple harmonic motions with Lissajous figures, Simple	
Lecture-6	Compound & torsional pendulum	
Week-3		

Lecture-7	Differential equation of damped oscillations	
Lecture-8	Differential equation of forced oscillation, resonance	
Lecture-9	differential equation of a progressive wave	
Week-4		
Lecture-10	Relation between particle and wave velocity	
Lecture-11	Energy of a progressive wave	
Lecture-12	stationary waves	
Week-5		CT-2
Lecture-13	sound waves	
Lecture-14	interference of sound waves	
Lecture-15	**Crystallography:** Classification of solids, Crystalline and non-crystalline solids	
Week-6		
Lecture-16	single Crystal and polycrystalline solids	
Lecture-17	lattice, unit cell, basis & translation vector	
Lecture-18	crystal system	
Week-7		
Lecture-19	packing fraction and its calculations for different crystal structure,	
Lecture-20	NaCl & CsCl crystal structure	
Lecture-21	Zinc Blende crystal structure, crystal planes & directions, interplaner spacing	
Week-8		
Lecture-22	Miller indices	
Lecture-23	relation between interplaner spacing and Miller indices	
Lecture-24	Bragg's law	
Week-9		CT-3
Lecture-25	X-ray diffraction	
Lecture-26	Defects in Crystals	
Lecture-27	different types of bonds in solids	
Week-10		
Lecture-28	Inter atomic distances and forces of equilibrium	
Lecture-29	**Physical Optics:** Huygens's principle and construction, Interference of light, Conditions of interference, Young's double slit experiment	
Lecture-30	theory of interference fringes	
Week-11		
Lecture-31	Fresnel bi-prism	
Lecture-32	Interference in thin films, Newton's rings, Interferometers,	
Lecture-33	diffraction by single slit, diffraction by double slits and N-slits, diffraction gratings	
Week-12		
Lecture-34	diffraction at a circular aperture	
Lecture-35	Resolving power of a telescope	
Lecture-36	Resolving power of a microscope	
Week-13		CT-4
Lecture-37	relation between magnifying power and resolving power	
Lecture-38	polarization of light	
Lecture-39	production and analysis of polarized light	

Week-14		
Lecture-40	Brewster's law, Malus law	
Lecture-41	polarization by double refraction Nicole prism	
Lecture-42	Optical activity, specific rotation, polarimeters	

Text and Reference Books:

1. Waves & Oscillation by Brijlal and Subramanyam.
2. A text book of Optics by Brijlal and Subramanyam
3. Physics for Engineers- I & II by Dr Gais Uddin
4. Heat and Thermodynamics by- Brijlal and Subramannyam
5. Physics for Engineers Lecture Series by M Ziaul Ahsan

PME 123: Reservoir Rock and Fluid Properties

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The aim of this module is for students to understand the fundamental importance of the reservoir rock properties in petroleum engineering practice. Estimate porosity, permeability, saturation, relative permeability, capillary pressure and then the initial hydrocarbon in place using volumetric method. In addition, establish various petrophysical relations and relevant equations and determine the rock wettability.

Objective:

The overall objective of the course is to provide the student with basic understanding of the petrophysics of petroleum reservoirs; and expand his/her ability to perform quantitative calculations related to fluid storage capacity and fluid-flow performances of reservoirs. Specific objectives are:

1. Learn the nature of a petroleum reservoir, reservoir forming rock types and their petrographic properties.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Reservoir Rock and Fluid Properties founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Rock and Fluid Properties demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Reservoir Rock and Fluid Properties uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Reservoir Rock and Fluid Properties by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Reservoir Rock Properties:-

Overview of Reservoir Rock Properties: Porosity, fluid saturation, permeability, compressibility, core resistivity, capillary pressure, wettability and relative permeability.

Coring and Core Analysis: Coring and core analysis objectives; Coring hardware and maximizing core recovery; Core-handling, wellsite procedures, and preservation methods; Sidewall coring and analysis; Organizing effective laboratory programs; Porosity, permeability and fluid saturation; Quality control in core analysis; Petrography and mineralogy; Special core analysis, sample selection and statistical data analysis; Core-log correlation (includes nmr log calibration, acoustic, nuclear, and electrical properties), an introduction to rock mechanics; Wettability, relative permeability, capillary pressure, and reservoir fluid distribution; Data integration in reservoir simulation; Design of coring and core analysis program; NMR Core Analysis.

Electric Resistivity Analysis of Core:

Capillarity in Rocks: Capillary pressure applications in reservoir characterization; Rock properties from mercury/air capillary pressures; Capillary pressure data representativeness; Capillary forces in reservoir rocks, their measurement; Capillary pressure data fitting methods; Representing a large number of capillary curves (averaging); Permeability from capillary pressure curves and petrography; Saturation-height functions; Surface phenomena, capillarity, wettability, and interphase tension; The competition between capillary and gravity forces; Relationships between initial and residual saturations; Interpretation of single and multiple pore system rocks; Clay-bound water; Capillary pressure vs. NMR ; Seal capacity.

Relative Permeability: Imbibition and drainage process; Oil-water system; Oil-Gas system; Water-Gas system; Water-Oil--Gas system, stone model; Saturation function.

Rock Compaction Function: Newman correlation, Hall correlation, Knaap correlation.

Core Photography:

Application of reservoir rock properties modeling software.

Reservoir Fluid Properties:-

Reservoir Fluid Sampling:

Volumetric and Phase Behavior of Oil and Gas Systems: Reservoir-Fluid Composition; Phase Diagrams for Simple Systems; Retrograde Condensation; Classification of Oilfield Systems.

Gas and Oil Properties and Correlations: Properties, Nomenclature, and Units; Gas Mixtures; Oil Mixtures; IFT and Diffusion Coefficients; K-Value Correlations.

Equation-of-State Calculations: Cubic EOS's; Two-Phase Flash Calculation; Phase Stability; Saturation-Pressure Calculation; Equilibrium in a Gravity Field, Compositional Gradients; Matching an EOS to Measured Data.

Heptanes-Plus Characterization: Experimental Analyses; Molar Distribution; Inspection-Properties Estimation; Critical-Properties Estimation; Recommended C7 Characterizations; Grouping and Averaging Properties.

Conventional PVT Measurements: Wellstream Compositions; Multistage-Separator Test; Constant Composition Expansion; Bubble Point Estimation; Differential Liberation Expansion; Constant Volume Depletion; Due Point Estimation; Composition variation with depth.

Black-Oil PVT Formulations: Traditional Black-Oil Formulation: Modified Black-Oil (MBO) Formulation; Applications of MBO Formulation; Partial-Density Formulation; Modifications for Gas Injection.

Water/Hydrocarbon Systems: Properties and Correlations; EOS Predictions; Hydrates.

Preparation for Reservoir Engineering and Simulation Studies: Fundamentals of Hydrocarbon Phase Behavior: single, two, and multi-component systems, classification of reservoirs and fluids, location of gas-oil contact ; Characterizing hydrocarbon-plus fractions: generalized correlations, PNA determination, splitting and lumping schemes for equation of state applications ; Natural gas properties: behavior and properties of ideal and real gases, wet gases and their behavior, analysis of gas condensate behavior ; PVT properties of crude oils: crude oil properties, surface and interfacial tension, properties of reservoir water, understanding laboratory data, constant-composition expansion test, differential liberation test, separator test, liquid dropout, swelling test, slim tube test, calculations of minimum miscibility pressure, modeling of compositional variation with EOS and depth; Equations of state and phase equilibria.

Application of reservoir fluid modeling software.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Reservoir Rock and Fluid Properties founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Rock and Fluid Properties demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Reservoir Rock and Fluid Properties and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Reservoir Rock and Fluid Properties by using commercial software that is commonly used					√							

	in the industry to develop competency in the use of technology											

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Overview of Reservoir Rock Properties**: Porosity, fluid saturation, permeability	
Lecture-2	Compressibility, core resistivity, capillary pressure, wettability and relative permeability	
Lecture-3	**Coring and Core Analysis:** Coring and core analysis objectives; Coring hardware and maximizing core recovery; Core-handling, wellsite procedures, and preservation methods; Sidewall coring and analysis	
Week-2		
Lecture-4	Organizing effective laboratory programs; Porosity, permeability and fluid saturation; Quality control in core analysis	
Lecture-5	Petrography and mineralogy; Special core analysis, sample selection and statistical data analysis	
Lecture-6	Core-log correlation (includes nmr log calibration, acoustic, nuclear, and electrical properties), an introduction to rock mechanics	
Week-3		
Lecture-7	Wettability, relative permeability, capillary pressure, and reservoir fluid distribution; Data integration in reservoir simulation; Design of coring and core analysis program; NMR Core Analysis	
Lecture-8	Electric Resistivity Analysis of Core	
Lecture-9	**Capillarity in Rocks:** Capillary pressure applications in reservoir characterization; Rock properties from mercury/air capillary pressures	
Week-4		
Lecture-10	Capillary pressure data representativeness	
Lecture-11	Capillary forces in reservoir rocks, their measurement	
Lecture-12	Capillary pressure data fitting methods; Representing a large number of capillary curves (averaging)	
Week-5		CT-2
Lecture-13	Permeability from capillary pressure curves and petrography; Saturation-height functions; Surface phenomena, capillarity	
Lecture-14	wettability, and interphase tension; The competition between capillary and gravity forces	
Lecture-15	Relationships between initial and residual saturations	
Week-6		

Lecture-16	Interpretation of single and multiple pore system rocks; Clay-bound water; Capillary pressure vs. NMR ; Seal capacity	
Lecture-17	**Relative Permeability:** Imbibition and drainage process; Oil-water system; Oil-Gas system	
Lecture-18	Water-Gas system; Water-Oil--Gas system, stone model; Saturation function	
Week-7		
Lecture-19	Rock Compaction Function: Newman correlation, Hall correlation, Knaap correlation	
Lecture-20	Core Photography	
Lecture-21	Application of reservoir rock properties modeling software	
Week-8		
Lecture-22	**Volumetric and Phase Behavior of Oil and Gas Systems:** Reservoir-Fluid Composition	
Lecture-23	Phase Diagrams for Simple Systems; Retrograde Condensation; Classification of Oilfield Systems	
Lecture-24	**Gas and Oil Properties and Correlations:** Properties, Nomenclature, and Units; Gas Mixtures; Oil Mixtures	
Week-9		
Lecture-25	IFT and Diffusion Coefficients; K-Value Correlations	
Lecture-26	**Equation-of-State Calculations:** Cubic EOS's; Two-Phase Flash Calculation; Phase Stability	
Lecture-27	Saturation-Pressure Calculation; Equilibrium in a Gravity Field, Compositional Gradients; Matching an EOS to Measured Data	
Week-10		
Lecture-28	**Heptanes-Plus Characterization**: Experimental Analyses; Molar Distribution; Inspection-Properties Estimation; Critical-Properties Estimation	
Lecture-29	Recommended C7 Characterizations	
Lecture-30	Grouping and Averaging Properties	
Week-11		CT-3
Lecture-31	**Conventional PVT Measurements:** Wellstream Compositions; Multistage-Separator Test; Constant Composition Expansion; Bubble Point Estimation	
Lecture-32	Differential Liberation Expansion; Constant Volume Depletion	
Lecture-33	Due Point Estimation; Composition variation with depth	
Week-12		
Lecture-34	**Black-Oil PVT Formulations:** Traditional Black-Oil Formulation: Modified Black-Oil (MBO) Formulation; Applications of MBO Formulation	
Lecture-35	Partial-Density Formulation; Modifications for Gas Injection	
Lecture-36	**Water/Hydrocarbon Systems:** Properties and Correlations; EOS Predictions; Hydrates	
Week-13		
Lecture-37	**Preparation for Reservoir Engineering and Simulation Studies:** Fundamentals of Hydrocarbon Phase Behavior: single, two, and multi-component systems, classification of reservoirs and fluids, location of gas-oil contact ; Characterizing hydrocarbon-plus fractions: generalized correlations	CT-4

Lecture-38	PNA determination, splitting and lumping schemes for equation of state applications ; Natural gas properties: behavior and properties of ideal and real gases, wet gases and their behavior, analysis of gas condensate behavior	
Lecture-39	PVT properties of crude oils: crude oil properties, surface and interfacial tension, properties of reservoir water, understanding laboratory data, constant-composition expansion test	
Week-14		
Lecture-40	differential liberation test, separator test, liquid dropout, swelling test, slim tube test	
Lecture-41	Calculations of minimum miscibility pressure, modeling of compositional variation with EOS and depth; Equations of state and phase equilibria	
Lecture-42	Application of reservoir fluid modeling software	

Text and Reference Books:

1. Phase Behavior by Curtis H. Whitson & Michael R. Brule
2. Low Invasion Coring by J.B. Bloys and H.R. Warner Jr
3. The Properties of Petroleum Fluids by William D. McCain Jr
4. Fundamentals of Reservoir Engineering by L. P. Dake
5. Petroleum Engineering Handbook by John R. Fanchi

Chem 172: Chemistry Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Chemistry is the molecular science. Chemists believe that the best understanding of the properties of matter comes from study at the molecular level. Chemistry provides the basic principles that govern the structure (and therefore the behavior and reactivity) of molecules.

Objective:

1. General familiarity with the following areas in chemistry: analytical, inorganic, organic and physical.
2. The basic analytical and technical skills to work al and technical skills to work effectively in the various fields of chemistry.
3. The ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.
4. The ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.
5. The ability to use information technology tools such as the Internet and computer-based literature searches as well as printed literature resources to locate and retrieve scientific information needed for laboratory or theoretical work.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Chemistry founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Chemistry demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Chemistry uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize reaction rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Qualitative and Quantitative Chemical Analysis

Qualitative Analysis:

i) Identification of functional group of organic compounds.

ii) Presence of N, S and halogens in organic compounds.

Quantitative Chemical Analysis: Estimation of Zinc and copper from analysis of brass.

Compleximetric Titration: Determination of Nichel and sulphet by compleximetric titration.

Analysis of Fats and Oils:

i) Iodine value (IV)

ii) Safonification value (SV)

iii) Acid value (AV)

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Chemistry on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Chemistry demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of chemicals and data management validated against national or international standards				√								
5.	Perform, analyze and optimize reaction rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Experiments
Week-1	Identification of functional group of organic compounds
Week-2	Identification of functional group of organic compounds
Week-3	Presence of N, S and halogens in organic compounds
Week-4	Presence of N, S and halogens in organic compounds
Week-5	Estimation of Zinc from analysis of brass
Week-6	Estimation of copper from analysis of brass
Week-7	Quiz

Week-8	Determination of Nichel by compleximetric titration
Week-9	Determination of sulphet by compleximetric titration
Week-10	Analysis of Fats and Oils
Week-11	Iodine value (IV)
Week-12	Safonification value (SV)
Week-13	Acid value (AV)
Week-14	Quiz

Text and Reference Books:

1. Basic Chemistry, Books a la Carte Edition by Karen C. Timberlake and William Timberlake
2. Understanding Basic Chemistry Through Problem Solving: The Learner's Approach by Jeanne Tan and Kim Seng Chan
3. Understand Basic Chemistry Concepts: The Periodic Table, Chemical Bonds,by Chris McMulen
4. Introductory Chemistry by Nivaldo J. Tro
5. Basic Chemistry Concepts and Exercises by John Kenkel

Phy 172: Physics Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Physics is a fundamental science that endeavors to explain all the natural phenomena that occur in the universe. Physics uses qualitative and quantitative models and theories based on physical laws to visualize, explain and predict physical phenomena.

Objective:

1. To learn Solve for the solutions and describe the behavior of a dampedand driven harmonic oscillator in both time and frequency domains
2. Understand and implement Fourier series.
3. Understand the general motion of a particle in two dimensions so that, given functions x(t) and y(t) which describe this motion, they can determine the components, magnitude, and direction of the particle's velocity and acceleration as functions of time
4. To understand the basic working principle of various energy storage devices like capacitors, inductors and resistors.
5. Analyze under what circumstances an object will start to slip, or to calculate the magnitude of the force of static friction.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Physics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Physics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Physics uncertainty and data management validated against national or international standards

Course Contents:

1. Determination of frequency of a tuning fork by the Melde's experiment.
2. Determination of the spring constant and the effective mass of a loaded spring and hence calculation of the rigidity modulus of the spring.

3. Determination of the value of g acceleration due to gravity by means of a compound pendulum.
4. Determination of the velocity of sound.
5. Determination of focal length of a concave lens by auxiliary lens method.
6. Determination of radius of curvature of a Plano convex lens by Newton's ring method.
7. Determination of the refractive index of the material of a prism by spectrometer
8. Determination of the specific rotation of sugar solution by polarimeter.
9. Determination of a high resistance by the method of deflection.
10. Determination of electrochemical equivalent (ECE) of copper by the cooper Voltammeter.
11. Determination of specific resistance of a wire using a meter bride.
12. Determination of Young's modulus of a bar by bending method.
13. Determination of the modulus of rigidity of a wire by statical method.
14. Determination of the moment of inertia of a fly-wheel about its axis of rotation.
15. Verification of the law of conservation of linear momentum.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Physics founded on a theory based understanding of mathematics and the natural and	√											

	physical sciences												
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Physics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Physics uncertainty and data management validated against national or international standards				√								

Lecture Schedule: Lecture Topic

Lecture	Experiments
Week-1	Determination of frequency of a tuning fork by the Melde's experiment
Week-2	Determination of the spring constant and the effective mass of a loaded spring and hence calculation of the rigidity modulus of the spring
Week-3	Determination of the value of g acceleration due to gravity by means of a compound pendulum
Week-4	Determination of the velocity of sound
Week-5	Determination of focal length of a concave lens by auxiliary lens method
Week-6	Determination of radius of curvature of a Plano convex lens by Newton's ring method. Determination of the refractive index of the material of a prism by spectrometer
Week-7	Quiz
Week-8	Determination of the specific rotation of sugar solution by polarimeter
Week-9	Determination of a high resistance by the method of deflection
Week-10	Determination of electrochemical equivalent (ECE) of copper by the cooper Voltammeter
Week-11	Determination of specific resistance of a wire using a meter bride Determination of Young's modulus of a bar by bending method
Week-12	Determination of the modulus of rigidity of a wire by statical method
Week-13	Determination of the moment of inertia of a fly-wheel about its axis of rotation and Verification of the law of conservation of linear momentum
Week-14	Quiz

Text and Reference Books:

1. Waves & Oscillation by Brijlal and Subramanyam.
2. A text book of Optics by Brijlal and Subramanyam
3. Physics for Engineers- I & II by Dr Gais Uddin
4. Heat and Thermodynamics by- Brijlal and Subramannyam
5. Physics for Engineers Lecture Series by M Ziaul Ahsan

PME 124: Reservoir Rock and Fluid Properties Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

The aim of this module is for students to understand the fundamental importance of the reservoir rock properties in petroleum engineering practice. Estimate porosity, permeability, saturation, relative permeability, capillary pressure and then the initial hydrocarbon in place using volumetric method. In addition, establish various petrophysical relations and relevant equations and determine the rock wettability.

Objective:

The overall objective of the course is to provide the student with basic understanding of the petrophysics of petroleum reservoirs; and expand his/her ability to perform quantitative calculations related to fluid storage capacity and fluid-flow performances of reservoirs. Specific objectives are:

1. Learn the nature of a petroleum reservoir, reservoir forming rock types and their petrographic properties,

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Reservoir Rock and Fluid Properties founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Rock and Fluid Properties demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Reservoir Rock and Fluid Properties uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Reservoir Rock and Fluid Properties by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

1. Preparation of Reservoir Fluid Sample and Determine composition of reservoir fluid sample by Gas Chromatograph

2. Perform PVT analysis (CCE,BP,DLE) for reservoir oil sample
3. Perform PVT analysis (CCE,DP,CVD) for reservoir gas sample
4. Perform PVT analysis (CCE,DP,CVD) for reservoir gas condensate sample
5. Perform multistage separator test for reservoir oil sample
6. Preparation of core sample by Cutting, Plugging and Trimming
7. Measurement of porosity in the core sample
8. Measurement of permeability in the core sample
9. Measurement of capillary pressure in the core sample
10. Measurement of relative permeability in the core sample
11. Determination of wettability and interfacial tension
12. Processing of core analysis data for reservoir modeling

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Reservoir Rock and Fluid Properties founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Rock and Fluid Properties demonstrated through appropriate and relevant		√										

	assessment												
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Reservoir Rock and Fluid Properties and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Reservoir Rock and Fluid Properties by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Experiments
Week-1	Preparation of Reservoir Fluid Sample and Determine composition of reservoir fluid sample by Gas Chromatograph
Week-2	Perform PVT analysis (CCE,BP,DLE) for reservoir oil sample
Week-3	Perform PVT analysis (CCE,DP,CVD) for reservoir gas sample
Week-4	Perform PVT analysis (CCE,DP,CVD) for reservoir gas condensate sample
Week-5	Perform multistage separator test for reservoir oil sample
Week-6	Preparation of core sample by Cutting, Plugging and Trimming
Week-7	Quiz
Week-8	Measurement of porosity in the core sample
Week-9	Measurement of permeability in the core sample
Week-10	Measurement of capillary pressure in the core sample
Week-11	Measurement of relative permeability in the core sample
Week-12	Determination of wettability and interfacial tension
Week-13	Processing of core analysis data for reservoir modeling
Week-14	Quiz

Text and Reference Books:

1. Phase Behavior by Curtis H. Whitson & Michael R. Brule
2. Low Invasion Coring by J.B. Bloys and H.R. Warner Jr

3. The Properties of Petroleum Fluids by William D. McCain Jr
4. Fundamentals of Reservoir Engineering by L. P. Dake
5. Petroleum Engineering Handbook by John R. Fanchi

Level-2, Term-1

EECE 271: Fundamentals of Electrical and Electronic Engineering

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Electrical & Electronic Engineering is a fascinating field, and one which could make your time at unique challenging, enriching and rewarding experience. Just as the world needs its Doctors, Nurses and Teachers, Electrical Engineering is something which we simply couldn't do without. If you like the idea of creating electrical systems which could help millions of people on a day-to-day basis, like the systems used in phones, or computers, then read these reasons to study Electrical & Electronic Engineering.

Objective:

1. Be successful in understanding, formulating, analyzing and solving a variety of electrical engineering problems.
2. Be successful in operating and designing a variety of engineering systems, products or experiments.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Electrical and Electronic Engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Electrical and Electronic Engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Electrical and Electronic Engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Electrical and Electronic devices by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Introduction: Sources of energy; General structure of electrical power systems, Power Transmission and distribution via overhead lines and underground cables; Steam, Hydel, Gas and Nuclear power generation.

DC Networks: Kickoff's laws, Node voltage and mesh current methods, Delta-star and star-delta conversion, Superposition principle, Thevenin's and Norton's theorems.

Single Phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, solution of R,L,C series circuits, the j operator, complex representation of impedances phasor diagram, power factor, power in complex notation, solution of parallel and series-parallel circuits.

Three Phase AC Circuits: Three phase EME generation, delta and Y-connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in thee phase circuits, Three phase four wire circuits.

Magnetic Circuits: Ampere's circuital law, B-H curve, Solution of magnetic circuits, Hysteresis and eddy current losses, Relays, an application of magnetic force, Basic principles of stepper motor.

Electrical Measuring Instruments: DC PMMC instruments, Shunt and multipliers, Multimeters, Moving iron ammeters and voltmeters, Dynamometers, Wattmeter, AC watthour meter, Extension of instrument ranges.

Electrical Machines: DC generators: Construction, operation and types, DC motors: Operation, classification, characteristics and applications. Transformers: Operation and classification, Three Phase Induction Motors: Working principle, characteristics and starting, Alternators: Working principle and synchronization, Synchronous Motors: Operation and applications.

Electronics: p-n junction diode, rectifiers, BJT: Switching and amplification.

Power Supply: Choice of voltage, surface and underground supply, Mine cable construction, installation, fault location, Switchgears, Earthing methods, Protective devices: over current and over voltage.

Control and Instrumentation: Introduction to control system, open loop and closed loop system, remote control, sequence control, introduction to programmable logic controller, embedded controller. Drives: DC drives: single phase half wave converter drives, AC drives: Induction motor drives-Stator voltage and rotor voltage control Transducers: Electrical Transducers, Advantages of Electrical Transducer, Resistance Thermometers, Thermistor, Thermocouple, Integrated Circuit temperature sensors, Linear Variable Differential Transformer (LVDT), Capacitive Transducer:Piezo-electric Transducer, Opto-electronic transducers. Sensors for measurement of various operational parameters, environmental parameters and safety parameters in underground and open pit mines.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Electrical and Electronic Engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Electrical and Electronic Engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to				√								

	suggest approaches and strategies for the assessment and quantification of Electrical and Electronic uncertainty and data management validated against national or international standards												
5.	Perform, analyze and optimize Electrical and Electronic devices by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule: Lecture Topic

Lecture		**Class Test (CT)**
Week-1		
Lecture-1	**Introduction**: Sources of energy; General structure of electrical power systems, Power Transmission and distribution via overhead lines and underground cables	
Lecture-2	Steam, Hydel	
Lecture-3	Gas and Nuclear power generation	
Week-2		
Lecture-4	**DC Networks**: Kickoff's laws, Node voltage and mesh current methods	
Lecture-5	Delta-star and star-delta conversion	
Lecture-6	Superposition principle	
Week-3		CT-1
Lecture-7	Thevenin's and Norton's theorems	
Lecture-8	**Single Phase AC Circuits**: Single phase EMF generation, average and effective values of sinusoids, solution of R,L,C series circuits	
Lecture-9	the j operator, complex representation of impedances phasor diagram, power factor	
Week-4		
Lecture-10	power in complex notation	
Lecture-11	Solution of parallel and series-parallel circuits	
Lecture-12	**Three Phase AC Circuits**: Three phase EME generation, delta and Y-connections, line and phase quantities, solution of three phase circuits	
Week-5		
Lecture-13	balanced supply voltage and balanced load	
Lecture-14	phasor diagram, measurement of power in thee phase circuits	CT-2
Lecture-15	Three phase four wire circuits	
Week-6		
Lecture-16	**Magnetic Circuits**: Ampere's circuital law, B-H curve, Solution of	

	magnetic circuits, Hysteresis and eddy current losses	
Lecture-17	Relays, an application of magnetic force	
Lecture-18	Basic principles of stepper motor	
Week-7		
Lecture-19	**Electrical Measuring Instruments**: DC PMMC instruments, Shunt and multipliers, Multimeters, Moving iron ammeters and voltmeters	
Lecture-20	Dynamometers, Wattmeter	
Lecture-21	AC watthour meter, Extension of instrument ranges	
Week-8		
Lecture-22	**Electrical Machines:** DC generators: Construction, operation and types	
Lecture-23	DC motors: Operation, classification, characteristics and applications	
Lecture-24	Transformers: Operation and classification	
Week-9		CT-3
Lecture-25	Three Phase Induction Motors: Working principle, characteristics and starting, Alternators	
Lecture-26	Working principle and synchronization	
Lecture-27	Synchronous Motors: Operation and applications	
Week-10		
Lecture-28	**Electronics:** p-n junction diode	
Lecture-29	rectifiers, BJT	
Lecture-30	Switching and amplification	
Week-11		
Lecture-31	**Power Supply:** Choice of voltage, surface and underground supply, Mine cable construction, installation, fault location	
Lecture-32	Switchgears, Earthing methods	
Lecture-33	Protective devices: over current and over voltage	
Week-12		
Lecture-34	**Control and Instrumentation:** Introduction to control system	
Lecture-35	open loop and closed loop system, remote control, sequence control	
Lecture-36	Introduction to programmable logic controller, embedded controller	
Week-13		CT-4
Lecture-37	Drives: DC drives: single phase half wave converter drives, AC drives	
Lecture-38	Induction motor drives-Stator voltage and rotor voltage control Transducers: Electrical Transducers	
Lecture-39	Advantages of Electrical Transducer, Resistance Thermometers, Thermistor, Thermocouple	
Week-14		
Lecture-40	Integrated Circuit temperature sensors, Linear Variable Differential Transformer (LVDT)	
Lecture-41	Capacitive Transducer: Piezo-electric Transducer, Opto-electronic transducers	
Lecture-42	Sensors for measurement of various operational parameters, environmental parameters and safety parameters in underground and open pit mines	

Text and Reference Books:

1. Basic Electrical and Electronics Engineering by Sabyasachi Bhattacharya
2. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N.O. Sadiku
3. The Engineering Handbook by Richard C. Dorf
4. Electromagnetism for Electronic Engineers by Richard Geoffrey Carter
5. Industrial Electrical Troubleshooting by Lynn Lundquist
6. Wire Bonding in Microelectronics: Materials, Processes, Reliability, and Yield by George G. Harman

Math 271: Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis

4.00 Contact Hour; 4.00 Credit Hour

Pre-requisite: None

Rationale:

The aim of the Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis is that learners should be provided with a conceptual background which empowers them to make rational sense of elementary Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis.

Objectives:

1. To explain the characteristics of Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis
2. To provide a physical interpretation of the Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis
3. To apply Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis in solving engineering problems
4. To use integral operations for simplification of complex problems

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis uncertainty and data management validated against national or international standards

Course Contents:

Section-A

Differential Equations

Ordinary Differential Equations (ODE): Definition, Formulation, Classification, Solution of first order differential equation using various methods, Higher order differential equation with constant co-efficient, Homogeous differential equation. Solution of DE in series by the method of Frobenious.

Partial Differentiation Equation (PDE): Linear and non-linear PDE of first order**,** Linear PDE with constant coefficients, Boundary value problems (BVP): Wave and heat transfer equations.

Fourier Analysis:

Fourier Analysis: Fourier series, Fourier integral, Fourier transform, Inverse Fourier Transform and their Engineering applications.

Section-B

Laplace Transform (LT): Introduction, Laplace transform, Properties of Laplace transform, Inverse Laplace transforms, Derivative and Integral of LT., Convolution theorem, Heavisides expansion formula.

Numerical Analysis: Numerical Solution of Algebraic and Transcendental Equations: Introduction, Bisection method, Newton-Raphson method. Solution of system of linear equations using direct and iterative method.

Interpolation: Finite differences, Forward and backward differences, Difference table, difference of polynomial. Newton forward and backward interpolation formula, Central and divided differences, Numerical solution of ordinary differential equations.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Performance	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Written Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Differential Equations, Fourier Analysis, Laplace Transform and Numerical Analysis uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Ordinary Differential Equations (ODE):** Definition, Formulation	
Lecture-2	Classification, Solution of first order differential equation using various methods	
Lecture-3	Classification, Solution of first order differential equation using various methods	
Lecture-4	Classification, Solution of first order differential equation using various methods	
Week-2		
Lecture-5	Higher order differential equation with constant co-efficient	
Lecture-6	Homogeous differential equation	
Lecture-7	Homogeous differential equation	
Lecture-8	Solution of DE in series by the method of Frobenious	
Week-3		
Lecture-9	Solution of DE in series by the method of Frobenious	
Lecture-10	**Partial Differentiation Equation (PDE):** Linear and non-linear PDE of first order	
Lecture-11	Linear and non-linear PDE of first order	
Lecture-12	Linear PDE with constant coefficients	
Week-4		CT-2
Lecture-13	Linear PDE with constant coefficients	
Lecture-14	Boundary value problems (BVP)	
Lecture-15	Boundary value problems (BVP)	
Lecture-16	Boundary value problems (BVP)	
Week-5		
Lecture-17	Wave and heat transfer equations	
Lecture-18	Wave and heat transfer equations	
Lecture-19	**Fourier Analysis:** **Fourier Analysis:** Fourier series, Fourier integral, Fourier transform	
Lecture-20	Fourier series, Fourier integral, Fourier transform	
Week-6		
Lecture-21	Fourier series, Fourier integral, Fourier transform	
Lecture-22	Fourier series, Fourier integral, Fourier transform	
Lecture-23	Fourier series, Fourier integral, Fourier transform	
Lecture-24	Fourier series, Fourier integral, Fourier transform	
Week-7		CT-3
Lecture-25	Inverse Fourier Transform and their Engineering applications	
Lecture-26	Inverse Fourier Transform and their Engineering applications	
Lecture-27	Inverse Fourier Transform and their Engineering applications	

Lecture-28	Inverse Fourier Transform and their Engineering applications	
Week-8		
Lecture-29	**Laplace Transform (LT):** Introduction, Laplace transform	
Lecture-30	Properties of Laplace transform	
Lecture-31	Properties of Laplace transform	
Lecture-32	Properties of Laplace transform	
Week-9		
Lecture-33	Inverse Laplace transforms	
Lecture-34	Inverse Laplace transforms	
Lecture-35	Inverse Laplace transforms	
Lecture-36	Derivative and Integral of LT	
Week-10		CT-4
Lecture-37	Convolution theorem	
Lecture-38	Heavisides expansion formula	
Lecture-39	**Numerical Analysis: Numerical Solution of Algebraic and Transcendental Equations**: Introduction, Bisection method	
Lecture-40	Introduction, Bisection method	
Week-11		
Lecture-41	Introduction, Bisection method	
Lecture-42	Introduction, Bisection method	
Lecture-43	Newton-Raphson method	
Lecture-44	Newton-Raphson method	
Week-12		CT-5
Lecture-45	Solution of system of linear equations using direct and iterative method	
Lecture-46	Solution of system of linear equations using direct and iterative method	
Lecture-47	Solution of system of linear equations using direct and iterative method	
Lecture-48	Solution of system of linear equations using direct and iterative method	
Week-13		
Lecture-49	**Interpolation**: Finite differences, Forward and backward differences	
Lecture-50	Difference table, difference of polynomial	
Lecture-51	Newton forward and backward interpolation formula	
Lecture-52	Newton forward and backward interpolation formula	
Week-14		
Lecture-53	Central and divided differences	
Lecture-54	Numerical solution of ordinary differential equations	
Lecture-55	Numerical solution of ordinary differential equations	
Lecture-56	Numerical solution of ordinary differential equations	

Text and Reference Books:

1. Fourier series, Schaum's outlines series, Murray R. Spiegel.
2. Theory and problems of Laplace Transforms, Schaum's outlines series, Murray R. Spiegel.
3. Mathematical Physics, B D Gupta.
4. Ordinary and Partial Differential Equations – M.D. Raisinghania.

5. Differential Equations – Schaum’s out lines.
6. Differential Equations – B. D. Sharma.
7. Differential Equations – P. N. Chatterjee.
8. Differential Equations with applications–Dr Md. Mustafa Kamal
9. Numerical analysis by Walter Gautschi

PME 211: Engineering Mechanics

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The branch of applied science that deals with state of rest or the state of motion is termed as Mechanics. Starting from the analysis of rigid bodies under gravitational force and simple applied forces the mechanics has grown to the analysis of robotics, aircrafts, space crafts under dynamic force, atmospheric forces, temperatures forces etc.

Objective:

The student will be able to:

1. Understand concepts of mechanics involving force & its effects on objects, motion of bodies, and friction with applications.
2. Apply the principles to Engineering problems
3. Understand principles of simple machines

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Engineering Mechanics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Engineering Mechanics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Engineering Mechanics uncertainty and data management validated against national or international standards

Course Contents:

Fundamental Concepts: Free body diagram, Concurrent / coplanar / non-coplanar force systems, Resultant of forces, Resolution of forces.

Equilibrium of Particles: Conditions for equilibrium, Moments of force in vector notation, Resultant of force couple system.

Equilibrium of Rigid Bodies: Rectangular components of forces in plane and space, Moment of forces and couples, resolution of a given force or force system into a force and couple, Wrench, Equivalent force system.

Analysis of Structures: Trusses and frames, Forces in members, Zero force member.

Belt, Rope and Chain Drive: Belt: types: Flat and V- belt, Selection, Length of open and cross belt drives, Power transmitted by belt, Ratio of driving tension, Condition for transmission of maximum power, Rope drive, ratio of driving tensions for rope, Chain drive, Kinematics of chain drive.

Centroid and Center of Gravity: Line, Area, Volume, Composite bodies. Moment of inertia of area, masses; Parallel axis theorem.

Gear Train: Simple and compound gear train, Different types of gear train and their applications.

Kinematics of Particles: Rectilinear and curvilinear motion of particles, Position vector, Velocity and acceleration, Derivative of vector functions.

Kinetics of Particles in Two Dimensions: Newton's second law of motion- dynamic equilibrium, angular momentum and its rate of change; motion under a central force.

Energy and Momentum Methods: Principle of work and energy; Conservation of energy; Principle of impulse and momentum; Impulsive motion, Impact, Linear and angular momentum of system of particles.

Kinetics of Rigid Bodies in Two Dimensions: Translation, rotation about a fixed axis; Absolute/relative velocity and absolute/relative acceleration in plane motion, Instantaneous center of rotation.

Plane Motion of Rigid Bodies: Equation of motions for a plane body, Angular momentum and its rate of change, D'Alemberts principle; Constrained plane motion; Principle of work and energy; Conservation of energy and angular momentum; Principle of impulse and momentum

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Engineering Mechanics founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Engineering Mechanics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Engineering Mechanics uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Fundamental Concepts**: Free body diagram, Concurrent / coplanar / non-coplanar force systems	
Lecture-2	Resultant of forces	
Lecture-3	Resolution of forces	
Week-2		
Lecture-4	**Equilibrium of Particles**: Conditions for equilibrium	
Lecture-5	Moments of force in vector notation	
Lecture-6	Resultant of force couple system	
Week-3		
Lecture-7	**Equilibrium of Rigid Bodies**: Rectangular components of forces in plane and space, Moment of forces and couples	
Lecture-8	resolution of a given force or force system into a force and couple	
Lecture-9	Wrench, Equivalent force system	
Week-4		
Lecture-10	**Analysis of Structures**: Trusses and frames	
Lecture-11	Forces in members	
Lecture-12	Zero force member	
Week-5		CT-2
Lecture-13	**Belt, Rope and Chain Drive**: Belt: types: Flat and V- belt, Selection, Length of open and cross belt drives, Power transmitted by belt	
Lecture-14	Ratio of driving tension, Condition for transmission of maximum power	
Lecture-15	Rope drive, ratio of driving tensions for rope, Chain drive, Kinematics of chain drive	
Week-6		
Lecture-16	**Centroid and Center of Gravity**: Line, Area, Volume, Composite bodies. Moment of inertia of area, masses; Parallel axis theorem	
Lecture-17	**Gear Train**: Simple and compound gear train	
Lecture-18	Different types of gear train and their applications	
Week-7		
Lecture-19	**Kinematics of Particles:** Rectilinear and curvilinear motion of particles, Position vector	
Lecture-20	Velocity and acceleration	
Lecture-21	Derivative of vector functions	
Week-8		
Lecture-22	**Kinetics of Particles in Two Dimensions**: Newton's second law of motion	
Lecture-23	dynamic equilibrium	
Lecture-24	angular momentum and its rate of change	
Week-9		CT-3
Lecture-25	motion under a central force	

Lecture-26	**Energy and Momentum Methods**: Principle of work and energy	
Lecture-27	Conservation of energy	
Week-10		
Lecture-28	Principle of impulse and momentum	
Lecture-29	Impulsive motion, Impact	
Lecture-30	Linear and angular momentum of system of particles	
Week-11		
Lecture-31	**Kinetics of Rigid Bodies in Two Dimensions**: Translation	
Lecture-32	rotation about a fixed axis	
Lecture-33	Absolute/relative velocity and absolute/relative acceleration in plane motion	
Week-12		
Lecture-34	Instantaneous center of rotation	
Lecture-35	**Plane Motion of Rigid Bodies:** Equation of motions for a plane body	
Lecture-36	Angular momentum and its rate of change	
Week-13		CT-4
Lecture-37	Angular momentum and its rate of change	
Lecture-38	D'Alemberts principle	
Lecture-39	Constrained plane motion	
Week-14		
Lecture-40	Principle of work and energy	
Lecture-41	Conservation of energy and angular momentum	
Lecture-42	Principle of impulse and momentum	

Text and Reference Books:

1. Engineering Mechanics 1: Statics by Dietmar Gross, Jörg Schröder, Werner Hauger, and Wolfgang A. Wall
2. Meriam Engineering Mechanics – Dynamic by J.L. Meriam
3. Textbook of Engineering Mechanics by R.S. Khurmi
4. Engineering Mechanics: Combined Statics & Dynamics by Russell Hibbeler

PME 213: Petroleum Engineering Thermodynamics

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

It is a core subject of petroleum engineering and is essential for understanding basic concepts, thermodynamic properties of fluids and performance of thermal used in industry.

Objective:

This course is designed to make the students:

1. Understand zeroth, first and second laws of thermodynamics.
2. Discern various thermodynamic properties such as internal energy, specific volume, enthalpy, entropy, specific heat etc. from fundamental correlations.
3. Learn the application of various thermodynamic laws for the analysis of chemical processes.
4. Understand the concept and models of residual and excess Gibbs energy and the associated calculations for VLE, VLLE, SVE and SLE.
5. Learn the application of the laws of thermodynamics for hydrocarbon (both liquid and gas) characterization, handling, storage and transport.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Petroleum Engineering Thermodynamics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum Engineering Thermodynamics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum Engineering Thermodynamics uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Petroleum Engineering Thermodynamic rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Introduction to Thermodynamics: Introduction to SI system of units; Definition of thermodynamics; Thermodynamic system and control volume; Classes of systems; Thermodynamic properties, Processes and cycles; Reversible and irreversible processes; Flow and non-flow processes; Constant volume, Constant pressure, Isothermal, Adiabatic, Polytrophic and isentropic processes; Thermodynamic equilibrium; Zeroth law of thermodynamics.

First Law of Thermodynamics: The first law of thermodynamics; Non-flow energy equation; Internal energy; Enthalpy; Law of conservation of energy; Corollaries of First Law, Specific heats; Relation between specific heats; Application of the first law to some common closed system processes; The first law as applied to open system; steady flow energy equation; applications of the steady flow energy equation.

Pure Substance: Definition; phase of a pure substance; phase changes; independent properties of a pure substance; p-T, p-v, T-s and h-s diagrams; triple point and critical point; tables of thermodynamic properties of steam; Mollier Diagram. EOS

Second Law of Thermodynamics: Limitation of the first law of thermodynamics; Heat engines and heat pumps; Corollaries of the 2nd law, Efficiencies of reversible engines, Thermodynamics temperature scale; Entropy, Temperature-entropy diagrams for gases and vapors, Entropy changes for a perfect gas undergoing various reversible processes.

Perfect Gas: Equation of state of a perfect gas; Internal energy, enthalpy and specific heat capacities of a perfect gas; Coefficient of volume expansion and isothermal compressibility for a perfect gas; Various reversible processes undergone by a perfect gas; Perfect gas mixtures; Gibbs-Dalton law; Relations involving pressure, volume and composition, internal energy, enthalpy and specific heats of mixtures.

Internal Combustion Engines: Introduction of petrol and diesel engines; Working principle of both 4-stroke and 2-stroke engines; Introduction of main parts. Indicated power, brake power and mechanical efficiency calculations. Air standard Otto and Diesel cycles; p-v and T-s diagrams of cycles.

Vapor Power Cycles: Vapor power cycle; Rankine cycle; Reheat cycle; calculations of cycle efficiency.

Vapor Compression Refrigeration Systems: Simple vapor compression refrigeration cycle. p-h and T-s diagrams. Actual cycle and its analysis. Study of compressor, condenser, expansion device and evaporator used in a refrigeration system.

