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 meet 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 in Civil Engineering. Bachelor's degree in Computer Science Engineering course started in 2001. Bachelor courses in Electrical, Electronics & 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,and Coastal Engineering (EWCE).Industrial and Production Engineering (IPE), and Petroleum and Mining Engineering (PME) departments started their academic session from 2015-2016.

Foreign students from Sri Lanka were admitted for the first time at MIST. Presently students from Maldives, Palestine, Nepal, and Gambia are also studying in different Engineering Programs. MIST envisages creating facilities for the military as well as civil students from home and abroad dedicated to pursue standard curriculum leading to Graduation Degree. As an Institution without any gender biasness, MIST is already on steady stride upholding its motto “Technology for Advancement”. MIST remains committed to contributing to the wider spectrum of the national educational arena and play a significant role in the development of human resources and ardently pursuing its goal to grow into a “Centre of Excellence”. MIST has well-equipped classrooms with multimedia and web cameras with internet facilities and laboratories with modern equipment. The medium of instruction for all engineering programs is English. All academic programs of MIST are affiliated with the Bangladesh University of Professionals (BUP) and have close cooperation with Bangladesh University of Engineering and Technology (BUET) and Dhaka University (DU).

1.2 Vision and Mission of MIST

Vision: To be a center of excellence for providing quality education in the field of science, engineering, and technology and conduct research to meet the national and global challenges.

Mission:

a. To provide comprehensive education and conduct research in diverse disciplines of science, engineering, technology, and engineering management.
b. To produce technologically advanced intellectual leaders and professionals with high moral and ethical values to meet the socio-economic development of Bangladesh and global needs.
c. To conduct collaborative research activities with national and international communities for continuous interaction with academicians and industry.
d. To provide consultancy, advisory, testing, and other related services to government, non-government, and autonomous organizations including personnel for widening practical knowledge and contributing to the sustainable development of the society.

1.3 Salient Features of MIST

a. Rigorous admission and selection process for the best possible screening interactive sessions in the classroom.
b. Qualified faculty members.
c. Regular guest lectures and educational visits.
d. Culture of timeliness, commitment, and uninterrupted curriculum.
e. Flexibility in choosing competent faculties through outsourcing.
f. Well-thought-out and continuous feedback and assessment system.
g. Effective teaching through the innovative method.
h. Industrial attachment for on job training.
i. Emphasis on code of conduct and dress code.
j. Focus to develop students as good humans with all possible attributes of a successful leader.
k. Tranquil, pollution-free and secure campus life.

1.4 Location

MIST is located at Mirpur Cantonment, northwest edge of the greater Dhaka city, a hub of knowledge for the armed forces. Mirpur Cantonment is a small, calm, and quiet education village and free from all possible pollution of city life. A garland like a lake with migratory birds, three sides with extended green fields in the summer and water bodies in the rainy season, whistling birds on the tree branches, and overall bounty of nature adds to the already existing splendid academic atmosphere. Other neighboring academic institutions are National Defense College (NDC) and Defense Services Command and Staff College (DSCSC) – two international standard education centers.

1.5 Faculties

1.5.1 Faculty of Civil Engineering (FCE):

- Civil Engineering (CE)
- Architecture (Arch)
- Environmental, WaterResouce and Coastal Engineering (EWCE)
- Petroleum and Mining Engineering (PME)

1.5.2 Faculty of Electrical and Computer Engineering (FECE):

- Computer Science and Engineering (CSE)
- Electrical, Electronic and Communication Engineering (EECE)

1.5.3 Faculty of Mechanical Engineering (FME):

- Mechanical Engineering (ME)
- Aeronautical Engineering (AE)
- Naval Architecture and Marine Engineering (NAME)
- Industrial and Production Engineering (IPE)

1.5.4 Faculty of Science and Engineering (FSE):

- Biomedical Engineering (BME)
- Nuclear Science and Engineering (NSE)
- Department of Science (Mathematics, Physics, Chemistry) and Humanities

Presently MIST has 12 (twelve) departments to conduct B Sc. Engineering program under 04(four) different engineering faculties. The departments impart education basing on common objectives and outcomes set by MIST and have defined program objectives and outcomes, specific to the departments respectively

1.6 Eligibility of Students for Admission in MIST(Subject to review each year)

The students must fulfill the following requirements:

1.6.1 Bangladeshi Students. Minimum qualifications to take part in theadmission test are as follows:

a. The applicant must have passed SSC / equivalent examination from Board of Intermediate and Secondary Education/Madrasa Education Board/Technical Education Board in Science Group obtaining GPA 4.00 (without a fourth subject) on a 5 points scale 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 GPA 4.00 on a 5 points scale. In HSC/Equivalent and SSC/Equivalent examination: (i) the applicant passed HSC or Equivalent in must obtain a minimum total grade point 17 in four subjects (Mathematics, Physics, Chemistry, and English), (ii) SSC Examination (or Equivalent).

b. The applicant must have qualified in minimum five subjects including Mathematics, Physics, Chemistry and English Language with minimum 'B' in average [i.e., A=5, B=4,C=3,D=2 & E=1,minimum required grade point=20] in GCE 'O' Level and in 'A' level/Equivalent background of Minimum 'B' grade in Mathematics, Physics and Chemistry.

C. Applicants who have passed HSC or equivalent examination in the current previous year must grade obtain 19 in four subjects (Mathematics, Physics, Chemistry, and English).

d. Sex: Male and Female.

1.6.2 **Foreign Students.**Maximum 3% of overall vacancies availablewill 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:

a. Educational qualifications as applicable for Bangladeshi civil students or equivalent.

b. Must have security clearance from respective Embassy/High Commission in Bangladesh.

c. Sex: Male and Female.

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

1.7 Number of Seats

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

Allocation of Seats

Ser	Unit	Department	Seats
1.	A	Civil Engineering (CE)	120
2.		Computer Science and Engineering (CSE)	120
3.		Electrical, Electronic & Communication Engineering (EECE)	120
4.		Mechanical Engineering (ME)	120

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 Resource, and Coastal Engineering (EWCE)	60
10.		Industrial and Production Engineering (IPE)	50
11.		Petroleum and Mining Engineering (PME)	40
12.	**B**	Architecture (Arch)	25
	Total		825

1.8 Admission Procedure

1.8.1 **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. There will be no multiple-choice type questions (MCQ). Admission test will be conducted out of 200 marks and the distribution of marks is given below:

Ser.	Subjects	Marks
a.	Mathematics	90
b.	Physics	70
c.	Chemistry	30
d.	English	10
	Total =	200

1.8.2 **Final Selection**. Students will be selected based on the results of the admission test. The individual choice for selection of departments will be given preference as far as possible. The minimum qualifying marks in the test is 40% for the applicants. In the case of a tie in the result of the admission test, the difference will be judged based on marks obtained in Mathematics, Physics, Chemistry, and English respectively in the admission test.

1.8.3 **Medical Checkup.**Civil candidates selected through the admission test will go for medical checkups in MIST medical center. If the medical authority considers any candidate unfit for study in MIST due to critical/contagious/mental diseases as shown in the medical policy of MIST will be declared unsuitable for admission.

1.9 Students Withdrawal Policy

1.9.1 General Policy of Withdrawal

The undergraduate (B.Sc.) Engineering programs for all engineering disciplines are planned for 04 regular levels, comprising of 08 regular terms for Architecture programme it is planned for 05 regular levels, comprising of 10 regular terms. It is expected that all students will earn a degree by clearing all the offered courses in the stipulated time. In case of failure the following policies will be adopted:

a. Studentsfailing in any course/subject will have to clear/pass the said course/subject by appearing in referred examination as per examination policy. In the case of students completing level-4, a maximum of three courses/subjects will be allowed in the referred examination (which is to be cleared within 6 years of registration).

b. The referred examination will be conducted at this institution before the commencement of the next level.

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 the Academic Council of MIST, a student may be allowed for the third time as the last chance.

e. In case of sickness, which leads to missing more than 40% of 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. The minimum credit for the award of a bachelor’s degree in Engineering (BSc. 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's 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 the MIST Examination Policy remain valid.

1.9.2 Withdrawal on Disciplinary Ground

a. **Unfair Means**. Adoption of unfair means may result in expulsion of a student from the programme and expulsion 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:

i. Communicating with fellow students for obtaining help in the examination.

ii. Copying from another student's script/ report /paper.

iii. Copying from desk or palm of a hand or from other incrimination documents.

iv. Possession of any incriminating document whether used or not.

b. **Influencing Grades.**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