Applications of the First and Second Laws of Thermodynamics with strong emphasis on material, energy and entropy balances to solve engineering problems involving pure components. Cycles (Rankine, Brayton, refrigeration, etc.), the calculusof thermodynamics, equations of state for realistic thermodynamicproperties, departure functions, equilibrium and stability criteria,fugacity, and single component phase equilibrium (vaporization, melting, sublimation).

Application in gas processing, petroleum refining, LPG, LNG, EOR

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Petroleum Engineering Thermodynamics founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum Engineering Thermodynamics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical			√									

	evidence and the scientific approach to knowledge development												
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum Engineering Thermodynamics uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Petroleum Engineering Thermodynamic rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Introduction to Thermodynamics:** Introduction to SI system of units; Definition of thermodynamics; Thermodynamic system and control volume; Classes of systems; Thermodynamic properties, Processes and cycles; Reversible and irreversible processes	
Lecture-2	Flow and non-flow processes; Constant volume, Constant pressure, Isothermal, Adiabatic	
Lecture-3	Polytrophic and isentropic processes; Thermodynamic equilibrium; Zeroth law of thermodynamics	
Week-2		
Lecture-4	**First Law of Thermodynamics**: The first law of thermodynamics; Non-flow energy equation; Internal energy; Enthalpy; Law of conservation of energy; Corollaries of First Law	
Lecture-5	Specific heats; Relation between specific heats	
Lecture-6	Application of the first law to some common closed system processes	
Week-3		
Lecture-7	The first law as applied to open system	
Lecture-8	steady flow energy equation	
Lecture-9	Applications of the steady flow energy equation	
Week-4		
Lecture-10	**Pure Substance**: Definition; phase of a pure substance; phase changes; independent properties of a pure substance	
Lecture-11	p-T, p-v, T-s and h-s diagrams	

Lecture-12	triple point and critical point	
Week-5		CT-2
Lecture-13	Tables of thermodynamic properties of steam	
Lecture-14	Mollier Diagram	
Lecture-15	EOS	
Week-6		
Lecture-16	**Second Law of Thermodynamics**: Limitation of the first law of thermodynamics; Heat engines and heat pumps; Corollaries of the 2nd law, Efficiencies of reversible engines	
Lecture-17	Thermodynamics temperature scale; Entropy	
Lecture-18	Temperature-entropy diagrams for gases and vapors	
Week-7		
Lecture-19	Entropy changes for a perfect gas undergoing various reversible processes	
Lecture-20	**Perfect Gas**: Equation of state of a perfect gas; Internal energy	
Lecture-21	enthalpy and specific heat capacities of a perfect gas	
Week-8		
Lecture-22	Coefficient of volume expansion and isothermal compressibility for a perfect gas	
Lecture-23	Various reversible processes undergone by a perfect gas; Perfect gas mixtures	
Lecture-24	Gibbs-Dalton law; Relations involving pressure	
Week-9		CT-3
Lecture-25	Volume and composition, internal energy, enthalpy and specific heats of mixtures	
Lecture-26	**Internal Combustion Engines**: Introduction of petrol and diesel engines	
Lecture-27	Working principle of both 4-stroke and 2-stroke engines; Introduction of main parts	
Week-10		
Lecture-28	Indicated power, brake power and mechanical efficiency calculations	
Lecture-29	Air standard Otto and Diesel cycles; p-v and T-s diagrams of cycles	
Lecture-30	**Vapor Power Cycles**: Vapor power cycle; Rankine cycle; Reheat cycle; calculations of cycle efficiency	
Week-11		
Lecture-31	**Vapor Compression Refrigeration Systems**: Simple vapor compression refrigeration cycle. p-h and T-s diagrams. Actual cycle and its analysis. Study of compressor, condenser, expansion device and evaporator used in a refrigeration system	
Lecture-32	**Vapor Compression Refrigeration Systems**: Simple vapor compression refrigeration cycle. p-h and T-s diagrams. Actual cycle and its analysis. Study of compressor, condenser, expansion device and evaporator used in a refrigeration system	
Lecture-33	**Vapor Compression Refrigeration Systems**: Simple vapor compression refrigeration cycle. p-h and T-s diagrams. Actual cycle and its analysis. Study of compressor, condenser, expansion device and evaporator used in a refrigeration system	
Week-12		

Lecture-34	Applications of the First and Second Laws of Thermodynamics with strong emphasis on material, energy and entropy balances to solve engineering problems involving pure components	
Lecture-35	Applications of the First and Second Laws of Thermodynamics with strong emphasis on material, energy and entropy balances to solve engineering problems involving pure components	
Lecture-36	Applications of the First and Second Laws of Thermodynamics with strong emphasis on material, energy and entropy balances to solve engineering problems involving pure components	
Week-13		
Lecture-37	Cycles (Rankine, Brayton, refrigeration, etc.), the calculus of thermodynamics, equations of state for realistic thermodynamic properties, departure functions, equilibrium and stability criteria,fugacity, and single component phase equilibrium (vaporization, melting, sublimation)	
Lecture-38	Cycles (Rankine, Brayton, refrigeration, etc.), the calculus of thermodynamics, equations of state for realistic thermodynamic properties, departure functions, equilibrium and stability criteria,fugacity, and single component phase equilibrium (vaporization, melting, sublimation)	
Lecture-39	Cycles (Rankine, Brayton, refrigeration, etc.), the calculus of thermodynamics, equations of state for realistic thermodynamic properties, departure functions, equilibrium and stability criteria,fugacity, and single component phase equilibrium (vaporization, melting, sublimation)	CT-4
Week-14		
Lecture-40	Application in gas processing, petroleum refining, LPG, LNG, EOR	
Lecture-41	Application in gas processing, petroleum refining, LPG, LNG, EOR	
Lecture-42	Application in gas processing, petroleum refining, LPG, LNG, EOR	

Text and Reference Books:

1. Thermal Engineering by Balleny, Prentice Hall Publications
2. Chemical Engineering Thermodynamics by YUC Rao
3. Engineering Thermodynamics by PK Nag
4. Introduction to Chemical Engineering Thermodynamics by JL Smith and Vanners, McGraw Hill Publication
5. Equation of State and PVT analysis,Tarek Ahmed, Gulf publishing company

PME 215: Rock Mechanics for Mining and Petroleum Engineers

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

1. **Rationale:**

To understand the mechanical behavior of rock and rock masses to the force fields of their physical environment in Mining and Petroleum fields.

2. **Objectives:**

1. To understand about the physical properties of rocks and weakening mechanism of rock.
2. To calculate and analyze porosity, elastic wave velocity and permeability measurements of rocks.
3. To understand the deformation and failure mechanism of rock under tension, uniaxial compression and triaxial compression.
4. To analyze stress distribution around excavation.
5. To design underground excavation.
6. To analyze surface subsidence.
7. To analyze slope stability of rock.
8. To analyze and design support system.
9. To understand reservoir compaction.
10. To analyze stress evolution due to production.
11. To analyze stress effect on porosity and permeability.
12. To understand the hydraulic fracturing.
13. To analyze hydraulic fracturing for stress determination.
14. To analyze mud weight limit to prevent hole collapse.
15. To analyze the effect of temperature and mud composition on borehole stability.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories relating to physical properties of rocks, deformation and failure of rocks under tension, uniaxial compression, triaxial compression.

2. Apply the knowledge to design underground and open pit mine, borehole.

3. Evaluate the design requirement from rock engineering point of view.

4. Analyze of design parameters of various rock engineering structures.

4. Course Contents:

Physical properties of rock: Density, porosity, elastic wave velocity and dynamic elastic constants, permeability of rock, permeability measurement at field scale, expansion coefficient, weakening mechanism of rocks.

Deformation and failure of rock under tension: Why tension? How to measure tensile strength of rock? Criterion of crack growth, Fracture toughness, Stable and unstable crack growth.

Deformation and failure of rock under uniaxial compression: Why uniaxial? Uniaxial compression test, Analysis of result, Axial stress, axial strain, lateral strain and volumetric strain relationship of rock. Dilatancy. Mode and process of failure. Growth of inclined crack under compressive stress.

Deformation and failure under triaxial compression: Why triaxial compression? How to perform triaxial compression test? Experimental procedure. The characteristic of stress and strain curves. Why confining pressure hinders nucleation of secondary cracks. Failure criterion of rock. Physical meaning of columb’s criterion. Crack growth under triaxial compression, Effect of pore fluid, Law of effective stress.

Rock stresses: Methods of stress measurements in fields. Stress controlled instability. Rock mass characterization. Surface subsidence. Slope stability. Roof control plan. Design of entry, Pillar, and bolt systems. Stresses around excavations. Convergence and stress measurements.

Reservoir Geomechanics: Introduction to poroelasticity theory; Reservoir compaction; Linear elastic model and inelastic effects; Surface subsidence; Stress evolution during production; Compaction as a drive mechanism; Stress effects on porosity and permeability; Coupled reservoir simulation; Link to 4D seismic.

Borehole Stability: Diagnostics; Critical mud weight limits to prevent hole collapse and mud losses; Effects of temperature and mud composition on borehole stability; Stability of deviated and horizontal holes; Effects of plasticity; Modeling of borehole stability.

Sand and Particle Production; Basic mechanisms; Sand control; Sand prediction; Volumetric sand production.

Hydraulic Fracturing: Initiation and growth of hydraulic fractures; Thermal fracturing during water injection; Use of fracturing during simulation; Stress determination; Waste storage.

5. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	(100%)
1. Class Assessment	
(i) Class Participation	05
(ii) Class Attendance	05
(iii) Class Tests/Assignment/Presentation	20
2. Examination	
(i) Final Examination	70

6. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes (CO) of the Course		Program Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories relating to physical properties of rocks, deformation and failure of rocks under tension, uniaxial compression, triaxial compression	√											
2	Apply the knowledge to design underground and open pit mine, borehole for petroleum production		√										
3	Evaluate the design requirement for mining and petroleum structures from rock engineering point of view.			√									
4	Analyze of design parameters of various rock engineering structures.				√								

7. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Physical properties of rock; Reservoir Geomechanics**	
Lecture-1	Density, porosity, elastic wave velocity and dynamic elastic constants, permeability of rock	
Lecture-2	Permeability measurement at field scale, expansion coefficient	
Lecture-3	Introduction to poroelasticity theory	

Week-2	**Wakening Mechanism of rocks, Deformation and failure of rock under tension; Reservoir Geomechanics**	CT-1; CT-2
Lecture-4	Weakening mechanism of rocks	
Lecture-5	Why tension? How to measure tensile strength of rock?	
Lecture-6	Reservoir compaction	
Week-3	**Deformation and failure of rock under uniaxial compression; Reservoir Geomechanics**	
Lecture-7	Criterion of crack growth, Fracture toughness, Stable and unstable crack growth	
Lecture-8	Why uniaxial? Uniaxial compression test, Analysis of result	
Lecture-9	Reservoir compaction	
Week-4	**Deformation and failure of rock under uniaxial compression; Reservoir Geomechanics**	
Lecture-10	Axial stress, axial strain, lateral strain and volumetric strain relationship of rock	
Lecture-11	Dilatancy. Mode and process of failure. Growth of inclined crack under compressive stress	
Lecture-12	Linear elastic model and inelastic effects	
Week-5	**Deformation and failure of rock under triaxial compression; Reservoir Geomechanics**	
Lecture-13	Why triaxial compression? How to perform triaxial compression test? Experimental procedure	
Lecture-14	The characteristic of stress and strain curves. Why confining pressure hinders nucleation of secondary cracks. Failure criterion of rock. Physical meaning of columb's criterion	
Lecture-15	Surface subsidence; Stress evolution during production	
Week-6	**Deformation and failure of rock under triaxial compression; Reservoir Geomechanics**	
Lecture-16	Crack growth under triaxial compression	
Lecture-17	Effect of pore fluid, Law of effective stress	
Lecture-18	Compaction as a drive mechanism; Stress effects on porosity and permeability	
Week-7	**Rock stresses; Borehole stability**	
Lecture-19	Methods of stress measurements in fields. Stress controlled instability	
Lecture-20	Borehole stability: Diagnostics; Critical mud weight limits to prevent hole collapse and mud losses	
Lecture-21	Borehole stability: Diagnostics; Critical mud weight limits to prevent hole collapse and mud losses	
Week-8	**Rock stresses; Borehole stability**	
Lecture-22	Rock mass characterization	
Lecture-23	Stability of deviated and horizontal holes	
Lecture-24	Effects of temperature and mud composition on borehole stability	
Week-9	**Rock stresses;**	
Lecture-25	Slope stability	
Lecture-26	Sand and Particle Production; Basic mechanisms	
Lecture-27	Sand and Particle Production; Basic mechanisms	
Week-10		
Lecture-28	Roof control plan	

Lecture-29	Effects of plasticity; Modeling of borehole stability	CT-3; CT-4
Lecture-30	Effects of plasticity; Modeling of borehole stability	
Week-11		
Lecture-31	Design of entry, Pillar, and bolt systems	
Lecture-32	Volumetric sand production	
Lecture-33	Volumetric sand production	
Week-12		
Lecture-34	Stresses around excavations	
Lecture-35	Sand control; Sand prediction	
Lecture-36	Sand control; Sand prediction	
Week-13		
Lecture-37	Convergence and stress measurements	
Lecture-38	Hydraulic Fracturing: Initiation and growth of hydraulic fractures; Thermal fracturing during water injection	
Lecture-39	Use of fracturing during simulation; Stress determination; Waste storage.	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Materials recommended:

1. Rock Mechanics for underground mining, BHG Brady and ET Brown. 2004, 628 pp.
2. Fundamentals of Rock Mechanics. JC Jaeger, NGW Cook and RW Zimmerman. 2007, 475 pp.
3. Supplied materials.

EECE 272: Electrical and Electronic Engineering Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Electrical & Electronic Engineering is a fascinating field, and one which could make your time at unique challenging, enriching and rewarding experience. Just as the world needs its Doctors, Nurses and Teachers, Electrical Engineering is something which we simply couldn't do without. If you like the idea of creating electrical systems which could help millions of people on a day-to-day basis, like the systems used in phones, or computers, then read these reasons to study Electrical & Electronic Engineering.

Objective:

1. Be successful in understanding, formulating, analyzing and solving a variety of electrical engineering problems.
2. Be successful in operating and designing a variety of engineering systems, products or experiments.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Electrical and Electronic Engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Electrical and Electronic Engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Electrical and Electronic Engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Electrical and Electronic devices by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

1. Construction and operation of simple electrical circuit
2. Verification of KVL & KCL.
3. Verification of superposition theorem.
4. Verification of thevenin’s theorem.

5. Familiarization with alternating current (ac) waves.
6. Study of R-L-C series circuit.
7. Different types of filters and its characteristics with different input frequency.
8. Series resonance and parallel resonance.
9. Study of diode characteristics.
10. Study of diode rectifier circuit.
11. Study of N-P-N CB (Common Base) transistor characteristics.
12. Study of N-P-N CE (Common Emitter) transistor characteristics

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Electrical and Electronic Engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Electrical and Electronic Engineering demonstrated through appropriate and relevant		√										

	assessment												
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Electrical and Electronic uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Electrical and Electronic devices by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule: Lecture Topic

Lecture	Experiments
Week-1	Construction and operation of simple electrical circuit
Week-2	Verification of KVL & KCL
Week-3	Verification of superposition theorem
Week-4	Verification of thevenin’s theorem
Week-5	Familiarization with alternating current (ac) waves
Week-6	Study of R-L-C series circuit
Week-7	Quiz
Week-8	Different types of filters and its characteristics with different input frequency
Week-9	Series resonance and parallel resonance
Week-10	Study of diode characteristics
Week-11	Study of diode rectifier circuit
Week-12	Study of N-P-N CB (Common Base) transistor characteristics
Week-13	Study of N-P-N CE (Common Emitter) transistor characteristics
Week-14	Quiz

Text and Reference Books:

1. Basic Electrical and Electronics Engineering by Sabyasachi Bhattacharya
2. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N.O. Sadiku
3. The Engineering Handbook by Richard C. Dorf

4. Electromagnetism for Electronic Engineers by Richard Geoffrey Carter
5. Industrial Electrical Troubleshooting by Lynn Lundquist
6. Wire Bonding in Microelectronics: Materials, Processes, Reliability, and Yield by George G. Harman

PME 216: Rock Mechanics Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

1. **Rationale:**

The module is to determine the engineering properties as well as characterization of rocks considering different in-situ conditions of mining and petroleum fields as an engineering point of view.

2. **Objective:**
    1. To determine engineering properties of rock considering different in-situ conditions.
    2. To determine in-situ moisture content of rocks in a coal mine.
    3. To determine fracture-influence on permeability of rocks.
    4. To determine dynamic properties of rocks.
    5. To determine strength of irregular shaped rock samples.
    6. To determine slaking properties of sedimentary rocks.
    7. To determine properties of joints in rocks.
    8. To determine stress-strain relationship in the formation to estimate the sand production tendency.
    9. To determine shear modulus (dynamic), and bulk compressibility (dynamic) of the formation.
    10. To carry out scanning electron microscope (SEM) and X-ray diffraction analyses to determine the cementing materials such as calcite, dolomite, illite, mixed-layer clay, chlorite, and others.
    11. To determine uniaxial compressive strength of the formation to estimate the sand production tendency.
    12. To perform Anelastic Strain Recovery (ASR) testing to predict the direction of the in-situ stresses in the formation.
    13. To have idea about the directional acoustic measuring devices, such as the circumferential acoustic scanning tool (CAST) and the borehole televiewer (BHTV) to know how the devices can run on wireline to observe natural and induced fractures that intersect the borehole wall.

3. **Course Learning Outcomes (CO):**

On successful completion of this course students will be able to:

1) To determine the engineering properties as well as characterization of rocks considering different in-situ conditions of mining and petroleum fields as an engineering point of view.
2) Apply a critical-thinking and problem-solving approach using engineering properties of rock towards mining and petroleum engineering fields.

3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development.
4) Approaches and strategies for the assessment and quantification of reservoir formation properties.
5) Analysis the data of directional devices to determine fractures in reservoir.

4. Course Contents:

1. Determination of engineering properties of rock considering different in-situ conditions.
2. Determination of in-situ moisture content of rocks in a coal mine.
3. Determination of fracture-influence on permeability of rocks.
4. Determination of dynamic properties of rocks.
5. Determination of strength of irregular shaped rock samples.
6. Determination of slaking properties of sedimentary rocks.
7. Determination of properties of joints in rocks.
8. Determination of stress-strain relationship in the formation to estimate the sand production tendency.
9. Determination of shear modulus (dynamic), and bulk compressibility (dynamic) of the formation.
10. Scanning electron microscope (SEM) and X-ray diffraction analyses to determine the cementing materials such as calcite, dolomite, illite, mixed-layer clay, chlorite, and others.
11. Determination of Uniaxial Compressive Strength of the formation to estimate the sand production tendency.
12. Perform Anelastic Strain Recovery (ASR) testing to predict the direction of the in-situ stresses in the formation.
13. Demonstration of directional acoustic measuring devices, such as the circumferential acoustic scanning tool (CAST) and the borehole televiewer (BHTV), in order to know how the devices can run on wireline to observe natural and induced fractures that intersect the borehole wall.

5. Teaching-Learning Strategy:

- Class Lectures
- Experiment
- Exercise
- Group Project
- Class Tests
- Assignments
- Presentation

6. Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/ Report Writing/ Project Work/ Assignment	50
Quiz Test	30
Viva Voce	10

7. Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	To determine the engineering properties as well as characterization of rocks considering different in-situ conditions of mining and petroleum fields as an engineering point of view	√											
2.	Apply a critical-thinking and problem-solving approach using engineering properties of rock towards mining and petroleum engineering fields		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Approaches and strategies for the assessment and quantification of reservoir formation properties					√							
5.	Analysis the data of directional devices to determine fractures in reservoir				√								

8. Lecture Schedule:

Lecture	Experiments
Week-1	Determination of engineering properties of rock considering different in-situ conditions
Week-2	
Week-3	Determination of in-situ moisture content of rocks in a coal mine
Week-4	Determination of fracture-influence on permeability of rocks

Week-5	Determination of dynamic properties of rocks
Week-6	Determination of strength of irregular shaped rock samples
Week-7	(Quiz) + Determination of slaking properties of sedimentary rocks
Week-8	Determination of properties of joints in rocks
Week-9	Determination of stress-strain relationship in the formation to estimate the sand production tendency
Week-10	Determination of shear modulus (dynamic), and bulk compressibility (dynamic) of the formation
Week-11	Scanning electron microscope (SEM) and X-ray diffraction analyses to determine the cementing materials such as calcite, dolomite, illite, mixed-layer clay, chlorite, and others
Week-12	Determination of Uniaxial Compressive Strength of the formation to estimate the sand production tendency
Week-13	Perform Anelastic Strain Recovery (ASR) testing to predict the direction of the in-situ stresses in the formation
Week-14	(Quiz) + Demonstration of directional acoustic measuring devices, such as the circumferential acoustic scanning tool (CAST) and the borehole televiewer (BHTV), in order to know how the devices can run on wireline to observe natural and induced fractures that intersect the borehole wall, (Quiz)

9. Methods and materials:

1. Laboratory experiments
2. Supplied materials

PME 218: Drilling Fluid Laboratory

1.50 Contact Hour; 0.75 Credit Hour

Pre-requisite: None

Rationale:

Drilling engineering is a subset of petroleum engineering. Drilling engineers design and implement procedures to drill wells as safely and economically as possible. They work closely with the drilling contractor, service contractors, and compliance personnel, as well as with geologists and other technical specialists

Objective:

1. To introduce students to basic concepts, theories, principles and overview of drilling
2. Expose students to the various drilling facilities onshore and offshore and rig set-up
3. Introduce students to the history of drilling, drilling terminologies and drilling methodologies
4. Show students the basic concept of drilling operation and process
5. Present and explain the fundamental and basic calculations in drilling
6. Identify potential drilling problems, means for prevention and mitigation

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to drilling engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of drilling engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of drilling engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize drilling design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable drilling system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the drilling engineering practice

9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

1. Preparation of Drilling Fluid by Blender and Determination of mud density by Mud Balances
2. Determination of mud viscosity by Marsh Funnel Viscometer
3. Determination of mud viscosity by Rheometer
4. Determination of mud P^H by P^H meters
5. Determination of mud Resistivity by Resistivity Meters
6. Determination of mud filtration tendency by Filter Press unit

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to drilling engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of drilling engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of drilling uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize drilling design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable drilling system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics,								√				

	responsibilities and the norms of the drilling engineering practice												
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Experiments
Week-1	Preparation of Drilling Fluid by Blender and Determination of mud density by Mud Balances
Week-2	
Week-3	Determination of mud viscosity by Marsh Funnel Viscometer
Week-4	
Week-5	Determination of mud viscosity by Rheometer
Week-6	
Week-7	Quiz
Week-8	
Week-9	Determination of mud P^H by P^H meters
Week-10	
Week-11	Determination of mud Resistivity by Resistivity Meters
Week-12	
Week-13	Determination of mud filtration tendency by Filter Press unit
Week-14	Quiz

Text and Reference Books:

1. Fundamentals of Drilling Engineering by Robert F. Mitchell and Stefan Z. Miska
2. Applied Drilling Engineering by T. Bourgoyne Jr, K.K. Millheim, M.E. Chenevert & F.S. Young Jr
3. Managed Pressure Drilling by Barkim Demirdal

4. Advanced Drilling and Well Technology by Bernt Aadnoy, Iain Cooper, Stefan Miska, Robert F. Mitchell, and Michael L. Payne
5. Advanced Well Control by David Watson, Terry Brittenham and Preston L. Moore

Level-2, Term-2

CSE 271: Introduction to Computer Programming

2.00 Contact Hour; 2.00 Credit Hour

Pre-requisite: None

Rationale:

Computer science is present in every aspect of modern society. The course looks to build on any coding skills that primary students might have acquired while offering insight into possible future studies in computer science and software engineering.

Objective:

Formulating algorithmic solutions to problems and implementing algorithms in C.

1. Notion of operation of a CPU, Notion of an algorithm and computational procedure, editing and executing programs in Linux.
2. Understanding branching, iteration and data representation using arrays.
3. Modular programming and recursive solution formulation.
4. Understanding pointers and dynamic memory allocation.
5. Understanding miscellaneous aspects of C.
6. Comprehension of file operations.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Computer Programming founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Computer Programming demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Computer Programming uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize program by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Introduction to Computer Fundamentals: Types and generation of computer, Basic organization and functional units; Input, output and memory devices; Keyboard, Mouse, CD ROM, Printers, Floppy disk, Hard disk, Magnetic tape, etc.

Software and Application: Types of software, System software, Applications software, Operating systems.

High Level Programming Language: Programming algorithms and flow chart. Information representation in digital computers. Elements of computer structures and languages. Principles of programming, Structured programming and Object oriented programming concepts. Writing, Debugging and running programs: Variables, Data Types, Operators and Expressions, Control flow, Procedures and Functions, Arrays, Records, Pointers input/output system, Graphics.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Computer Programming founded on a theory based understanding of	√											

	mathematics and the natural and physical sciences												
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Computer Programming demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Computer Programming uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize program by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		
Lecture-1	Introduction to Computer Fundamentals: Types and generation of computer	
Lecture-2	Basic organization and functional units	
Week-2		
Lecture-3	Input, output and memory devices; Keyboard, Mouse	
Lecture-4	CD ROM, Printers, Floppy disk, Hard disk, Magnetic tape, etc	CT-1
Week-3		
Lecture-5	Software and Application: Types of software, System software, Applications software, Operating systems	
Lecture-6	Software and Application: Types of software, System software, Applications software, Operating systems	

Week-4		
Lecture-7	Software and Application: Types of software, System software, Applications software, Operating systems	
Lecture-8	Software and Application: Types of software, System software, Applications software, Operating systems	
Week-5		
Lecture-9	High Level Programming Language: Programming algorithms and flow chart	
Lecture-10	Programming algorithms and flow chart	
Week-6		
Lecture-11	Information representation in digital computers	CT-2
Lecture-12	Information representation in digital computers	
Week-7		
Lecture-13	Elements of computer structures and languages	
Lecture-14	Elements of computer structures and languages	
Week-8		
Lecture-15	Principles of programming	
Lecture-16	Principles of programming	
Week-9		
Lecture-17	Structured programming and Object oriented programming concepts	
Lecture-18	Structured programming and Object oriented programming concepts	
Week-10		
Lecture-19	Structured programming and Object oriented programming concepts	
Lecture-20	Writing	
Week-11		
Lecture-21	Debugging and running programs	
Lecture-22	Variables	CT-3
Week-12		
Lecture-23	Data Types	
Lecture-24	Operators and Expressions	
Week-13		
Lecture-25	Control flow	
Lecture-26	Procedures and Functions	
Week-14		
Lecture-27	Arrays, Records	
Lecture-28	Pointers input/output system, Graphics	

Text and Reference Books:

1. ANSI C Programming, Gary J. Bronson, Cengage Learning.
2. Programming in C, Bl Juneja Anita Seth, Cengage Learning.
3. The C programming Language, Dennis Richie and Brian Kernighan, Pearson Education.
4. C Programming-A Problem Solving Approach, Forouzan, Gilberg, Cengage.

5. Programming with C, Bichkar, Universities Press.
6. Programming in C, ReemaThareja, OXFORD.
7. C by Example, Noel Kalicharan, Cambridge.

PME 223: Exploration Geophysics

2.00 Contact Hour; 2.00 Credit Hour

Pre-requisite: None

Rationale:

Exploration geophysics. Exploration geophysics is an applied branch of geophysics, which uses physical methods, such as seismic, gravitational, magnetic, electrical and electromagnetic at the surface of the Earth to measure the physical properties of the subsurface, along with the anomalies in those properties

Objective:

1. Exploration of coal, oil, gas and geothermal energy resources as well as groundwater and mineral deposits,
2. Assessment of earthquake hazards such as strong ground shaking, landslides and liquefaction,
3. Investigation of subsurface for engineering structures,
4. Imaging of the subsurface for environmental hazards.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Exploration Geophysics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Exploration Geophysics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Exploration Geophysics uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize subsurface interpretation by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Gravimetric Technology: Basic principles; Earth gravity field and its variation; Gravity data reduction; Rock and mineral density; Gravity surveying, instrument, type, working principle, calibration.

Magnetic Technology: Basic principles; Geomagnetic field and its variation; Magnetism; Rock and mineral magnetism; Magnetic surveying, instrument, type, working principle, calibration.

Electromagnetic Technology: Basic principles; Rock and mineral electromagnetism; Electromagnetic surveying, instrument, type, working principle, calibration.

Seismic Technology: The nature of seismic data; What is propagating? ; What causes seismic reflections and how they relate to rock properties including pore filling material ; The wavelet in the seismic data and its limit of resolution ; Seismic velocities as they relate to rock properties and the imaging process ; The relationship between seismic velocities and pore pressure ; Pore pressure prediction ; Seismic data processing and seismic migration ; Prestack, poststack, time and depth imaging ; Direct hydrocarbon indicators and AVO ; Seismic inversion for rock and fluid properties ; Seismic attributes ; Time lapse reservoir monitoring (4D seismic surveys); Recent developments in seismic acquisition, processing, and interpretation.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Exploration Geophysics founded on a theory based understanding of	√											

	mathematics and the natural and physical sciences												
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Exploration Geophysics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Exploration Geophysics uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize subsurface interpretation by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		CT-1
Lecture-1	**Gravimetric Technology:** Basic principles; Earth gravity field and its variation; Gravity data reduction	
Lecture-2	Rock and mineral density	
Week-2		
Lecture-3	Gravity surveying	
Lecture-4	instrument, type working principle, calibration	
Week-3		
Lecture-5	**Magnetic Technology:** Basic principles; Geomagnetic field and its variation; Magnetism	
Lecture-6	Rock and mineral magnetism	
Week-4		

Lecture-7	Magnetic surveying	
Lecture-8	instrument, type, working principle, calibration	
Week-5		
Lecture-9	**Electromagnetic Technology:** Basic principles	
Lecture-10	Rock and mineral electromagnetism	
Week-6		
Lecture-11	Electromagnetic surveying	
Lecture-12	Instrument, type, working principle, calibration	
Week-7		
Lecture-13	**Seismic Technology:** The nature of seismic data; What is propagating?	
Lecture-14	What causes seismic reflections and how they relate to rock properties including pore filling material	
Week-8		
Lecture-15	The wavelet in the seismic data and its limit of resolution	
Lecture-16	Seismic velocities as they relate to rock properties and the imaging process	CT-2
Week-9		
Lecture-17	The relationship between seismic velocities and pore pressure	
Lecture-18	Pore pressure prediction	
Week-10		
Lecture-19	Seismic data processing and seismic migration	
Lecture-20	Prestack, poststack, time and depth imaging	
Week-11		
Lecture-21	Direct hydrocarbon indicators and AVO	
Lecture-22	Seismic inversion for rock and fluid properties	
Week-12		
Lecture-23	Seismic inversion for rock and fluid properties	
Lecture-24	Seismic attributes	
Week-13		
Lecture-25	Time lapse reservoir monitoring (4D seismic surveys)	CT-3
Lecture-26	Time lapse reservoir monitoring (4D seismic surveys)	
Week-14		
Lecture-27	Recent developments in seismic acquisition, processing, and interpretation	
Lecture-28	Recent developments in seismic acquisition, processing, and interpretation	

Text and Reference Books:

1. Exploration Geophysics by Mamdouh R. Gadallah • Ray Fisher
2. Seismic Amplitude by Rob Simm & Mike Bacon
3. Geology & Geophysics in Oil Exploration by Mahmoud Sroor
4. Field Geophysics by John Milsom

ME 271: Fluid Mechanics

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.

Objective:

1. The course on fluid mechanics is devised to introduce fundamental aspects of fluid flow behavior.
2. Students will learn to develop steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Fluid Mechanics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Fluid Mechanics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Fluid Mechanics uncertainty and data management validated against national or international standards

Course Contents:

Introduction: Fundamental concepts, Viscosity, Compressibility, Surface tension and capillarity, Vapor pressure, Manometers and other pressure measuring devices.

Fluid Statics: Pressure at a point, pressure gradient, Pressure on flat and curved surfaces immersed in fluids, center of pressure. Buoyancy and flotation, Metacentre and metacentric height, Stability of submerged and floating bodies.

Kinematics of Fluid Flow: Velocity and acceleration of fluid particles, types of fluid flow, systems and control volumes; one and two dimensional flow; continuity equation. Eulers' equation and Bernoulis' equation. Energy equation with or without losses, comparison of energy equation with Bernaullis equation, kinetic energy correction factor. Flow measuring devices. Flow through sharp edged orifice, the pitot tube, the venturi-meter, the flow nozzle and orifice meter.

Dimensional Analysis: Fundamental and derived units, Buckinghum theorem, significance of dimensionless numbers, Application of dimensional analysis in fluid flow problems.

Fluid Machinery: Introduction to roto-dynamic and positive displacement machinery; Euler's pump turbine equation. Degrees of reaction. Impulse and reaction turbine classification; performance of Pelton wheel, Francis turbine and Kaplan turbine; characteristic curves, governing of turbines, selections and model test of turbine.

Reciprocating Compressors: Work of compression; Single stage compressor; Multistage compressor with inter cooling; Volumetric efficiency.

Centrifugal Compressors: Principle of operation, work done and pressure rise, Velcoity diagram for centrifugal compressor, Slip factor, Stage pressure rise, Loading coefficient, Diffuser, Degree of reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, Centrifugal Compressor characteristic curves.

Reciprocating Pumps: Working principle of reciprocating pump. Types of reciprocating pumps, Work done by reciprocating pump; Co-efficient of discharge, Slip, Cavitation of reciprocating pumps; Effect of acceleration of piston on velocity and pressure in the suction and delivery pipes.

Centrifugal Pumps: Work done and efficiency of centrifugal pumps, Advantage over reciprocating pumps, Types of centrifugal pumps, Characteristics curves. Priming, Troubles and remedies, Specific speed. Pumps in series and in parallel, Multistage pumps, Turbine pump, Selection of pumps.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Fluid Mechanics founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Fluid Mechanics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Fluid Mechanics uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Introduction**: Fundamental concepts, Viscosity, Compressibility, Surface tension and capillarity	
Lecture-2	Vapor pressure, Manometers and other pressure measuring devices	
Lecture-3	**Fluid Statics**: Pressure at a point, pressure gradient, Pressure on flat and curved surfaces immersed in fluids, center of pressure	
Week-2		
Lecture-4	Buoyancy and flotation	
Lecture-5	Metacentre and metacentric height	
Lecture-6	Stability of submerged and floating bodies	
Week-3		
Lecture-7	**Kinematics of Fluid Flow**: Velocity and acceleration of fluid particles, types of fluid flow, systems and control volumes	
Lecture-8	One and two dimensional flow; continuity equation	
Lecture-9	Eulers' equation and Bernoulis' equation	
Week-4		
Lecture-10	Energy equation with or without losses, comparison of energy equation with Bernaullis equation, kinetic energy correction factor	
Lecture-11	Flow measuring devices	
Lecture-12	Flow through sharp edged orifice, the pitot tube, the venturi-meter, the flow nozzle and orifice meter	
Week-5		CT-2
Lecture-13	**Dimensional Analysis**: Fundamental and derived units, Buckinghum theorem, significance of dimensionless numbers	
Lecture-14	Application of dimensional analysis in fluid flow problems	
Lecture-15	**Fluid Machinery**: Introduction to roto-dynamic and positive displacement machinery; Euler's pump turbine equation. Degrees of reaction	
Week-6		
Lecture-16	Impulse and reaction turbine classification	
Lecture-17	performance of Pelton wheel	
Lecture-18	Francis turbine and Kaplan turbine	
Week-7		
Lecture-19	Characteristic curves, governing of turbines	
Lecture-20	selections and model test of turbine	
Lecture-21	**Reciprocating Compressors**: Work of compression	
Week-8		
Lecture-22	Single stage compressor	
Lecture-23	Multistage compressor with inter cooling	
Lecture-24	Volumetric efficiency	
Week-9		
Lecture-25	**Centrifugal Compressors**: Principle of operation, work done and pressure rise, Velcoity diagram for centrifugal compressor, Slip factor	

Lecture-26	Stage pressure rise, Loading coefficient	CT-3
Lecture-27	Diffuser, Degree of reaction	
Week-10		
Lecture-28	Effect of impeller blade profile	
Lecture-29	Pre-whirl and inlet guide vanes	
Lecture-30	Centrifugal Compressor characteristic curves	
Week-11		
Lecture-31	**Reciprocating Pumps**: Working principle of reciprocating pump	
Lecture-32	Types of reciprocating pumps	
Lecture-33	Work done by reciprocating pump	
Week-12		
Lecture-34	Co-efficient of discharge, Slip	
Lecture-35	Cavitation of reciprocating pumps	
Lecture-36	Effect of acceleration of piston on velocity and pressure in the suction and delivery pipes	
Week-13		CT-4
Lecture-37	**Centrifugal Pumps**: Work done and efficiency of centrifugal pumps, Advantage over reciprocating pumps, Types of centrifugal pumps	
Lecture-38	Characteristics curves. Priming	
Lecture-39	Troubles and remedies, Specific speed	
Week-14		
Lecture-40	Pumps in series and in parallel	
Lecture-41	Multistage pumps	
Lecture-42	Turbine pump, Selection of pumps	

Text and Reference Books:

1. Fundamentals of fluid mechanics by Bruce Roy Munson and Donald F. Young
2. A Textbook of Fluid Mechanics and Hydraulic Machines by R. K. Bansal
3. Engineering Fluid Mechanics by C. T. Crowe, Donald F. Elger, and John A. Roberson
4. Transport Phenomena by Edwin N. Lightfoot, Robert Byron Bird, and Warren E. Stewart

PME 227: Mining System

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

1. **Rationale:**

To understand the principles and procedures of extracting minerals economically from surface and subsurface conditions.

2. **Objectives:**

1. To understand and carry out the steps of mineral exploration and the methods of reserve estimation.
2. To understand the basics of mining system.
3. To calculate and analyze slope stability for open pit mine.
4. To calculate and analyze the pit limit and stripping ratio.
5. To design mechanical excavation.
6. To analyze and design underground excavations of different mining systems.
7. To analyze strata control of a mine.
8. To understand the mechanics of subsidence.
9. To analyze subsidence damage.
10. To understand about the basics technologies of CBM, UCG and SCG methods.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories and calculations of mineral exploration.

2. Apply the knowledge to design underground and open pit mine systems.

3. Evaluate the design requirement of underground and open pit mining systems from rock engineering point of view.

4. Analyze of design parameters of underground and open pit mining structures.

4. Course Contents:

Mineral exploration: Regional and detail exploration, Resource and reserve; Relation between resource, reserve and exploration. Methods of reserve estimation.

Basics of mining system: Unit operations; Rock breakage; Principles of rock penetration and application, Blasting; zones of detonation, Effective energy release, Blast geometry, Mechanical excavation.

Open Pit Mining System:

An overview of open pit mining methods. Bench geometry. Typical workings of an open pit mine. Pit limit and stripping ratio. Slope stability. Mechanical excavations.

Underground Mining Systems: Methods (classification and selection). Equipment selection. Technical issues of a mine under water; Support systems: Strata movement, Strata behavior, Setting load, Support components and accessories, Support configurations and their effects, Support and component loading; Strata control in coal mines: Characteristics of coal measure strata, Premining stresses in rock, Theories of mechanics of strata behavior, Modern concept of strata pressure redistribution, Manifestation of strata pressure, Effects of mining parameters on strata control, Roof falls and fracture systems due to mining; Mine subsidence: Mechanics of development of subsidence, Engineering parameters of subsidence, Subsidence monitoring, magnitude of subsidence, Subsidence damage, Measurement of subsidence.

Coal Bed Methane (CBM) and Underground Coal Gasification (UCG) Subsurface Cultivation and Gasification (SCG): Principles and technologies.

5. **Teaching-learning and Assessment Strategy:**

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	**(100%)**
1. Class Assessment	
(i) Class Participation	05
(ii) Class Attendance	05
(iii) Class Tests/Assignment/Presentation	20
2. Examination	
(i) Final Examination	70

6. **Mapping of Course Outcomes (CO) and Program Outcomes (PO):**

Course Outcomes (CO) of the Course		**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories and calculations of mineral exploration.	√											
2	Apply the knowledge to design underground and open pit mine systems.		√										
3	Evaluate the design requirement of underground and open pit mining systems from rock engineering point of view.			√									

4	Analyze of design parameters of underground and open pit mining structures.				√								

7. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Mineral exploration**	
Lecture-1	Regional ad detail exploration	CT-1; CT-2
Lecture-2	Resource and reserve; Relation between resource, reserve and exploration	
Lecture-3		
Week-2	**Mineral exploration**	
Lecture-4	Methods of exploration and reserve estimation.	
Lecture-5		
Lecture-6		
Week-3	**Basics of mining system**	
Lecture-7	Unit operations	
Lecture-8	Rock breakage	
Lecture-9	Principles of rock penetration and application	
Week-4	**Basics of mining system**	
Lecture-10	Blasting; zones of detonation, Effective energy release	
Lecture-11	Blast geometry	
Lecture-12	Principles of Mechanical excavation	
Week-5	**Open Pit Mining System**	
Lecture-13	An overview of open pit mining methods	
Lecture-14	Bench geometry. Typical workings of an open pit mine	
Lecture-15	Pit limit and stripping ratio	
Week-6	**Open Pit Mining System**	
Lecture-16	Pit limit and stripping ratio	
Lecture-17	Slope stability	
Lecture-18		
Week-7	**Rock stresses; Borehole stability**	
Lecture-19	Mechanical excavations: principles	
Lecture-20	Mechanical excavations: selection of machineries	
Lecture-21		
Week-8	**Underground Mining Systems**	CT-3; CT-4
Lecture-22	Methods (classification and selection)	
Lecture-23		
Lecture-24		
Week-9	**Underground Mining Systems: Support systems**	
Lecture-25	Strata movement and strata behavior	
Lecture-26		
Lecture-27	Support components and accessories	
Week-10	**Underground Mining Systems: Support systems**	
Lecture-28	Support configurations and their effects	
Lecture-29		

Lecture-30		
Week-11	**Underground Mining Systems: Strata control in coal mine**	
Lecture-31	Premining stresses in rock	
Lecture-32	Theories of strata behavior	
Lecture-33	Fracture systems due to mining	
Week-12	**Underground Mining Systems: Mine subsidence**	
Lecture-34	Mechanics of subsidence development	
Lecture-35		
Lecture-36	Engineering parameters of subsidence	
Week-13	**Underground Mining Systems: Mine subsidence**	
Lecture-37	Subsidence monitoring	
Lecture-38	Measurement of subsidence	
Lecture-39	Analysis of subsidence data	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Materials recommended:

1) Rock Mechanics for Underground Mining; BHG Brady and ET Brown. 2004, 628 pp.
2) Mining. Boky. 1967, 753 pp.
3) Introduction to Mining Engineering; HL Hartman, JM Mutmansky.
4) Underground Mining Methods: Engineering Funadamentals and International Case Studies; WA Hustrulid, William A Hustruid, R C Bullock.
5) Open pit Mine Planning and design;William A Hustruid, M Kuchta, RK Martin.
6) Supplied materials.

PME 229: Strength of Materials

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Diploma holders in this course are required to analyze reasons for failure of different components and select the required material for different applications. For this purpose, it is essential to teach them concepts, principles, applications and practices covering stress, strain, bending moment, shearing force, shafts, columns and springs. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles in the solution of applied problems to develop the required competencies.

Objective:

1. To Provide the basic concepts and principles of strength of materials and to give an ability to analyze a given problem in a simple manner
2. To give an ability to calculate stresses and deformations of objects under external forces

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Strength of Materials founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Strength of Materials demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Strength of Materials uncertainty and data management validated against national or international standards

Course Contents:

Simple Stress and Strain: Introduction, Analysis of internal forces. Tension, Compression, Shear stress, Axial stress in composites. Shearing, Bending, Centrifugal and thermal stresses, Strain and deformation, Stress-strain diagram, Elasticity and elastic limits.

Modulus of Elasticity and Rigidity: Definition of some mechanical properties of materials, Poission’s ratio, Volumetric strain and bulk modulus. Relation between modulus of elasticity and bulk modulus, Statically indeterminate members. Stresses in thin walled pressure vessels.

Statically Determinate Beams: Introduction, Different types of loading and supports, Shear force and bending moment diagram, Various types of stresses in beams, Flexure formula, Economic sections, Shearing stress in beam, General shear formula, Deflection of beams, Elastic curve, Method of double integration, Area moment and super-position methods, Shearing stress and deflection in composite beams.

Statically Indeterminate Beams: Redundant supports in propped and restrained beams, Solution by double integration. Area moment and superposition methods. Design of restrained beams, Continuous beams. The three moment equation, Determination of support reactions of continuous beam, Shear and moment diagram.

Torsion: Torsion formula, Angle of twist of solid and hollow shaft, Torsional stiffness and equivalent shaft, Classed coil helical spring.

Combined Stresses and Strains: Principal stresses and principal planes, Combined axial and bending stresses, Stress at a point, Stress on inclined cutting planes, Analytical method for the determination of stresses on oblique section, Mohr’s circle, Application of Mohr’s circle to combined loading. Transformation of strain components, Strain rosette. Relation between modulus of rigidity and modulus of elasticity.

Column Theory: Introduction to elastic stability, Euler’s formula for central load and different end conditions, Modes of failure and critical load, Slenderness ratio and classification of columns, Empirical formula for columns, secant formula for columns with eccentric loading.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Strength of Materials founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Strength of Materials demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Strength of Materials uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		
Lecture-1	**Simple Stress and Strain**: Introduction, Analysis of internal forces. Tension, Compression, Shear stress, Axial stress in composites. Shearing, Bending, Centrifugal and thermal stresses	
Lecture-2	Strain and deformation, Stress-strain diagram	CT-1
Lecture-3	Elasticity and elastic limits	
Week-2		
Lecture-4	**Modulus of Elasticity and Rigidity:** Definition of some mechanical properties of materials	
Lecture-5	Poission's ratio	

Lecture-6	Volumetric strain and bulk modulus	
Week-3		
Lecture-7	Relation between modulus of elasticity and bulk modulus	
Lecture-8	Statically indeterminate members	
Lecture-9	Stresses in thin walled pressure vessels	
Week-4		
Lecture-10	**Statically Determinate Beams**: Introduction, Different types of loading and supports, Shear force and bending moment diagram	
Lecture-11	Various types of stresses in beams	
Lecture-12	Flexure formula, Economic sections	
Week-5		CT-2
Lecture-13	Shearing stress in beam	
Lecture-14	General shear formula	
Lecture-15	Deflection of beams	
Week-6		
Lecture-16	Elastic curve, Method of double integration	
Lecture-17	Area moment and super-position methods	
Lecture-18	Shearing stress and deflection in composite beams	
Week-7		
Lecture-19	**Statically Indeterminate Beams**: Redundant supports in propped and restrained beams	
Lecture-20	Solution by double integration	
Lecture-21	Area moment and superposition methods	
Week-8		
Lecture-22	Design of restrained beams, Continuous beams	
Lecture-23	Design of restrained beams, Continuous beams	
Lecture-24	The three moment equation	
Week-9		CT-3
Lecture-25	Determination of support reactions of continuous beam	
Lecture-26	Determination of support reactions of continuous beam	
Lecture-27	Shear and moment diagram	
Week-10		
Lecture-28	**Torsion:** Torsion formula, Angle of twist of solid and hollow shaft,	
Lecture-29	Torsional stiffness and equivalent shaft	
Lecture-30	Classed coil helical spring	
Week-11		
Lecture-31	**Combined Stresses and Strains**: Principal stresses and principal planes, Combined axial and bending stresses, Stress at a point, Stress on inclined cutting planes	
Lecture-32	Analytical method for the determination of stresses on oblique section	
Lecture-33	Mohr's circle	
Week-12		
Lecture-34	Application of Mohr's circle to combined loading	
Lecture-35	Transformation of strain components, Strain rosette	
Lecture-36	Relation between modulus of rigidity and modulus of elasticity.	
Week-13		CT-4
Lecture-37	**Column Theory**: Introduction to elastic stability	

Lecture-38	Euler's formula for central load and different end conditions	
Lecture-39	Modes of failure and critical load	
Week-14		
Lecture-40	Slenderness ratio and classification of columns	
Lecture-41	Empirical formula for columns, secant formula for columns with eccentric loading	
Lecture-42	Empirical formula for columns, secant formula for columns with eccentric loading	

Text and Reference Books:

1. Strength of materials by singer and pytel
2. A Textbook of Strength of Materials by R. K. Bansal
3. SOM by Birinder Singh,; Katson Publishing House,
4. SOM by RS Khurmi; S.Chand & Co;
5. Elements of SOM by D.R. Malhotra & H.C.Gupta; Satya Prakashan,

Hum 271: Sociology

2.00 Contact Hour; 2.00 Credit Hour

Pre-requisite: None

Rationale:

Sociology is of great importance in the solution of social problems. The present world is suffering from many problems that can be solved through scientific study of the society. It is the task of sociology to study the social problems through the methods of scientific research and to find out solution to them.

Objective:

1. To train students to understand and to interpret objectively the role of social processes, social institutions and social interactions in their lives.
2. To enable students to cope effectively with the socio-cultural and interpersonal processes of a constantly changing complex society.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Sociology founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Sociology demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Sociology uncertainty and data management validated against national or international standards

Course Contents:

Emergence and Early Development of Sociology: History and Scope of Sociology. Sociological Perspective-Three major perspectives. Social forces in the development of sociology: French revolution, industrial revolution and the rise of capitalism. Development of sociology in Bangladesh.

Sociological Research Methods: Sociology as science, Scientific method for sociology, Basic sociological research concepts. Ethics in sociological research.

Societies, Culture and Environment: Culture: Concept, Elements, and Types, Cultural lag, Culture's roots, Diversity of cultures, Subculture, Counter-culture, Cultural conflict, Nature and culture. Societies: Society as a subjunctive reality, The individual and the society. Types of society: From hunting-gathering to post-modern society. Tribal societies in Bangladesh and their social development, Rural-urban family structure. Environment: The ideology of environmental domination, The human nature of nature, The encounter of development and environment-sustainability, Climate change and vulnerability of Bangladesh.

Socialization Process, Education and Personality: Meaning of socialization; Socialization agents: Family, School, Gang, Mass media etc. Personality, Personality traits, Development of personality, Type A behavior pattern, Hostility, Modification of hostility. Educational Institute in contemporary society, Education and social control, The educational system's functions, Education and gender.

Social Stratification and Work Division: Work and work division, Theory of classes and class stratification. Class, Status and Power, Lifestyle and Social mobility. Companies and organization in the digital era, Environment and engineering psychology–Fatigue, Job analysis, Pros and cons of bureaucracy. Leadership and group dynamic, Work organization in the company, Taylorism, Fordism, Post-Fordism, Toyotism; Unemployment: Social characteristics and problems.

Globalization, Sustainability Concept: Understanding the concept of sustainability and its degree in the development of Bangladesh, Ecological footprint, Sustainable consumption. Impact of globalization on poor, Supporting rural development and natural resources, Consequences of mining and excessive energy uses on the climate change.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Sociology founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Sociology demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Sociology uncertainty and data management validated against national or international standards				√								

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Emergence and Early Development of Sociology**: History and Scope of Sociology. Sociological Perspective-Three major perspectives	
Lecture-2	Social forces in the development of sociology: French revolution, industrial revolution and the rise of capitalism. Development of sociology in Bangladesh	
Week-2		
Lecture-3	**Sociological Research Methods**: Sociology as science, Scientific method for sociology	
Lecture-4	Basic sociological research concepts. Ethics in sociological research.	

Week-3		
Lecture-5	**Societies, Culture and Environment**: Culture: Concept, Elements, and Types, Cultural lag, Culture's roots, Diversity of cultures, Subculture, Counter-culture, Cultural conflict, Nature and culture. Societies: Society as a subjunctive reality, The individual and the society. Types of society: From hunting-gathering to post-modern society.	
Lecture-6	Tribal societies in Bangladesh and their social development	
Week-4		
Lecture-7	Rural-urban family structure. Environment: The ideology of environmental domination	
Lecture-8	The human nature of nature	
Week-5		
Lecture-9	The encounter of development and environment-sustainability	
Lecture-10	Climate change and vulnerability of Bangladesh.	
Week-6		
Lecture-11	**Socialization Process, Education and Personality**: Meaning of socialization; Socialization agents: Family, School, Gang, Mass media etc.	CT-2
Lecture-12	Personality, Personality traits, Development of personality	
Week-7		
Lecture-13	Type A behavior pattern	
Lecture-14	Hostility, Modification of hostility.	
Week-8		
Lecture-15	Educational Institute in contemporary society, Education and social control	
Lecture-16	The educational system's functions, Education and gender.	
Week-9		
Lecture-17	**Social Stratification and Work Division**: Work and work division, Theory of classes and class stratification. Class, Status and Power, Lifestyle and Social mobility. Companies and organization in the digital era	
Lecture-18	Environment and engineering psychology–Fatigue, Job analysis	
Week-10		
Lecture-19	Pros and cons of bureaucracy. Leadership and group dynamic	
Lecture-20	Work organization in the company	
Week-11		
Lecture-21	Taylorism, Fordism, Post-Fordism, Toyotism	
Lecture-22	Unemployment: Social characteristics and problems.	CT-3
Week-12		
Lecture-23	**Globalization, Sustainability Concept**: Understanding the concept of sustainability and its degree in the development of Bangladesh	
Lecture-24	Understanding the concept of sustainability and its degree in the development of Bangladesh	
Week-13		
Lecture-25	Ecological footprint	
Lecture-26	Sustainable consumption. Impact of globalization on poor	
Week-14		
Lecture-27	Supporting rural development and natural resources	

Lecture-28	Consequences of mining and excessive energy uses on the climate change.	

Text and Reference Books:

1. The Sociological Imagination by C. Wright Mills
2. The Social Construction of Reality by Peter L. Berger and Thomas Luckmann
3. Economy and Society by Max Weber

CSE 272: Computer Programming Sessional

1.50 Contact Hour; 0.75 Credit Hour

Pre-requisite: None

Rationale:

Computer science is present in every aspect of modern society. The course looks to build on any coding skills that primary students might have acquired while offering insight into possible future studies in computer science and software engineering.

Objective:

Formulating algorithmic solutions to problems and implementing algorithms in C.

1. Notion of operation of a CPU, Notion of an algorithm and computational procedure, editing and executing programs in Linux.
2. Understanding branching, iteration and data representation using arrays.
3. Modular programming and recursive solution formulation.
4. Understanding pointers and dynamic memory allocation.
5. Understanding miscellaneous aspects of C.
6. Comprehension of file operations.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Computer Programming founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Computer Programming demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Computer Programming uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize program by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Developing Algorithm and Programming for:
1) Solution of quadratic equation
2) Solution of sets of linear equation by Gauss elimination method
3) Solution of non-linear equation by Newton Rapson method

4) Numerical solution of differential equations
5) Evaluation of numerical integration of functions by Simpsons Rules
6) Evaluation of numerical integration of functions by Trapezium Rules

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Computer Programming founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Computer Programming demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical			√									

	evidence and the scientific approach to knowledge development												
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Computer Programming uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize program by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Experiments
Week-1	Solution of quadratic equation
Week-2	
Week-3	Solution of sets of linear equation by Gauss elimination method
Week-4	
Week-5	Solution of non-linear equation by Newton Rapson method
Week-6	
Week-7	Quiz
Week-8	Numerical solution of differential equations
Week-9	
Week-10	Evaluation of numerical integration of functions by Simpsons Rules
Week-11	
Week-12	Evaluation of numerical integration of functions by Trapezium Rules
Week-13	
Week-14	Quiz

Text and Reference Books:

1. ANSI C Programming, Gary J. Bronson, Cengage Learning.
2. Programming in C, Bl Juneja Anita Seth, Cengage Learning.
3. The C programming Language, Dennis Richie and Brian Kernighan, Pearson Education.
4. C Programming-A Problem Solving Approach, Forouzan, Gilberg, Cengage.
5. Programming with C, Bichkar, Universities Press.
6. Programming in C, ReemaThareja, OXFORD.
7. C by Example, Noel Kalicharan, Cambridge.

PME 224: Exploration Geophysics Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Exploration geophysics. Exploration geophysics is an applied branch of geophysics, which uses physical methods, such as seismic, gravitational, magnetic, electrical and electromagnetic at the surface of the Earth to measure the physical properties of the subsurface, along with the anomalies in those properties

Objective:

1. Exploration of coal, oil, gas and geothermal energy resources as well as groundwater and mineral deposits,
2. Assessment of earthquake hazards such as strong ground shaking, landslides and liquefaction,
3. Investigation of subsurface for engineering structures,
4. Imaging of the subsurface for environmental hazards.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Exploration Geophysics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Exploration Geophysics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Exploration Geophysics uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize subsurface interpretation by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Acquisition of seismic data: (Field trip in BAPEX, GSB)

1. Perform acquisition of 2D seismic data in onshore
2. Perform acquisition of 3D seismic data in onshore
3. Perform acquisition of 2D seismic data in offshore
4. Perform acquisition of 3D seismic data in offshore

Processing of seismic data: (BAPEX, GSB lab)

1. Processing of onshore raw 2D seismic data
2. Processing of onshore raw 3D seismic data
3. Processing of offshore raw 2D seismic data
4. Processing of offshore raw 3D seismic data

Interpretation of seismic data:

1. Case study: Interpretation of onshore 2D seismic data
2. Case study: Interpretation of onshore 3D seismic data
3. Case study: Interpretation of offshore 2D seismic data
4. Case study: Interpretation of offshore 3D seismic data

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Exploration Geophysics founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of		√										

	Exploration Geophysics demonstrated through appropriate and relevant assessment												
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Exploration Geophysics uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize subsurface interpretation by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule: Lecture Topic

Lecture	Experiments
Week-1	Perform acquisition of 2D seismic data in onshore
Week-2	Perform acquisition of 3D seismic data in onshore
Week-3	Perform acquisition of 2D seismic data in offshore
Week-4	Perform acquisition of 3D seismic data in offshore
Week-5	Processing of onshore raw 2D seismic data
Week-6	Processing of onshore raw 3D seismic data
Week-7	Quiz
Week-8	Processing of offshore raw 2D seismic data
Week-9	Processing of offshore raw 3D seismic data
Week-10	Case study: Interpretation of onshore 2D seismic data
Week-11	Case study: Interpretation of onshore 3D seismic data
Week-12	Case study: Interpretation of offshore 2D seismic data
Week-13	Case study: Interpretation of offshore 3D seismic data
Week-14	Quiz

Text and Reference Books:

1. Exploration Geophysics by Mamdouh R. Gadallah • Ray Fisher

2. Seismic Amplitude by Rob Simm & Mike Bacon
3. Geology & Geophysics in Oil Exploration by Mahmoud Sroor
4. Field Geophysics by John Milsom

PME 228: Mining System Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

1. **Rationale:**

The module is to determine the optimum model by numerical analysis considering different influencing factors and to prepare physical models of surface and underground mines.

2. **Objective:**
    1. To perform slope stability analysis.
    2. To analyze and prepare surface and underground mine models by numerical analysis.
    3. To calculate and analyze to design optimum support system of mines.
    4. To analyze and determine the stress field effects on mining openings.
    5. To analyze the effects of in-homogeneity in stability of mine openings.
    6. To analyze and determine the effect of plane of weakness on stability of openings of mine.
    7. To prepare physical models on different mining systems.

3. **Course Learning Outcomes (CO):**

On successful completion of this course students will be able to:

1) Apply a critical-thinking and problem-solving approach using engineering properties of rock considering different influencing factors to tackle different engineering issues of mining fields.
2) Apply theoretical and analytical skills to prepare mine models.
3) Apply the analysis outcomes to prepare physical models.

4) Course Contents:

1. **Numerical modeling;** 1. Slope stability 2. Modeling surface and underground mine, 3. Support design of openings, 4. Stress filed consideration, 5. Effects of multiple materials, 6. Effects of weak planes on stability.

2. **Physical modeling;** 7. Room and pillar, 8. Long wall mining, 9. Open pit mining, 10. UCG method, 11. Skip shaft.

5) Teaching-Learning Strategy:

- Class Lectures
- Numerical analysis
- Group Project
- Class Tests
- Assignments
- Presentation

6) Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/ Report Writing/ Project Work/ Assignment	50
Quiz Test	30
Viva Voce	10

7) Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Apply a critical-thinking and problem-solving approach using engineering properties of rock considering different influencing factors to tackle different engineering issues of mining fields	√	√										
2.	Apply theoretical and analytical skills to prepare mine models				√	√							
3.	Apply the analysis outcomes to prepare physical models			√						√			

8. Lecture Schedule:

Lecture		Experiments
Week-1	**Numerical modeling**	Slope stability
Week-2		Modeling surface and underground mine
Week-3		Support design of openings
Week-4		Stress filed consideration
Week-5		Effects of multiple materials
Week-6		Effects of weak planes on stability
Week-7	Quiz	
Week-8	**Physical modeling**	1. Room and pillar 2. Long wall mining 3. Open pit mining 4. UCG method 5. Skip shaft
Week-9		
Week-10		
Week-11		
Week-12		
Week-13		
Week-14	Quiz	

9. Methods and materials:

1. Numerical analysis
2. Preparation of physical models
3. Supplied materials

ME 272: Fluid Mechanics Laboratory

1.50 Contact Hour; 0.75 Credit Hour

Pre-requisite: None

Rationale:

To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.

Objective:

1. The course on fluid mechanics is devised to introduce fundamental aspects of fluid flow behavior.
2. Students will learn to develop steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Fluid Mechanics founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Fluid Mechanics demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Fluid Mechanics uncertainty and data management validated against national or international standards

Course Contents:

1. Verification of Bernoulli’s equation.
2. Determination of coefficient of discharge by orifice.
3. Determination of coefficient of discharge by venturimeter.
4. Determination of head loss due to friction, bend, sudden expansion, sudden contraction, in gate and globe valves.
5. Performance test of pumps.
6. Performance test of compressor, fan, blower

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Fluid Mechanics founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Fluid Mechanics demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and				√								

	strategies for the assessment and quantification of Fluid Mechanics uncertainty and data management validated against national or international standards												

Lecture Schedule:

Lecture	Experiments
Week-1	Verification of Bernoulli's equation.
Week-2	
Week-3	Determination of coefficient of discharge by orifice.
Week-4	
Week-5	Determination of coefficient of discharge by venturimeter
Week-6	
Week-7	Quiz
Week-8	
Week-9	Determination of head loss due to friction, bend, sudden expansion, sudden contraction, in gate and globe valves
Week-10	
Week-11	Performance test of pumps.
Week-12	
Week-13	Performance test of compressor, fan, blower
Week-14	Quiz

Text and Reference Books:

1. Fundamentals of fluid mechanics by Bruce Roy Munson and Donald F. Young
2. A Textbook of Fluid Mechanics and Hydraulic Machines by R. K. Bansal
3. Engineering Fluid Mechanics by C. T. Crowe, Donald F. Elger, and John A. Roberson
4. Transport Phenomena by Edwin N. Lightfoot, Robert Byron Bird, and Warren E. Stewart

Level-3, Term-1

PME 311: Mine Instrumentation and Machinery

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

1. **Rationale:**

To understand the principles and procedures to select mine instruments and machineries, and their applicable conditions.

2. **Objectives:**

1. To understand the principles and applications fields of mine monitoring instruments.
2. To understand the mine transportation system and layouts.
3. To analyze and design mine machineries for surface and underground mine.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the principles of mine instruments.
2. Understand the theories and calculations of mine machineries.
3. Evaluate the design requirements of mine machineries.
4. Analyze the design parameters of mine machineries.
5. Apply the knowledge to design mine instruments and machineries.

4. Course Contents:

Mine Monitoring instruments: Stress meter, Extensometer and field strain , Joint meter, Vibrating ware sensor and micro-seismic sensor, Hydraulic sensor and piezometer, Optical sensor and electrical sensor

Mine Machinery: Fundamental concepts of equipment economics. Planning for earthwork construction. Dozers: performance characteristics, pushing materials, land clearing, ripping rock. Scapers: Operations, types, performance charts, production cycle. Excavators; Front shovels, hoes, loaders. Tracks and hauling equipment; capacities, size affects productivity, Performance calculation, Safety. Cranes; mobile cranes, tower cranes, rigging, Safety. Draglines and clamshells; description, factors affecting production.

Maintenance of Mining Machinery: Maintenance management and safety, CAD, remote monitoring and control in mines and automation.

Classification of Mine Transport Systems and Layouts: Techno-economics Indices, transport by gravity. Underground conveyor transport, scraper chain conveyor, belt conveyor, special belt conveyor (cable belt) shaker and vibrating conveyors. Scrapper haulage.

Rail Track: Construction of rail track, mines car, choice of car, resistant to motion of car, motion of car under gravity, man-riding cars. Rope haulage: Equipment of rope of haulage, rope haulage calculations, scope of application of a rope haulage.

Locomotive Haulage: Types of mine locomotives. Load haul dumpers. Trackless mining concepts, shuttle cars, mine trucks and their application.

Underground Hydraulics: Hydraulic breaking, theory of transportation, hydraulic transportation by gravity and by pumps, equipment. Stowing material, transport.

Aerial Ropeway: construction of aerial ropeway, principle of rope way, calculation plan and profile of ropeways.

5. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	**(100%)**
1. Class Assessment	
(i) Class Participation	05
(ii) Class Attendance	05
(iii) Class Tests/Assignment/Presentation	20
2. Examination	
(i) Final Examination	70

6. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes (CO) of the Course		**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the principles of mine instruments	√											
2	Understand the theories and calculations of mine machineries.		√										
3	Evaluate the design requirements of mine machineries.		√										
4	Analyze the design parameters of mine machineries.				√								
5	Apply the knowledge to design mine instruments and machineries.			√									

7. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Mine Monitoring instruments**	CT-1; CT-2
Lecture-1	Stress meter	
Lecture-2	Extensometer and field strain	
Lecture-3	Joint meter	
Week-2	**Mine Monitoring instruments**	
Lecture-4	Vibrating ware sensor and micro-seismic sensor	
Lecture-5	Hydraulic sensor and piezometer	
Lecture-6	Optical sensor and electrical sensor	
Week-3	**Mine Machinery**	
Lecture-7 Lecture-8	Fundamental concepts of equipment economics	
Lecture-9	Planning for earthwork construction	
Week-4	**Mine Machinery: Dozers**	
Lecture-10 Lecture-11 Lecture-12	Dozers: performance characteristics, pushing materials, land clearing, ripping rock, analysis of design parameters, and selection criterion of dozer	
Week-5	**Mine Machinery: Scrapers**	
Lecture-13 Lecture-14 Lecture-15	Scrapers: Operations, types, performance charts, production cycle, analysis of design parameters, selection criterion of scrapers	
Week-6	**Mine Machinery: Excavators**	
Lecture-16 Lecture-17 Lecture-18	Front shovels, hoes, loaders. Tracks and hauling equipment; capacities, size affects productivity, Performance calculation, Safety, analysis of design parameters, Selection of excavators	
Week-7	**Mine Machinery: cranes**	
Lecture-19 Lecture-20 Lecture-21	Cranes; mobile cranes, tower cranes, rigging, safety, analysis of design parameters, Selection of cranes	
Week- 8	**Min Machinery: Draglines**	CT-3; CT-4
Lecture-22 Lecture-23 Lecture-24	Draglines and clamshells; description, factors affecting production, analysis of design parameters, selection of draglines and clamshells	
Week-9	**Maintenance of Mining Machinery**	
Lecture-25 Lecture-26 Lecture-27	Maintenance management and safety, CAD, remote monitoring and control in mines and automation	
Week-10	**Classification of Mine Transport Systems and Layouts**	
Lecture-28 Lecture-29 Lecture-30	Techno-economics Indices, transport by gravity. Underground conveyor transport, scraper chain conveyor, belt conveyor, special belt conveyor (cable belt) shaker and vibrating conveyors. Scrapper haulage	
Week-11	**Rail Track**	
Lecture-31	Construction of rail track, mines car, choice of car, resistant to	

Lecture-32	motion of car, motion of car under gravity, man-riding cars	
Lecture-33		
Week-12	**Rope haulage, Aerial ropeway**	
Lecture-34	Equipment of rope of haulage, rope haulage calculations, scope of application of a rope haulage	
Lecture-35		
Lecture-36	Construction of aerial ropeway, principle of rope way, calculation plan and profile of ropeways	
Week-13	**Locomotive Haulage, Underground Hydraulics**	
Lecture-37	Types of mine locomotives. Load haul dumpers. Trackless mining concepts, shuttle cars, mine trucks and their application	
Lecture-38	Hydraulic breaking, theory of transportation, hydraulic transportation by gravity and by pumps, equipment. Stowing material, transport	
Lecture-39		
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Books recommended:

1. SME Mining Engineering Handbook; SME.

2. Surface and underground excavations; RR tatiya.

3. Mining Engineering; Boky

4. Supplied materials.

PME 313: Shaft Sinking and Tunneling

3.00 Contact Hour; 3.00 Credit Hour;

Pre-requisite: None

4. **Rationale:**

To understand the principles and methods of the site preparation, initial construction of vertical and lateral development of underground opening.

5. **Objectives:**

1. To understand about the options and principles to choose the openings to access mineral deposits.
2. To understand the principles of shaft location selection.
3. To understand the shaft sinking methods.
4. To calculate and analyze the shaft sinking by freezing method.
5. To calculate and design the hoisting system
6. To calculate and design the dewatering system.
7. To calculate and design tunnel driving and boring.

6. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories and calculations of location selection, supports, hoisting system, and dewatering system.
2. Evaluate the design requirements for shaft sinking and tunneling.
3. Analyze the design parameters of shaft sinking and tunneling.
4. Apply the knowledge to design shaft sinking and tunneling methods.

4. Course Contents:

Access to mineral deposit: Vertical shaft, inclined shaft, adit, tunnel, drift, etc. Advantages and disadvantages. Factors affect the choice of the openings.

Shaft locations, stress and supports: Factors to choose shaft location. Shaft models; advantages and disadvantages. Optimum locations of shaft. Pressure on shaft wall. Theory of side pressure formation. Theory of cylinder wall. Supports.

Shafts sinking methods: Shape and size of Shaft. Surface plants. Shaft sinking methods; conventional and unconventional. Freezing method; Principles. Physical and mechanical characteristics of frozen rocks. Refrigerants. Diameter of periphery and number of boreholes.

Refrigerative equipment ability and its work time. Temperature of freezing pipe. Ice wall thickness.

Hoisting system: Components. Hoisting types. Design of hoisting system. Total tension in hoisting rope. Maximum static load. Maximum dynamic load.

Dewatering system: Principles. Mine pumps. Pumps in series. Pumps in parallel. Selection of mine pumps.

Different shaft-sinking technologies: Mine entries. Horizontal, inclined and vertical development workings. Shaft sinking and tunneling (drifting). Evaluation of ground conditions.

Methods of tunnel driving and boring: Principles, Estimation of support requirements: Types of support and materials for supporting, etc.

8. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	**(100%)**
3. Class Assessment	
(iv) Class Participation	05
(v) Class Attendance	05
(vi) Class Tests/Assignment/Presentation	20
4. Examination	
(ii) Final Examination	70

9. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes (CO) of the Course		**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories and calculations of location selection, supports, hoisting system, and dewatering system	√											
2	Evaluate the design requirements for shaft sinking and tunneling		√										
3	Analyze the design parameters of shaft sinking and tunneling				√								
4	Apply the knowledge to design shaft sinking and tunneling methods			√									

10. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Access to mineral deposit**	CT-1; CT-2
Lecture-1	Vertical shaft	
Lecture-2		
Lecture-3	Inclined shaft	
Week-2	**Access to mineral deposit**	
Lecture-4	Adit	
Lecture-5	Ttunnel, drift	
Lecture-6	Factors affect the choice of the openings	
Week-3	**Shaft locations, stress and supports**	
Lecture-7	Factors to choose shaft location	
Lecture-8	Shaft models	
Lecture-9	Optimization of shaft location	
Week-4	**Shaft locations, stress and supports**	
Lecture-10	Pressure on shaft wall.	
Lecture-11	Theory of side pressure formation. Theory of cylinder wall.	
Lecture-12	Supports	
Week-5	**Shafts sinking methods**	
Lecture-13	Shape and size of Shaft. Surface plants.	
Lecture-14	Shaft sinking methods; conventional and unconventional.	
Lecture-15	Freezing method; Principles. Physical and mechanical characteristics of frozen rocks	
Week-6	**Shafts sinking methods**	
Lecture-16	Refrigerants. Diameter of periphery and number of boreholes	
Lecture-17	Refrigerative equipment ability and its work time	
Lecture-18	Temperature of freezing pipe. Ice wall thickness	
Week-7	**Hoisting system**	
Lecture-19	Components	
Lecture-20	Hoisting types	
Lecture-21	Total tension in hoisting rope	
Week- 8	**Hoisting system**	
Lecture-22	Maximum static load	
Lecture-23	Maximum dynamic load	
Lecture-24	Design of hoisting system	
Week-9	**Dewatering system**	CT-3; CT-4
Lecture-25	Principles of dewatering system	
Lecture-26	Mine pumps	
Lecture-27	Pumps in series. Pumps in parallel.	
Week-10	**Dewatering system**	
Lecture-28	Calculation and design of mine pumps	
Lecture-29		
Lecture-30		
Week-11	**Different shaft-sinking technologies**	
Lecture-31	Mine entries	

Lecture-32 Lecture-33	Horizontal, inclined and vertical development workings	
Week-12	**Different shaft-sinking technologies**	
Lecture-34	Shaft sinking and tunneling (drifting).	
Lecture-35 Lecture-36	Evaluation of ground conditions.	
Week-13	**Methods of tunnel driving and boring**	
Lecture-37	Principles	
Lecture-38 Lecture-39	Estimation of support requirements: Types of support and materials for supporting, etc.	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Books recommended:

1. Practical Shaft Sinking; F Donaldson.
2. Vertical and Decline Shaft Sinking: Good Practices in Technique and Technology; J Kicki, J Sobczyk, P Kaminski.
3. Introduction to Tunnel Construction; DN Chapman, N Metje, A Stark.
4. Supplied materials.

PME 315: Well Logging and Formation Evaluation

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Well logging, also known as borehole logging is the practice of making a detailed record of a well. A log of the natural radioactivity of the formation along the borehole, measured in API units. Although there are now developed some memory "Open Hole" compact formation evaluation tool combinations.

Objective:

1. Determine Porosity, both primary and secondary (fractures and vugs)
2. Determine permeability
3. Determine water saturation and hydrocarbon movability
4. Determine hydrocarbon type (oil, gas, or condensate)
5. Determine lithology
6. Determine formation (bed) dip and strike
7. Determine sedimentary environment
8. Determine travel times of elastic waves in a formation

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Well Logging and Formation Evaluation founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Well Logging and Formation Evaluation demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Well Logging and Formation Evaluation uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Well Logging and Formation Evaluation design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Well Logging and Formation Evaluation system development solutions with minimum environmental impact and beneficial for society

8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Well Logging and Formation Evaluation practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Well Logging:

Wireline Well Logging: Wirelinewell logging process, tools, sensors, such as gamma ray, resistivity, density and neutron porosity;Open-hole wireline logging; Cased-hole wireline logging; Mobilization.

Theory, Measurement and Interpretation of Well Logs: Electrical resistivity of rocks ; Radioactive and acoustic properties of rocks ; Measurement environment ; Resistivity logs ; The spontaneous potential log ; Gamma ray, neutron, and sonic porosity logs ; Conventional interpretation techniques ; Reconnaissance and pattern-recognition interpretation techniques ; Log interpretation of shaly formations ; Evaluation of gas-bearing formations; Logging objectives ; Invasion profile ; Challenge of borehole geophysics ; Passive electrical properties of earth materials ; Resistivity measuring tools, normal, induction, laterolog ; Reservoir/non-reservoir discrimination ; Matrix-sensitivity logs, GR, SGR, Pe ; Depth measurements and control ; Borehole calipers ; Porosity-mineralogy logs, density, neutron, sonic ; Porosity determination in clean formations ; Formation resistivity factor ; Conductivity of shales ; Porosity log crossplots and mineralogy identification ; Partially saturated rock properties and Archie Equation ; Linear movable oil plot ; Reconnaissance techniques, Rwa, FR/FP, logarithmic scaler ; Logarithmic MOP ; Porosity-resistivity crossplots ; Permeability relationships ; Use of pressure measurements ; Computerized log evaluation ; Recommended logging programs; Simultaneous acoustic and resistivity log (STAR)

Nuclear Magnetic Resonance (NMR): Basics of NMR technology ; Rock typing from NMR core data and its relationship to logs ; Pore geometry and what it means for the interpretation of NMR data ; NMR logs ; Job Planning ; Log Quality Control ; Working with NMR data (various exercises throughout the course)

Structural and Stratigraphic Interpretation of Dipmeters and Borehole-Imaging Logs: Applications and types of dipmeters and borehole images ; Data acquisition and processing ; Quality control and artifacts ; Oil Based Mud and Logging While Drilling Applications ; Generation and use of stereonets and rose diagrams ; Quantitative analysis using cumulative dip plots, vector plots, and SCAT plots ; Fractures, faults, micro-faults, and unconformities ;

Sub-seismic scale faults ; Determination of fracture spacing and fracture porosity ; In situ stress from borehole breakout and drilling induced fractures ; Thin bed analysis and net sand counts ; Carbonate porosity and facies interpretation ; Application of image data in sequence stratigraphy ; Sedimentology from borehole images: burrows, cross beds, scoured surfaces, slumps ; Determination of paleocurrent directions ; Interpretation of borehole images in various depositional settings ; Reservoir characterization using borehole images ; Integration with seismic, NMR, and production logs

Logging While Drilling (LWD): Logging While Drilling process, tools, sensors, such as gamma ray, resistivity, density and neutron porosity.

Formation Evaluation:-

Cased Hole Formation Evaluation: Pulsed Neutron Capture Logs ; Basics of neutron generation and gamma detections and how that leads to sigma ; Basics of calculation of water saturation from sigma ; Methods to correct the saturation calculation for shaliness ; Log-Inject-Log measurements to maximize accuracy ; Why logs from different service companies report different sigma values ; Distinguishing gas from oil ; Estimating porosity ; Use of all the auxiliary traces on the logs ; Use of oxygen activation to determine brine entry ; Use of special modifications of the logs ; Planning to maximize success of log runs ; Carbon/Oxygen logs ? How the logs work ; Deciding when Carbon/ Oxygen logs have a better chance for success ; Planning log runs to maximize chances for success ; New developments that promise improved Carbon/ Oxygen logs best drilled solids removal.

Magnetic Resonance Imaging Analysis: The clay-bound water porosity (MCBW) and total porosity (MPHIT); enhanced permeability calculations ; zones of potential water production ; hydrocarbon-water contacts ; Calculate water saturation in the uninvaded zone ; low-resistivity pay reservoirs ; dual-water Rw by reconstructing spontaneous potential (SP) ; dual-water resistivity model to provide improved water saturation (Sw) calculations, especially in shaly reservoirs ; Determination of bulk volume irreducible (BVI) ; Measurement of movable water ; Quantification of viscous oil reserves ; Estimation of permeability in water-wet reservoirs.

MRI Petrophysics: Simultaneous T1 and T2 log measurement; Magnetic Resonance Imaging Analysis; Time Domain Analysis (TDA); Diffusion Analysis (DIFAN); Heavy oil MRIAN; Combination of magnetic resonance imaging logging analyses and reservoir stimulations;

Volumetric Petrophysics: Formation evaluation computation, weighted least-squares error optimization technique to determine fractional lithology constituents (clay, sandstone, limestone, and other minerals) and the percent of saturation of individual fluid components which occupy total pore space.

Formation Lithology Analysis: CORAL analysis computes water saturation (Sw), lithology, effective porosity (φeff) and relative permeabilities in carbonates and complex lithology reservoirs. CORAL analysis produces an analysis of the lithology in terms of percent volume shale, limestone, dolomite, sandstone, coal, and salt. It includes logic for detection and correction for salt, rugosity, and gas.

Laminated Reservoir Analysis: Resolving gross shale volume percent to high resolution laminated and dispersed clay content; Detection of thin-bed reservoirs ; Improve saturation analysis of the laminated reservoir.

Borehole Image Analysis: Constant dip with depth; Increasing dip with depth: Decreasing dip with depth: Facies profile partitions the reservoir into discrete electrofacies or flow units; Producing electro-facies is a common and valuable operation performed by oil companies to discriminate discrete reservoir components. These components are used to populate reservoir models, flow simulators, determine porosity/permeability relationships, and describe the reservoir. Log interpretation that helps define 3D reservoir facies models describing the distribution of porosity, permeability, and capillary pressure in more detail than is possible with reflection seismology • Determination of the optimal number of clusters, while still allowing the analyst to control the level of detail actually needed to define the electro-facies.

Net to Gross Sand Count: High-resolution net sand and net pay images and curves; Cumulative net sand and net pay curve ; Logic to prevent interpretation of tight streaks as pay ; Interactive histogram based calibration of logging curves ; Accurate sand and net pay counts in laminated sediments of fluvial and turbidite formations.

Anisotropy Analysis: Analyze WaveSonic tool waveform data to identify fast and slow shear wave travel times and their orientation in the formation ; Develop synthetic seismograms to improve 3D seismic analysis and future seismic acquisition ; Identification of compressive fluids in the pore space to maximize completion planning.

Saturation Analysis: Saturation analysis of a single well based on sigma logs; Saturation analysis of a single well based on carbon/oxygen (C/O) logs; Combination of C/O and sigma measurements and is used to calculate saturation when three fluids are present in the reservoir.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Well Logging and Formation Evaluation founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Well Logging and Formation Evaluation demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Well Logging and Formation Evaluation uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Well Logging and Formation Evaluation design and operation by using commercial software that is commonly used in the					√							

	industry to develop competency in the use of technology												
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Well Logging and Formation Evaluation system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Well Logging and Formation Evaluation practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Wireline Well Logging:** Wirelinewell logging process, tools, sensors, such as gamma ray, resistivity, density and neutron porosity	
Lecture-2	Open-hole wireline logging	
Lecture-3	Cased-hole wireline logging; Mobilization	
Week-2		

Lecture-4	**Theory, Measurement and Interpretation of Well Logs**: Electrical resistivity of rocks ; Radioactive and acoustic properties of rocks ; Measurement environment ; Resistivity logs ; The spontaneous potential log ; Gamma ray, neutron, and sonic porosity logs ; Conventional interpretation techniques ; Reconnaissance and pattern-recognition interpretation techniques ; Log interpretation of shaly formations	
Lecture-5	Evaluation of gas-bearing formations; Logging objectives ; Invasion profile	
Lecture-6	Challenge of borehole geophysics ; Passive electrical properties of earth materials	
Week-3		
Lecture-7	Resistivity measuring tools, normal, induction, laterolog ; Reservoir/non-reservoir discrimination	
Lecture-8	Matrix-sensitivity logs, GR, SGR, Pe ; Depth measurements and control	
Lecture-9	Borehole calipers ; Porosity-mineralogy logs, density, neutron, sonic ; Porosity determination in clean formations	
Week-4		
Lecture-10	Formation resistivity factor ; Conductivity of shales ; Porosity log crossplots and mineralogy identification ; Partially saturated rock properties and Archie Equation	
Lecture-11	; Linear movable oil plot ; Reconnaissance techniques, Rwa, FR/FP, logarithmic scaler ; Logarithmic MOP ; Porosity-resistivity crossplots	
Lecture-12	Permeability relationships ; Use of pressure measurements ; Computerized log evaluation ; Recommended logging programs; Simultaneous acoustic and resistivity log (STAR)	
Week-5		CT-2
Lecture-13	**Nuclear Magnetic Resonance (NMR):** Basics of NMR technology ; Rock typing from NMR core data and its relationship to logs	
Lecture-14	Pore geometry and what it means for the interpretation of NMR data ; NMR logs	
Lecture-15	Job Planning ; Log Quality Control ; Working with NMR data (various exercises throughout the course)	
Week-6		
Lecture-16	**Structural and Stratigraphic Interpretation of Dipmeters and Borehole-Imaging Logs:** Applications and types of dipmeters and borehole images ; Data acquisition and processing ; Quality control and artifacts	
Lecture-17	Oil Based Mud and Logging While Drilling Applications ; Generation and use of stereonets and rose diagrams	
Lecture-18	Quantitative analysis using cumulative dip plots, vector plots, and SCAT plots ; Fractures, faults, micro-faults, and unconformities ; Sub-seismic scale faults	
Week-7		
Lecture-19	Determination of fracture spacing and fracture porosity ; In situ stress from borehole breakout and drilling induced fractures ; Thin	

	bed analysis and net sand counts	
Lecture-20	Carbonate porosity and facies interpretation ; Application of image data in sequence stratigraphy ; Sedimentology from borehole images: burrows, cross beds, scoured surfaces, slumps	
Lecture-21	Determination of paleocurrent directions ; Interpretation of borehole images in various depositional settings ; Reservoir characterization using borehole images ; Integration with seismic, NMR, and production logs	
Week-8		
Lecture-22	**Logging While Drilling (LWD):** Logging While Drilling process	
Lecture-23	Tools, sensors, such as gamma ray, resistivity	
Lecture-24	Density and neutron porosity.	
Week-9		CT-3
Lecture-25	**Open and Cased Hole Formation Evaluation:** Pulsed Neutron Capture Logs ; Basics of neutron generation and gamma detections and how that leads to sigma ; Basics of calculation of water saturation from sigma	
Lecture-26	Methods to correct the saturation calculation for shaliness ; Log-Inject-Log measurements to maximize accuracy ; Why logs from different service companies report different sigma values ; Distinguishing gas from oil ; Estimating porosity ; Use of all the auxiliary traces on the logs ; Use of oxygen activation to determine brine entry ; Use of special modifications of the logs	
Lecture-27	Planning to maximize success of log runs, Carbon/Oxygen logs ? How the logs work ; Deciding when Carbon/ Oxygen logs have a better chance for success ; Planning log runs to maximize chances for success ; New developments that promise improved Carbon/ Oxygen logs best drilled solids removal	
Week-10		
Lecture-28	**Magnetic Resonance Imaging Analysis:** The clay-bound water porosity (MCBW) and total porosity (MPHIT); enhanced permeability calculations ; zones of potential water production ; hydrocarbon-water contacts	
Lecture-29	Calculate water saturation in the uninvaded zone ; low-resistivity pay reservoirs ; dual-water Rw by reconstructing spontaneous potential (SP) ; dual-water resistivity model to provide improved water saturation (Sw) calculations, especially in shaly reservoirs ; Determination of bulk volume irreducible (BVI)	
Lecture-30	Measurement of movable water; Quantification of viscous oil reserves; Estimation of permeability in water-wet reservoirs.	
Week-11		
Lecture-31	**MRI Petrophysics:** Simultaneous T1 and T2 log measurement; Magnetic Resonance Imaging Analysis; Time Domain Analysis (TDA); Diffusion Analysis (DIFAN); Heavy oil MRIAN; Combination of magnetic resonance imaging logging analyses and reservoir stimulations	
Lecture-32	**Volumetric Petrophysics**: Formation evaluation computation, weighted least-squares error optimization technique to determine	

	fractional lithology constituents (clay, sandstone, limestone, and other minerals)	
Lecture-33	Percent of saturation of individual fluid components which occupy total pore space.	
Week-12		
Lecture-34	**Formation Lithology Analysis:** CORAL analysis computes water saturation (Sw), lithology, effective porosity (φeff) and relative permeabilities in carbonates and complex lithology reservoirs.	
Lecture-35	CORAL analysis produces an analysis of the lithology in terms of percent volume shale, limestone, dolomite, sandstone, coal, and salt. It includes logic for detection and correction for salt, rugosity, and gas.	
Lecture-36	**Laminated Reservoir Analysis:** Resolving gross shale volume percent to high resolution laminated and dispersed clay content; Detection of thin-bed reservoirs; Improve saturation analysis of the laminated reservoir.	
Week-13		CT-4
Lecture-37	**Borehole Image Analysis:** Constant dip with depth; Increasing dip with depth: Decreasing dip with depth: Facies profile partitions the reservoir into discrete electrofacies or flow units; Producing electro-facies is a common and valuable operation performed by oil companies to discriminate discrete reservoir components.	
Lecture-38	The components used to populate reservoir models, flow simulators, determine porosity/permeability relationships, and describe the reservoir. number of clusters, while still allowing the analyst to control the level of detail actually needed to define the electro-facies.	
Lecture-39	Log interpretation that helps define 3D reservoir facies models describing the distribution of porosity, permeability, and capillary pressure in more detail than is possible with reflection seismology • Determination of the optimal number of cluster	
Week-14		
Lecture-40	**Net to Gross Sand Count:** High-resolution net sand and net pay images and curves; Cumulative net sand and net pay curve ; Logic to prevent interpretation of tight streaks as pay ; Interactive histogram based calibration of logging curves ; Accurate sand and net pay counts in laminated sediments of fluvial and turbidite formations.	
Lecture-41	**Anisotropy Analysis:** Analyze WaveSonic tool waveform data to identify fast and slow shear wave travel times and their orientation in the formation; Develop synthetic seismograms to improve 3D seismic analysis and future seismic acquisition ; Identification of compressive fluids in the pore space to maximize completion planning.	
Lecture-42	**Saturation Analysis:** Saturation analysis of a single well based on sigma logs; Saturation analysis of a single well based on carbon/oxygen (C/O) logs; Combination of C/O and sigma measurements and is used to calculate saturation when three fluids	

	are present in the reservoir.	

Text and Reference Books:

1. Basic Well Log Analysis by George Asquith and Daniel Krygowski

2. Theory, Measurement and Interpretation of Well Logs by Zaki Bassiouni

3. Well Logging II: Electric & Acoustic Logging by James R. Jorden & Frank L. Campbell

4. Well Logging and Formation Evaluation by Toby Darling

PME 317: Drilling Engineering

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Drilling engineering is a subset of petroleum engineering. Drilling engineers design and implement procedures to drill wells as safely and economically as possible. They work closely with the drilling contractor, service contractors, and compliance personnel, as well as with geologists and other technical specialists

Objective:

1. To introduce students to basic concepts, theories, principles and overview of drilling
2. Expose students to the various drilling facilities onshore and offshore and rig set-up
3. Introduce students to the history of drilling, drilling terminologies and drilling methodologies
4. Show students the basic concept of drilling operation and process
5. Present and explain the fundamental and basic calculations in drilling
6. Identify potential drilling problems, means for prevention and mitigation

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to drilling engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of drilling engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of drilling engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize drilling design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable drilling system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the drilling engineering practice

9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Drilling Overview: Rig systems; Hydrostatics; Drill string; Casing; Drilling hydraulics; Cementing; Well control; Pore pressure and fracture gradient; Drill bits; Well planning.

Hydraulic Friction in the Circulating System: Head loss; Laminar flow; Pipe flow; Annular flow; Shear rate and effective viscosity; Laminar pressure loss example; Turbulent pipe flow; Singularity losses.

Removal of Cuttings from Under the Bit: Cuttings removal process; Boundary conditions of the drilling process; Friction loss increases with depth; Annular flow velocity limitations; Optimizing ROP, liner by liner; Optimizing the complete well.

Transport of Cuttings to the Surface: Hole cleaning in vertical wells; Slip velocity of perfect spheres; Slip velocity of imperfect spheres; Hole cleaning in inclinded wells; Mechanistic model; Empirical model; Effect of barite segregation.

Keeping Wellbore within Maximum and Minimum Pressure; ECD-Control: Density control; ECD factors; Mud density vs. temperature and pressure; Annular friction; Effect of cuttings; Surge & swab; Other effects; Temperature variation; Ocean and wellbore temperature profile; Conduction; Convection; Numerical solution.

Keeping the Wellbore Stable: Wellbore stability problems; Filtration control; Mechanical stability; Chemical stability; Swelling of shale; Bit balling; Downhole problems; Inhibitive muds; Oil based muds (OBM); Water based mud (WBM).

Standard Killing Methods: Surface and bottom pressure of a shut in well ; Stabilized pressure just after shut in ; Gas percolation in a closed well ; MAASP ; Estimating kill mud weight and safety factors ; Composition of influxing pore fluid; Hydraulic friction during killing ; Killing by means of Driller’s Method ; Six phases of killing ; Critical pressures during killing ; The Engineer’s Method and kill sheet ; Killing when unable to circulate from bottom.

Deviatory Behavior of Gas: Transport of gas; Gas bubbles; Gas bubble velocity; Well bore pressure during stationary gas flow; Surface pressure during killing; Gas solubility; Solubility in general; Solubility of gas in liquids; Operational problems related to dissolved gas.

Narrow Pressure Window: Lowered mud window in deep wells and in deep water; High annular friction pressure hidden in SICP; Modified killing procedure with BOP on seabed; Killing highly inclined wells.

Special Offshore Safety Issues: Low sea temperature; Hydrates; Gelled mud in cold pipelines; Other deep water problems; Riser Margin and riser disconnect; Gas trapped in BOP or hidden in Riser; Shallow sands below deep water; Shallow water flow; Shallow gas; Killing procedure in shallow sands.

Drilling Practices: Planning including requirements for the completion and testing, AFE preparation; HSE at the rig site; Cost control, evaluating alternative drilling methods and maximizing penetration rate; Hole cleaning, sloughing shale, lost circulation, stuck pipe and fishing operations; Lifting capacity of drilling fluids, pressure losses in the circulating system and ECD; Maximizing hydraulics in the planning phase and at the rig; Bit selection and application; Casing and drill string design, selection of casing seats, BOP equipment; Cement, cement additives and displacement mechanics; Deviation control, directional drilling and horizontal drilling; Pressure control, routine and special problems; Project post analysis.

Drill String Vibration and Mitigation: Axial, lateral, torsional vibration; Vibration mechanism, stick slip, bit bounce, bit whirl, BHA whirl, lateral shocks, torsional resonance, parametric resonance, bit chatter, modal coupling.

Casing and Cementing: Selecting casing & hole sizes; Setting depths; Casing loads; Selecting casing & connections; Casing stress calculations; Selecting appropriate cement slurries; Mud removal & cement placement; Stage cementing, squeezes, & plugs; Preventing gas migration; Cementing calculations; Cementing equipment; Well head equipment.

Stuck Pipe Prevention: Stuck pipe prevention; Rock mechanics; Wellbore stress; Wellbore instability; Trend recognition; Hole cleaning; Differential sticking; Wellbore geometry; Tripping practices; Fishing practices.

Drill String Design and Optimization: Drill string and BHA failure prevention; Low-angle design applications; High-angle design applications; Torque, Drag, and Casing wear mitigation; Vibration monitoring and avoidance; Drill string handling and inspection; Vibration sensors, Vibration operating limit tables.

Directional, Horizontal and Multilateral Drilling: Applications for directional drilling; Directional profiles; Extended reach wells; Survey calculations and accuracy; Dogleg severity calculations and problems associated with doglegs; Planning directional and horizontal wells; Horizontal drilling methods and applications; Logging high angle wells; Hole-cleaning; Multi-laterals; Types of survey instruments; Tools used to deflect a wellbore; Torque and drag calculations; Cementing.

Managing Wellsite Operations: Critical elements of effective planning and management of drilling operations; Design and implement a program “checklist” for critical well drilling operations; Investigate various elements of a drilling operation and mitigate visible and hidden risk; Investigate and perform an analysis of trouble time events, nonproductive time occurrences and invisible lost time for a drilling operation; Dissect the drilling plan and apply total task analysis to wellsite activities; Enhance knowledge of organizational learning systems and transfer lessons learned; Perform technical limit analysis to improve wellsite performance; Measure and performance monitoring of the drilling operation; Maximize the inexperienced resources through total task analysis in a case study to reduce drilling costs and improve safety.

Practical Drilling Skills: Interpretation of mud logger gas units; Determining pore pressure; On-site hydraulic optimization; Selecting proper bit loading (weight on bit and rotary speed) for the fastest, cheapest hole; Interpreting pressure integrity tests; Hole problems (such as, stuck pipe, lost circulation, and ballooning); Borehole stability; Operating guidelines; Drilling fluid properties necessary to maximize drilling performance; Discussion of polymers in drilling fluids; Solids control equipment arrangement to assure best drilled solids removal.

Optimized Pressure Drilling: Managed Pressure Drilling; Rotating Control Devices; Underbalanced Applications.

Special Topics: Advanced Well Control topics causes of kicks, kick detection, shut-in procedures, dual gradient drilling; Unusual well control operations, shallow gas, subsea operations; Underbalanced Drilling, Introduction to UBD, UBD techniques, benefits of UBD equipment, Selecting an appropriate candidate and UBD well engineering; Casing drilling, HPHT, Introduction to Horizontal/Extended Reach/and Multilateral Drilling; Non-conventional drilling methods and equipment including environmental aspects of drilling activities.

Optimization: Drilling Optimization; Drill Bit Optimization; Fluids Optimization; Optimization Software.

Survey Management: At-Bit Inclination Sensor; Compares inclination measured at the bit with inclination measured higher up at the MWD tool; Wellbore Positioning; Directional Survey delivers a comprehensive well positioning approach, generating the necessary risk versus reward analysis and survey program.

Telemetry: Electromagnetic Telemetry; Mud Pulse Telemetry System; MWD/LWD Telemetry Systems.

Mud Logging: Sampling and cuttings analysis; Volume calculations; Advanced sample evaluation; Formation pressures; Borehole problems.

Application of drilling engineering software: Mud design, Casing design, BHA design, Drill String Design, Drill Hydraulics, Rig Floor Simulator.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour

- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to drilling engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of drilling engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of drilling uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize drilling design and operation by using commercial software that is commonly used in the industry to develop competency in the use					√							

	of technology												
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable drilling system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the drilling engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	.	
Lecture-1	**Drilling Overview**: Rig systems; Hydrostatics; Drill string; Casing; Drilling hydraulics; Cementing; Well control; Pore pressure and fracture gradient; Drill bits; Well planning	
Lecture-2	**Hydraulic Friction in the Circulating System**: Head loss; Laminar flow; Pipe flow; Annular flow; Shear rate and effective viscosity; Laminar pressure loss example; Turbulent pipe flow; Singularity losses.	CT-1
Lecture-3	**Removal of Cuttings from Under the Bit:** Cuttings removal process; Boundary conditions of the drilling process; Friction loss	

	increases with depth; Annular flow velocity limitations; Optimizing ROP, liner by liner; Optimizing the complete well.	
Week-2		
Lecture-4	**Transport of Cuttings to the Surface:** Hole cleaning in vertical wells; Slip velocity of perfect spheres; Slip velocity of imperfect spheres; Hole cleaning in inclined wells; Mechanistic model; Empirical model; Effect of barite segregation.	
Lecture-5	**Keeping Wellbore within Maximum and Minimum Pressure; ECD-Control:** Density control; ECD factors; Mud density vs. temperature and pressure; Annular friction; Effect of cuttings; Surge & swab; Other effects; Temperature variation; Ocean and wellbore temperature profile; Conduction; Convection; Numerical solution.	
Lecture-6	**Keeping the Wellbore Stable**: Wellbore stability problems; Filtration control; Mechanical stability; Chemical stability; Swelling of shale; Bit balling; Downhole problems; Inhibitive muds; Oil based muds (OBM); Water based mud (WBM).	
Week-3		
Lecture-7	**Standard Killing Methods:** Surface and bottom pressure of a shut in well ; Stabilized pressure just after shut in ; Gas percolation in a closed well ; MAASP ; Estimating kill mud weight and safety factors ; Composition of influxing pore fluid; Hydraulic friction during killing ; Killing by means of Driller's Method ; Six phases of killing ; Critical pressures during killing ; The Engineer's Method and kill sheet ; Killing when unable to circulate from bottom.	
Lecture-8	**Deviatory Behavior of Gas:** Transport of gas; Gas bubbles; Gas bubble velocity; Well bore pressure during stationary gas flow; Surface pressure during killing; Gas solubility; Solubility in general; Solubility of gas in liquids; Operational problems related to dissolved gas.	
Lecture-9	**Narrow Pressure Window:** Lowered mud window in deep wells and in deep water; High annular friction pressure hidden in SICP; Modified killing procedure with BOP on seabed; Killing highly inclined wells.	
Week-4		
Lecture-10	**Special Offshore Safety Issues:** Low sea temperature; Hydrates; Gelled mud in cold pipelines; Other deep water problems; Riser Margin and riser disconnect; Gas trapped in BOP or hidden in Riser; Shallow sands below deep water; Shallow water flow; Shallow gas; Killing procedure in shallow sands.	
Lecture-11	**Drilling Practices:** Planning including requirements for the completion and testing, AFE preparation; HSE at the rig site; Cost control, evaluating alternative drilling methods and maximizing penetration rate	
Lecture-12	Hole cleaning, sloughing shale, lost circulation, stuck pipe and fishing operations; Lifting capacity of drilling fluids, pressure losses in the circulating system and ECD; Maximizing hydraulics in the planning phase and at the rig; Bit selection and application;	

	Casing and drill string design, selection of casing seats, BOP equipment	
Week-5		CT-2
Lecture-13	Cement, cement additives and displacement mechanics; Deviation control, directional drilling and horizontal drilling; Pressure control, routine and special problems; Project post analysis.	
Lecture-14	**Drill String Vibration and Mitigation:** Axial, lateral, torsional vibration; Vibration mechanism, stick slip, bit bounce, bit whirl, BHA whirl, lateral shocks, torsional resonance, parametric resonance, bit chatter, modal coupling.	
Lecture-15	**Casing and Cementing:** Selecting casing & hole sizes; Setting depths; Casing loads	
Week-6		
Lecture-16	Selecting casing & connections; Casing stress calculations	
Lecture-17	Selecting appropriate cement slurries; Mud removal & cement placement; Stage cementing, squeezes, & plugs; Preventing gas migration	
Lecture-18	Cementing calculations; Cementing equipment; Well head equipment.	
Week-7		
Lecture-19	**Stuck Pipe Prevention:** Stuck pipe prevention; Rock mechanics; Wellbore stress	
Lecture-20	Wellbore instability; Trend recognition; Hole cleaning	
Lecture-21	Differential sticking; Wellbore geometry; Tripping practices; Fishing practices.	
Week-8		
Lecture-22	**Drill String Design and Optimization:** Drill string and BHA failure prevention; Low-angle design applications; High-angle design applications	
Lecture-23	Torque, Drag, and Casing wear mitigation; Vibration monitoring and avoidance	
Lecture-24	Drill string handling and inspection; Vibration sensors, Vibration operating limit tables.	
Week-9		CT-3
Lecture-25	**Directional, Horizontal and Multilateral Drilling:** Applications for directional drilling; Directional profiles; Extended reach wells; Survey calculations and accuracy	
Lecture-26	Dogleg severity calculations and problems associated with doglegs; Planning directional and horizontal wells; Horizontal drilling methods and applications	
Lecture-27	Logging high angle wells; Hole-cleaning; Multi-laterals; Types of survey instruments; Tools used to deflect a wellbore; Torque and drag calculations; Cementing.	
Week-10		
Lecture-28	**Managing Wellsite Operations:** Critical elements of effective planning and management of drilling operations; Design and implement a program "checklist" for critical well drilling operations	
Lecture-29	Investigate various elements of a drilling operation and mitigate	

	visible and hidden risk; Investigate and perform an analysis of trouble time events, nonproductive time occurrences and invisible lost time for a drilling operation	
Lecture-30	Dissect the drilling plan and apply total task analysis to wellsite activities; Enhance knowledge of organizational learning systems and transfer lessons learned; Perform technical limit analysis to improve wellsite performance	
Week-11		
Lecture-31	Measure and performance monitoring of the drilling operation; Maximize the inexperienced resources through total task analysis in a case study to reduce drilling costs and improve safety.	
Lecture-32	**Practical Drilling Skills:** Interpretation of mud logger gas units; Determining pore pressure; On-site hydraulic optimization; Selecting proper bit loading (weight on bit and rotary speed) for the fastest, cheapest hole	
Lecture-33	Interpreting pressure integrity tests; Hole problems (such as, stuck pipe, lost circulation, and ballooning); Borehole stability; Operating guidelines	
Week-12		
Lecture-34	Drilling fluid properties necessary to maximize drilling performance; Discussion of polymers in drilling fluids; Solids control equipment arrangement to assure best drilled solids removal.	
Lecture-35	**Optimized Pressure Drilling:** Managed Pressure Drilling; Rotating Control Devices; Underbalanced Applications.	
Lecture-36	**Special Topics:** Advanced Well Control topics causes of kicks, kick detection, shut-in procedures, dual gradient drilling; Unusual well control operations, shallow gas, subsea operations; Underbalanced Drilling, Introduction to UBD, UBD techniques, benefits of UBD equipment, Selecting an appropriate candidate and UBD well engineering	
Week-13		CT-4
Lecture-37	Casing drilling, HPHT, Introduction to Horizontal/Extended Reach/and Multilateral Drilling; Non-conventional drilling methods and equipment including environmental aspects of drilling activities.	
Lecture-38	**Optimization**: Drilling Optimization; Drill Bit Optimization; Fluids Optimization; Optimization Software.	
Lecture-39	**Survey Management**: At-Bit Inclination Sensor; Compares inclination measured at the bit with inclination measured higher up at the MWD tool; Wellbore Positioning; Directional Survey delivers a comprehensive well positioning approach, generating the necessary risk versus reward analysis and survey program.	
Week-14		
Lecture-40	**Telemetry**: Electromagnetic Telemetry; Mud Pulse Telemetry System; MWD/LWD Telemetry Systems.	
Lecture-41	**Mud Logging:** Sampling and cuttings analysis; Volume calculations; Advanced sample evaluation; Formation pressures; Borehole problems.	

Lecture-42	**Application of drilling engineering software**: Mud design, Casing design, BHA design, Drill String Design, Drill Hydraulics, Rig Floor Simulator.	

Text and Reference Books:

1. Fundamentals of Drilling Engineering by Robert F. Mitchell and Stefan Z. Miska
2. Applied Drilling Engineering by T. Bourgoyne Jr, K.K. Millheim, M.E. Chenevert & F.S. Young Jr
3. Managed Pressure Drilling by Barkim Demirdal
4. Advanced Drilling and Well Technology by Bernt Aadnoy, Iain Cooper, Stefan Miska, Robert F. Mitchell, and Michael L. Payne
5. Advanced Well Control by David Watson, Terry Brittenham and Preston L. Moore

PME 319: Heat Transfer and Mass Transfer

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Heat can be transferred from one place to another by three methods: conduction in solids, convection of fluids (liquids or gases), and radiation through anything that will allow radiation to pass. The method used to transfer heat is usually the one that is the most efficient.

Mass transfer is the net movement of mass from one location, usually meaning stream, phase, fraction or component, to another. Mass transfer occurs in many processes, such as absorption, evaporation, drying, precipitation, membrane filtration, and distillation.

Objective:

Heat Transfer

1. Model basic heat transfer processes and identify modes

2. Calculate thermal resistances

3. Perform an energy balance to determine temperature and heat flux

4. Identify fins and calculate fin performance

5. Use shape factors for 2-D conduction

6. Solve lumped parameter transient heat transfer problems

7. Solve distributed parameter transient heat transfer problems

8. Recognize basic convective heat transfer and apply appropriate methods for quantifying convection

9. Calculate convective heat transfer coefficients for internal flow

10. Calculate convective heat transfer coefficients for external flow

11. Design and size heat exchangers

12. Predict heat exchanger performance

13. Calculate radiation view factors

14. Determine radiation heat transfer

Mass Transfer

1. The objective of this module is to bring in the concept of mass transfer, which is mass in transit as a result of species concentration difference in a mixture.
2. For this module, it is assumed that the student already has a good concept of conduction and convection heat transfer, so that the mass transfer concepts are taught with the help of drawing analogy from heat transfer.
3. It is important for the student to understand the context in which the term mass transfer is used. The student should understand that the driving potential for mass transfer is concentration gradient, and one can obtain a mass transfer flux due the concentration gradient.
4. The student should understand that there are modes of mass transfer that are similar to conduction and convection modes in heat transfer. Equivalent non-dimensional numbers will also be introduced to describe the relative effects of various parameters governing mass transfer.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Heat Transfer and Mass Transfer founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Heat Transfer and Mass Transfer demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Heat Transfer and Mass Transfer uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Heat Transfer and Mass Transfer rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Heat Transfer

Modes of Heat Transfer: Introduction to basic modes of heat transfer.

Conduction: Law of conduction, general heat conduction equation. Steady-state one-dimensional heat conduction: plane wall, cylinder, sphere, composite structures. Straight fins of rectangular and triangular profiles. Consideration of variable thermal conductivity and systems with heat sources. Overall heat transfer coefficient, critical thickness of insulation, thermal contact resistance; Steady State Conduction and Unsteady State Conduction.

Convection: Different types of flow and convection, boundary layer concepts, dimensional analysis of forced and natural convection; Forced Convection and Natural Convection.

Radiation: Basic concept of Radiation; Application in Oil & Gas, mining industries.

Heat Exchanger: Basic types of heat exchanger, LMTD, heat exchanger efficiency, fouling and scaling of exchanger surface, NTU method of heat exchanger design, applications of heat exchangers; Natural gas heater.

Introduction of thermal oil recovery processes: Steam Assisted Gravity Drainage (SAGD) Cyclic Steam Stimulation (CSS), Steamflood, In Situ Combustion and Microwave heating.

Application of heat transfer software:

Mass Transfer

Introduction to Mass transfer operation, Assignment and short type questions; Diffusion: Fick's law of diffusion, Steady state molecular diffusion in fluids under stagnant and laminar flow conditions, Diffusion through variable cross-sectional area, Diffusion coefficient: measurement and prediction, Measurement of liquid-phase diffusion coefficient, Multicomponent diffusion, Diffusivity in solids and its applications, Assignment and short type questions; Mass transfer coefficients: Introduction to mass transfer coefficient, Equimolar counter-diffusion of A and B (NA = -NB), Correlation for convective mass transfer coefficient, Correlation of mass transfer coefficients for single cylinder, Theories of mass transfer, Penetration theory, Surface Renewal Theory, Boundary Layer Theory, Interphase mass transfer theory, Overall mass transfer coefficients,

Absorption and adsorption: Introduction to absorption, Design of packed tower, Design of packed tower based on overall mass transfer coefficient, Counter-current multi-stage absorption (Tray absorber), Continuous contact equipment, Absorption with chemical reaction, Absorption accompanied by irreversible reactions, Absorption resistance,

Distillation: Introduction to distillation, Distillation columns and their process calculations, Continuous distillation columns, Analysis of binary distillation in trayed towers: McCabe-Thele Method, Determination of the stripping section operating line (SOL), Analysis of binary distillation by Ponchon-Savarit Method, Stepwise procedure to determine the number of theoretical trays, Introduction to Multicomponent Distillation,

Humidification and air conditioning: Basic concepts, Adiabatic saturation temperature, Humidification and dehumidification operations and design calculations, Mechanical Draft Towers: forced draft towers and induced draft towers, Design calculations of cooling tower, Key points in the design of cooling tower and Step-by-step design procedure of cooling tower, Evaporation loss of water in cooling tower, Example problems on humidification, Example problems on dehumidification; Multicomponent absorption.

Application of mass transfer software:

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Heat Transfer and Mass Transfer founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Heat Transfer and Mass Transfer demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical			√									

	evidence and the scientific approach to knowledge development												
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Heat Transfer and Mass Transfer uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Heat Transfer and Mass Transfer rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		CT-1
Lecture-1	**Modes of Heat Transfer**: Introduction to basic modes of heat transfer.	
Lecture-2	**Conduction**: Law of conduction, general heat conduction equation. Steady-state one-dimensional heat conduction: plane wall, cylinder, sphere, composite structures. Straight fins of rectangular and triangular profiles.	
Lecture-3	Consideration of variable thermal conductivity and systems with heat sources. Overall heat transfer coefficient, critical thickness of insulation, thermal contact resistance; Steady State Conduction and Unsteady State Conduction.	
Week-2		
Lecture-4	**Convection**: Different types of flow and convection, boundary layer concepts, dimensional analysis of forced and natural convection	
Lecture-5	Forced Convection and Natural Convection	
Lecture-6	**Radiation**: Basic concept of Radiation	
Week-3		
Lecture-7	Application in Oil & Gas, mining industries.	
Lecture-8	**Heat Exchanger**: Basic types of heat exchanger	
Lecture-9	LMTD	
Week-4		
Lecture-10	heat exchanger efficiency	
Lecture-11	Fouling	

Lecture-12	Scaling of exchanger surface	
Week-5		CT-2
Lecture-13	NTU method of heat exchanger design	
Lecture-14	Applications of heat exchangers	
Lecture-15	Natural gas heater	
Week-6		
Lecture-16	Introduction of thermal oil recovery processes	
Lecture-17	Steam Assisted Gravity Drainage (SAGD)	
Lecture-18	Cyclic Steam Stimulation (CSS)	
Week-7		
Lecture-19	Steam flooding	
Lecture-20	In Situ Combustion and Microwave heating.	
Lecture-21	Application of heat transfer software	
Week-8		
Lecture-22	Introduction to Mass transfer operation, Assignment and short type questions; Diffusion: Fick's law of diffusion	
Lecture-23	Steady state molecular diffusion in fluids under stagnant and laminar flow conditions	
Lecture-24	Diffusion through variable cross-sectional area, Diffusion coefficient: measurement and prediction, Measurement of liquid-phase diffusion coefficient	
Week-9		CT-3
Lecture-25	Multicomponent diffusion, Diffusivity in solids and its applications, Assignment and short type questions; Mass transfer coefficients: Introduction to mass transfer coefficient	
Lecture-26	Equimolar counter-diffusion of A and B (NA = -NB), Correlation for convective mass transfer coefficient, Correlation of mass transfer coefficients for single cylinder	
Lecture-27	Theories of mass transfer, Penetration theory, Surface Renewal Theory, Boundary Layer Theory, Interphase mass transfer theory, Overall mass transfer coefficients	
Week-10		
Lecture-28	Absorption and adsorption: Introduction to absorption, Design of packed tower	
Lecture-29	Design of packed tower based on overall mass transfer coefficient, Counter-current multi-stage absorption (Tray absorber)	
Lecture-30	Continuous contact equipment, Absorption with chemical reaction, Absorption accompanied by irreversible reactions, Absorption resistance	
Week-11		
Lecture-31	Distillation: Introduction to distillation, Distillation columns and their process calculations	
Lecture-32	Continuous distillation columns	
Lecture-33	Analysis of binary distillation in trayed towers: McCabe-Thele Method	
Week-12		
Lecture-34	Determination of the stripping section operating line (SOL)	
Lecture-35	Analysis of binary distillation by Ponchon-Savarit Method, Stepwise procedure to determine the number of theoretical trays	

Lecture-36	Introduction to Multicomponent Distillation	
Week-13		CT-4
Lecture-37	Humidification and air conditioning: Basic concepts, Adiabatic saturation temperature	
Lecture-38	Humidification and dehumidification operations and design calculations	
Lecture-39	Mechanical Draft Towers: forced draft towers and induced draft towers, Design calculations of cooling tower	
Week-14		
Lecture-40	Key points in the design of cooling tower and Step-by-step design procedure of cooling tower	
Lecture-41	Evaporation loss of water in cooling tower, Example problems on humidification, Example problems on dehumidification; Multicomponent absorption.	
Lecture-42	Application of mass transfer software	

Text and Reference Books:

1. A heat transfer textbook by John H. Lienhard IV and. John H. Lienhard V
2. Basic Heat Transfer by D.H.Bacon
3. Fundamentals of Heat and Mass. Transfer By FRANK P. INCROPERA
4. Mass-transfer operations by Robert Ewald Treybal

PME 312: Mine Instrumentation and Machineries Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

1. **Rationale:**

The module is to have deep understanding about the instruments for mining and to know about the criterion of mine machineries selection.

2. **Objective:**
    1. To perform test and analyze stress data from stress meter.
    2. To perform test and analyze strains data from extensometer and field strain gauge.
    3. To perform test and analyze displacement data from joint meter.
    4. To perform test and analyze seismic data from seismic sensor.
    5. To perform test and analyze hydraulic pressure data from hydraulic sensor and piezometer.
    6. To perform test and analyze light and electric current data from optical sensor.
    7. To calculate and analyze the selection criterion of mine machineries.

3. **Course Learning Outcomes (CO):**

On successful completion of this course students will be able to:

1) To understand the working principles of mine instruments.
2) To carry out test and analysis data of sensors for mining application.
3) Evaluate the data of sensors to solve mining engineering issues.
4) Calculation and evaluation to select mine instruments and machineries.

5) **Course Contents:**

    a. Stress meter: How to measure the stress in mine area
    b. Extensometer and field strain gauge: How to determine convergence and strain in a mine area
    c. Joint meter: How to monitor joints in a mine area?
    d. Vibrating ware sensor and micro-seismic sensor: How to detect vibration and micro-seismic activities in mine area?
    e. Hydraulic sensor and piezometer: How to detect hydraulic pressure and status of water body in a mine area?
    f. Optical sensor and electrical sensor: How to detect level of light and electric current in a mine area?

Criterion to select machineries in a mine.

6) Teaching-Learning Strategy:

- Class Lectures
- Experiment
- Group Project
- Class Tests
- Assignments
- Presentation

7) Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/ Report Writing/ Project Work/ Assignment	50
Quiz Test	30
Viva Voce	10

8) Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course LearningOutcomes(CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	To understand the working principles of mine instruments	√											
2.	To carry out test and analysis data of sensors for mining application		√			√							
3.	Evaluate the data of sensors to solve mining engineering issues				√								
4.	Calculation and evaluation to select mine instruments and machineries		√										

8. Lecture Schedule:

Lecture	Experiments
Week-1	Stress meter: How to measure the stress in mine area
Week-3	Extensometer and field strain gauge: How to determine convergence and strain in a mine area
Week-5	Joint meter: How to monitor joints in a mine area
Week-7	Vibrating ware sensor and micro-seismic sensor: How to detect vibration and micro-seismic activities in mine area?
Week-9	Hydraulic sensor and piezometer: How to detect hydraulic pressure and status of water body in a mine area
Week-11	Optical sensor and electrical sensor: How to detect level of light and

	electric current in a mine area
Week-13	Criterion to select machineries in a mine
Week-14	Quiz

9. Methods and materials:

1. Experiments
2. Supplied materials

PME 316: Well Logging and Formation Evaluation Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Well logging, also known as borehole logging is the practice of making a detailed record of a well. A log of the natural radioactivity of the formation along the borehole, measured in API units. Although there are now developed some memory "Open Hole" compact formation evaluation tool combinations.

Objective:

1. Determine Porosity, both primary and secondary (fractures and vugs)
2. Determine permeability
3. Determine water saturation and hydrocarbon movability
4. Determine hydrocarbon type (oil, gas, or condensate)
5. Determine lithology
6. Determine formation (bed) dip and strike
7. Determine sedimentary environment
8. Determine travel times of elastic waves in a formation

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Well Logging and Formation Evaluation founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Well Logging and Formation Evaluation demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Well Logging and Formation Evaluation uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Well Logging and Formation Evaluation design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Well Logging and Formation Evaluation system development solutions with minimum environmental impact and beneficial for society

8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Well Logging and Formation Evaluation practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Well Logging:-

1. Introduction of well logging equipment and recording devices and their working principle; Demonstration of data acquisition, processing and interpretation of Spontaneous Potential log (SP).
2. Demonstration of data acquisition, processing and interpretation of Resistivity and Induction log (RT, AT, ILD, ILM, MSFL, SFLU); Demonstration of data acquisition, processing and interpretation of Gamma Ray log (GR, CGR).
3. Demonstration of data acquisition, processing and interpretation of Porosity logs (PHI, NPHI); Demonstration of data acquisition, processing and interpretation of Nuclear Magnetic Resonance log (NMR, MRI)
4. Demonstration of data acquisition, processing and interpretation of Caliper log (CAL, CALI); Demonstration of data acquisition, processing and interpretation of Simultaneous Acoustic and Resistivity log (STAR)
5. Demonstration of data acquisition, processing and interpretation of Sonic log (AC, DT); Demonstration of data acquisition, processing and interpretation of Density log (DRHO, RHOB)

Formation Evaluation:-

1. Estimation of formation porosity (PORO, POR, PORA, PORD, PORF, PORN, PORW); Estimation of formation permeability (K, PERM) ;Estimation of formation water (SW, SWIR) ; Estimation of formation shale content (SH)
2. Reservoir quality measurements of NMR; Light hydrocarbon identification
3. The clay-bound water porosity (MCBW) and total porosity (MPHIT) measurement; Magnetic Resonance Imaging Analysis to determine Permeability, effective porosity, total porosity, water saturation, free water volume, irreducible water volume ; Time Domain Analysis (TDA) for volumetric calculation of gas, oil, and water; formation total and effective porosity; permeability estimation.
4. Diffusion Analysis (DIFAN) to determine Porosity, Sw, diffusion ratios, permeability, watercut (if relative permeabilities are known) ; Residual oil saturation, porosity, permeability, viscosity, flushed zone Sw; Heavy Oil MRI to

determine corrected BVI, clay porosity, total porosity, improved permeability estimates, effective porosity, water saturations, viscosity.

5. Magnetic resonance imaging logging and reservoir stimulations analyses to determine initial production rate, time of recovery, porosity, permeability, Young's modulus, Poisson's ratio optimum NPV for the well ;Analysis of well log to determine Sw, Sxo, Vsh, φeff, lithology, hydrocarbon weight, permeability, plus volumetric percent of selected minerals.
6. Shaly Sand Analysis to determine Sw, Sxo, Vsh, φeff, lithology, hydrocarbon weight, permeability; Complex Lithology Analysis to determine Sw, Sxo, Vsh, φeff, Lithology volume percent, permeability; Laminated Reservoir Analysis to determine Sw, Sxo, VSH, φeff, lithology hydrocarbon weight (oil, gas), permeability.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Well Logging and Formation Evaluation founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach		√										

	towards the main principles of Well Logging and Formation Evaluation demonstrated through appropriate and relevant assessment												
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Well Logging and Formation Evaluation uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Well Logging and Formation Evaluation design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Well Logging and Formation Evaluation system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Well Logging and Formation Evaluation practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and										√		

	communication skills												
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Experiments
Week-1	Introduction of well logging equipment and recording devices and their working principle; Demonstration of data acquisition, processing and interpretation of Spontaneous Potential log (SP).
Week-2	Demonstration of data acquisition, processing and interpretation of Resistivity and Induction log (RT, AT, ILD, ILM, MSFL, SFLU); Demonstration of data acquisition, processing and interpretation of Gamma Ray log (GR, CGR).
Week-3	Demonstration of data acquisition, processing and interpretation of Porosity logs (PHI, NPHI); Demonstration of data acquisition, processing and interpretation of Nuclear Magnetic Resonance log (NMR, MRI)
Week-4	Demonstration of data acquisition, processing and interpretation of Caliper log (CAL, CALI); Demonstration of data acquisition, processing and interpretation of Simultaneous Acoustic and Resistivity log (STAR)
Week-5	Demonstration of data acquisition, processing and interpretation of Sonic log (AC, DT); Demonstration of data acquisition, processing and interpretation of Density log (DRHO, RHOB)
Week-6	Introduction of well logging equipment and recording devices and their working principle; Demonstration of data acquisition, processing and interpretation of Spontaneous Potential log (SP).
Week-7	Quiz
Week-8	Estimation of formation porosity (PORO, POR, PORA, PORD, PORF, PORN, PORW); Estimation of formation permeability (K, PERM) ;Estimation of formation water (SW, SWIR) ; Estimation of formation shale content (SH)
Week-9	Reservoir quality measurements of NMR; Light hydrocarbon identification
Week-10	The clay-bound water porosity (MCBW) and total porosity (MPHIT) measurement; Magnetic Resonance Imaging Analysis to determine Permeability, effective porosity, total porosity, water saturation, free water volume, irreducible water volume ; Time Domain Analysis (TDA) for volumetric calculation of gas, oil, and water; formation total and effective porosity; permeability estimation.
Week-11	Diffusion Analysis (DIFAN) to determine Porosity, Sw, diffusion ratios, permeability, watercut (if relative permeabilities are known) ; Residual oil saturation, porosity, permeability, viscosity, flushed zone Sw; Heavy Oil MRI to determine corrected BVI, clay porosity, total porosity, improved

	permeability estimates, effective porosity, water saturations, viscosity.
Week-12	Magnetic resonance imaging logging and reservoir stimulations analyses to determine initial production rate, time of recovery, porosity, permeability, Young's modulus, Poisson's ratio optimum NPV for the well ;Analysis of well log to determine Sw, Sxo, Vsh, φeff, lithology, hydrocarbon weight, permeability, plus volumetric percent of selected minerals.
Week-13	Shaly Sand Analysis to determine Sw, Sxo, Vsh, φeff, lithology, hydrocarbon weight, permeability; Complex Lithology Analysis to determine Sw, Sxo, Vsh, φeff, Lithology volume percent, permeability; Laminated Reservoir Analysis to determine Sw, Sxo, VSH, φeff, lithology hydrocarbon weight (oil, gas), permeability.
Week-14	Quiz

Text and Reference Books:

1. Basic Well Log Analysis by George Asquith and Daniel Krygowski

2. Theory, Measurement and Interpretation of Well Logs by Zaki Bassiouni

3. Well Logging II: Electric & Acoustic Logging by James R. Jorden & Frank L. Campbell

4. Well Logging and Formation Evaluation by Toby Darling

PME 318: Rig Floor Simulation Laboratory

3.00 Contact Hour; 1.5 Credit Hour

Pre-requisite: None

Rationale:

Drilling engineering is a subset of petroleum engineering. Drilling engineers design and implement procedures to drill wells as safely and economically as possible. They work closely with the drilling contractor, service contractors, and compliance personnel, as well as with geologists and other technical specialists

Objective:

1. To introduce students to basic concepts, theories, principles and overview of drilling
2. Expose students to the various drilling facilities onshore and offshore and rig set-up
3. Introduce students to the history of drilling, drilling terminologies and drilling methodologies
4. Show students the basic concept of drilling operation and process
5. Present and explain the fundamental and basic calculations in drilling
6. Identify potential drilling problems, means for prevention and mitigation

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to drilling engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of drilling engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of drilling engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize drilling design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable drilling system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the drilling engineering practice

9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Onshore Drilling

1. Perform well killing operation by volumetric method
2. Perform well killing operation by COMBINED STRIPPING AND VOLUMETRIC METHOD
3. Perform well killing operation by DRILLER'S METHOD
4. Perform well killing operation by WAIT AND WEIGHT METHOD.
5. Perform well killing operation by CONCURRENT METHOD.
6. Case Study

Offshore Drilling

1. Perform well killing operation by volumetric method
2. Perform well killing operation by COMBINED STRIPPING AND VOLUMETRIC METHOD
3. Perform well killing operation by DRILLER'S METHOD
4. Perform well killing operation by WAIT AND WEIGHT METHOD.
5. Perform well killing operation by CONCURRENT METHOD.
6. Case Study

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to drilling engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of drilling engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of drilling uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize drilling design and operation by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class						√						

	and online discussions to help in communicating complex concepts to professional colleagues												
7.	Design sustainable drilling system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the drilling engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Experiments
Week-1	Perform well killing operation by volumetric method
Week-2	Perform well killing operation by COMBINED STRIPPING AND VOLUMETRIC METHOD
Week-3	Perform well killing operation by DRILLER'S METHOD
Week-4	Perform well killing operation by WAIT AND WEIGHT METHOD.
Week-5	Perform well killing operation by CONCURRENT METHOD.
Week-6	Case Study
Week-7	Quiz
Week-8	Perform well killing operation by volumetric method
Week-9	Perform well killing operation by COMBINED STRIPPING AND VOLUMETRIC METHOD
Week-10	Perform well killing operation by DRILLER'S METHOD
Week-11	Perform well killing operation by WAIT AND WEIGHT METHOD.

Week-12	Perform well killing operation by CONCURRENT METHOD.
Week-13	Case Study
Week-14	Quiz

Text and Reference Books:

1. Fundamentals of Drilling Engineering by Robert F. Mitchell and Stefan Z. Miska
2. Applied Drilling Engineering by T. Bourgoyne Jr, K.K. Millheim, M.E. Chenevert & F.S. Young Jr
3. Managed Pressure Drilling by Barkim Demirdal
4. Advanced Drilling and Well Technology by Bernt Aadnoy, Iain Cooper, Stefan Miska, Robert F. Mitchell, and Michael L. Payne
5. Advanced Well Control by David Watson, Terry Brittenham and Preston L. Moore

Level-3, Term-2

PME 321: Petroleum Production Engineering

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Petroleum production engineering is a branch of petroleum engineering that includes: selecting equipment for surface facilities that separate and measure the produced fluids (oil, natural gas, water, and impurities), prepare the oil and gas for transportation to market, and handle disposal of any water and impurities.

Objective:

1. Evaluating inflow and outflow performance between the reservoir and the wellbore.

2. Designing completion systems, including tubing selection, perforating, sand control, matrix stimulation, and hydraulic fracturing.

3. Selecting artificial lift equipment, including sucker-rod lift (typically beam pumping), gas lift, electrical submersible pumps, subsurface hydraulic pumps, progressing-cavity pumps, and plunger lift.

4. Selecting (not design) equipment for surface facilities that separate and measure the produced fluids (oil, natural gas, water, and impurities), prepare the oil and gas for transportation to market, and handle disposal of any water and impurities.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to petroleum production engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of petroleum production engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum production uncertainty and data management validated against national or international standards

5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable petroleum production system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum production engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Production System: Introduction to petroleum production system**;** Overview of surface and subsurface equipment, tools, devices, hardware.

Surface Separation Systems: Applied principles of Oil and Gas Surface Operations; Characterization of Petroleum Fluids; Two-Phase Oil and Gas Systems; Two-Phase Separation Operations, and Selection Procedures.

Artificial Lift Systems: Overview of artificial lift technology; Criteria for selection of artificial lift system; Reservoir performance: inflow and outflow relationships; Artificial lift screening.

Relief and Flare Systems: Purposes and overview of typical relief and flare systems and key components; Safety implications and the causes of overpressure; Codes, standards and recommended practices used for overpressure protection design and operation in oil and gas facilities.

Process Utility Systems: Process heating systems, Steam , Hot oil , Glycol and water ; Process cooling systems , Indirect, cooling water , Direct-seawater ; Process drains – open and closed ; Refrigeration ; Power generation and distribution ; Instrument/Plant air and breathing air; Fresh & potable water ; Fuel systems , Natural gas , Diesel ; Firewater ; Inert gas systems ; Utilities energy considerations ; Utilities management issues; CO2 Surface Facilities.

Production Modeling and Optimization: Review of reservoir inflow characterization and modeling tools; inflow performance relationships; numerical vs. analytical modeling; steady-state, pseudo steady-state and transient reservoir flow; Review of multiphase flow modeling in wellbores, risers and flowlines, empirical vs. mechanistic models; nodal analysis; steady-state flow models vs. transient flow models; Tuning of multiphase flow models; Flow assurance issues (i.e. hydrates, asphaltenes, waxes, scales); Production optimization techniques, solutions to boost oil production, liquid unloading techniques in gas wells, downhole and seabed water separation.

Production Operations: Importance of the geological model ; Reservoir engineering fundamentals in production operations ; Well testing methods applicable to production operations ; Understanding inflow and outflow and applied system analysis ; Primary and remedial cementing operations ; Well completion design and equipment ; Completion and workover well fluids ; Perforating design and applications ; Production logging ; Artificial lift completions ; Problem wells ; Formation damage ; Acidizing ; Corrosion control ; Scale deposition, removal, and prevention ; Surfactants ; Paraffin and asphaltenes ; Sand control ; Hydraulic fracturing ; Unconventional Resources, Shale Gas and Oil, Heavy Oil and Bitumen.

Well Stimulation: Geological / basic reservoir properties ; Formation damage; Non-acid damage removal techniques ; Acidizing, Objectives, types, additives ; Acidizing placement techniques and the pressure chart ; Quality control and safety ; Hydraulic fracturing materials and their importance to success, including gel and slick water treatments ; The frac chart ; Hydraulic fracturing quality control and safety ; Energized fluids - application and safety.

Multiphase Flow in Production Operations: Gas and Liquid pertinent PVT properties for multiphase flows ; Fundamentals and principles of multiphase flows ; Multiphase flows in production tubing and casing (horizontal, vertical and inclined) ; Multiphase flows in pipelines and transportation systems ; Multiphase flow constraints and flow though restrictions ; Production delivery assurance under multiphase flow conditions ; Production assurance considerations in conceptual design and operations.

Performance Analysis, Prediction, and Optimization Using NODAL Analysis: General Overview of Nodal Analysis ; Inflow Performance ; Completion Performance ; Tubing Performance ; Flowline Performance ; Artificial Lift.

Flow Assurance for Offshore Production: Overview of flow assurance ; PVT analysis and fluid properties ; Steady state and transient multiphase flow modeling ; Hydrate, paraffin and asphaltene control ; Corrosion, erosion and sand control; Fluid property and phase behavior modeling ; Equations of state ; Fugacity and equilibrium; Viscosities of oils; Thermal modeling ; Multiphase pressure boosting ; Slugging: hydrodynamic, terrain induced & ramp up ; Commissioning, Start-up, and Shutdown Operations.

Production Logging: Problem identification and solution with production logs ; Temperature logs ; Radioactive tracer logs ; Spinner flowmeter logs ; Log combinations for injection well profiling ; Multiphase flow effects ; Deflector or basket flowmeters ; Fluid density logs ; Fluid capacitance logs ; Slip velocity correlations ; Multiphase log interpretation ; Noise logs ; Cement bond logs ; Ultrasonic pulse-echo logs ; Pulsed neutron logs for flow identification ; Horizontal well production logs.

Sand Control: Sand control techniques ; Radial flow and formation damage ; Causes and effects of sand production ; Predicting sand production ; Gravel pack design ; Slotted liners and wire wrapped screens ; Gravel pack completion equipment and service tools ; Well preparation for gravel packing ; Perforating for gravel placement techniques ; Perforation prepacking and enhanced prepacking ; Frac packing ; Open hole gravel packing ; Expandable screens ; Gravel pack performance ; Horizontal well completions.

Water Technology in Oil and Gas Production: Water chemistry fundamentals ; Water sampling and analysis ; Water-formed scales ; Corrosion control ; Water treatment microbiology ; Produced water discharge/disposal and treatment principles ; Produced water treating equipment, theory of operation, advantages and disadvantages, and the importance of oil droplet size ; Water injection and disposal systems, theory of operation, corrosion, scale, and biological control ; Case study.

Corrosion Management in Production/Processing Operations: Fundamentals of corrosion theory ; Major causes of corrosion (O2, CO2, H2S, microbiologically influenced corrosion) ; Forms of corrosion damage ; Materials selection ; Protective coatings & linings ; Cathodic protection ; Corrosion inhibitors ; Corrosion monitoring and inspection ; Corrosion in gas processing facilities ; Corrosion in water injection systems ; Corrosion management strategy and life-cycle costs.

Troubleshooting Oil and Gas Processing Facilities: Understanding the similarities and differences between Troubleshooting vs. Optimization vs. Debottlenecking ; Types of oil and gas processing facilities ; Typical processing facility block flow diagrams and how to use them ; System trouble versus Component/Equipment- Specific trouble ; Defining good/normal operation ; Quantifying the cost of the trouble ; Gathering, validating and utilization of data (Types of data, Sources of data, Data quality and validation, Using the data) ; Fundamentals of root cause analysis and methodology ; Developing a step-by-step troubleshooting methodology/flowchart (What, why, how, who, when?) ; Identifying the best solution (Criteria for defining best solution [cost/ profitability, safety, environmental impact, regulatory, combination of above]) ; Troubleshooting checklists for main processes and major equipment types.

Completion process: Zonal isolation ; Tubing, packers & completion equipment ; Safety & flow control devices ; Open hole completions ; Basic completion types ; Perforating ; Open & cased hole logging ; Formation damage & treatment ; Completion fluids ; Multiple completions; Completion performance and completion skin factor.

Workovers techniques: Stimulation application, surfactants, solvents, acidizing, fracturing &deep perforating ; Formation & sand control, screens, chemical consolidation, gravel packing, frac-pack, new & novel techniques ; Scale & corrosion ; Paraffin &asphaltenes ; Recompletions ; Reworks ; Sidetracking ; Deepening ; Coiled tubing.

Well Intervention: Coiled Tubing; Hydraulic Workover & Snubbing; Slickline.

Application of petroleum production engineering software: MBAL, PVTi, SCHEDULE, ECLIPSE, PETREL, VFPi, PIPESIM

Teaching-Learning Strategy:

- Class Lectures
- Exercise

- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to petroleum production engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of petroleum production engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of reservoir				√								

	uncertainty and data management validated against national or international standards												
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable petroleum production system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum production engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Production System**	
Lecture-1	**Production System:** Introduction to petroleum production system**;** Overview of surface and subsurface equipment, tools, devices, hardware.	
Lecture-2	**Surface Separation Systems:** Applied principles of Oil and Gas Surface Operations; Characterization of Petroleum Fluids; Two-Phase Oil and Gas Systems; Two-Phase Separation Operations, and Selection Procedures.	
Lecture-3	**Artificial Lift Systems:** Overview of artificial lift technology; Criteria for selection of artificial lift system; Reservoir performance: inflow and outflow relationships; Artificial lift screening.	
Week-2	**Relief and Flare Systems and Process Utility Systems**	
Lecture-4	**Relief and Flare Systems:** Purposes and overview of typical relief and flare systems and key components; Safety implications and the causes of overpressure; Codes, standards and recommended practices used for overpressure protection design and operation in oil and gas facilities.	
Lecture-5	**Process Utility Systems:** Process heating systems, Steam , Hot oil , Glycol and water ; Process cooling systems , Indirect, cooling water , Direct-seawater ; Process drains – open and closed ; Refrigeration ; Power generation and distribution	CT-1
Lecture-6	Instrument/Plant air and breathing air; Fresh & potable water ; Fuel systems , Natural gas , Diesel ; Firewater ; Inert gas systems ; Utilities energy considerations ; Utilities management issues; CO2 Surface Facilities.	
Week-3	**Production Modeling and Optimization**	
Lecture-7	Review of reservoir inflow characterization and modeling tools; inflow performance relationships; numerical vs. analytical modeling; steady-state, pseudo steady-state and transient reservoir flow	
Lecture-8	Review of multiphase flow modeling in wellbores, risers and flowlines, empirical vs. mechanistic models; nodal analysis; steady-state flow models vs. transient flow models; Tuning of multiphase flow models	
Lecture-9	Flow assurance issues (i.e. hydrates, asphaltenes, waxes, scales); Production optimization techniques, solutions to boost oil production, liquid unloading techniques in gas wells, downhole and seabed water separation.	
Week-4	**Production Operations**	
Lecture-10	Importance of the geological model ; Reservoir engineering	

	fundamentals in production operations ; Well testing methods applicable to production operations ; Understanding inflow and outflow and applied system analysis ; Primary and remedial cementing operations	
Lecture-11	Well completion design and equipment ; Completion and workover well fluids ; Perforating design and applications ; Production logging ; Artificial lift completions ; Problem wells ; Formation damage	
Lecture-12	Acidizing ; Corrosion control ; Scale deposition, removal, and prevention ; Surfactants ; Paraffin and asphaltenes ; Sand control ; Hydraulic fracturing ; Unconventional Resources, Shale Gas and Oil, Heavy Oil and Bitumen.	
Week-5	**Well Stimulation**	CT-2
Lecture-13	Geological / basic reservoir properties ; Formation damage; Non-acid damage removal techniques ; Acidizing, Objectives, types, additives	
Lecture-14	Acidizing placement techniques and the pressure chart ; Quality control and safety ; Hydraulic fracturing materials and their importance to success, including gel and slick water treatments	
Lecture-15	The frac chart ; Hydraulic fracturing quality control and safety ; Energized fluids - application and safety.	
Week-6	**Multiphase Flow in Production Operations**	
Lecture-16	Gas and Liquid pertinent PVT properties for multiphase flows ; Fundamentals and principles of multiphase flows	
Lecture-17	Multiphase flows in production tubing and casing (horizontal, vertical and inclined); Multiphase flows in pipelines and transportation systems; Multiphase flow constraints and flow though restrictions	
Lecture-18	Production delivery assurance under multiphase flow conditions ; Production assurance considerations in conceptual design and operations	
Week-7	**Performance Analysis, Prediction, and Optimization Using NODAL Analysis**	
Lecture-19	General Overview of Nodal Analysis	
Lecture-20	Inflow Performance ; Completion Performance	
Lecture-21	Tubing Performance ; Flowline Performance ; Artificial Lift.	
Week-8	**Flow Assurance for Offshore Production**	
Lecture-22	Overview of flow assurance ; PVT analysis and fluid properties ; Steady state and transient multiphase flow modeling ; Hydrate, paraffin and asphaltene control	
Lecture-23	Corrosion, erosion and sand control; Fluid property and phase behavior modeling ; Equations of state ; Fugacity and equilibrium; Viscosities of oils	
Lecture-24	Thermal modeling; Multiphase pressure boosting ; Slugging: hydrodynamic, terrain induced & ramp up ; Commissioning, Start-up, and Shutdown Operations.	
Week-9	**Production Logging**	
Lecture-25	Problem identification and solution with production logs ; Temperature logs ; Radioactive tracer logs ; Spinner flowmeter logs	

Lecture-26	Log combinations for injection well profiling ; Multiphase flow effects ; Deflector or basket flowmeters ; Fluid density logs ; Fluid capacitance logs ; Slip velocity correlations	
Lecture-27	Multiphase log interpretation ; Noise logs ; Cement bond logs ; Ultrasonic pulse-echo logs ; Pulsed neutron logs for flow identification ; Horizontal well production logs.	CT-3
Week-10	**Sand Control**	
Lecture-28	Sand control techniques ; Radial flow and formation damage ; Causes and effects of sand production ; Predicting sand production	
Lecture-29	Gravel pack design ; Slotted liners and wire wrapped screens ; Gravel pack completion equipment and service tools ; Well preparation for gravel packing ; Perforating for gravel placement techniques	
Lecture-30	Perforation prepacking and enhanced prepacking ; Frac packing ; Open hole gravel packing ; Expandable screens ; Gravel pack performance ; Horizontal well completions	
Week-11	**Water Technology in Oil and Gas Production**	
Lecture-31	Water chemistry fundamentals ; Water sampling and analysis ; Water-formed scales ; Corrosion control ; Water treatment microbiology	
Lecture-32	Produced water discharge/disposal and treatment principles ; Produced water treating equipment, theory of operation, advantages and disadvantages, and the importance of oil droplet size	
Lecture-33	Water injection and disposal systems, theory of operation, corrosion, scale, and biological control; Case study.	
Week-12	**Corrosion Management in Production/Processing Operations**	
Lecture-34	Fundamentals of corrosion theory ; Major causes of corrosion (O2, CO2, H2S, microbiologically influenced corrosion) ; Forms of corrosion damage	
Lecture-35	Materials selection ; Protective coatings & linings ; Cathodic protection ; Corrosion inhibitors ; Corrosion monitoring and inspection	
Lecture-36	Corrosion in gas processing facilities; Corrosion in water injection systems ; Corrosion management strategy and life-cycle costs.	
Week-13	**Troubleshooting Oil and Gas Processing Facilities**	
Lecture-37	Understanding the similarities and differences between Troubleshooting vs. Optimization vs. Debottlenecking; Types of oil and gas processing facilities ; Typical processing facility block flow diagrams and how to use them ; System trouble versus Component/Equipment- Specific trouble ; Defining good/normal operation ; main processes and major equipment types.	
Lecture-38	Quantifying the cost of the trouble; Gathering, validating and utilization of data (Types of data, Sources of data, Data quality and validation, Using the data) ; Fundamentals of root cause analysis and methodology ; Developing a step-by-step troubleshooting methodology/flowchart (What, why, how, who, when?) ; Identifying the best solution (Criteria for defining best solution [cost/ profitability, safety, environmental impact, regulatory, combination of above]) ; Troubleshooting checklists.	CT-4

Lecture-39	**Completion process:** Zonal isolation ; Tubing, packers & completion equipment ; Safety & flow control devices ; Open hole completions ; Basic completion types ; Perforating ; Open & cased hole logging ; Formation damage & treatment ; Completion fluids ; Multiple completions; Completion performance and completion skin factor.	
Week-14	**Workovers techniques**	
Lecture-40	Stimulation application, surfactants, solvents, acidizing, fracturing &deep perforating ; Formation & sand control, screens, chemical consolidation, gravel packing, frac-pack, new & novel techniques ; Scale & corrosion ; Paraffin &asphaltenes ; Recompletions ; Reworks ; Sidetracking ; Deepening ; Coiled tubing.	
Lecture-41	**Well Intervention**: Coiled Tubing; Hydraulic Workover & Snubbing; Slickline.	
Lecture-42	**Application of petroleum production engineering software**: MBAL, PVTi, SCHEDULE, ECLIPSE, PETREL, VFPi, PIPESIM	

Text and Reference Books:

1. Petroleum Production Engineering by Boyun Guo, Ph.D., William C. Lyons, Ph.D., and Ali Ghalambor, Ph.D
2. Multiphase Flow in Wells by James P. Brill and Hemanta Mukherjee
3. Design and Appraisal of Hydraulic Fractures by Jack R. Jones and Larry K. Britt
4. Offshore Multiphase Production Operations by Mack Shippen and Stuart Scott
5. Sand Control by W.L. Penberthy Jr and C.M. Shaughnessy
6. Petroleum Production Systems by Michael J. Economides, A. Daniel Hill

PME 323: Natural Gas Processing and LNG Technology

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Natural-gas processing is a complex industrial process designed to clean raw natural gas by separating impurities and various non-methane hydrocarbons and fluids to produce what is known as pipeline quality dry natural gas. Liquefied natural gas (LNG) is natural gas (predominantly methane with some mixture of ethane that has been cooled down to liquid form for ease and safety of non-pressurized storage or transport.

Objective:

1. Explain the key functional and commercial activities across the industry and recognize how they relate to their own company and their own role
2. Cooperate more effectively with people in other functional areas by better understanding their roles and the terminology used
3. Improve workflow quality by better understanding the sources of information and the purpose and uses of their work output
4. Recognize the key drivers of revenues and costs, giving them tools to identify how they can make a difference through their own actions
5. Understand how industry trends and challenges require adjustment to changing needs

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Natural Gas Processing and LNG Technology founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Natural Gas Processing and LNG Technology engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Natural Gas Processing and LNG Technology uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize gas processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues

7) Design sustainable Natural Gas Processing system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Natural Gas Processing and LNG Technology engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to Natural Gas Processing and LNG Technology plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Natural Gas Conditioning: Physical properties of hydrocarbons; Terminology and nomenclature ; Qualitative phase behavior ; Vapor-liquid equilibrium ; Water-hydrocarbon phase behavior, hydrates etc ; Basic Thermodynamics and Application of Energy Balances ; Process Control and Instrumentation ; Relief and Flare Systems ; Fluid hydraulics; two-phase flow ; Separation equipment ;Heat Transfer Equipment ; Pumps ; Compressors and Drivers ; Refrigeration in Gas Conditioning and NGL Extraction Facilities ; Fractionation ; Glycol dehydration; TEG ; Adsorption Dehydration and Hydrocarbon Removal ; Gas Treating and Sulfur Recovery

Natural Gas Processing: Introduction of Gas Processing ; Different methods of removing oil & condensate, water, natural gas liquids, sulfur and carbon dioxide; Low-Temperature Separation (LTX); Dehydrating the natural gas by absorption & adsorption process-diethylene glycol (DEG), triethylene glycol (TEG), flash tank separator condensers and solid desiccant dehydration; sweetening of natural gas, amine process; Design of gas process plant using ASPEN HYSIS; Gas Gathering pipe lines and associated facilities; Gas process plant operation and control; Safety & Environment.

Gas Treating and Sulfur Recovery: Fundamentals of sour gas processing, sweetening etc. ; Overview of gas treating and sulfur recovery, terminology ; Gas specifications and process selection criteria ; Generic and specialty amine treating ; Common operating and technical problems ; Proprietary amine solvents such as Sulfinol and Flexsorb ; Carbonate processes ; Physical absorption processes, e.g. Selexol ; Metallurgical issues – corrosion ; Other technologies and new developments ; Selective treating, acid gas enrichment ; Solid bed and non-regenerable treating; scavengers ; Liquid product treating ; Sulfur recovery processes ; Tail gas clean-up: SCOT-type, CBA and others ; Acid gas injection ; Emerging and new technologies

Natural Gas Liquid (NGL): Introduction of Natural Gas Liquid (NGL) extraction; Techniques for removing NGLs from the natural gas stream, the absorption method and the cryogenic expander process; Natural Gas Liquid Fractionation, Deethanizer ,Depropanizer, Debutanizer and Deisobutanizer; Design of NGL Extraction and Fractionation Plant; Operation, Safety and Environment.

Liquid Natural Gas (LNG): Introduction of LNG; Properties of LNG,CNG ,PNG , LCNG; Liquefaction Plant; LNG storage tanks; LNG loading system; LNG Ships; LNG receiving terminal: pipelines, ship berthing facilities, unloading facilities, storage tanks, vaporization system, units for handling boil-off from the tanks, metering station and ancillaries; Hydrocarbon Properties ; Vapor Liquid Equilibrium ; Gas Pre-treatment ; Heat Exchangers used in LNG Processing ; Refrigeration (Single and Multi-component) ; Compressors and Drivers used in LNG Processing ; Liquefaction ; LNG Storage ; LNG Shipping ; LNG Terminal Siting and HSE ; LNG Receiving Terminals (unloading, send-out, BoG Management) ; LNG Commercial Issues ; LNG Project Issues ; Future trends and New Developments; Properties of hydrocarbons – LNG focus ; Vapor-liquid phase behavior and equilibrium ; Water-hydrocarbon system behavior. ; Hydrates and Inhibition; Thermodynamics of LNG processes; Separation equipment ; Gas treatment, CO_2 and H_2S removal for liquefaction. ; Dehydration of natural gas – glycol, molecular sieves ; Heat transfer, heat exchangers ; Pumps and compressors; gas turbines ; Refrigeration systems ; LNG liquefaction technologies ; Fractionation and absorption; Process control examples ; LNG storage, shipping and receiving overview ; Prospect in Bangladesh.

Application of natural gas engineering software: Aspen Hysis, PIPESIM

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that	√											

	applies to Natural Gas Processing and LNG Technology founded on a theory based understanding of mathematics and the natural and physical sciences												
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Natural Gas Processing and LNG Technology demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Natural Gas Processing and LNG Technology uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize gas processing by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Natural Gas Processing and LNG Technology development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Natural Gas Processing and LNG Technology practice								√				

9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to Natural Gas Processing and LNG Technology plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		CT-1
Lecture-1	**Natural Gas Conditioning:** Physical properties of hydrocarbons; Terminology and nomenclature ; Qualitative phase behavior	
Lecture-2	Vapor-liquid equilibrium ; Water-hydrocarbon phase behavior, hydrates etc	
Lecture-3	Basic Thermodynamics and Application of Energy Balances	
Week-2		
Lecture-4	Process Control and Instrumentation ; Relief and Flare Systems	
Lecture-5	Fluid hydraulics; two-phase flow	
Lecture-6	Separation equipment ;Heat Transfer Equipment ; Pumps ; Compressors and Drivers	
Week-3		
Lecture-7	Refrigeration in Gas Conditioning and NGL Extraction Facilities ; Fractionation	
Lecture-8	Glycol dehydration; TEG	
Lecture-9	Adsorption Dehydration and Hydrocarbon Removal ; Gas Treating and Sulfur Recovery	
Week-4		
Lecture-10	**Natural Gas Processing:** Introduction of Gas Processing ; Different methods of removing oil & condensate, water	
Lecture-11	natural gas liquids, sulfur and carbon dioxide	
Lecture-12	Low-Temperature Separation (LTX)	
Week-5		CT-2

Lecture-13	Dehydrating the natural gas by absorption	
Lecture-14	adsorption process- diethylene glycol (DEG), triethylene glycol (TEG)	
Lecture-15	flash tank separator condensers and solid desiccant dehydration	
Week-6		
Lecture-16	Sweetening of natural gas, amine process	
Lecture-17	Design of gas process plant using ASPEN HYSIS; Gas Gathering pipe lines and associated facilities	
Lecture-18	Gas process plant operation and control; Safety & Environment.	
Week-7		
Lecture-19	**Gas Treating and Sulfur Recovery:** Fundamentals of sour gas processing, sweetening etc. ; Overview of gas treating and sulfur recovery, terminology ; Gas specifications and process selection criteria ; Generic and specialty amine treating ; Common operating and technical problems	
Lecture-20	Proprietary amine solvents such as Sulfinol and Flexsorb ; Carbonate processes ; Physical absorption processes, e.g. Selexol	
Lecture-21	Metallurgical issues – corrosion ; Other technologies and new developments ; Selective treating, acid gas enrichment	
Week-8		
Lecture-22	Solid bed and non-regenerable treating; scavengers ; Liquid product treating	
Lecture-23	Sulfur recovery processes ; Tail gas clean-up: SCOT-type	
Lecture-24	CBA and others ; Acid gas injection ; Emerging and new technologies	
Week-9		CT-3
Lecture-25	**Natural Gas Liquid (NGL):**Introduction of Natural Gas Liquid (NGL) extraction; Techniques for removing NGLs from the natural gas stream, the absorption method and the cryogenic expander process; Natural Gas Liquid Fractionation	
Lecture-26	Deethanizer ,Depropanizer, Debutanizer and Deisobutanizer; Design of NGL	
Lecture-27	Extraction and Fractionation Plant; Operation, Safety and Environment.	
Week-10		
Lecture-28	**Liquid Natural Gas (LNG):** Introduction of LNG; Properties of LNG,CNG ,PNG , LCNG; Liquefaction Plant; LNG storage tanks; LNG loading system; LNG Ships	
Lecture-29	LNG receiving terminal: pipelines, ship berthing facilities, unloading facilities, storage tanks	
Lecture-30	vaporization system, units for handling boil-off from the tanks	
Week-11		
Lecture-31	Metering station and ancillaries	
Lecture-32		
Lecture-33	Hydrocarbon Properties ; Vapor Liquid Equilibrium	
Week-12		
Lecture-34	Gas Pre-treatment ; Heat Exchangers used in LNG Processing	
Lecture-35	Refrigeration (Single and Multi-component) ; Compressors and Drivers used in LNG Processing ; Liquefaction ; LNG Storage	

	LNG Shipping ; LNG Terminal Siting and HSE	
Lecture-36	LNG Receiving Terminals (unloading, send-out, BoG Management) ; LNG Commercial Issues ; LNG Project Issues	
Week-13		CT-4
Lecture-37	Future trends and New Developments; Properties of hydrocarbons – LNG focus ; Vapor-liquid phase behavior and equilibrium ; Water-hydrocarbon system behavior.	
Lecture-38	Hydrates and Inhibition; Thermodynamics of LNG processes; Separation equipment ; Gas treatment, CO_2 and H_2S removal for liquefaction.	
Lecture-39	Dehydration of natural gas – glycol, molecular sieves ; Heat transfer, heat exchangers ; Pumps and compressors; gas turbines ; Refrigeration systems	
Week-14		
Lecture-40	LNG liquefaction technologies ; Fractionation and absorption; Process control examples ; LNG storage, shipping and receiving overview	
Lecture-41	**Application of natural gas engineering software**: Aspen Hysis, PIPESIM	
Lecture-42	Prospect in Bangladesh	

Text and Reference Books:

1. Fundamentals of Natural Gas Processing by Arthur J. Kidnay
2. Handbook of Natural Gas Transmission and Processing by Saeid Mokhatab, William A. Poe and John Y. Mak
3. Handbook of Liquefied Natural Gas by Saeid Mokhatab

PME 325: Reservoir Engineering

4.00 Contact Hour; 4.00 Credit Hour

Pre-requisite: None

Rationale:

Reservoir engineering is a branch of petroleum engineering that applies scientific principles to the fluid flow through porous medium during the development and production of oil and gas reservoirs so as to obtain a high economic recovery. The working tools of the reservoir engineer are subsurface geology, applied mathematics, and the basic laws of physics and chemistry governing the behavior of liquid and vapor phases of crude oil, natural gas, and water in reservoir rock. Of particular interest to reservoir engineers is generating accurate reserves estimates for use in financial reporting. Other job responsibilities include numerical reservoir modeling, production forecasting, well testing, well drilling and workover planning, economic modeling, and PVT analysis of reservoir fluids. Reservoir engineers also play a central role in field development planning, recommending appropriate and cost effective reservoir depletion schemes such as waterflooding or gas injection to maximize hydrocarbon recovery.

Objectives:

1. Present volumetric method to calculate initial oil in place.
2. Demonstrate volumetric method to calculate unit recovery from volumetric gas reservoirs.
3. Calculate unit recovery from gas reservoirs under water drive.
4. Define and the effects of water drive mechanism on the hydrocarbon reservoirs.
5. Demonstrate the linear form of the Material Balance equation for a gas reservoir and comment on its application.
6. Present how calculate the total water influx resulting from a known aquifer volume in terms of total aquifer compressibility and pressure drop over the aquifer.
7. Present how to calculate initial oil and gas from the gas condensate reservoirs based on mole composition and other properties of typical single phase reservoir fluids.
8. Predict and calculate volumetric depletion performance of a retrograde gas condensation.
9. Present how to calculate initial oil in place by the volumetric method and estimate of oil recoveries in under-saturated reservoir.
10. How to use Material Balance in under-saturated reservoirs.
11. Predict and calculate solution gas drive performance.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to reservoir engineering founded on a theory based understanding of mathematics and the natural and physical sciences

2) Apply a critical-thinking and problem-solving approach towards the main principles of reservoir engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of reservoir uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize a material balance / decline curve / water influx exercise, by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable reservoir development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the reservoir engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to development field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Fundamentals of Reservoir Engineering: Fundamentals of reservoir fluid flow; Reservoir fluid distribution; Reservoir classification; Darcy’s law; Flow equation; Two-phase flow model; Three-phase flow model.

Fluid Gradients and Pressure Regimes: Hydrostatic pressure; Phase pressure; Capillary pressure and relative permeability in two phase (Oil-Water) system, two phase (Gas-Water) system, two phase (Gas-Oil) system and three phase (Water-Oil-Gas) system.

Reservoir Drive Mechanisms: Reservoir drive mechanisms; Gas cap drive, Solution gas drive, Water drive, Rock compaction, Gravity drainage, Expansion of oil and Combined drive; Reservoir types as per drive mechanisms; Recovery by different drive mechanisms; Gas reservoirs; volumetric, water drive and compaction drive; Oil reservoirs; water drive, water flood, gravity, drainage, gas cap expansion, combination drive; Quantifying production by different drive mechanisms and recovery factors.

Flow Through Porous Media and Flow Equations: Reservoir geometry; Coordinate system; Derivation fluid flow equations; continuity equation, Darcy´s equation, fluid and rock equations, initial and boundary conditions, analytical solution, steady and transient states, Diffusivity equation, General form of flow equation using Black Oil PVT relationships, Multiphase flow; Non-horizontal flow; Multidimensional flow in Cartesian, cylindrical and spherical coordinate systems.

Material Balance: Development of general material balance equation; Havlena-Odeh linear material balance equation and examples; Oil recovery material balance; Gas material balance; Material balance for volumetric, compaction, water drive and compartmentalized reservoirs; Gas recovery factor and gas production forecasting; Reserve estimation by material balance.

Rate Decline Analysis: Conventional decline curve equations; exponential, hyperbolic and harmonic rate versus time and rate versus cumulative production relationships, selecting the proper equation based on reservoir properties and drive mechanisms; The effects of transient production, recognize transient production, transient forecasts can overestimate remaining reserves, properly constrain transient forecasts; Forecasting during displacement processes, using trends like water-oil ratio and versus cumulative oil production to estimate ultimate oil recovery, converting trends into an oil rate versus time forecast; Difficult situations, layered and compartmented reservoirs, downtime, workovers, changing facility conditions and facility constraints, forecasting groups of wells, common mistakes; Production decline type-curves.

Immiscible Displacement: Fluid displacement process; Fractional flow; Buckley Leverett and Welge analysis; Vertical and diffuse flow; Buckley-Leverett 1D displacement; Oil recovery by Buckley-Leverett-Welge method; Segregated flow and oil recovery; Dietz model; Vertical sweep efficiency; Dykstra-Parsons model.

Production Forecasting: Types of forecasts; Purposes; Methods; Tools; Practices and procedures.

Aquifers: Schilthuis, Hurst van Everdingen, Carter Tracy, and Fetkovitch methods of aquifer analysis and description; Natural water influx; Steady state models; Van Everdingen-Hurst unsteady state model; History matching; Carter-Tracy model.

Petroleum Resources Management System: Petroleum resources definitions, classification, and categorization guidelines; Seismic applications; Assessment of petroleum resources using deterministic procedures; Probabilistic reserves estimation; Aggregation of reserves; Evaluation of petroleum reserves and resources; Production measurement and operational issues; Resources entitlement and recognition.

Reservoir Characterization: Data for reservoir characterization, sources, scale of the data/extrapolation to other areas, acquisition planning, cross-disciplinary applications/integration; quality/error minimization, data management; Geostatistics in reservoir characterization, applicable techniques, data viability and applicability, multiple working models, ranking of models with multi-source data; Reservoir models, sequence stratigraphic, geological, geophysical, reservoir engineering, flow unit, preliminary production ; Economics and risking, volumetrics, probability of success, financial returns of project; Organizational structure, team styles, team communications; Assessment and evaluation, the holistic reservoir characterization model.

Reservoir Management: Definition of reservoir management; an integrated, interdisciplinary team effort; Goal setting, planning, implementing, monitoring, and evaluating reservoir performance; Field development and field operating plans to optimize profitability; Efficient monitoring of reservoir performance; Minimizing drilling of unnecessary wells; Wellbore and surface systems; Well testing and automated production systems; Economic impact of operating plans; Identifying and acquiring critical data, data acquisition, and analysis; Maximizing economic recovery and minimizing capital investment, risk, and operating expenses; Timing of field implementation of reservoir management plan; Case histories and analysis; Importance of reservoir characterization and drilling and operating plans; Primary recovery, pressure maintenance, and secondary and tertiary recovery; Responsibilities for team members; Project management in reservoir development.

Role of Reservoir Engineers in Managing Asset Values: Asset life cycles, professional roles, hydrocarbon reservoir descriptions; Reservoir Engineering Ethics.

Application of reservoir engineering software: MBAL, FEKETE, SCAL, PVTi, SCHEDULE, ECLIPSE, PETREL

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Performance	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Written Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to reservoir engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of reservoir engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of reservoir uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize a material balance / decline curve / water influx exercise, by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable reservoir development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and								√				

	commit to professional ethics, responsibilities and the norms of the reservoir engineering practice												
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to development field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Fundamentals of Reservoir Engineering:**	CT-1
Lecture-1	Fundamentals of reservoir fluid flow	
Lecture-2	Reservoir fluid distribution	
Lecture-3	Reservoir classification; Darcy's law	
Lecture-4	Flow equation; Two-phase flow model; Three-phase flow model.	
Week-2	**Fluid Gradients and Pressure Regimes**	
Lecture-5	Hydrostatic pressure; Phase pressure	
Lecture-6	Capillary pressure and relative permeability	
Lecture-7	Two phase (Oil-Water) system, two phase (Gas-Water) system, two phase (Gas-Oil) system	
Lecture-8	Three phase (Water-Oil-Gas) system	
Week-3	**Reservoir Drive Mechanisms**	
Lecture-9	Reservoir drive mechanisms; Gas cap drive, Solution gas drive, Water drive, Rock compaction, Gravity drainage, Expansion of oil and Combined drive	
Lecture-10	Reservoir types as per drive mechanisms; Recovery by different drive mechanisms	
Lecture-11	Gas reservoirs; volumetric, water drive and compaction drive; Oil reservoirs; water drive, water flood, gravity, drainage, gas cap	

	expansion, combination drive	
Lecture-12	Quantifying production by different drive mechanisms and recovery factors.	
Week-4	**Flow Through Porous Media and Flow Equations**	CT-2
Lecture-13	Reservoir geometry; Coordinate system; Derivation fluid flow equations; continuity equation	
Lecture-14	Darcy´s equation, fluid and rock equations, initial and boundary conditions, analytical solution, steady and transient states	
Lecture-15	Diffusivity equation, General form of flow equation using Black Oil PVT relationships	
Lecture-16	Multiphase flow; Non-horizontal flow; Multidimensional flow in Cartesian, cylindrical and spherical coordinate systems	
Week-5	**Material Balance**	
Lecture-17	Development of general material balance equation	
Lecture-18	Havlena-Odeh linear material balance equation and examples; Oil recovery material balance	
Lecture-19	Gas material balance; Material balance for volumetric, compaction, water drive and compartmentalized reservoirs	
Lecture-20	Gas recovery factor and gas production forecasting; Reserve estimation by material balance.	
Week-6	**Rate Decline Analysis**	
Lecture-21	Conventional decline curve equations; exponential, hyperbolic and harmonic rate versus time and rate versus cumulative production relationships	
Lecture-22	selecting the proper equation based on reservoir properties and drive mechanisms; The effects of transient production, recognize transient production, transient forecasts can overestimate remaining reserves, properly constrain transient forecasts	
Lecture-23	Forecasting during displacement processes, using trends like water-oil ratio and versus cumulative oil production to estimate ultimate oil recovery, converting trends into an oil rate versus time forecast	
Lecture-24	Difficult situations, layered and compartmented reservoirs, downtime, workovers, changing facility conditions and facility constraints, forecasting groups of wells, common mistakes; Production decline type-curves	
Week-7	**Immiscible Displacement**	CT-3
Lecture-25	Fluid displacement process; Fractional flow	
Lecture-26	Buckley Leverett and Welge analysis; Vertical and diffuse flow	
Lecture-27	Buckley-Leverett 1D displacement; Oil recovery by Buckley-Leverett-Welge method	
Lecture-28	Segregated flow and oil recovery; Dietz model; Vertical sweep efficiency; Dykstra-Parsons model	
Week-8	**Production Forecasting**	
Lecture-29	Types of forecasts	
Lecture-30	Purposes; Methods	
Lecture-31	Tools	
Lecture-32	Practices and procedures	
Week-9	**Aquifers**	
Lecture-33	Schilthuis, Hurst van Everdingen, Carter Tracy	

Lecture-34	Fetkovitch methods of aquifer analysis and description	
Lecture-35	Natural water influx; Steady state models	
Lecture-36	Van Everdingen-Hurst unsteady state model; History matching; Carter-Tracy model	
Week-10	**Petroleum Resources Management System**	CT-4
Lecture-37	Petroleum resources definitions, classification, and categorization guidelines; Seismic applications	
Lecture-38	Assessment of petroleum resources using deterministic procedures	
Lecture-39	Probabilistic reserves estimation; Aggregation of reserves	
Lecture-40	Evaluation of petroleum reserves and resources; Production measurement and operational issues; Resources entitlement and recognition	
Week-11	**Reservoir Characterization**	
Lecture-41	Data for reservoir characterization, sources, scale of the data/extrapolation to other areas, acquisition planning, cross-disciplinary applications/integration; quality/error minimization, data management	
Lecture-42	Geostatistics in reservoir characterization, applicable techniques, data viability and applicability, multiple working models, ranking of models with multi-source data	
Lecture-43	Reservoir models, sequence stratigraphic, geological, geophysical, reservoir engineering, flow unit, preliminary production	
Lecture-44	Economics and risking, volumetrics, probability of success, financial returns of project; Organizational structure, team styles, team communications; Assessment and evaluation, the holistic reservoir characterization model	
Week-12	**Reservoir Management**	CT-5
Lecture-45	Definition of reservoir management; an integrated, interdisciplinary team effort; Goal setting, planning, implementing, monitoring, and evaluating reservoir performance	
Lecture-46	Field development and field operating plans to optimize profitability; Efficient monitoring of reservoir performance; Minimizing drilling of unnecessary wells; Wellbore and surface systems	
Lecture-47	Well testing and automated production systems; Economic impact of operating plans; Identifying and acquiring critical data, data acquisition, and analysis; Maximizing economic recovery and minimizing capital investment, risk, and operating expenses; Timing of field implementation of reservoir management plan	
Lecture-48	Case histories and analysis; Importance of reservoir characterization and drilling and operating plans; Primary recovery, pressure maintenance, and secondary and tertiary recovery; Responsibilities for team members; Project management in reservoir development	
Week-13	**Role of Reservoir Engineers in Managing Asset Values**	
Lecture-49	Asset life cycles	
Lecture-50	Professional roles	
Lecture-51	Hydrocarbon reservoir descriptions	
Lecture-52	Reservoir Engineering Ethics	

Week-14	Application of reservoir engineering software	
Lecture-53	MBAL, FEKETE	
Lecture-54	SCAL, PVTi, SCHEDULE	
Lecture-55	ECLIPSE	
Lecture-56	PETREL	

Text and Reference Books:

1. Fundamentals of Reservoir Engineering by Dake
2. Fundamental principles of Reservoir Engineering by Towler
3. Applied Petroleum Reservoir Engineering by Craft, Hawkins and Terry
4. The Practice of Reservoir Engineering by Dake
5. Gas Reservoir Engineering by Lee and Wattenbarger
6. Petroleum Reservoir Engineering by Amyx, Bass and Whiting
7. Reservoir Engineering Handbook by Tarek Ahmed
8. Development of Petroleum Reservoirs by Papay
9. Well Testing by Lee
10. Advances in Well Testing by Earlougher, Jr.
11. Reservoir Engineering Aspects of Waterflooding by Craig
12. Enhanced Oil Recovery by Lake
13. Enhanced Oil Recovery by Green and Willhite
14. Miscible Flooding by Stalkup, Jr.

PME 327: Mine Survey

3.00 Contact Hour; 3.00 Credit Hour;

Pre-requisite: None

1. **Rationale:**

To understand the principles and methods of the site preparation, initial construction of vertical and lateral development of underground opening.

2. **Objectives:**

1. To measure distance, height, angle, area and volumes with different survey instruments in a mine field.
2. To apply leveling for mining.
3. To apply photogrammetry in mining field.
4. To calculate and analyze deformation monitoring data of a mine field.
5. To carry out underground mine survey and shaft plumbing.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories and calculations of distance, height, angle, area and volume of a mine field.
2. Evaluate the design requirements for open pit or underground mine.
3. Analyze the design parameters for mining methods.
4. Apply the knowledge to design a mine or to solve technical problems.

4. Course Contents:

Understand the earth, earth surface and surveying. **The basic principles of mine surveying.**

Fundamentals of the theory of Errors: Sources of errors, Kinds of errors, Theory of probability, Accuracy in surveying.

Measurement of distance: Direct distance measurement- Equipment, Direct linear measurement fieldwork, Errors in measurement and corrections. Indirect distance measurement- Optical distance measurement, Electromagnetic distance measurement, Application of EDM.

Height measurement: Leveling definition, Bench marks, Types of leveling, Principles of leveling, Modern surveyor's levels, The leveling stuff, Level accessories, Leveling fieldwork, Permanent adjustments to the level, Sources of errors in leveling.

Angular measurement: The basic construction of theodolite, Reading systems- Optical theodolites, Electronic theodolites, Setting on an angle, Measuring angles, Adjustments.

Leveling applications: Establishing TBM, Contouring plans by level and staff, Sections and cross sections, Precise leveling, Reciprocal leveling.

Areas and volumes: Area of simple figures, Areas from drawing and plans, Areas from survey field notes, Areas from co-ordinates, Alteration and subdivision of areas, Volume calculations, Volumes from cross sections, Volume from contours, Volume from spot heights.

Photogrammetry: Principles, Classification of aerial photograph, Advantages and applications, Photogrammetry measurements, Stereoscopy.

Geodetic survey: Introduction to geodesy, Geodetic surveying and GPS, Deformation monitoring surveys,

Underground mine survey: Horizontal surveys of underground working, the procedure of tunnel and shaft surveying, the procedure of underground surveying.
Correlation of surface surveys with underground surveys, Shaft plumbing, Transfer of height and coordinates.

5. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	**(100%)**
1. Class Assessment	
(i) Class Participation	05
(ii) Class Attendance	05
(iii) Class Tests/Assignment/Presentation	20
2. Examination	
(i) Final Examination	70

6. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes (CO) of the Course		**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories and calculations of distance, height, angle, area and volume of a mine	√											

	field												
2	Evaluate the design requirements for open pit or underground mine		√										
3	Analyze the design parameters for mining methods				√								
4	Apply the knowledge to design a mine or to solve technical problems			√		√							

7. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		
Lecture-1	**Understand the earth, earth surface and surveying**.	
Lecture-2	**The basic principles of mine surveying.**	
Lecture-3		
Week-2	**Fundamentals of the theory of Errors**	
Lecture-4	Sources of errors, Kinds of errors	
Lecture-5	Theory of probability	
Lecture-6	Accuracy in surveying	
Week-3	**Measurement of distance**	
Lecture-7	Direct distance measurement- Equipment	
Lecture-8	Direct linear measurement fieldwork,	
Lecture-9	Errors in measurement and corrections	
Week-4	**Measurement of distance**	
Lecture-10	Indirect distance measurement- Optical distance measurement	
Lecture-11	Electromagnetic distance measurement	
Lecture-12	Application of EDM	CT-1; CT-2
Week-5	**Height measurement**	
Lecture-13	Leveling definition, Bench marks, Types of leveling	
Lecture-14	Principles of leveling, Modern surveyor’s levels	
Lecture-15	The leveling stuff, Level accessories, Leveling fieldwork	
Week-6	**Height measurement, Measurement of distance**	
Lecture-16	Permanent adjustments to the level, Sources of errors in leveling.	
Lecture-17	Exercises	
Lecture-18	Exercises	
Week-7	**Angular measurement**	
Lecture-19	The basic construction of theodolite	
Lecture-20	Reading systems- Optical theodolites, Electronic theodolites	
Lecture-21	Setting on an angle, Measuring angles, Adjustments	
Week- 8	**Leveling applications**	
Lecture-22	Establishing TBM	
Lecture-23	Contouring plans by level and staff	
Lecture-24	Exercises	
Week-9	**Leveling applications**	
Lecture-25	Sections and cross sections	

Lecture-26	Precise leveling, Reciprocal leveling	CT-3; CT-4
Lecture-27	Exercises	
Week-10	**Areas and volumes**	
Lecture-28	Area of simple figures, Areas from drawing and plans, Areas from survey field notes, Areas from co-ordinates	
Lecture-29	Alteration and subdivision of areas, Volume calculations, Volumes from cross sections	
Lecture-30	Volume from contours, Volume from spot heights	
Week-11	**Photogrammetry**	
Lecture-31	Principles, Classification of aerial photograph, Advantages and applications	
Lecture-32	Photogrammetry measurements	
Lecture-33	Stereoscopy	
Week-12	**Geodetic survey**	
Lecture-34	Introduction to geodesy	
Lecture-35	Geodetic surveying and GPS	
Lecture-36	Deformation monitoring surveys	
Week-13	**Methods of tunnel driving and boring**	
Lecture-37	Horizontal surveys of underground working	
Lecture-38	The procedure of tunnel and shaft surveying, the procedure of underground surveying	
Lecture-39	Correlation of surface surveys with underground surveys, Shaft plumbing, Transfer of height and coordinates.	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Books recommended:

1. Surveying; Punmia.

2. Basic Surveying; White.

3. Mine Surveying. Kim Check University of Technology.

4. Supplied materials.

PME 329: Health, Safety and Environment in Petroleum and Mining Industries

2.00 Contact Hour; 2.00 Credit Hour

Pre-requisite: None

Rationale:

Health and safety procedures in the workplace reduce the employee illnesses and injuries greatly. Training is important and effective, as it will educate your employees on proper workplace procedures, practices, and behavior to prevent possible injuries and illness or contamination from improper hygiene.

Objective:

1. To prevent injury and ill health and to continually improve our health and safety performance
2. To develop a positive health and safety culture across the company, involving and engaging our workforce at all times
3. To apply best practice across the company, to work with our regulators and industry bodies to demonstrate leadership within our industry as a best practice employer
4. To comply with statutory requirements and strive to exceed these where appropriate.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to petroleum production engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of petroleum production engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum production uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Overview of Health, Safety & Environment: History and Overview of health, Environment and safety in petroleum and mining industries, Introduction to safety: Occupational (industrial) and process safety; Roles, Responsibilities and accountability of Health and

Safety professionals ensuring safe and healthy working condition, Effective health, Environment and safety management systems. Safety Regulations and Safety signs, Fire and Explosion Hazards: Definition, Prerequisites for combustion, Fire triangle, Fire Pyramid, Ignition Temperature, Explosion Limits, Fire Extinction, Fire Prevention.

Health Hazards in Petroleum and Mining Industry: Health hazard anticipation, identification, risk management, evaluation and controls, Industrial Hygiene in Petroleum and mining field, Toxicity, Physiological, Asphyxiation, respiratory and skin effect, Impact of sour gases with their thresh-hold limits, Effect of corrosive atmosphere and additives, Controls of respirable dust impact Human health, Noise issues in industries impact Human health.

Safety System in Petroleum and Mining Industry: Hazard anticipation, recognition, Hazards Analysis (HA), Developing a safe process, Safe work practices and procedures, HAZOP (Hazardous Operation) practices and procedure, failure mode analysis, safety Analysis, Causes and effect of Loss, safety analysis function evaluation chart, Measurement Techniques, Personal Protecting Equipments/systems & measures in petroleum and mining industry, Manual & atmospheric shut down system, Gas detection system and controls, Electrical safety, Haulage safety in mine industry, Fire detection and controls, Inspections and auditing, Incident reporting and analysis, Behavioral Based Safety system (BBS) to improve petroleum and mine safety, Contractor Health and safety management, Building a health and safety culture, Emergency management system (EMS) in Petroleum and mining industry, Disaster & Crisis management in petroleum and mining fields, Policies, standards & specifications for safety professionals, Regulatory requirements impact petroleum and mining operations.

Environment in Petroleum and Mining Industry: Environmental Pollution causes for fossil fuel (coal, oil and gas), General concept of Pollutants, Conventional Fossil Fuel and Renewable Energy; Pollution of the Environment: Air pollution, Water pollution, Noise and Sound pollution etc. Climate change and role of petroleum and mining industry; Green House Gases: Definition, Emitting sources, measurement, Causes of Greenhouse effect; Global Warming Potential: Definition, potential impacts of global warming and a changing climate, Estimation process for CO2 emissions for fuel combustion, Computation of CO2 emission related to energy use, Concept of carbon cycle; Clean Development Mechanism (CDM): Definition, Works and salient features. Environmental problems in national and international. Initial
Environment Examination (IEE), Concept of Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP). Environmental management and ISO 14000, Environment and Sustainable development. Environmental laws/regulations.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation

- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes(CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Health, Safety and Environment founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Health, Safety and Environment demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Health, Safety and Environment uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry					√							

	to develop competency in the use of technology											

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Overview of Health, Safety & Environment:** History and Overview of health, Environment and safety in petroleum and mining industries, Introduction to safety: Occupational (industrial) and process safety; Roles	
Lecture-2	Responsibilities and accountability of Health and Safety professionals ensuring safe and healthy working condition, Effective health, Environment and safety management systems. Safety Regulations and Safety signs, Fire and Explosion Hazards: Definition, Prerequisites for combustion, Fire triangle, Fire Pyramid, Ignition Temperature, Explosion Limits, Fire Extinction, Fire Prevention.	
Week-2		
Lecture-3	**Health Hazards in Petroleum and Mining Industry:** Health hazard anticipation, identification, risk management, evaluation and controls	
Lecture-4	Industrial Hygiene in Petroleum and mining field, Toxicity, Physiological, Asphyxiation, respiratory and skin effect	
Week-3		
Lecture-5	Impact of sour gases with their thresh-hold limits, Effect of corrosive atmosphere and additives	
Lecture-6	Controls of respirable dust impact Human health, Noise issues in industries impact Human health.	
Week-4		
Lecture-7	**Safety System in Petroleum and Mining Industry:** Hazard anticipation, recognition, Hazards Analysis (HA), Developing a safe process, Safe work practices and procedures, HAZOP (Hazardous Operation) practices and procedure, failure mode analysis, safety Analysis, Causes and effect of Loss, safety analysis function evaluation chart	
Lecture-8	Measurement Techniques, Personal Protecting Equipments/systems & measures in petroleum and mining industry, Manual & atmospheric shut down system, Gas detection system and controls	
Week-5		
Lecture-9	Electrical safety, Haulage safety in mine industry	
Lecture-10	Fire detection and controls, Inspections and auditing	
Week-6		
Lecture-11	Incident reporting and analysis, Behavioral Based Safety system (BBS) to improve petroleum and mine safety, Contractor	CT-2
Lecture-12	Health and safety management, Building a health and safety culture	

Week-7		
Lecture-13	Emergency management system (EMS) in Petroleum and mining industry	
Lecture-14	Disaster & Crisis management in petroleum and mining fields	
Week-8	Policies, standards & specifications for safety professionals	
Lecture-15	Regulatory requirements impact petroleum and mining operations.	
Lecture-16	**Environment in Petroleum and Mining Industry:** Environmental Pollution causes for fossil fuel (coal, oil and gas), General concept of Pollutants	
Week-9		
Lecture-17	Conventional Fossil Fuel and Renewable Energy	
Lecture-18	Pollution of the Environment: Air pollution	
Week-10		
Lecture-19	Water pollution, Noise and Sound pollution etc.	
Lecture-20	Climate change and role of petroleum and mining industry	
Week-11		
Lecture-21	Green House Gases: Definition, Emitting sources, measurement, Causes of Greenhouse effect; Global Warming Potential	
Lecture-22	Definition, potential impacts of global warming and a changing climate, Estimation process for CO2 emissions for fuel combustion	CT-3
Week-12		
Lecture-23	Computation of CO2 emission related to energy use, Concept of carbon cycle	
Lecture-24	Clean Development Mechanism (CDM)	
Week-13		
Lecture-25	Definition, Works and salient features. Environmental problems in national and international. Initial	
Lecture-26		
Week-14		
Lecture-27	Environment Examination (IEE), Concept of Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP).	
Lecture-28	Environmental management and ISO 14000, Environment and Sustainable development. Environmental laws/regulations.	

Text and Reference Books:

1. Safety, Health and Environment Handbook by K. T. Narayanan
2. Health, Safety and Environment Test: For Operatives (BSL) by CITB
3. Health, Safety and Environment Test: For Managers and Professionals
4. Environmental and health & safety management by Nicholas P. Cheremisinoff
5. Occupational Environment: Its Evaluation and Control by Salvatore R. DiNardi
6. Environmental and workplace safety by James T. O'Reilly
7. Hazards of the job by Christopher C. Sellers

PME 3211: Rock Blasting and Explosive Technology

3.00 Credits; 3.00 Periods/ Hour;

Pre-requisite: None

1. **Rationale:**

To understand the principles and methods of rock blasting and to prepare optimum blast design and to understand different explosive technologies.

2. **Objectives:**

1. To understand the basics of rock blasting and explosive technologies.
2. To calculate and design drilling.
3. To calculate and design blast pattern.
4. To design mechanical excavation.
5. To analyze and re-design for optimum drilling and blasting method.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories and calculations of drilling and blast design.
2. Evaluate the design requirements for rock blasting.
3. Analyze the design parameters for rock blasting.
4. Apply the knowledge to design a optimum blast design.

4. Course Contents:

Basics of blasting: Rock Strength and Fracture Properties. Mechanical Drilling and Boring in Rock. Explosives. Shock Waves and Detonations, Explosive Performance. Initiation Systems. Principles of Charge Calculation for Surface Blasting. Charge Calculations for Tunneling. Stress Waves in Rock, Rock Mass Damage, and Fragmentation. Contour Blasting. Computer Calculations for Rock Blasting. Blast Performance Control. Flyrock. Ground Vibrations. Air Blast Effects. Toxic Fumes. Metal Acceleration, Fragment Throw, Metal Jets and Penetration. Explosive Art, Explosive Metal Forming, Welding, Powder Compaction, and Reaction Sintering. Safety Precautions, Rules, and Regulations.

Detonation: An introduction to the theory of detonation (ideal and non ideal), sensitivity, performance and numerical modeling of detonation, and the description of modern commercial explosives including typical compositions, mixing, priming and handling.

Blasting agents (Initiation devices and Safety fuse, Electric shot-firing and detonating cords, Primers & boosters).

Blast design: Rock fragmentation; Blast design; Powder factor; Trench rock; Breakage control techniques. Design of round blasting. Practical usage of explosives (Blasting in quarries, Blasting in shaft, tunnels, Blasting in stope operations, Blasting in coal mines).

Specific problems related to the use of explosives: such as desensitization, sympathetic detonation, gas and dust explosions.

5. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	**(100%)**
3. Class Assessment	
(iv) Class Participation	05
(v) Class Attendance	05
(vi) Class Tests/Assignment/Presentation	20
4. Examination	
(ii) Final Examination	70

6. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes (CO) of the Course		**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories and calculations of drilling and blast design.	√											
2	Evaluate the design requirements for rock blasting		√										
3	Analyze the design parameters for rock blasting				√								
4	Apply the knowledge to design a optimum blast design			√		√							

7. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Basics of blasting**	CT-1; CT-2
Lecture-1	Rock Strength and Fracture Properties	
Lecture-2	Mechanical Drilling and Boring in Rock	
Lecture-3	Explosives	
Week-2	**Basics of blasting**	
Lecture-4	Shock Waves and Detonations	
Lecture-5	Explosive Performance	
Lecture-6	Initiation Systems	
Week-3	**Basics of blasting**	
Lecture-7	Principles of Charge Calculation for Surface Blasting	
Lecture-8	Charge Calculations for Tunneling	
Lecture-9	Stress Waves in Rock, Rock Mass Damage, and Fragmentation	
Week-4	**Basics of blasting**	
Lecture-10	Contour Blasting	
Lecture-11	Computer Calculations for Rock Blasting	
Lecture-12	Blast Performance Control	
Week-5	**Basics of blasting**	
Lecture-13	Flyrock	
Lecture-14	Ground Vibrations	
Lecture-15	Air Blast Effects	
Week-6	**Basics of blasting**	
Lecture-16	Toxic Fumes	
Lecture-17	Metal Acceleration, Fragment Throw	
Lecture-18	Metal Jets and Penetration	
Week-7	**Basics of blasting**	
Lecture-19	Explosive Art	
Lecture-20	Explosive Metal Forming	
Lecture-21	Welding, Powder Compaction, and Reaction Sintering	
Week- 8	**Basics of blasting, Detonation**	
Lecture-22	Safety Precautions, Rules, and Regulations	
Lecture-23	An introduction to the theory of detonation	
Lecture-24	Sensitivity, performance	
Week-9	**Detonation**	
Lecture-25	Sections and cross sections	
Lecture-26	Numerical modeling of detonation	
Lecture-27		
Week-10	**Detonation**	
Lecture-28	description of modern commercial explosives including typical compositions, mixing, priming and handling	
Lecture-29		
Lecture-30		
Week-11	**Detonation**	
Lecture-31	Initiation devices and Safety fuse	
Lecture-32	Electric shot-firing and detonating cords	

Lecture-33	Primers & boosters	CT-3; CT-4
Week-12	**Blast design**	
Lecture-34	Powder factor	
Lecture-35	Trench rock	
Lecture-36	Breakage control techniques	
Week-13	**Blast design, Specific problems related to the use of explosives**	
Lecture-37	Design of round blasting	
Lecture-38	Blasting in quarries, Blasting in shaft, tunnels, Blasting in stope operations, Blasting in coal mines	
Lecture-39	desensitization, sympathetic detonation, gas and dust explosions	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Books recommended:

1. Rock Blasting and Explosives Engineering; PA Persson, RHJ Lee.

2. Engineering Rock Blasting Operations; CSTubarao.

3. Supplied materials.

PME 324: Natural Gas Processing and LPG Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Natural-gas processing is a complex industrial process designed to clean raw natural gas by separating impurities and various non-methane hydrocarbons and fluids to produce what is known as pipeline quality dry natural gas. Liquefied natural gas (LNG) is natural gas (predominantly methane with some mixture of ethane that has been cooled down to liquid form for ease and safety of non-pressurized storage or transport.

Objective:

1. Explain the key functional and commercial activities across the industry and recognize how they relate to their own company and their own role
2. Cooperate more effectively with people in other functional areas by better understanding their roles and the terminology used
3. Improve workflow quality by better understanding the sources of information and the Purpose and uses of their work output
4. Recognize the key drivers of revenues and costs, giving them tools to identify how they can make a difference through their own actions
5. Understand how industry trends and challenges require adjustment to changing needs

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Natural Gas Processing and LNG Technology founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Natural Gas Processing and LNG Technology engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Natural Gas Processing and LNG Technology uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize gas processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues

7) Design sustainable Natural Gas Processing system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Natural Gas Processing and LNG Technology engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to Natural Gas Processing and LNG Technology plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

1. Determination of gas composition of inlet and outlet gas of gas process plant by chromatograph.
2. Simulation of process operation of the natural gas dehydration process (Glycol dehydration).
3. Simulation of process operation of the natural gas dehydration process (Solid Desiccant dehydration).
4. Simulation of process operation of the Natural Gas Liquids (NGL) recovery process.
5. Simulation of process operation of Liquid Natural Gas (LNG) production
6. Simulation of process operation of Liquid Natural Gas (LNG) regasification.

LPG:

1. Determination of composition of LPG by chromatograph.
2. Determination of density of LPG by hydrometer
3. Determination of heating value of LPG by calorimeter
4. Simulation of process operation of the LPG production.
5. Simulation of process operation of the LPG bottling plant.

Field Trip: Visiting a natural process plant to observe the main processing unit, process control system, utilities system, safety system./ LNG plant/ LPG plant.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour

- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Natural Gas Processing and LNG Technology founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Natural Gas Processing and LNG Technology demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Natural Gas Processing and LNG Technology uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize gas processing by using					√							

	commercial software that is commonly used in the industry to develop competency in the use of technology												
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Natural Gas Processing and LNG Technology development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Natural Gas Processing and LNG Technology practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to Natural Gas Processing and LNG Technology plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Experiments
Week-1	Determination of gas composition of inlet and outlet gas of gas process plant by chromatograph.
Week-2	Simulation of process operation of the natural gas dehydration process (Glycol dehydration).
Week-3	Simulation of process operation of the natural gas dehydration process (Solid Desiccant dehydration).
Week-4	Simulation of process operation of the Natural Gas Liquids (NGL) recovery

	process.
Week-5	Simulation of process operation of Liquid Natural Gas (LNG) production
Week-6	Simulation of process operation of Liquid Natural Gas (LNG) regasification.
Week-7	Quiz
Week-8	Determination of composition of LPG by chromatograph.
Week-9	Determination of density of LPG by hydrometer
Week-10	Determination of heating value of LPG by calorimeter
Week-11	Simulation of process operation of the LPG production.
Week-12	Simulation of process operation of the LPG bottling plant.
Week-13	Field Trip: Visiting a natural process plant to observe the main processing unit, process control system, utilities system, safety system/ LNG plant/ LPG plant.
Week-14	Quiz

Text and Reference Books:

1. Fundamentals of Natural Gas Processing by Arthur J. Kidnay
2. Handbook of Natural Gas Transmission and Processing by Saeid Mokhatab, William A. Poe and John Y. Mak
3. Handbook of Liquefied Natural Gas by Saeid Mokhatab

PME 328: Mine Survey Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

1. **Rationale:**

The module is designed to understand how to carry out survey in mine fields and to use the data for mining applications.

2. **Objective:**

1. To measure distance, height, angle, area and volumes with different survey instruments in a mine field.
2. To apply leveling for mine field.
3. To apply photogrammetry in mine field.
4. To calculate and analyze deformation monitoring data for mining application.
5. To understand, how to carry out underground mine survey and shaft plumbing.

3. **Course Learning Outcomes (CO):**

On successful completion of this course students will be able to:

1) Understand about different survey instruments and carry out survey to measure distance, height, angle, area and volume of a mine field.
2) Calculate and evaluate the design parameters for open pit or underground mine.
3) Apply the knowledge to design a mine or to solve technical problems.

4. **Course Contents:**

1. Chain survey
2. Plane table survey
3. Travers survey
4. Tachometry survey
5. Contouring
6. Curve setting
7. Route survey and leveling
8. Problem on height and distance
9. Digital survey
10. GPS data tracking from GIS software
11. Mining area measurement form GIS software
12. Application of Software: EARDUS

5. Teaching-Learning Strategy:

- Class Lectures
- Survey
- Exercise
- Group Project
- Class Tests
- Assignments
- Presentation

6. Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/ Report Writing/ Project Work/ Assignment	50
Quiz Test	30
Viva Voce	10

7. **Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):**

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Understand about different survey instruments and carry out survey to measure distance, height, angle, area and volume of a mine field	√				√							
2.	Calculate and evaluate the design parameters for open pit or underground mine	√			√								
3.	Apply the knowledge to design a mine or to solve technical problems		√	√									

8. Lecture Schedule:

Lecture	**Experiments**
Week-1	Chain survey
Week-2	Plane table survey
Week-3	Travers survey
Week-4	Tachometry survey
Week-5	Contouring
Week-6	Curve setting & Route survey and leveling
Week-7	Quiz

Week-8	Problem on height and distance
Week-9	Digital survey
Week-10	GPS data tracking from GIS software
Week-11	
Week-12	Mining area measurement form GIS software
Week-13	Application of Software: EARDUS
Week-14	Quiz

9. Methods and materials:

1. Carry out survey with survey instruments
2. Simulation and analysis software for mining application
3. Supplied materials

PME 320: Industrial Training

4 weeks; 0.75 Credit Hour

Pre-requisite: None

Rationale:

Industrial training is an extremely important component as it provides undergraduates with on-the-job training and real-life job experience, making them more aware of the needs and expectations of industry as well as making them more employment ready. Industrial training provides opportunities for undergraduates to apply what they have learnt in the classroom. Industrial training is also an avenue for students to further develop their skills, such as communication and interpersonal skills.

Objective:

At the end of the course students should be able to:

1. Develop soft skills in management, team skill & leadership skill and responsibilities in the work environment.
2. Point out the acquired knowledge and their understanding to dwell with the environmental issue.
3. Improve their knowledge and skills relevant to their area of study.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to petroleum and mining industries founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining industries demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining industries uncertainty and data management validated against national or international standards

Course Contents:

The students will visit different petroleum and/or mining installations and prepare a report of the work and finally present their work to the department.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to petroleum and mining industries founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining industries demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to				√								

	suggest approaches and strategies for the assessment and quantification of petroleum and mining industries uncertainty and data management validated against national or international standards												

Lecture Schedule:

Lecture	Experiments
Week-1	Training in Mining Industries
Week-2	Training in Petroleum Industries (Gas Fields)
Week-3	Training in Petroleum Industries (LPG,LNG, Refining)
Week-4	Report

Text and Reference Books:

1. Fundamentals of Natural Gas Processing by Arthur J. Kidnay
2. Handbook of Natural Gas Transmission and Processing by Saeid Mokhatab, William A. Poe and John Y. Mak
3. Handbook of Liquefied Natural Gas by Saeid Mokhatab
4. The Remaking of the Mining Industry by David Humphreys

Level-4, Term-1

PME 411: Well Test Analysis

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

A “well test” is simply a period of time during which the production of the well is measured, either at the well head with portable well test equipment, or in a production facility.

Objective:

Most well tests consist of changing the rate, and observing the change in pressure caused by this change in rate. To perform a well test successfully one must be able to measure the time, the rate, the pressure, and control the rate. Well tests, if properly designed, can be used to estimate the following parameters:

1. Flow conductance
2. Skin factor
3. Non-Darcy coefficient (multirate tests)
4. Storativity
5. Fractured reservoir parameters
6. Fractured well parameters
7. Drainage area
8. Distance to faults
9. Drainage shape

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Well Test Analysis founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Well Test Analysis demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Well Test Analysis uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Well Test Analysis system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Well Test Analysis practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Objectives of Well Tests: Determine formation productivity/deliverability, permeability, reservoir pressure, presence of skin damage, flow profile inside a formation and wellbore, reservoir geometry/size/drainage area, inter-well communication, and perforation efficiency**.**

Types of Well Tests: Closed chamber or surge test with the zero-emission system, shoot and pull test, drillstem test, cleanup test, slug test, early production test, multi-rate production/ injection well tests, reservoir limit test, permanent gauge test, and interference/pulse tests; Drawdown Test; Pressure Buildup Test; Injection Test; Fall-off Test; Interference, pulse and vertical permeability testing, Drill Stem Test(DST); Reservoir Limit Test; Wire line and Slick line Formation Tests; Repeat Formation Tester (RFT).

Well Tests Operation and Equipment: Well tests equipment, tools, devices; Data acquisition system; Equipment selection and layout; Equipment calibration; Sequence of operation; Data recording and processing.
Well Test Design: An overview of well test design, design consideration, implementation, operational safety, uncertainties and mitigation; Optimum test times; Optimum flow rates; The right equipment suited for the job; Models with sensitivities to reservoir, fluid, and wellbore parameters; Well test procedure.
Well Test Interpretation Model : Fluid Flow in porous media: Diffusivity equation in Rectangular, Cylindrical and Spherical Coordinates; Line source solution of diffusivity equations; Initial and Boundary conditions; Skin, wellbore storage, radius of investigation; Different flow regimes: transient, pseudo-steady state, steady state; Ei-function and its properties; Interpretation models of drawdown and buildup test for estimating formation permeability, skin, reservoir pore volume, average reservoir pressure; Superposition; Effect of fault and double porosity systems; derivative analysis, Image well; Modeling and effects of fault, Fracture, boundary, completion, anisotropy, skin and wellbore storage; Modeling of multiphase flow; Constant pressure testing; Test in horizontal well; Spherical flow; Well test in Naturally Fractured Reservoirs (NFR), Layered reservoir; Analytical & Numerical well test simulation; Anisotropy; Dimensionless Variables; Laplace Transformation; Bessel Functions; Error Function; Numerical Inversion; Convolution and Deconvolution; Flow

Period Diagnostic; Pressure Derivatives; Principle of Superposition and Image Wells; Solution of diffusivity equations for linear, radial and spherical flow; Straight line, Pressure Type Curves, Pressure Derivatives and Deconvolution Well Test Interpretation Methods; Modeling and Interpretation of Multirate Testing and Variable rate Testing.

Well Test Analysis: Radial Flow ; Log-log Type Curve Analysis ; Pressure Transient Testing for Gas Wells ; Flow Regimes and the Log-log Diagnostic Plot ; Bounded Reservoir Behavior ; Wellbore and Near-wellbore Phenomena ; Well Test Interpretation ; Well Test Design ; Estimation of Average Drainage Area Pressure ; Hydraulically Fractured Wells ; Horizontal Wells ; Naturally Fractured Reservoirs

Gas Well Testing: Introduction, Basic theory of Gas Flow in Reservoirs, Multi-rate(FAF), isochronal tests, Modified Isochronal tests and use of Pseudo pressure in Gas Well Test Analysis, Real gas potential application; gas flow tests with Non-Darcy flow; Extended well testing.

Analysis of Well test Using Type curve: Fundamentals of Type-curve analysis; varying wellbore storage; Determination of average pressure; Radius of drainage and stabilization time; Multiphase flow; Real gas potential application; Brief overview of Layered systems; Fractured reservoirs; Faults; Channel sands; Use of pressure and its time derivative in type curve matching.

Well Tests Report: Well test description; System evaluation; Discussion of each event; Gauge comparison; Analysis results; Well test data summary; Historical comparisons; Production improvement recommendations; Conclusions.

Computerized Methods of Analysis: Case studies of local field examples using Well Test Simulator.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Well Test Analysis founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Well Test Analysis demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Well Test Analysis uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Well Test Analysis system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics,								√				

	responsibilities and the norms of the Well Test Analysis practice												
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		
Lecture-1	**Objectives of Well Tests:** Determine formation productivity/deliverability, permeability, reservoir pressure, presence of skin damage	
Lecture-2	Flow profile inside a formation and wellbore, reservoir geometry/size/drainage area, inter-well communication, and perforation efficiency.	
Lecture-3	**Types of Well Tests:** Closed chamber or surge test with the zero-emission system, shoot and pull test, drillstem test, cleanup test, slug test, early production test, multi-rate production/ injection well tests	CT-1
Week-2		
Lecture-4	Reservoir limit test, permanent gauge test, and interference/pulse tests; Drawdown Test; Pressure Buildup Test	
Lecture-5	Injection Test; Fall-off Test; Interference, pulse and vertical permeability testing, Drill Stem Test(DST); Reservoir Limit Test	
Lecture-6	Wire line and Slick line Formation Tests; Repeat Formation Tester (RFT).	
Week-3		
Lecture-7	**Well Tests Operation and Equipment:** Well tests equipment	
Lecture-8	tools, devices	

Lecture-9	Data acquisition system	
Week-4		
Lecture-10	Equipment selection and layout	
Lecture-11	Equipment calibration	
Lecture-12	Sequence of operation; Data recording and processing.	
Week-5		CT-2
Lecture-13	**Well Test Design:** An overview of well test design, design consideration, implementation, operational safety, uncertainties and mitigation;	
Lecture-14	Optimum test times; Optimum flow rates; The right equipment suited for the job	
Lecture-15	Models with sensitivities to reservoir, fluid, and wellbore parameters; Well test procedure	
Week-6		
Lecture-16	**Well Test Interpretation Model** : Fluid Flow in porous media: Diffusivity equation in Rectangular	
Lecture-17	Cylindrical and Spherical Coordinates; Line source solution of diffusivity equations	
Lecture-18	Initial and Boundary conditions; Skin, wellbore storage, radius of investigation	
Week-7		
Lecture-19	Different flow regimes: transient, pseudo-steady state, steady state;	
Lecture-20	Ei-function and its properties; Interpretation models of drawdown and buildup test for estimating formation permeability, skin, reservoir pore volume, average reservoir pressure	
Lecture-21	Superposition; Effect of fault and double porosity systems; derivative analysis, Image well; Modeling and effects of fault, Fracture, boundary, completion, anisotropy, skin and wellbore storage	
Week-8		
Lecture-22	Modeling of multiphase flow; Constant pressure testing; Test in horizontal well; Spherical flow; Well test in Naturally Fractured Reservoirs (NFR)	
Lecture-23	Layered reservoir; Analytical & Numerical well test simulation; Anisotropy; Dimensionless Variables; Laplace	
Lecture-24	Transformation; Bessel Functions; Error Function; Numerical	
Week-9		CT-3
Lecture-25	Inversion; Convolution and Deconvolution; Flow Period Diagnostic; Pressure Derivatives; Principle of Superposition and	
Lecture-26	Image Wells; Solution of diffusivity equations for linear, radial and spherical flow; Straight line, Pressure Type Curves, Pressure	
Lecture-27	Derivatives and Deconvolution Well Test Interpretation Methods; Modeling and Interpretation of Multirate Testing and Variable rate Testing.	
Week-10		
Lecture-28	**Well Test Analysis**: Radial Flow ; Log-log Type Curve Analysis ; Pressure Transient Testing for Gas Wells ; Flow Regimes and the Log-log Diagnostic Plot	

Lecture-29	Bounded Reservoir Behavior ; Wellbore and Near-wellbore Phenomena	
Lecture-30	Well Test Interpretation ; Well Test Design	
Week-11		
Lecture-31	Estimation of Average Drainage Area Pressure	
Lecture-32	Hydraulically Fractured Wells ; Horizontal Wells	
Lecture-33	Naturally Fractured Reservoirs	
Week-12		
Lecture-34	**Gas Well Testing:** Introduction, Basic theory of Gas Flow in Reservoirs, Multi-rate(FAF), isochronal tests	
Lecture-35	Modified Isochronal tests and use of Pseudo pressure in Gas Well Test Analysis	
Lecture-36	Real gas potential application; gas flow tests with Non-Darcy flow; Extended well testing.	
Week-13		CT-4
Lecture-37	**Analysis of Well test Using Type curve**: Fundamentals of Type-curve analysis; varying wellbore storage; Determination of average pressure; Radius of drainage and stabilization time; Multiphase flow	
Lecture-38	Real gas potential application; Brief overview of Layered systems;	
Lecture-39	Fractured reservoirs; Faults; Channel sands; Use of pressure and its time derivative in type curve matching.	
Week-14		
Lecture-40	**Well Tests Report:** Well test description; System evaluation; Discussion of each event; Gauge comparison; Analysis results; Well test data summary	
Lecture-41	Historical comparisons; Production improvement recommendations; Conclusions	
Lecture-42	**Computerized Methods of Analysis:** Case studies of local field examples using Well Test Simulator	

Text and Reference Books:

1. Transient Well Testing by Medhat M. Kamal
2. Modern Well Test Analysis, A Computer Aided Approach by Horne R
3. Applied Well Test Interpretation by John P. Spivey and W. John Lee

PME 413: Reservoir Modeling and Simulation

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Reservoir simulation is an area of reservoir engineering in which computer models are used to predict the flow of fluids (typically, oil, water, and gas) through porous media. Reservoir simulation models are used by oil and gas companies in the development of new fields. Also, models are used in developed fields where production forecasts are needed to help make investment decisions. As building and maintaining a robust, reliable model of a field is often time-consuming and expensive, models are typically only constructed where large investment decisions are at stake. Improvements in simulation software have lowered the time to develop a model. Also, models can be run on personal computers rather than more expensive workstations

Objective:

Reservoir simulations can at best only give an educated guess at the likely outcomes because the input data is riddled with uncertainties. Though the data should not be scoffed at and instantly dismissed, when combined with statistical likelihoods the data can present a useful picture of the upper and lower boundaries of recovery and the most likely scenario from which future actions can be planned. At the appraisal stage we typically determine:

1. The nature of the reservoir recovery plan
2. The nature of the facility required to develop the field
3. Nature and capacities of plant equipment for injection and separation
4. The different types and number of wells to be drilled
5. Sequence of the drilling program

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Reservoir Modeling and Simulation founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Modeling and Simulation demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development

4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Reservoir Modeling and Simulation uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Reservoir Modeling and Simulation system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Reservoir Modeling and Simulation practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Introduction: Reservoir models and simulation; Various simulation models; Simulator types.

Integrated Reservoir Modeling: Basic statistical principles ; Spatial modeling ; Structural modeling ; Estimation of properties at well locations ; Conditional simulation ; Facies/rock type modeling ; Petrophysical properties simulation ; Ranking of realizations ; Construction of simulator input model ; History matching ; Future predictions and quantification of uncertainty

Reservoir Simulation Models: Analytical and numerical form equations for flow through porous medium for various reservoir fluid systems in different coordinates in production and injection conditions; Reservoir structural model; Reservoir fluid models; Petrophysical properties model; Vertical Lift model; Production profile model; Buckley Leverett displacement ; One dimensional water oil displacement ; Model components, types, and modern gridding methods ; Two dimensional displacement ; Grid orientation and refinement ; Routine and special core analysis ; Pseudo relative permeability and capillary pressure ; Relative permeability manipulation ; PVT experiments, aquifer representation ; Debug a problem model ; Recurrent data, history matching, and transition to prediction mode ; Well test history match and prediction for design of extended test.

History Matching and Reservoir Optimization: History Matching - Overview and State of the Art ; History Matching – Workflows; Review of Reservoir Simulation Equations;

Reservoir Simulation: Background ; History Matching: Mathematical Background ; Unconventional Reservoirs: Background and Performance Analysis; Drainage Volume Calculations and Completion Optimization; History Matching of Unconventional Reservoirs ; History Matching: Practical Considerations ; Experimental Design and Surrogate Models ; Multiscale History Matching with Grid Coarsening ; Case Study: History Matching and Rate Optimization ; Case Study: History Matching and Well Placement Optimization; History Matching: New Developments

Streamlines: Applications to Reservoir Simulation, Characterization and Management
Streamlines: Fundamentals, Overview, Strengths and Limitations ; Basic Governing Equations ; Line Source and Sink Solutions ; Streamfunctions and Streamtubes ; Tracing streamlines in 3-D ; The streamline time of flight and its significance ; Use of Streamlines with Finite-Difference Models ; Flow simulation through geologic models ; Streamline vs. Finite Difference ; Analytical/numerical solutions along streamlines ; Modeling gravity and crossstreamline mechanisms ; Compressibility Effects ; Mapping and Material Balance Errors ; Practical Considerations and Limitations ; Flow Visualization ; Primary Recovery and Drainage Volume Calculations ; Swept Volume Calculations and Optimizing Infill Wells ; Pattern Balancing/Rate Allocations ; Improved Waterflood Management ; Waterflood Field Tracer Interpretation ; Hybrid Methods: Sector Models and Streamtubes ; Miscible Flood Modeling and Predictions ; Model Ranking and Uncertainty Assessment ; Dynamic Reservoir Characterization ; Upscaling/ Upgridding ; Why Streamlines ; History Matching: Workflows ; Assisted History Matching of Finite-Difference Models ; Streamline- Based Sensitivity Computations ; Field Case Studies ; Fractured Reservoir Modeling and Applications ; Corner Point Geometry and Faults ; Compositional Modeling ; Time Step and Stability Considerations ; Front Tracking Methods ;Streamline vs. Finite Difference: Advantages and Limitations
Application of petroleum production engineering software: MBAL, PVTi, SCHEDULE, ECLIPSE, PETREL, VFPi, PIPESIM

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Reservoir Modeling and Simulation founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Modeling and Simulation demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Reservoir Modeling and Simulation uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Reservoir Modeling and Simulation system development solutions with minimum environmental impact and beneficial for society							√					

8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Reservoir Modeling and Simulation practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		CT-1
Lecture-1	**Introduction**: Reservoir models and simulation; Various simulation models; Simulator types.	
Lecture-2	**Integrated Reservoir Modeling:** Basic statistical principles	
Lecture-3	Spatial modeling	
Week-2		
Lecture-4	Structural modeling	
Lecture-5	Estimation of properties at well locations	
Lecture-6	Conditional simulation	
Week-3		
Lecture-7	Facies/rock type modeling	
Lecture-8	Petrophysical properties simulation	
Lecture-9	Ranking of realizations	
Week-4		
Lecture-10	Construction of simulator input model	
Lecture-11	History matching	
Lecture-12	Future predictions and quantification of uncertainty	
Week-5		CT-2

Lecture-13	**Reservoir Simulation Models:** Analytical and numerical form equations for flow through porous medium for various reservoir fluid systems in different coordinates in production and injection conditions	
Lecture-14	Reservoir structural model; Reservoir fluid models	
Lecture-15	Petrophysical properties model; Vertical Lift model; Production profile model	
Week-6		
Lecture-16	Buckley Leverett displacement ; One dimensional water oil displacement	
Lecture-17	Model components, types, and modern gridding methods	
Lecture-18	Two dimensional displacement	
Week-7		
Lecture-19	Grid orientation and refinement	
Lecture-20	Routine and special core analysis	
Lecture-21	Pseudo relative permeability and capillary pressure ; Relative permeability manipulation	
Week-8		
Lecture-22	PVT experiments, aquifer representation	
Lecture-23	Debug a problem model ; Recurrent data, history matching, and transition to prediction mode	
Lecture-24	Well test history match and prediction for design of extended test.	
Week-9		CT-3
Lecture-25	**History Matching and Reservoir Optimization:** History Matching - Overview and State of the Art ; History Matching – Workflows; Review of Reservoir Simulation Equations; Reservoir Simulation	
Lecture-26	Background ; History Matching: Mathematical Background ; Unconventional Reservoirs: Background and	
Lecture-27	Performance Analysis; Drainage Volume Calculations and Completion Optimization; History Matching of Unconventional Reservoirs	
Week-10		
Lecture-28	History Matching: Practical Considerations ; Experimental Design and Surrogate Models ; Multiscale History Matching with Grid Coarsening	
Lecture-29	Case Study: History Matching and Rate Optimization ; Case Study: History Matching and Well Placement Optimization; History Matching: New Developments	
Lecture-30	**Streamlines: Applications to Reservoir Simulation, Characterization and Management** Streamlines: Fundamentals, Overview, Strengths and Limitations ; Basic Governing Equations	
Week-11		
Lecture-31	Line Source and Sink Solutions ; Streamfunctions and Streamtubes ; Tracing streamlines in 3-D ; The streamline time of flight and its significance	
Lecture-32	Use of Streamlines with Finite-Difference Models ; Flow simulation through geologic models	

Lecture-33	Streamline vs. Finite Difference ; Analytical/numerical solutions along streamlines ; Modeling gravity and crossstreamline mechanisms	
Week-12		
Lecture-34	Compressibility Effects ; Mapping and Material Balance Errors ; Practical Considerations and Limitations ; Flow Visualization ; Primary Recovery and Drainage Volume Calculations	
Lecture-35	Swept Volume Calculations and Optimizing Infill Wells ; Pattern Balancing/Rate Allocations ; Improved Waterflood Management	
Lecture-36	Waterflood Field Tracer Interpretation ; Hybrid Methods: Sector Models and Streamtubes ; Miscible Flood Modeling and Predictions	
Week-13		
Lecture-37	Model Ranking and Uncertainty Assessment ; Dynamic Reservoir Characterization ; Upscaling/ Upgridding ; Why Streamlines	
Lecture-38	History Matching: Workflows ; Assisted History Matching of Finite-Difference Models	
Lecture-39	Streamline- Based Sensitivity Computations ; Field Case Studies ; Fractured Reservoir Modeling and Applications	
Week-14		CT-4
Lecture-40	Corner Point Geometry and Faults ; Compositional Modeling ; Time Step and Stability Considerations	
Lecture-41	Front Tracking Methods ;Streamline vs. Finite Difference: Advantages and Limitations	
Lecture-42	**Application of petroleum production engineering software**: MBAL, PVTi, SCHEDULE, ECLIPSE, PETREL, VFPi	

Text and Reference Books:

1. Reservoir Simulation by Calvin C. Mattax and Robert L. Dalton
2. Streamline Simulation: Theory and Practice by Akhil Datta-Gupta and Michael J. King
3. Reservoir Simulation: History Matching and Forecasting by James R. Gilman and Chet Ozgen
4. Principles of applied reservoir simulation by John R Fanchi
5. Practical Reservoir Simulation: Using, Assessing, and Developing Results by M. R. Carlson

PME 415: Mine Ventilation and Environmental Engineering

3.00 Contact Hour; 3.00 Credit Hour;

Pre-requisite: None

1. **Rationale:**

To understand the principles and methods of mine ventilation systems and to design fan system for mine ventilation.

2. **Objectives:**

1. To understand the basics of mine ventilation system.
2. To calculate and design mine ventilations system and ventilation network analysis.
3. To measure and analyze mine pollutants and design for their remedy.
4. To know about the mining laws, mine rules and regulations.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories and calculations for mine ventilation system.
2. Evaluate the design requirements for mine fans.
3. Analyze the design parameters of mine fans.
4. Apply the knowledge to design an optimum mine ventilation system.

4. Course Contents:

Mine ventilation systems: Natural ventilation, auxiliary ventilation, booster ventilation. Mine ventilation design calculations and ventilation network analysis. Procedures for conducting the test for air quantity, pressure and air quality, airway resistance, loss of air distribution. Ventilation surveys, mine air heating and cooling, dust and fume control, and ventilation economics.

Mine Fan: Design difficulties with a mine fan, design requirements, fan pressure and system pressure requirements; Axial flow fan and centrifugal fan; Fan performance and test; Pressure loss, mine resistance and equivalent orifice; Fan operation; Choice of Fan; Underground booster fans; Auxiliary Fans; Layout of installation.

Introduction to Mine Environmental Engineering: Environmental Pollution due to mining industry, Hazards in mining field of outburst, explosion, fires, fume, dust, radiation, and noises. Potential high consequence hazards in a mine including outbursts, explosion, fires, spontaneous combustion, inrush hazards, radiation, windblast, noises, miners diseases; Mine Illumination: its effect on safety, efficiency and health, flame and electric safety lamps-their uses and lamp-room-layout and organization, standards of illumination in mines, lighting from the mains, photometric illumination survey, Mine gases, mine dust.

Mine Legislation: General principles of Mining law, Mine Act, Mine Rules & Regulations, Mines and Mineral Rules.

5. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	(100%)
1. Class Assessment	
(i) Class Participation	05
(ii) Class Attendance	05
(iii) Class Tests/Assignment/Presentation	20
2. Examination	
(i) Final Examination	70

6. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes(CO) of the Course		Program Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories and calculations for mine ventilation system	√											
2	Evaluate the design requirements for mine fans		√										
3	Analyze the design parameters of mine fans				√								
4	Apply the knowledge to design an optimum mine ventilation system			√		√							

7. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**Mine ventilation systems**	
Lecture-1	Natural ventilation	
Lecture-2	Auxiliary ventilation	
Lecture-3	Booster ventilation	
Week-2	**Mine ventilation systems**	

Lecture-4	Mine ventilation design calculations	CT-1; CT-2
Lecture-5 Lecture-6	Ventilation network analysis	
Week-3	**Mine ventilation systems**	
Lecture-7 Lecture-8 Lecture-9	Procedures for conducting the test for air quantity, pressure and air quality, airway resistance, loss of air distribution	
Week-4	**Mine ventilation systems**	
Lecture-10	Ventilation surveys	
Lecture-11	Mine air heating and cooling	
Lecture-12	Dust and fume control	
Week-5	**Mine ventilation systems; Mine Fan**	
Lecture-13	Ventilation economics	
Lecture-14	Basics of mine fan	
Lecture-15	Design difficulties with a mine fan	
Week-6	**Mine Fan**	
Lecture-16	Design requirements	
Lecture-17	Fan pressure and system pressure requirements	
Lecture-18	Axial flow fan and centrifugal fan	
Week-7	**Mine Fan**	
Lecture-19	Fan performance and test	
Lecture-20	Pressure loss	
Lecture-21	Mine resistance and equivalent orifice	
Week- 8	**Mine Fan**	
Lecture-22	Fan operation	
Lecture-23	Choice of Fan	
Lecture-24	Underground booster fans	
Week-9	**Mine Fan**	CT-3; CT-4
Lecture-25	Auxiliary Fans	
Lecture-26 Lecture-27	Layout of installation	
Week-10	**Mine Environmental Engineering**	
Lecture-28	Environmental Pollution due to mining industry	
Lecture-29 Lecture-30	Hazards in mining field of outburst, explosion, fires, fume, dust, radiation, and noises	
Week-11	**Mine Environmental Engineering**	
Lecture-31	Potential high consequence hazards in a mine including outbursts, explosion, fires, spontaneous combustion, inrush hazards, radiation, windblast, noises, miners diseases	
Lecture-32	Mine Illumination: its effect on safety, efficiency and health, flame and electric safety lamps-their uses and lamp-room-layout and organization	
Lecture-33	Standards of illumination in mines	
Week-12	**Mine Environmental Engineering**	
Lecture-34	Photometric illumination survey	
Lecture-35	Mine gases	
Lecture-36	Mine dust	
Week-13	**Mine Legislation**	

Lecture-37	General principles of Mining law	
Lecture-38	Mine act	
Lecture-39	Mine rules & regulations	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Books recommended:

1. Mine Ventilation; Panigrahi.

2. Mine Environmental Engineering; M Sengupta.

PME 417: Petroleum Refining and LPG Technology

4.00 Contact Hour; 4.00 Credit Hour

Pre-requisite: None

Rationale:

Oil refinery or petroleum refinery is an industrial process plant where crude oil is transformed and refined into more useful products such as petroleum naphtha, gasoline, diesel fuel, asphalt base, heating oil, kerosene, liquefied petroleum gas, jet fuel and fuel oils.

Objectives:

1. Explain the need for petroleum refining and provide a basic understanding of how a petroleum refinery works
2. Introduce and review physical and chemical processes used to convert crude oil into desired products
3. Discuss changing crude oil base with its implications on future prospects with environmental, technical, and economic constraints.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Petroleum Refining and LPG Technology founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum Refining and LPG Technology demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum Refining and LPG Technology uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize a material balance / energy balance exercise, by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Petroleum Refining and LPG Technology solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Petroleum Refining and LPG Technology practice

9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to development field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Crude Oil: Introduction of crude oil; Properties, API gravity, Watson Characterization factor , Viscosity, Sulfur content, True boiling point (TBP) curve, Pour point, Flash and fire point, ASTM distillation curve, Octane number.

Processes: Process description, chemistry, process flow diagram, design methods, operating procedures, and troubleshooting of Atmospheric crude distillation ,Vacuum distillation , Thermal cracker, Hydrotreaters, Fluidized catalytic cracker, Separators, Naphtha splitter, Reformer, Alkylation and isomerization, Gas treating, Blending pools, Stream splitters, Hydrorefining, catalytic reforming, hydrocracking, Coking, Polymer gasoline.

Processing Unit: Crude Distillation Unit; Catalytic Reforming Unit; Hydrodesulphurization Unit; Asphaltic Bitumen Plant i)Vacuum Distillation Unit ii)Bitumen Blowing Unit ; Long Residue Visbrear Unit; Mild Hydrocracker Unit; NGC (Natural Gas Condensate) unit; LPG Merox Unit; Gasoline Merox Unit; Kerosene Merox Unit

Unit Operation and Process Control: Principles of unit operation**;** Process controlling methods; Process control parameters, Temperature, Pressure, Flow rate, Fluid level; Description of DCS, PLC, Microcontroller.

Products: Description and use of refinery products**,** RG (Refinery Gas), LPG (Liqueified Petroleum Gas, SBP (Special Boiling Point Solvent), Naptha, MOGAS (Regular), MOGAS (Premium), SKO (Superior Kerosene Oil), MTT (Mineral Turpentine), JET A-1, JBO (Jute Batching Oil), HSD (High Speed Diesel), LSDO (Low Sulfur Diesel Oil), LDO (Light Diesel Oil), HSFO (High Sulfur Fuel Oil), LSFO (Low Sulfur Furnace Oil), BITUMEN; Transportation, distribution and storage of refinery products.

Utilities: Hydrogen Plant; Steam Generation Unit; Power Generation and other utilities units.

Health, Safety and Environments: Occupation and personal Health, Safety and Environmental (HSE) practice in petroleum refining industries.
Software: Application of refining process simulation software

Liquid Petroleum Gas (LPG):
LPG Production:
LPG Transportation: Ship, rail, tanker trucks, intermodal tanks, cylinder trucks, pipelines and local gas reticulation systems.

LPG Storage: Butane Lighters, Disposable Butane Cartridges, Small BBQ Bottles, Forklift Gas Bottles, Large Bottles, Large Tanks, Storage in Intermodal ISO Tank Containers, Mounded Tanks, Storage Spheres - Horton Spheres, Underground Storage Caverns,
LPG Bottling.

Process Safety: Historical Incident & Problem Areas ; Risk Analysis Basics ; Process Hazards Analysis Techniques – Overview ; Layers of Protection ; Inherently Safer Design ; Hazards Associated with Process Fluids ; Leakage and Dispersion of Hydrocarbon Releases ; Combustion Behavior of Hydrocarbons ; Sources of Ignition ; Hazards Associated with Specific Plant Systems ; Plant Layout & Equipment Spacing ; Pressure Relief and Disposal Systems ; Process Monitoring and Control ; Safety Instrumented Systems ; Fire Protection Principles ; Explosion Protection.

Application of Petroleum Refining and LPG Technology software:

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Performance	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Written Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Petroleum Refining and LPG Technology founded on a theory based understanding of mathematics and the natural and	√											

	physical sciences												
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Petroleum Refining and LPG Technology demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Petroleum Refining and LPG Technology uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize a material balance / energy balance exercise, by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Petroleum Refining and LPG Technology solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Petroleum Refining and LPG Technology practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			

10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to development field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		
Lecture-1	**Crude Oil:** Introduction of crude oil; Properties, API gravity, Watson Characterization factor	
Lecture-2	Viscosity, Sulfur content, True boiling point (TBP) curve, Pour point, Flash and fire point, ASTM distillation curve, Octane number.	
Lecture-3	**Processes:** Process description, chemistry, process flow diagram, design method	
Lecture-4	Operating procedures, and troubleshooting	
Week-2		
Lecture-5	Atmospheric crude distillation ,Vacuum distillation , Thermal cracker	
Lecture-6	Hydrotreaters, Fluidized catalytic cracker, Separators, Naphtha splitter, Reformer	CT-1
Lecture-7	Alkylation and isomerization, Gas treating, Blending pools, Stream splitters	
Lecture-8	Hydrorefining, catalytic reforming, hydrocracking, Coking, Polymer gasoline.	
Week-3		
Lecture-9	**Processing Unit:** Crude Distillation Unit; Catalytic Reforming Unit; Hydrodesulphurization Unit	
Lecture-10	Asphaltic Bitumen Plant i)Vacuum Distillation Unit ii)Bitumen Blowing Unit	
Lecture-11	Long Residue Visbrear Unit; Mild Hydrocracker Unit; NGC (Natural Gas Condensate) unit	
Lecture-12	LPG Merox Unit; Gasoline Merox Unit; Kerosene Merox Unit	
Week-4		CT-2

Lecture-13	**Unit Operation and Process Control:** Principles of unit operation**;** Process controlling methods; Process control parameters	
Lecture-14	Temperature	
Lecture-15	Pressure	
Lecture-16	Flow rate	
Week-5		
Lecture-17	Fluid level	
Lecture-18	Description of DCS	
Lecture-19	PLC	
Lecture-20	Microcontroller.	
Week-6		
Lecture-21	**Products:** Description and use of refinery products**,** RG (Refinery Gas)	
Lecture-22	LPG (Liqueified Petroleum Gas, SBP (Special Boiling Point Solvent)	
Lecture-23	Naptha	
Lecture-24	MOGAS (Regular), MOGAS (Premium)	
Week-7		CT-3
Lecture-25	SKO (Superior Kerosene Oil), MTT (Mineral Turpentine)	
Lecture-26	JET A-1, JBO (Jute Batching Oil)	
Lecture-27	HSD (High Speed Diesel)	
Lecture-28	LSDO (Low Sulfur Diesel Oil), LDO (Light Diesel Oil)	
Week-8		
Lecture-29	HSFO (High Sulfur Fuel Oil), LSFO (Low Sulfur Furnace Oil), BITUMEN	
Lecture-30	Transportation, distribution and storage of refinery products	
Lecture-31	**Utilities:** Hydrogen Plant; Steam Generation Unit	
Lecture-32	Power Generation and other utilities units	
Week-9		
Lecture-33	**Health, Safety and Environments**: Introduction of Occupation and personal Health, Safety	
Lecture-34	Occupation and personal Health, Safety	
Lecture-35	Personal Health, Safety	
Lecture-36	Environmental (HSE) practice in petroleum refining industries.	
Week-10		CT-4
Lecture-37	**Liquid Petroleum Gas (LPG):** LPG Production: LPG Transportation: Ship, rail, tanker trucks, intermodal tanks, cylinder trucks, pipelines and local gas reticulation systems.	
Lecture-38	LPG Storage: Butane Lighters, Disposable Butane Cartridges	
Lecture-39	Small BBQ Bottles, Forklift Gas Bottles, Large Bottles, Large Tanks	
Lecture-40	Storage in Intermodal ISO Tank Containers	
Week-11		
Lecture-41	Mounded Tanks	
Lecture-42	Storage Spheres, Horton Spheres	
Lecture-43	Underground Storage Caverns	
Lecture-44	LPG Bottling	

Week-12		CT-5
Lecture-45	**Process Safety:** Historical Incident & Problem Areas ; Risk Analysis Basics ; Process Hazards Analysis Techniques – Overview ; Layers of Protection ; Inherently Safer Design	
Lecture-46	Hazards Associated with Process Fluids	
Lecture-47	Leakage and Dispersion of Hydrocarbon Releases	
Lecture-48	Combustion Behavior of Hydrocarbons	
Week-13		
Lecture-49	Sources of Ignition	
Lecture-50	Hazards Associated with Specific Plant Systems	
Lecture-51	Plant Layout & Equipment Spacing ; Pressure Relief and Disposal Systems	
Lecture-52	Process Monitoring and Control ; Safety	
Week-14		
Lecture-53	Instrumented Systems	
Lecture-54	Fire Protection Principles	
Lecture-55	Explosion Protection.	
Lecture-56	Application of Petroleum Refining and LPG Technology software	

Text and Reference Books:

1. Fundamentals of Petroleum Refining by Mohamed A. Fahim, Taher A. Alsahhaf and Amal Elkilani
2. Handbook of Petroleum Refining Processes by Robert A. Meyers
3. Understanding LPG by Kosan Crisplant
4. Petroleum Refining, by J. H. Gary and G. E. Handwerk

PME 419: Professional Practices and Communication

2.00 Contact Hour; 2.00 Credit Hour

Pre-requisite: None

Rationale:

Professional standards describe the competent level of care in each phase of the nursing process. The main purpose of professional standards is to direct and maintain safe and clinically competent nursing practice. These standards are important to our profession because they promote and guide our clinical practice.

Objective:

1. Describe and evaluate a range of positions in the design community, with regard to the social, cultural and professional practice of communication design.
2. Analyze how your creative, practical and professional expertise prepares you for future study and a career in the creative industries.
3. Identify a range of roles and tasks within conventional and emerging communication design practices.
4. Critically discuss how these roles are combined in collaborative and/or hierarchical production structures.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Professional Practices and Communication founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Professional Practices and Communication demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Professional Practices and Communication uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Project: characteristic feature, types and life cycle; type of contracts and estimates; procurement regulations and law; documents for procurement of works, goods, services and their application; tender procedure with the light of PPR; claims, disputes and arbitration procedure.

Communication: concepts, methods and strategies for effective speaking and inter-personal communication; business and engineering reports, proposals and messages; conducting meetings; an introduction to the code of ethics for engineers; introduction to MOI (Method of Instruction).

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Professional Practices and Communication founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Professional Practices and Communication demonstrated		√										

	through appropriate and relevant assessment												
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Professional Practices and Communication uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Professional Practices and Communication by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		CT-1
Lecture-1	Project: characteristic feature	
Lecture-2	Project: characteristic feature	
Week-2		
Lecture-3	Types and life cycle	
Lecture-4	Types and life cycle	
Week-3		
Lecture-5	Type of contracts and estimates	
Lecture-6	Type of contracts and estimates	
Week-4		
Lecture-7	Procurement regulations and law	
Lecture-8	Procurement regulations and law	
Week-5		
Lecture-9	Documents for procurement of works, goods	
Lecture-10	Documents for procurement of works, goods	
Week-6		
Lecture-11	Services and their application	CT-2

Lecture-12	Services and their application	
Week-7		
Lecture-13	Tender procedure with the light of PPR, Claims	
Lecture-14	Disputes and arbitration procedure.	
Week-8		
Lecture-15	Communication	
Lecture-16	concepts, methods	
Week-9		
Lecture-17	strategies for effective speaking	
Lecture-18	inter-personal communication	
Week-10		
Lecture-19	Business reports	
Lecture-20	Business Proposals	
Week-11		
Lecture-21	Business Messages	
Lecture-22	Engineering reports	CT-3
Week-12		
Lecture-23	Engineering Proposals	
Lecture-24	Engineering Messages	
Week-13		
Lecture-25	Conducting meetings	
Lecture-26	An introduction to the code of ethics for engineers	
Week-14		
Lecture-27	An introduction to the code of ethics for engineers	
Lecture-28	Introduction to MOI (Method of Instruction).	

Text and Reference Books:

1. The Theory and Practice of Corporate Communication: A Competing Values by Alan T. Belasen
2. A Guide to Professional Communication Practices by Nancy A. Wiencek
3. Planning for Strategic Communication: A Workbook for Applying Social Theory by John A. McArthur
4. Business Communication: Rethinking Your Professional Practice for the Post-digital Age by Peter Chatterton and Peter Hartley
5. PPR

PME 400: Project / Thesis- Part: I

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

The rationale of research is the reason for conducting the study. The rationale should answer the need for conducting the said research. It is a very important part of your publication as it justifies the significance and novelty of the study. Ideally, the research should be structured as observation, rationale, hypothesis, objectives, methods, results and conclusions.

Objective:

The students are guided to learn the following aspects:

1. Understanding & evaluating the design / operation / environmental aspects of a petroleum and mining equipment/ process.
2. Understanding & evaluating the technology aspects of various alternatives available, called "Best Available Technologies (BAT)", through literature & references and select a suitable equipment/ process with optimum capacity.
3. Carrying-out the basic design of the process using steady state simulation.
4. Preparation of equipment layout & plot plan drawing.
5. Preliminary cost estimation of CAPEX and OPEX.
6. Presentation & research management skills.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Experimental and theoretical investigation of various problems related to petroleum and mining engineering will be carried out. The topic should provide an opportunity to the student in developing initiative, creative ability and engineering judgment with different objectives of same data. Individual study will be required.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society							√					

8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Work Schedule:

Lecture	Tasks
Week-1	Step 1 – Formulate Your Question • Your research may start as a general idea or a specific question, statement or thesis. • Know what you want to focus on before you begin.
Week-2	Step 2 – Review the Literature • Read about your topic using websites or encyclopedias. • It introduces you to the topic, helps you to focus on its key elements and can help you decide to broaden or narrow your focus. • These sources often include bibliographies that you can “piggyback” to find more sources on your topic.
Week-3	Step 2 – Review the Literature • Read about your topic using websites or encyclopedias. • It introduces you to the topic, helps you to focus on its key elements and can help you decide to broaden or narrow your focus. • These sources often include bibliographies that you can “piggyback” to find more sources on your topic.
Week-4	Step 2 – Review the Literature • Read about your topic using websites or encyclopedias. • It introduces you to the topic, helps you to focus on its key elements and can help you decide to broaden or narrow your focus.

	• These sources often include bibliographies that you can "piggyback" to find more sources on your topic.
Week-5	Step 2 – Review the Literature • Read about your topic using websites or encyclopedias. • It introduces you to the topic, helps you to focus on its key elements and can help you decide to broaden or narrow your focus. • These sources often include bibliographies that you can "piggyback" to find more sources on your topic.
Week-6	Step 3 – Focus and Refine Your Topic • Think about how you want to explore the topic. • Ask yourself: ◦Is my research intended for a general group or class or is it more specialized? • Can or should I limit my topic by time period or place?
Week-7	Report
Week-8	Step 4 – Research Tools • You need the right tool for the job. Using our research guides can help you find these answers. • Ask yourself: • What types of materials do I need? • How recent should my materials be? • How long do I have to do my research? • What subjects are covered by my topic?
Week-9	Step 5 – Select Your Tool and Begin • Use the library's resources to find journal articles, eBooks and videos. • Use our library catalog to find books or DVDs. • If you are using websites, make sure they are quality resources – not just the first result!
Week-10	Step 6 – Get Stuck, Get Help! • Never fear, we are here to help you with your research questions
Week-11	Step 7 – Gather Your Materials • Are your best resources books, journals or websites?
Week-12	Step 7 – Gather Your Materials • Are your best resources books, journals or websites?
Week-13	Step 7 – Gather Your Materials • Are your best resources books, journals or websites?
Week-14	Report

Text and Reference Books:

1. How to Write a Thesis by Umberto Eco
2. Writing Your Dissertation in Fifteen Minutes a Day: A Guide to Starting, Revising by Joan Bolker
3. Matching Method, Paradigm, Theories and Findings by Kember, David, Corbett, Michael
4. Research Methods and Thesis Writing' by Calmorin

PME 412: Integrated Design Project- Part: I

2.00 Contact Hour; 1.00 Credit Hour

Pre-requisite: None

Rationale:

The rationale of project is the reason for conducting the study. The rationale should answer the need for conducting the said project. It is a very important part of your publication as it justifies the significance and novelty of the study. Ideally, the research should be structured as observation, rationale, hypothesis, objectives, methods, results and conclusions.

Objective:

The students are guided to learn the following aspects:

1. Understanding & evaluating the design / operation / environmental aspects of a petroleum and mining equipment/ process.
2. Understanding & evaluating the technology aspects of various alternatives available, called "Best Available Technologies (BAT)", through literature & references and select a suitable equipment/ process with optimum capacity.
3. Carrying-out the basic design of the process using steady state simulation.
4. Preparation of equipment layout & plot plan drawing.
5. Preliminary cost estimation of CAPEX and OPEX.
6. Presentation & research management skills.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Integrated design project offers a distinctive opportunity to play a key role as part of a team working on a realistic design project. It’s about creating and testing ideas to solve real-world problems. In doing so, students’ will improve technical knowledge, communication, practical skills and employability at a stroke.

The integrated design project will develop your skills in:
Acquiring and applying technical knowledge.
Group work – leadership, discussion, planning, monitoring, assessing, reporting on progress, taking responsibility, taking action.
Understanding the bigger picture that surrounds engineering projects – the issues, the aims, and sometimes the constraints; the different viewpoints of people working on and affected by a project.
Creativity and innovation – priceless skills in the modern workplace.
Presenting and arguing the case for your ideas.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Work Schedule:

Lecture	**Tasks**
Week-1	Step 1. Identify a need:
Week-2	The need (also called the problem you are solving or the Engineering Goal) is frequently identified by customers–the users of the product. The customer could be a retail consumer or the next team in a product development. Customers may express needs by describing a product (I need a car) or as a functional requirement (I need a way to get to school). The need should be described in a simple statement that includes what you are designing (the product), who it is for (customer), what need does it satisfy (problem to solve), and how does it improve previous designs (easier to use, less expensive, more

	efficient, safer).
Week-3 Week-4 Week-5 Week-6 Week-7	Step 2. Establish design criteria and constraints: Design criteria are requirements you specify that will be used to make decisions about how to build and evaluate the product. Criteria are derived from needs expressed by customers. Criteria define the product’s physical and functional characteristics and must be declared as a measurable quantity. Some examples of measurable criteria include length (in cm, km, etc.); mass (in mg, kg, etc.); velocity (in m/sec, km/hr., etc.); and ruggedness (able to withstand an impact force of x Newtons). Some examples of measurable accuracy include, ‘…fewer than y errors per mSec…’ or ‘…fewer than z particles per liter of fluid….’ Constraints are factors that limit the engineer’s flexibility. Some typical constraints are cost, time, and knowledge; legal issues; natural factors such as topography, climate, raw materials; and where the product will be used. Good designs will meet important design criteria within the limits fixed by the constraints. Good designs are also economical to make and use because cost is always a design constraint!
Week-8 Week-9 Week-10 Week-11 Week-12 Week-13 Week-14	Step 3. Evaluate alternative designs and create your test plan: Your research into possible solutions will reveal what has been done to satisfy similar needs. You’ll discover where knowledge and science limit your solutions, how previous solutions may be improved, and what different approaches may meet design objectives. You should consider at least two or three alternative designs and consider using available technology, modifying current designs, or inventing new solutions. Superior work will demonstrate tradeoff analyses such as comparing the strength vs. cost of various bridge-building materials. It’s important to document in your project notebook how you chose and evaluated alternative designs. Can you defend your choices to the judges? You will develop an initial test plan describing how you will test the design criteria and constraints you listed in Step 2. Many engineering design projects will require pre-approval from the SRC. A risk assessment form (3) is required for any project using hazardous chemicals, activities or devices and microorganisms exempt from pre-approval. If you will involve humans in your product testing, you will be required to fill out a Human Participant Research Plan. The exemption to this requirement is if your invention does not pose a risk, and it is being tested only by yourself or your team members. STOP! You must complete an Application Form including a completed engineering template, risk assessment form and/or Human Participant Research Plan as appropriate. Obtain approval from your teacher and the SRC (Scientific Review Committee) BEFORE you build your prototype.

Text and Reference Books:

1. How to Write a Thesis by Umberto Eco
2. Writing Your Dissertation in Fifteen Minutes a Day: A Guide to Starting, Revising by Joan Bolker

3. Matching Method, Paradigm, Theories and Findings by Kember, David, Corbett, Michael
4. Research Methods and Thesis Writing' by Calmorin
5. Sustainable Development Projects: Integrated Design, Development, and Regulation by David R. Godschalk

PME 414: Reservoir Modeling and Simulation Sessional

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Reservoir simulation is an area of reservoir engineering in which computer models are used to predict the flow of fluids (typically, oil, water, and gas) through porous media. Reservoir simulation models are used by oil and gas companies in the development of new fields. Also, models are used in developed fields where production forecasts are needed to help make investment decisions. As building and maintaining a robust, reliable model of a field is often time-consuming and expensive, models are typically only constructed where large investment decisions are at stake. Improvements in simulation software have lowered the time to develop a model. Also, models can be run on personal computers rather than more expensive workstations

Objective:

Reservoir simulations can at best only give an educated guess at the likely outcomes because the input data is riddled with uncertainties. Though the data should not be scoffed at and instantly dismissed, when combined with statistical likelihoods the data can present a useful picture of the upper and lower boundaries of recovery and the most likely scenario from which future actions can be planned. At the appraisal stage we typically determine:

1. The nature of the reservoir recovery plan
2. The nature of the facility required to develop the field
3. Nature and capacities of plant equipment for injection and separation
4. The different types and number of wells to be drilled
5. Sequence of the drilling program

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Reservoir Modeling and Simulation founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Modeling and Simulation demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development

4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Reservoir Modeling and Simulation uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Reservoir Modeling and Simulation system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Reservoir Modeling and Simulation practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Development of reservoir model to simulate the reservoir responses for history matching and forecasting using the following workflow:-
Stratigraphic Modeling: Prepare well head, deviation and well log data as per the software format and insert all data into the project. Interpret the log data to make well correlation. Make synthetic log.

Geophysical Modeling: Prepare 2D/3D seismic data as per the software format and insert all data into the project. Make synthetic seismogram, well tie and mis-tie analysis. Interpret horizons. Develop velocity model.

Structural Modeling: Make Fault molding, pillar grid, horizon, zone, layer and fluid contact.

Property Modeling: Property modeling is the process of filling the cells of the grid with discrete (facies) or continuous (petrophysics) properties. Petrel assumes that the layer geometry given to the grid follows the Geological layering in the model area. These processes are therefore dependent upon the geometry of the existing grid. When interpolating between data points, Petrel will propagate property values along the grid layers.
Property modeling in Petrel is split into three separate processes:

- Geometrical modeling - No interpolation of input data is required. Properties are built based on the geometrical properties of the grid cells themselves, like a cell volume, angle, height, etc.; some algorithms also require input data, but this data is simply sampled into the grid (e.g. seismic).
- Facies Modeling - Interpolation or simulation of discrete data, e.g. facies.

- Petrophysical modeling - Interpolation or simulation of continuous data, e.g. porosity, permeability and saturation.

In addition there are three other process steps which can be used when modeling properties:

- Scale Up Well Logs - The process of sampling values from well logs or well log attributes into the grid, ready for use as input to facies modeling and petrophysical modeling.
- Data Analysis - The process of preparing the input data (normally upscaled well logs) for Property modeling. It consists of applying transformations on input data identifying trends for continuous data, vertical proportion and probability for discrete data; as well as defining variograms that describe the input in both cases. This is then used in the facies and petrophysical modeling to ensure that the same trends appear in the result.
- Fault Analysis - The process where the user can generate fault transmissibility multipliers, either directly or by modeling fault properties, providing grid permeabilities and calculating the multiplier. These are then used as input to the simulation or simply as a visual assessment of the sealing potential of faults.

Well Engineering

- Well Path Design
- Well Completion Design

Other Modeling for Simulation

- Making a fluid model
- Making rock physics functions
- Aquifers
- Development Strategies
- Defining a simulation case
- Simulation Sector Modeling

Simulation Results Displaying

Simulation results come in four forms:

- Summary Vectors- These are stored on the Results tab and may be displayed in the function window or in the map window. See Displaying simulation results using the data displayed on the Results pane for details of working with these plots.
- Properties- These are stored in the appropriate 3D grid and displayed in much the same way as any other grid property.
- Streamlines-These are stored on the 3D grid and displayed in a 3D window. See Streamlines for more details
- Simulation logs-These are stored on a per-simulation basis and are accessed using the Log folders on the Input tree. They can be displayed in 2D, 3D, well section and intersection windows. They are sometimes referred to as Dynamic logs

Case Study:

1. Development of reservoir geomodel and simulation model of gas field
2. Development of reservoir geomodel and simulation model of oil field

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Reservoir Modeling and Simulation founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Reservoir Modeling and Simulation demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to				√								

	suggest approaches and strategies for the assessment and quantification of Reservoir Modeling and Simulation uncertainty and data management validated against national or international standards												
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Reservoir Modeling and Simulation system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Reservoir Modeling and Simulation practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Experiments
Week-1	Stratigraphic Modeling
Week-2	Geophysical Modeling
Week-3	Geophysical Modeling
Week-4	Structural Modeling
Week-5	Structural Modeling
Week-6	Property Modeling
Week-7	Quiz
Week-8	Property Modeling
Week-9	Well Engineering
Week-10	Other Modeling for Simulation (PVT, Rock,)
Week-11	Simulation Results Displaying
Week-12	Development of reservoir geomodel and simulation model of gas field
Week-13	Development of reservoir geomodel and simulation model of oil field
Week-14	Quiz

Text and Reference Books:

1. Reservoir Simulation by Calvin C. Mattax and Robert L. Dalton
2. Streamline Simulation: Theory and Practice by Akhil Datta-Gupta and Michael J. King
3. Reservoir Simulation: History Matching and Forecasting by James R. Gilman and Chet Ozgen
4. Principles of applied reservoir simulation by John R Fanchi
5. Practical Reservoir Simulation: Using, Assessing, and Developing Results by M. R. Carlson

PME 416: Mine Ventilation and Environmental Engineering Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

1. **Rationale:**

The module is designed to understand and carry out different instruments for measurement of mine environmental elements and to build a mine ventilation model.

2. **Objective:**

1. To understand the basics of mine environmental survey instruments.
2. To calculate and design mine ventilations system and ventilation network analysis.

3. **Course Learning Outcomes (CO):**

On successful completion of this course students will be able to:

1. Understand the theories and calculations for mine ventilation instruments.
2. Evaluate the design requirements for mine fans.
3. Apply the knowledge to design an optimum mine ventilation system.

4. **Course Contents:**

Apparatus for mine environment:
1. Measurement of airbone dust particles
2. Measurement of ashes in mine air
3. Measurement of radiation level in mine
4. Measurement of sound level in mine

Mine ventilation design:
5. Building mine ventilation models
6. Creating pressure for flow
7. Simulating airflow in models

5. **Teaching-Learning Strategy:**

- Class Lectures
- Survey
- Simulation
- Group Project
- Class Tests
- Assignments
- Presentation

6. Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/ Report Writing/ Project Work/ Assignment	50
Quiz Test	30
Viva Voce	10

7. Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Understand the theories and calculations for mine ventilation instruments	√											
2.	Evaluate the design requirements for mine fans	√			√								
3.	Apply the knowledge to design an optimum mine ventilation system		√	√		√							

8. Lecture Schedule:

Lecture	Experiments
Week-1	Measurement of airbone dust particles
Week-2	Measurement of ashes in mine air
Week-3	Measurement of radiation level in mine
Week-4	Measurement of sound level in mine
Week-5	Building mine ventilation models
Week-6	
Week-7	Quiz
Week-8	Creating pressure for flow
Week-9	
Week-10	Simulating airflow in models
Week-11	
Week-12	
Week-13	
Week-14	Quiz

9. Methods and materials:

1. Carry out survey with survey instruments
2. Simulation and analysis software for mining application
3. Supplied materials

Level-4, Term-2

PME 421: Evaluation and Management of Petroleum and Mining Projects

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The Project Rationale is a statement of facts explaining the background of the project. The rationale identifies the need for the product or process and offers viable solutions. The rationale is one of the first documents to be written by the Project Manager and sets the background for the Business Case. Evaluations involve an assessment of the strengths and weaknesses of projects, programmers or policy to improve their effectiveness.

Objective:

1. To explain the main tasks undertaken by project managers
2. To introduce software project management and to describe its distinctive characteristics
3. To discuss project planning and the planning process
4. To show how graphical schedule representations are used by project management
5. To discuss the notion of risks and the risk and management process

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Evaluation and Management founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Evaluation and Management demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Evaluation and Management uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues

7) Design sustainable Evaluation and Management system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Evaluation and Management practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Economics: Pricing: natural gas, marker crudes, OPEC, spot and futures markets, transportation ; Production rate: mathematical models ; Cash flow: revenue, capital and operating costs, spreadsheet exercises ; Economic evaluation: present value concepts, sensitivity and risk analysis, royalty, sources of capital, incremental economics, sunk costs, inflation ; Long-range planning ; Cash versus write-off decision: depreciation, depletion, and amortization ; Annual report: statements, financial ratios; Worldwide business operations: concessions, licenses, production sharing contracts, joint ventures, cost of capital, sources of funding, debt and equity ; Performance appraisal: buy/sell assessments ; Ethics in economic analyses.

Finance and Accounting Principles: Financial terms and definitions, the language of business; accounting rules, standards, and policies; Constructing the basic financial statements; Classifying revenues, assets, liabilities, and equity; Comparing different accounting elements; Accounting for joint operations; Accounting and reporting.

Cost Management: Defining costs, classifications and terminology for an E&P company; Determining cost objects, cost drivers and their behaviors; Analyzing different types of cost management systems.

Budgeting: Defining the budget terms, classifications and terminology in an oil and gas sense; Tools and techniques for determining inputs to the budget process ; Tying the different budgets together to create a more effective budget process ; Analyzing different types of budget management systems.

Decision Analysis: Decision Modeling: application of DA process for modeling; influence diagrams; free cash flow concept; sensitivity analysis; good modeling practices; real options overview ; Monte Carlo Simulation: prospect risking (similar to play analysis); calculating probabilities and distributions with simulation; modeling and optimizing investment portfolios.

Project Management: The project methodology ; Identifying project risks and opportunities ; Project lifecycle ; Project manager ; Project business case ; Project sponsor ; Project scope ; Understanding project interfaces ; Managing a project budget ; Project scheduling ; Resource management ; Lead time and project inventory management.

Project Cost Scheduling: Project estimation and schedule ; Integrating cost and schedule ; The project lifecycle ; Tools and techniques used in cost scheduling ; Cost estimation ; Cost escalation and reduction ; Information; communication, monitoring, and control ; Stakeholder management ; Contractual issues and forms ; The project budget ; Ownership and reporting requirements.

Risk Management: Risk management planning; Roles/responsibilities, governance, and risk ownership; Identify, analyze, and respond to risk events; Types of risks: threats vs. opportunities; Risk analysis and prioritization; Risk mitigation and contingency planning; Monitor and control risk ; Risk reporting and communication ; High level overview of probabilistic cost and schedule peer reviews.

Troubled Projects: Troubled project characteristics and indicators ; Recovery methodology ; Assessment techniques for development concepts and definition maturity; project teams and stakeholders; execution strategy ; Assessment resources ; Intervention ; Recovery planning ; Gaining buy-in ; Implementation and residual issues.

Application of Evaluation and Management of Petroleum and Mining Projects software:

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Evaluation and Management founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Evaluation and Management demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Evaluation and Management uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Evaluation and Management system development solutions with minimum environmental impact							√					

	and beneficial for society												
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Evaluation and Management practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule: Lecture Topic

Lecture		**Class Test (CT)**
Week-1		CT-1
Lecture-1	**Economics:** Pricing: natural gas, marker crudes, OPEC, spot and futures markets, transportation ; Production rate: mathematical models	
Lecture-2	Cash flow: revenue, capital and operating costs, spreadsheet exercises	
Lecture-3	Economic evaluation: present value concepts, sensitivity and risk analysis, royalty, sources of capital, incremental economics, sunk costs, inflation ; Long-range planning	
Week-2		
Lecture-4	Cash versus write-off decision: depreciation, depletion, and amortization ; Annual report: statements, financial ratios	
Lecture-5	Worldwide business operations: concessions, licenses, production sharing contracts, joint ventures, cost of capital, sources of funding, debt and equity	
Lecture-6	Performance appraisal: buy/sell assessments; Ethics in economic analyses	

Week-3		
Lecture-7	**Finance and Accounting Principles: F**inancial terms and definitions, the language of business	
Lecture-8	Accounting rules, standards, and policies	
Lecture-9	Constructing the basic financial statements; Classifying revenues, assets, liabilities, and equity	
Week-4		
Lecture-10	Comparing different accounting elements	
Lecture-11	Accounting for joint operations	
Lecture-12	Accounting and reporting.	
Week-5		
Lecture-13	**Cost Management:** Defining costs, classifications and terminology for an E&P company	
Lecture-14	Determining cost objects, cost drivers and their behaviors	
Lecture-15	Analyzing different types of cost management systems.	
Week-6		
Lecture-16	**Budgeting:** Defining the budget terms, classifications and terminology in an oil and gas sense; Tools and techniques for determining inputs to the budget process	
Lecture-17	Tying the different budgets together to create a more effective budget process	
Lecture-18	Analyzing different types of budget management systems.	
Week-7		CT-2
Lecture-19	**Decision Analysis:** Decision Modeling: application of DA process for modeling; influence diagrams; free cash flow concept; sensitivity analysis; good modeling practices; real options overview	
Lecture-20	Monte Carlo Simulation: prospect risking (similar to play analysis)	
Lecture-21	Calculating probabilities and distributions with simulation; modeling and optimizing investment portfolios	
Week-8		
Lecture-22	**Project Management:** The project methodology ; Identifying project risks and opportunities ; Project lifecycle ; Project manager	
Lecture-23	Project business case ; Project sponsor ; Project scope ; Understanding project interfaces	
Lecture-24	Managing a project budget; Project scheduling; Resource management; Lead time and project inventory management.	
Week-9		
Lecture-25	**Project Cost Scheduling:** Project estimation and schedule ; Integrating cost and schedule ; The project lifecycle ; Tools and techniques used in cost scheduling	
Lecture-26	Cost estimation ; Cost escalation and reduction	
Lecture-27	Information; communication, monitoring, and control	
Week-10		CT-3
Lecture-28	Stakeholder management ; Contractual issues and forms	
Lecture-29	The project budget	
Lecture-30	Ownership and reporting requirements	
Week-11		
Lecture-31	**Risk Management:** Risk management planning; Roles/responsibilities, governance, and risk ownership	

Lecture-32	Identify, analyze, and respond to risk events; Types of risks: threats vs. opportunities	
Lecture-33	Risk analysis and prioritization	
Week-12		
Lecture-34	Risk mitigation and contingency planning	
Lecture-35	Monitor and control risk ; Risk reporting and communication	
Lecture-36	High level overview of probabilistic cost and schedule peer reviews	
Week-13		
Lecture-37	**Troubled Projects:** Troubled project characteristics and indicators ; Recovery methodology	
Lecture-38	Assessment techniques for development concepts and definition maturity	
Lecture-39	project teams and stakeholders	CT-4
Week-14		
Lecture-40	execution strategy	
Lecture-41	Assessment resources ; Intervention ; Recovery planning ; Gaining buy-in ; Implementation and residual issues	
Lecture-42	Application of Evaluation and Management of Petroleum and Mining Projects software	

Text and Reference Books:

1. Project Management Body of Knowledge by Project Management Institute
2. The art of project management by Scott Berkun
3. Strategic Project Management Made Simple: Practical Tools for Leaders and Teams by Terry Schmidt
4. Engineering Economy by illiam G. Sullivan
5. Engineering Project Management by Nigel J. Smith
6. Project Management for Engineers by J Michael Bennett

PME 423: Transmission and Distribution of Natural Gas

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Gas transmission & distribution system are gas pipeline system and associated facilities designed for gas supply to consumers. Gas transmission & distribution system is a link between gas fields and gas consumers.

Objective:

1. To connect gas sources to major demand centers and ensure availability of gas to consumers in various sectors.
2. Explain the key functional and commercial activities across the industry and recognize how they relate to their own company and their own role
3. Cooperate more effectively with people in other functional areas by better understanding their roles and the terminology used
4. Improve workflow quality by better understanding the sources of information and the
5. purpose and uses of their work output
6. Recognize the key drivers of revenues and costs, giving them tools to identify how they can make a difference through their own actions
7. Understand how industry trends and challenges require adjustment to changing needs

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Transmission and Distribution of Natural Gas founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Transmission and Distribution of Natural Gas demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Transmission and Distribution of Natural Gas uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues

7) Design sustainable petroleum production system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Transmission and Distribution of Natural Gas practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Natural Gas & Condensate Transmission System: Introduction and Overview ; Route Survey; Route Selection; Horizontal Directional Drilling (HDD) Method;Flow Equations ;Pipe Design ; Mainline Valves ; Blowdown Time ; Overpressure Protection ; Gas Quality and Gas Conditioning ; Valves and Fittings ; Valve Set Design ; Branch Connections ; Launchers and Receivers ; Road and Railroad Crossings ; Stream and River Crossings ; Cathodic Protection ;Construction—Lowering In ; Hydrostatic Testing ; Increased MAOP ; Non-destructive Inspection; Codes and Standards; Compressor Stations;RMSs and Associated Facilities; Metering and Manifold Station; City Gate Station;Town Boarder Stations;Network Analysis; Safety.

Scada System: Introduction of Scada system; Supervisory control and data acquisition; Monitoring of all transmission parameters : Gas flow at supply and off-take points, line pressure, movement of gas and condensate volumes and gas quality; Pipeline integrity monitoring, leak detection and alarm, metering values of gas and condensate at each of the inlet and outlet points, open-closed status of all line and station valves, direct digital data transmission and voice communication.

Gas Distribution Piping Systems: Industry and Structure; Codes and Standards; Code Compliance; Distribution Integrity Management (DIM); Incident Investigation; Leakage Control; Repair/Replace Decisions; Steel Pipe Properties and Design; Plastic Pipe Properties and Design; Cast Iron Properties; External Loading of Pipe and Service Conditions; Secondary Stress Calculation; Exposed Crossings; Expansion Loops; Construction & Joining; Tie-Ins Methods and Plans; Corrosion and Cathodic Protection; Transmission Pipeline Integrity Plan and Evaluation; Route Selection Criteria; Testing; Uprating; Network Analysis; Safety.

Gas Distribution System Planning: Measurement Principles and Meter Fundamentals: Positive Displacement Diaphragm Meters, Positive Displacement Rotary Meters, Gas Turbine Meters, Ultrasonic Meters; Pressure Regulation Principles; Overpressure Protection; Pressure Regulation Sizing and Selection; Gas Supply Planning; Gas Control Operations;

System Design Principles and Considerations; Load Estimating; Flow Equations; System Modeling; Monitoring System Pressure; Enhancing Pressure by Redirecting Flow; Economic.

Gas Distribution Operations: Codes and Standards ; Leak Inspection ; Odor Investigation ; Emergency Response ; Operation and Maintenance Activities; Valves, Patrol, Locates, Pump Drips ;Outage Control ; ; Leakage Control ;Repair/Replace ; Performance Measures; Regulator Problems and Possible Causes ;Customer Service Operations; Safety.

Environmental Study: IEE, EIA, SIA, RP/RAP of Transmission and Distribution projects.

Case Study: Design of Transmission and Distribution line using Simulation Software (PIPESIM, HYSIS).

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Transmission and Distribution of Natural Gas founded on a theory based understanding of mathematics and the natural and physical sciences	√											

2.	Apply a critical-thinking and problem-solving approach towards the main principles of Transmission and Distribution of Natural Gas demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Transmission and Distribution of Natural Gas uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Transmission and Distribution of Natural Gas system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum production engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to										√		

	practice teamwork and communication skills												
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Natural Gas & Condensate Transmission System**: Introduction and Overview ; Route Survey; Route Selection; Horizontal Directional Drilling (HDD) Method;Flow Equations ;Pipe Design ; Mainline Valves ; Blowdown Time	
Lecture-2	Overpressure Protection ; Gas Quality and Gas Conditioning ; Valves and Fittings	
Lecture-3	Valve Set Design ; Branch Connections ; Launchers and Receivers	
Week-2		
Lecture-4	Road and Railroad Crossings ; Stream and River Crossings	
Lecture-5	Cathodic Protection ;Construction—Lowering In ; Hydrostatic Testing	
Lecture-6	Increased MAOP	
Week-3		
Lecture-7	Non-destructive Inspection	
Lecture-8	Codes and Standards; Compressor Stations;RMSs and Associated Facilities; Metering and Manifold Station;	
Lecture-9	City Gate Station;Town Boarder Stations;Network Analysis; Safety.	
Week-4		
Lecture-10	**Scada System**: Introduction of Scada system; Supervisory control and data acquisition; Monitoring of all transmission parameters	
Lecture-11	Gas flow at supply and off-take points, line pressure, movement of gas and condensate volumes and gas quality	
Lecture-12	Pipeline integrity monitoring	
Week-5		CT-2
Lecture-13	Leak detection and alarm, metering values of gas	
Lecture-14	Leak detection and alarm, metering values of condensate at each of the inlet and outlet points, open-closed status of all line and station	

	valves	
Lecture-15	Direct digital data transmission and voice communication.	
Week-6		
Lecture-16	**Gas Distribution Piping Systems:** Industry and Structure; Codes and Standards; Code Compliance; Distribution Integrity Management (DIM); Incident Investigation; Leakage Control	
Lecture-17		
Lecture-18	Pipe Properties and Repair/Replace Decisions; Steel Pipe Properties and Design; Plastic Design; Cast Iron Properties	
Week-7		
Lecture-19	External Loading of Pipe and Service Conditions; Secondary Stress Calculation; Exposed Crossings	
Lecture-20	Expansion Loops; Construction & Joining; Tie-Ins Methods and Plans	
Lecture-21	Corrosion and Cathodic Protection	
Week-8		
Lecture-22	Transmission Pipeline Integrity Plan and Evaluation	
Lecture-23	Route Selection Criteria	
Lecture-24	Testing; Uprating	
Week-9		CT-3
Lecture-25	Network Analysis; Safety	
Lecture-26	**Gas Distribution System Planning:** Measurement Principles and Meter Fundamentals	
Lecture-27	Positive Displacement Diaphragm Meters	
Week-10	Positive Displacement Rotary Meters	
Lecture-28	Gas Turbine Meters	
Lecture-29	Ultrasonic Meters; Pressure Regulation	
Lecture-30	Principles; Overpressure Protection	
Week-11		
Lecture-31	Pressure Regulation Sizing and Selection; Gas Supply Planning;	
Lecture-32	Gas Control Operations; System Design Principles and Considerations	
Lecture-33	Load Estimating	
Week-12		
Lecture-34	Flow Equations; System Modeling	
Lecture-35	Monitoring System Pressure	
Lecture-36	Enhancing Pressure by Redirecting Flow; Economic	
Week-13		CT-4
Lecture-37	**Gas Distribution Operations**: Codes and Standards ; Leak Inspection ; Odor Investigation ; Emergency Response ; Operation and Maintenance Activities; Valves, Patrol, Locates, Pump Drips ;Outage Control	
Lecture-38	Leakage Control ;Repair/Replace	
Lecture-39	Performance Measures	
Week-14		
Lecture-40	Regulator Problems and Possible Causes ;Customer Service Operations; Safety.	
Lecture-41	**Environmental Study**: IEE, EIA, SIA, RP/RAP of Transmission and Distribution projects.	

Lecture-42	**Case Study**: Design of Transmission and Distribution line using Simulation Software (PIPESIM, HYSIS).	

Text and Reference Books:

1. Natural Gas Transmission and Distribution Engineering by YAN MING QING & LIAN LE MING
2. Handbook of Natural Gas Transmission and Processing by Saeid Mokhatab, William A. Poe and James G. Speight
3. Natural Gas Transmission and Distribution Business by Pramod Paliwal and Sudhir Yadav
4. Handbook of Natural Gas Transmission and Processing: Principles and Practices by Saeid M.

PME 425: Enhanced Oil and Gas Recovery Techniques

2.00 Contact Hour; 2.00 Credit Hour

Pre-requisite: None

Rationale:

Oil production is separated into three phases: primary, secondary and tertiary, which is also known as Enhanced Oil Recovery (EOR). Primary oil recovery is limited to hydrocarbons that naturally rise to the surface, or those that use artificial lift devices, such as pump jacks.

Objective:

1. The main objective of all methods of EOR is to increase the volumetric (macroscopic) sweep efficiency and to enhance the displacement (microscopic) efficiency.
2. Primary surfactants usually have co-surfactants, activity boosters, and co-solvents added to them to improve stability of the formulation.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Enhanced Oil and Gas Recovery founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Enhanced Oil and Gas Recovery demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Enhanced Oil and Gas Recovery uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

Course Contents:

Enhanced Oil Recovery Fundamentals: Reservoir life cycle and recovery process ; Life under primary recovery phase: recovery targets and ways to improve ; Life under secondary recovery phases: immiscible gas injection, waterflooding, recovery targets, ways to improve ; Life under enhanced oil recovery phase: increasing complexity, cost/benefit consideration ; Miscible methods ; Chemical methods ; Thermal methods ; Technical challenges: current and future R&D directions, facilities modifications and personnel training.

Waterflooding: Overview and terminology ; Effect of rock properties ; Effect of heterogeneity and anisotropy ; Effect of fluid properties ; Wettability ; Capillary pressure ; Relative permeability ; Physics of water displacing oil ; Statistical forecasting ; Analytical forecasting ; Numerical forecasting ; Injector monitoring ; Producer monitoring ; Integrated monitoring ; Effect of water impurities ; Surface processing of injection and produced water ; Water shutoff ; Pattern rotation ; Natural and hydraulic fractures ; Horizontal well applications ; Downhole separation ; Enhanced waterfloods ; Waterflood planning ; Many case histories.

Enhanced Oil Recovery with Gas Injection: Reservoir characterization and phase behavior; Flow regimes and sweep ; Immiscible gas/water flood mechanisms ; First contact miscibility mechanisms ; Multi-contact miscibility mechanisms ; Reservoir simulation and performance forecasting ; Performance and monitoring of field projects.

Chemical Enhanced Oil Recovery: Review of Areal and Vertical sweep efficiencies ; Heterogeneity and vertical sweep efficiency ; Residual oil saturation ; Enhanced Oil Recovery (EOR) Methods ; Chemical EOR Methods ; Polymer Flooding: Polymers and their properties; Laboratory screening; Polymer flood field design and example field results; Overview of reservoir simulators for polymer flooding ; Surfactant/polymer (SP) methods: Surfactantbrine-oil phase behavior; Microemulsion properties; Capillary desaturation and oil mobilization; Laboratory screening; Field examples and designs; Reservoir simulators for SP ; Alkaline/Surfactant/Polymer (ASP) methods: Effect of alkali on phase behavior; Laboratory screening; Field examples and designs; Reservoir simulators for ASP ; Performance Control/Water Shutoff Methods: Overview of conformance control options (i.e. bulk gel, CDG, PPG, Bright Water); Gel properties; Laboratory screening; Field examples and designs; Reservoir simulators for conformance control methods.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Enhanced Oil and Gas Recovery founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Enhanced Oil and Gas Recovery demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Enhanced Oil and Gas Recovery uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil and gas production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1		CT-1
Lecture-1	**Enhanced Oil Recovery Fundamentals:** Reservoir life cycle and recovery process	
Lecture-2	Life under primary recovery phase: recovery targets and ways to	

	improve ; Life under secondary recovery phases	
Week-2		
Lecture-3	Immiscible gas injection, waterflooding, recovery targets, ways to improve	
Lecture-4	Life under enhanced oil recovery phase: increasing complexity, cost/benefit consideration ; Miscible methods	
Week-3		
Lecture-5	Chemical methods ; Thermal methods ; Technical challenges: current and future R&D directions	
Lecture-6	Facilities modifications and personnel training	
Week-4		
Lecture-7	**Waterflooding**: Overview and terminology ; Effect of rock properties ; Effect of heterogeneity and anisotropy ; Effect of fluid properties ; Wettability ; Capillary pressure ; Relative permeability ; Physics of water displacing oil ; Statistical forecasting ; Analytical forecasting ; Numerical forecasting ; Injector monitoring ; Producer monitoring	
Lecture-8	Integrated monitoring ; Effect of water impurities	
Week-5		
Lecture-9	Surface processing of injection and produced water	
Lecture-10	Water shutoff ; Pattern rotation	
Week-6		
Lecture-11	Natural and hydraulic fractures ; Horizontal well applications ; Downhole separation	CT-2
Lecture-12	Enhanced waterfloods ; Waterflood planning ; Many case histories.	
Week-7		
Lecture-13	**Enhanced Oil Recovery with Gas Injection**: Reservoir characterization and phase behavior; Flow regimes and sweep	
Lecture-14	Immiscible gas/water flood mechanisms	
Week-8		
Lecture-15	First contact miscibility mechanisms	
Lecture-16	Multi-contact miscibility mechanisms	
Week-9		
Lecture-17	Reservoir simulation and performance forecasting	
Lecture-18	Performance and monitoring of field projects.	
Week-10		
Lecture-19	**Chemical Enhanced Oil Recovery:** Review of Areal and Vertical sweep efficiencies ; Heterogeneity and vertical sweep efficiency ; Residual oil saturation ; Enhanced Oil Recovery (EOR) Methods ; Chemical EOR Methods ; Polymer Flooding: Polymers and their properties; Laboratory screening; Polymer flood field design and example field results; Overview of reservoir simulators for polymer flooding ; Surfactant/polymer (SP) methods: Surfactantbrine-oil phase behavior	
Lecture-20	Microemulsion properties; Capillary desaturation and oil mobilization	
Week-11		
Lecture-21	Laboratory screening; Field examples and designs; Reservoir simulators for SP	

Lecture-22	Alkaline/Surfactant/Polymer (ASP) methods	CT-3
Week-12		
Lecture-23	Effect of alkali on phase behavior; Laboratory screening	
Lecture-24	Field examples and designs; Reservoir simulators for ASP	
Week-13		
Lecture-25	Performance Control/Water Shutoff Methods	
Lecture-26	Overview of conformance control options (i.e. bulk gel, CDG, PPG, Bright Water); Gel properties	
Week-14		
Lecture-27	Laboratory screening; Field examples and designs	
Lecture-28	Reservoir simulators for conformance control methods	

Text and Reference Books:

1. Fundamentals of Enhanced Oil Recovery by Larry W. Lake, Russell Johns, Bill Rossen and Gary Pope
2. Enhanced Oil Recovery by Don W. Green and G. Paul Willhite
3. The Reservoir Engineering Aspects of Waterflooding by H.R. (Hal) Warner Jr.
4. Surfactant Flooding by Don W. Green, George J. Hirasaki, Gary A. Pope, and G. Paul Willhite

PME 427: Minerals Processing

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

Mineral processing is the first process that most ores undergo after mining in order to provide a more concentrated material for the procedures of extractive metallurgy. Although the primary operations are comminution and concentration, but there are other important operations in a modern mineral processing plant, including sizing, sampling and bulk material handling. This course is intended to provide a detailed understanding of the afore-mentioned operations

Objective:

1. To achieve the goal of recovering these concentrates, the raw ore must be reduced to fine size prior to separation.
2. The second objective of comminution in mineral processing is to adjust the size of mineral particles to adapt to the optimum size for the successive separation processes.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Minerals Processing founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Minerals Processing demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Minerals Processing uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Minerals Processing system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Minerals Processing practice

9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to minerals development and operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Introduction to mineral processing: The formation of matter; Elementary particles; Molecules; Solids; Minerals; Deposits, mining and mineral processing.

Characterization of mineralogical processes: Delineation, analysis, and evaluation of separation; Principles of separation.

Analysis and assessment of separation process: Division of feed into products (SP Upgrading (UP) ; Quantitative and qualitative analysis of upgrading ; Upgrading curves The Henry curve ; The Mayer curve ;The Dell curve; The Halbich curve; Equal basis upgrading curves; The Fuerstenau curve; The Mayer-Drzymala-Tyson-Wheelock curve; Other upgrading curves; Upgradeability ; Upgrading indices and evaluation of separation treated as upgrading Classification (CF) ; Analysis of separation process as classification ; Classification curves Frequency curves ; Distribution curve ; Partition curve ;Modified classification curves Other classification curves; The assessment of separation considered from classification point of view; Classificability and ideal classification ; The particle size analysis ; Densimetric analysis ; Other approaches to separation

Delineation of separation: Role of material and separator; Ordering; Mechanics of ordering; Thermodynamics of ordering; Probability of ordering; Stratification; Splitting; Total physical delineation of separation; Time aspects of separation.

Separation processes: Comminution; Principles of size reduction; Physicomechanical; description of particle disintegration; Empirical evaluation of size reduction; Other descriptions of grinding; Kinetics of grinding; Analysis of grinding process; Grinding as classification process; Grinding as upgrading process; Devices used for grinding

Screening ; Principles; Particle size and shape; Description of screening process; Mechanics of screening; Probability of screening; Kinetics of screening; Other parameters of screening

Analysis and evaluation of screening

Hydraulic and air separation; Principles; Classification by sedimentation; Fluidizing classification ; Classification in horizontal stream of medium; Classification in pulsating stream; Hydrocyclones.

Thin stream separation: Stream separators; Reichert cones ; Humphrey spiral concentrator

Concentrating tables; Other separators

Gravity separation ; 7.1. The basis of gravity separation in water and heavy liquids; Densimetric analysis; Gravity separation in magnetic liquids

Magnetic separation; Magnetic properties of materials; Diamagnetics ; Paramagnetics ;True paramagnetics ; Antiferromagnetics; Ferrimagnetics; Ferromagnetics ; Separation

Eddy current separation; Dielectric separation; Electric separation

Flotation: Theoretical basis; Hydrophobicity modification; Electrical phenomena at interfaces ;Delineation of flotation; Flotation reagents; Collectors; Frothers; Activators ; Depressors ; Depressors acting through adsorption ; Redox depressors ;Depressors decomposing the absorbed collector ; Flotation of mineral matter ; Naturally hydrophobic substances; Native metals and sulfides; Oxidized non-ferrous metals minerals; Oxides and hydroxides ; Sparingly soluble salts; Soluble salts; Flotation devices

Coagulation; The nature of coagulation; Adhesion of particles; Molecular interactions; Electrostatic interactions ; Structural interaction; Other interactions ; Stability factor *W;* Stability of coagulum ; The probability of particle collision in coagulation process; Kinetics and hydrodynamics of coagulation ; The factors effecting coagulation; The effect of other substances on the stability of suspensions; Selective coagulation; The structure of coagula

Flocculation: Flocculants; Flocculation Process; Selective flocculation

Oil agglomeration: Principles; Thermodynamics of oil agglomeration; Aquaoleophilicity of agglomerating systems; Selective oil agglomeration; The mechanism of oil agglomeration; Air in oil agglomeration of coal; Modifications of oil agglomeration

Application of minerals processing software:

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Assessment	
Class Participation	05
Class Attendance	05
Class Tests/Assignment/Presentation	20
Examination	
Final Examination	70

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Minerals Processing founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Minerals Processing demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Minerals Processing and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class						√						

	and online discussions to help in communicating complex concepts to professional colleagues												
7.	Design sustainable Minerals Processing system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Minerals Processing practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to minerals and operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1		
Lecture-1	**Introduction to mineral processing**: The formation of matter; Elementary particles; Molecules; Solids; Minerals; Deposits, mining and mineral processing.	
Lecture-2	**Characterization of mineralogical processes**: Delineation, analysis, and evaluation of separation; Principles of separation.	CT-1
Lecture-3	**Analysis and assessment of separation process:** Division of feed into products (SP Upgrading (UP) ; Quantitative and qualitative analysis of upgrading ; Upgrading curves The Henry curve ; The Mayer curve	
Week-2		
Lecture-4	The Dell curve; The Halbich curve; Equal basis upgrading curves;	

	The Fuerstenau curve	
Lecture-5	The Mayer-Drzymala-Tyson-Wheelock curve	
Lecture-6	Other upgrading curves; Upgradeability	
Week-3		
Lecture-7	Upgrading indices and evaluation of separation treated as upgrading Classification (CF)	
Lecture-8	Analysis of separation process as classification ; Classification curves Frequency curves	
Lecture-9	Distribution curve ; Partition curve ;Modified classification curves	
Week-4		
Lecture-10	Other classification curves; The assessment of separation considered from classification point of view	
Lecture-11	Classificability and ideal classification	
Lecture-12	The particle size analysis ; Densimetric analysis ; Other approaches to separation	
Week-5		CT-2
Lecture-13	**Delineation of separation:** Role of material and separator; Ordering; Mechanics of ordering	
Lecture-14	Thermodynamics of ordering	
Lecture-15	Probability of ordering	
Week-6		
Lecture-16	Stratification; Splitting	
Lecture-17	Total physical delineation of separation	
Lecture-18	Time aspects of separation	
Week-7		
Lecture-19	**Separation processes:** Comminution; Principles of size reduction; Physicomechanical; description of particle disintegration	
Lecture-20	Empirical evaluation of size reduction	
Lecture-21	Other descriptions of grinding	
Week-8		
Lecture-22	Kinetics of grinding; Analysis of grinding process	
Lecture-23	Grinding as classification process; Grinding as upgrading process	
Lecture-24	Devices used for grinding	
Week-9		CT-3
Lecture-25	**Screening ;** Principles; Particle size and shape; Description of screening process; Mechanics of screening; Probability of screening	
Lecture-26	Kinetics of screening; Other parameters of screening	
Lecture-27	Analysis and evaluation of screening	
Week-10		
Lecture-28	**Hydraulic and air separation;** Principles; Classification by sedimentation; Fluidizing classification	
Lecture-29	Classification in horizontal stream of medium	
Lecture-30	Classification in pulsating stream; Hydrocyclones.	
Week-11		
Lecture-31	**Thin stream separation**: Stream separators; Reichert cones ; Humphrey spiral concentrator Concentrating tables; Other separators	

Lecture-32	**Gravity separation** ; 7.1. The basis of gravity separation in water and heavy liquids; Densimetric analysis; Gravity separation in magnetic liquids	
Lecture-33	**Magnetic separation;** Magnetic properties of materials; Diamagnetics ; Paramagnetics ;True paramagnetics ; Antiferromagnetics; Ferrimagnetics; Ferromagnetics ; Separation	
Week-12		
Lecture-34	Eddy current separation; Dielectric separation; Electric separation	
Lecture-35	**Flotation:** Theoretical basis; Hydrophobicity modification; Electrical phenomena at interfaces ;Delineation of flotation; Flotation reagents; Collectors	
Lecture-36	Frothers; Activators ; Depressors ; Depressors acting through adsorption ; Redox depressors ;Depressors decomposing the absorbed collector ; Flotation of mineral matter ; Naturally hydrophobic substances; Native metals and sulfides	
Week-13		
Lecture-37	Oxidized non-ferrous metals minerals; Oxides and hydroxides ; Sparingly soluble salts; Soluble salts; Flotation devices	
Lecture-38	**Coagulation;** The nature of coagulation; Adhesion of particles; Molecular interactions; Electrostatic interactions ; Structural interaction; Other interactions ; Stability factor *W;* Stability of coagulum	
Lecture-39	The probability of particle collision in coagulation process; Kinetics and hydrodynamics of coagulation ; The factors effecting coagulation; The effect of other substances on the stability of suspensions; Selective coagulation; The structure of coagula	CT-4
Week-14		
Lecture-40	**Flocculation:** Flocculants; Flocculation Process; Selective flocculation	
Lecture-41	**Oil agglomeration:** Principles; Thermodynamics of oil agglomeration; Aquaoleophilicity of agglomerating systems; Selective oil agglomeration	
Lecture-42	The mechanism of oil agglomeration; Air in oil agglomeration of coal; Modifications of oil agglomeration	

Text and Reference Books:

1. Mineral processing technology by B. Wills
2. Principles of Mineral Processing by Maurice
3. Mineral Processing Design and Operation: An Introduction by A. Gupta and Denis S. Yan
4. Principles of Mineral Dressing by Antoine Marc Gaudin
5. Modeling and Simulation of Mineral Processing Systems by R. P. King

PME 429: Ground Water Managements in Mining

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

1. **Rationale:**

To understand the aquifer system of Bangladesh and to perform the equipment selection and economics of mine drainage system.

2. **Objectives:**

1. To understand the aquifer system of Bangladesh.
2. To calculate and design mine pumping system of a mine.
3. To know about the installation and maintenance of mine pump.
4. To know about the pump testing facilities.
5. To measure and analyze the performance of mine pumping system.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories and calculations for mine dewatering system.
2. Evaluate the design requirements for mine pump.
3. Analyze the design parameters of mine pump.
4. Apply the knowledge to design an optimum mine dewatering system.

4. Course Contents:

Ground water in Mine: Mining engineering hydrology, Bangladesh aquifer system, Aquifer characteristics. Sources and nature of mine waters. Estimation of water quantities. Methods of mine dewatering and drainage. Pumping systems. Equipment selection and economics of mine drainage. Groundwater recharge. Groundwater and mine water re-injection techniques. Mine-water balance, forecasting water inflows, water balance and reticulation, pump types. Hydrology risk analysis, rain water proposition.

Make of water- sump design- pump house: Introduction, Make of water, Capacity of water lodgement, Pump house design, Water lodgement design, Design of water passage

Mine water occurrence- Pumping status – Pump classification – pumping scheme: Water occurrence, Effects, Status of pumping in underground mines, Pump classification, Mine pumps and duty requirements, Properties of mine water, coast, Pumping scheme- single horizontal operation, Pumping scheme- multi horizontal operation.

Pump characteristics- system head curve- Operating point: Characteristics of pumps, System head curve, resistance correction, operating point, Various operating conditions and characteristics curve, Joint operation of pumps.

Pump testing and manufacturing testing facilities: Quality control test for raw material, Test carried out on critical parts, Final assembly test, Performance testing, Methods of measuring flow rate, Flow calculation, Flow time.
Material of construction: Allowable stresses, Consideration of material selection, Pump casing, Impeller, Shafts.

Installation and maintenance of pump: Foundation of pump, Pump installation, Instruction for alignment, Coupling, Pipe diameter selection, Pipes for mine drainage, Thickness of pipe, Pump suction design, Caution on piping, Intake of suction water sump, Maintenance of pump, Vibration, Noise in pump, Critical speed, trouble shooting for pumps.

5. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	**(100%)**
1. Class Assessment	
(i) Class Participation	05
(ii) Class Attendance	05
(iii) Class Tests/Assignment/Presentation	20
2. Examination	
(i) Final Examination	70

6. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes (CO) of the Course		**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories and calculations for mine dewatering system	√											
2	Evaluate the design requirements for mine pump		√										
3	Analyze the design parameters of mine pump				√								
4	Apply the knowledge to design an optimum mine dewatering system			√		√							

7. Lecture Schedule:

Lecture	**Lecture Topic**	**Class Test (CT)**
Week-1	**Ground water in Mine**	
Lecture-1	Mining engineering hydrology	
Lecture-2	Aquifer characteristics	
Lecture-3	Bangladesh aquifer system	

Week-2	**Ground water in Mine**	CT-1; CT-2
Lecture-4	Sources and nature of mine waters	
Lecture-5	Estimation of water quantities	
Lecture-6	Methods of mine dewatering and drainage	
Week-3	**Ground water in Mine**	
Lecture-7	Pumping systems	
Lecture-8	Equipment selection and economics of mine drainage	
Lecture-9	Groundwater recharge	
Week-4	**Ground water in Mine**	
Lecture-10	Groundwater and mine water re-injection techniques	
Lecture-11	Mine-water balance	
Lecture-12	Forecasting water inflows, water balance and reticulation	
Week-5	**Ground water in Mine, Make of water- sump design- pump house**	
Lecture-13	Hydrology risk analysis	
Lecture-14	Rain water proposition	
Lecture-15	Make of water, Capacity of water lodgement	
Week-6	**Make of water- sump design- pump house**	
Lecture-16	Pump house design	
Lecture-17	Water lodgment design	
Lecture-18	Design of water passage	
Week-7	**Mine water occurrence- Pumping status – Pump classification – pumping scheme**	
Lecture-19	Water occurrence, Effects	
Lecture-20	Status of pumping in underground mines	
Lecture-21	Pump classification	
Week- 8	**Mine water occurrence- Pumping status – Pump classification – pumping scheme**	
Lecture-22	Mine pumps and duty requirements	
Lecture-23	Properties of mine water, coast	
Lecture-24	Pumping scheme- single horizontal operation, Pumping scheme- multi horizontal operation	
Week-9	**Pump characteristics- system head curve- Operating point**	CT-3; CT-4
Lecture-25	Characteristics of pumps	
Lecture-26	Resistance correction, operating point	
Lecture-27	Various operating conditions and characteristics curve, Joint operation of pumps	
Week-10	**Pump testing and manufacturing testing facilities**	
Lecture-28	Quality control test for raw material, Test carried out on critical parts	
Lecture-29	Final assembly test	
Lecture-30	Performance testing	
Week-11	**Pump testing and manufacturing testing facilities**	
Lecture-31	Methods of measuring flow rate	
Lecture-32	Flow time	
Lecture-33	Flow calculation	
Week-12	**Material of construction**	
Lecture-34	Allowable stresses	

Lecture-35	Consideration of material selection	
Lecture-36	Pump casing, Impeller, Shafts	
Week-13	**Installation and maintenance of pump**	
Lecture-37	Foundation of pump, Pump installation, Instruction for alignment	
Lecture-38	Coupling, Pipe diameter selection, Pipes for mine drainage, Thickness of pipe, Pump suction design	
Lecture-39	Caution on piping, Intake of suction water sump, Maintenance of pump, Vibration, Noise in pump, Critical speed, trouble shooting for pumps	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Books recommended:

1. Water Management at Abandoned Flooded Underground Mines: Fundamentals, Tracer Tests, Modelling, Water Treatment; C Wolkersdorfer.

2. Groundwater Engineering; J Zhou, JYN Zhou, P Yang, and Y Tang.

3. Supplied materials.

PME 4211: Mine Planning and Design

3.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

1. **Rationale:**

To understand the principles and procedures to estimate mining revenue and costs of a mine, and to make a mine plane in a systematic manner.

2. **Objectives:**

1. To understand the principles of mine planning and design.
2. To estimate the mine revenue and costs.
3. To calculate and analyze mine production planning.
4. To analyze and design an open pit mine.
5. To analyze and design an underground mine.

3. **Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the theories and calculations of mine planning and design.

2. To calculate and analyze for revenue and cost estimation.

3. Apply the knowledge to design a mine.

4. Evaluate the design requirement for a mine plan.

5. Analyze of design parameters of a mine plan.

4. Course Contents:

General Mine Planning and design principles: Principles of mine planning, Stages of planning of new mines, selection of mine site, Division of a coalfield into mine areas, Types of mines, Surface layouts, Pit-bottom layout, Layout of underground workings, Mine development phases, The planning phase, Accuracy of estimates, Critical path presentation, Mine reclamation, Environmental planning procedure.

Mining revenues and costs: Economic concepts including cash flow, Estimating revenues, Estimating costs.

Production planning: Mine life rules, Cash flow calculations, Mine and mill plant sizing, Lanes algorithm, Production scheduling, Push back design.

Open pit mine: Geometrical considerations; pit expansion process, final pit slope angle, road construction, stripping ratios, geometric sequencing. Pit limits; hand methods, economic block models, floating cone techniques.

Underground mine: Fundamental decision; Block model, Financial model, Cut off grade, Mining methods. Access design; decision on access to ore deposits, detail layout of access networks considering physical and geotechnical constrains. Ventilation systems analysis. Dewatering system analysis. Equipment selection.

6. Teaching-learning and Assessment Strategy:

Lectures, Class Performances, Assignments, Class Tests, Final Examination

Assessment Methods & Their Weights:

Assessment Methods	**(100%)**
1. Class Assessment	
(iv) Class Participation	05
(v) Class Attendance	05
(vi) Class Tests/Assignment/Presentation	20
2. Examination	
(ii) Final Examination	70

7. Mapping of Course Outcomes (CO) and Program Outcomes (PO):

Course Outcomes (CO) of the Course		**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Understand the theories and calculations of mine planning and design	√											
2	To calculate and analyze for revenue and cost estimation		√										
3	Apply the knowledge to design a mine			√									
4	Evaluate the design requirement for a mine plan				√								
5	Analyze of design parameters of a mine plan					√							

8. Lecture Schedule:

Lecture	Lecture Topic	Class Test (CT)
Week-1	**General Mine Planning and design principles**	
Lecture-1	Principles of mine planning	CT-1; CT-2
Lecture-2	Stages of planning of new mines	
Lecture-3		
Week-2	**General Mine Planning and design principles**	
Lecture-4	Methods of exploration and reserve estimation.	
Lecture-5	Selection of a mine site	
Lecture-6	Division of a coalfield into mine areas	
Week-3	**General Mine Planning and design principles**	
Lecture-7	Types of mines	
Lecture-8	Surface layouts	
Lecture-9		
Week-4	**General Mine Planning and design principles**	
Lecture-10	Pit-bottom layout	
Lecture-11	Layout of underground workings	
Lecture-12		
Week-5	**General Mine Planning and design principles**	
Lecture-13	Mine development phases	
Lecture-14	The planning phase	
Lecture-15	Accuracy of estimates	
Week-6	**General Mine Planning and design principles**	
Lecture-16	Critical path presentation	
Lecture-17	Mine reclamation	
Lecture-18		
Week-7	**General Mine Planning and design principles**	
Lecture-19	Environmental planning procedure	
Lecture-20		
Lecture-21		
Week-8	**Mining revenues and costs**	CT-3; CT-4
Lecture-22	Economic concepts	
Lecture-23	Cash flow	
Lecture-24	Estimating revenues, Estimating costs	
Week-9	**Production planning**	
Lecture-25	Mine life rules	
Lecture-26	Mine and mill plant sizing	
Lecture-27	Lanes algorithm, Production scheduling, Push back design	
Week-10	**Open pit mine**	
Lecture-28	Geometrical considerations	
Lecture-29	Pit expansion process	
Lecture-30	Final pit slope angle	
Week-11	**Open pit mine**	
Lecture-31	Road construction	
Lecture-32	Stripping ratios, geometric sequencing	

Lecture-33	Pit limits; hand methods, economic block models, floating cone techniques	
Week-12	**Underground mine**	
Lecture-34	Fundamental discussion	
Lecture-35	Block model, Financial model, Cut off grade	
Lecture-36	The method in detail	
Week-13	**Underground mine**	
Lecture-37	Access design; decision on access to ore deposits	
Lecture-38	Detail layout of access networks considering physical and geotechnical constrains	
Lecture-39	Ventilation systems analysis. Dewatering system analysis. Equipment selection	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Books recommended:

1. Open pit Mine Planning and design;William A Hustruid, M Kuchta, RK Martin.

2. Underground Mining Methods: Engineering Funadamentals and International Case Studies; WA Hustrulid, William A Hustruid, R C Bullock.

3. Introduction to Mining Engineering; HL Hartman, JM Mutmansky.

4. Supplied materials.

PME 400: Project / Thesis- Part: II

6.00 Contact Hour; 3.00 Credit Hour

Pre-requisite: None

Rationale:

The rationale of research is the reason for conducting the study. The rationale should answer the need for conducting the said research. It is a very important part of your publication as it justifies the significance and novelty of the study. Ideally, the research should be structured as observation, rationale, hypothesis, objectives, methods, results and conclusions.

Objective:

The students are guided to learn the following aspects:

1. Understanding & evaluating the design / operation / environmental aspects of a petroleum and mining equipment/ process.
2. Understanding & evaluating the technology aspects of various alternatives available, called "Best Available Technologies (BAT)", through literature & references and select a suitable equipment/ process with optimum capacity.
3. Carrying-out the basic design of the process using steady state simulation.
4. Preparation of equipment layout & plot plan drawing.
5. Preliminary cost estimation of CAPEX and OPEX.
6. Presentation & research management skills.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Experimental and theoretical investigation of various problems related to petroleum and mining engineering will be carried out. The topic should provide an opportunity to the student in developing initiative, creative ability and engineering judgment with different objectives of same data. Individual study will be required.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society							√					

8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Work Schedule:

Lecture	Tasks
Week-1	Step 8 – Evaluate Your Resources • You may be overwhelmed by the amount of information you find. • To find “good” resources for your paper, you must analyze and carefully select them. • Journal articles have gone through peer-review before being published. • Books are also edited before publication. • Use the CRAAP test for website evaluation.
Week-2	Step 9 – Stay organized • Give yourself enough time to conduct your research, so you can understand your topic enough to write effectively on it. • Keep track of your research so you don’t have to scramble to find it later. • Use our research log or graphic organizer to help you stay on track.
Week-3	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.

Week-4	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-5	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-6	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-7	Report
Week-8	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-9	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-10	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-11	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-12	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-13	Step 10 – Write and Review Your Paper • Make sure your paper is formatted correctly – APA, MLA or another style an instructor requires. • Check to make sure all of your sources have been cited and your research is properly listed at the end of your paper.
Week-14	Final Report

Text and Reference Books:

1. How to Write a Thesis by Umberto Eco
2. Writing Your Dissertation in Fifteen Minutes a Day: A Guide to Starting, Revising by Joan Bolker
3. Matching Method, Paradigm, Theories and Findings by Kember, David, Corbett, Michael
4. Research Methods and Thesis Writing' by Calmorin

PME 412: Integrated Design Project- Part: II

2.00 Contact Hour; 1.00 Credit Hour

Pre-requisite: None

Rationale:

The rationale of project is the reason for conducting the study. The rationale should answer the need for conducting the said project. It is a very important part of your publication as it justifies the significance and novelty of the study. Ideally, the research should be structured as observation, rationale, hypothesis, objectives, methods, results and conclusions.

Objective:

The students are guided to learn the following aspects:

1. Understanding & evaluating the design / operation / environmental aspects of a petroleum and mining equipment/ process.
2. Understanding & evaluating the technology aspects of various alternatives available, called "Best Available Technologies (BAT)", through literature & references and select a suitable equipment/ process with optimum capacity.
3. Carrying-out the basic design of the process using steady state simulation.
4. Preparation of equipment layout & plot plan drawing.
5. Preliminary cost estimation of CAPEX and OPEX.
6. Presentation & research management skills.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology

6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice
9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

Integrated design project offers a distinctive opportunity to play a key role as part of a team working on a realistic design project. It's about creating and testing ideas to solve real-world problems. In doing so, students' will improve technical knowledge, communication, practical skills and employability at a stroke.

The integrated design project will develop your skills in:
Acquiring and applying technical knowledge.
Group work – leadership, discussion, planning, monitoring, assessing, reporting on progress, taking responsibility, taking action.
Understanding the bigger picture that surrounds engineering projects – the issues, the aims, and sometimes the constraints; the different viewpoints of people working on and affected by a project.
Creativity and innovation – priceless skills in the modern workplace.
Presenting and arguing the case for your ideas.

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to petroleum and mining engineering founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of petroleum and mining engineering demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of petroleum and mining engineering uncertainty and data management validated against national or international standards				√								
5.	Perform, analyze and optimize oil, gas and minerals production rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							

6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable petroleum and mining engineering system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the petroleum and mining engineering practice								√				
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to field development and field operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Work Schedule:

Lecture	**Tasks**
Week-1 Week-2 Week-3	Step 4. Build a prototype of best design: Use your alternative analyses to choose the design that best meets criteria considering the constraints, then build a prototype. A prototype is the first full scale and usually functional form of a new type or design.
Week-4 Week-5	Step 5. Test and evaluate the prototype against important design criteria to show how well the product meets the need You must test your prototype under actual or simulated operating conditions. Make sure you test all of your criteria and constraints to evaluate the success of your prototype. Customers are usually involved in product testing so be sure you have SRC approval if people are involved.
Week-6	Step 6. Analyze test results, make design changes and retest

Week-7	Testing will disclose some deficiencies in your design. Sometimes the testing fails completely and sends the designer “back to the drawing board.” Make corrections and retest OR prepare an analysis of what went wrong and how you will fix it. As always, document your analyses, fixes, and retests in your notebook.
Week-8	Step 7. Communicate the design The designer’s real product is the description of a design from which others will build the product. Use your notebook and the fair exhibit to communicate the design to your customer and the judges. Your product description will be conveyed in drawings, photos, materials lists, assembly instructions, test plans and results. Consider listing lessons learned so future designers need not repeat any of your “frustrations.” You’ll have clear instructions on how to produce your design, along with production cost estimates.
Week-9	
Week-10	
Week-11	Step 8. Prepare Prepare your engineering project exhibit board. See the Project Display Rules and Helpful Display Hints for a successful project board.
Week-12	
Week-13	Step 9. Prepare your abstracts and compliance checklist You will need to bring to Check-In day: • 15 copies of your Project Abstract for grades • your completed Compliance Checklist • your project board • research notebook
Week-14	

Text and Reference Books:

1. How to Write a Thesis by Umberto Eco
2. Writing Your Dissertation in Fifteen Minutes a Day: A Guide to Starting, Revising by Joan Bolker
3. Matching Method, Paradigm, Theories and Findings by Kember, David, Corbett, Michael
4. Research Methods and Thesis Writing' by Calmorin
5. Sustainable Development Projects: Integrated Design, Development, and Regulation by David R. Godschalk

PME 428: Minerals Processing Laboratory

3.00 Contact Hour; 1.50 Credit Hour

Pre-requisite: None

Rationale:

Mineral processing is the first process that most ores undergo after mining in order to provide a more concentrated material for the procedures of extractive metallurgy. Although the primary operations are comminution and concentration, but there are other important operations in a modern mineral processing plant, including sizing, sampling and bulk material handling. This course is intended to provide a detailed understanding of the afore-mentioned operations

Objective:

1. To achieve the goal of recovering these concentrates, the raw ore must be reduced to fine size prior to separation.
2. The second objective of comminution in mineral processing is to adjust the size of mineral particles to adapt to the optimum size for the successive separation processes.

Course Learning Outcomes (CO):

On successful completion of this course students will be able to:

1) Recognize the main terminology, concepts and techniques that applies to Minerals Processing founded on a theory based understanding of mathematics and the natural and physical sciences
2) Apply a critical-thinking and problem-solving approach towards the main principles of Minerals Processing demonstrated through appropriate and relevant assessment
3) Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development
4) Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Minerals Processing uncertainty and data management validated against national or international standards
5) Perform, analyze and optimize Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology
6) Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues
7) Design sustainable Minerals Processing system development solutions with minimum environmental impact and beneficial for society
8) Apply ethical principles and commit to professional ethics, responsibilities and the norms of the Minerals Processing practice

9) Analyze and devise relevant solutions to problems posed within the course, individually and with team mates
10) Demonstrate the ability to interact with other students to practice teamwork and communication skills
11) Demonstrate knowledge and understanding of the engineering and management principles to minerals development and operating plans to optimize profitability and project management.
12) Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation

Course Contents:

1. Identification of minerals in rock sample by X-ray diffraction (XRD)
2. Identification of elements in rock sample by X-ray florescence (XRF)
3. Identification of minerals in rock sample by Polarizing Microscope
4. Simulation of coagulation and flocculation process
5. Simulation of filtration and thickening process
6. Simulation of electrostatic separation process
7. Simulation of magnetic separation process
8. Simulation of solid-liquid separation process
9. Simulation of size reduction process
10. Simulation of material balance calculations for mineral processing circuit
11. Simulation of flow sheet design process
12. Field visit for observing mineral processing operation

Teaching-Learning Strategy:

- Class Lectures
- Exercise
- Software Laboratory
- Group Project
- Class Tests
- Assignments
- Presentation
- Study Tour
- Final Examination

Assessment Strategy & Their Weights:

Assessment Method	(100%)
Class Attendance	5
Class performance/observation	5
Lab Test/Report Writing/project work/Assignment	50
Quiz Test	30
Viva Voce	10

Mapping of Course Learning Outcomes (CO) and Program Learning Outcomes (PO):

Course Learning Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Recognize the main terminology, concepts and techniques that applies to Minerals Processing founded on a theory based understanding of mathematics and the natural and physical sciences	√											
2.	Apply a critical-thinking and problem-solving approach towards the main principles of Minerals Processing demonstrated through appropriate and relevant assessment		√										
3.	Apply theoretical and practice skills in data analysis used for real problems through case studies based on empirical evidence and the scientific approach to knowledge development			√									
4.	Demonstrate the ability to suggest approaches and strategies for the assessment and quantification of Minerals Processing and data management validated against national or international standards				√								
5.	Perform, analyze and optimize Minerals Processing rate by using commercial software that is commonly used in the industry to develop competency in the use of technology					√							
6.	Engage and participate in class and online discussions to help in communicating complex concepts to professional colleagues						√						
7.	Design sustainable Minerals Processing system development solutions with minimum environmental impact and beneficial for society							√					
8.	Apply ethical principles and commit to professional ethics,								√				

	responsibilities and the norms of the Minerals Processing practice												
9.	Analyze and devise relevant solutions to problems posed within the course, individually and with team mates									√			
10.	Demonstrate the ability to interact with other students to practice teamwork and communication skills										√		
11.	Demonstrate knowledge and understanding of the engineering and management principles to minerals and operating plans to optimize profitability and project management.											√	
12.	Evaluate and provide feedback on your own learning experience committed to self-review and performance evaluation												√

Lecture Schedule:

Lecture	Experiments
Week-1	Identification of minerals in rock sample by X-ray diffraction (XRD)
Week-2	Identification of elements in rock sample by X-ray florescence (XRF)
Week-3	Identification of minerals in rock sample by Polarizing Microscope
Week-4	Simulation of coagulation and flocculation process
Week-5	Simulation of filtration and thickening process
Week-6	Simulation of electrostatic separation process
Week-7	Quiz
Week-8	Simulation of magnetic separation process
Week-9	Simulation of solid-liquid separation process
Week-10	Simulation of size reduction process
Week-11	Simulation of material balance calculations for mineral processing circuit
Week-12	Simulation of flow sheet design process
Week-13	Field visit for observing mineral processing operation
Week-14	Quiz

Text and Reference Books:

1. Mineral processing technology by B. Wills
2. Principles of Mineral Processing by Maurice
3. Mineral Processing Design and Operation: An Introduction by A. Gupta and Denis S. Yan
4. Principles of Mineral Dressing by Antoine Marc Gaudin
5. Modeling and Simulation of Mineral Processing Systems by R. P. King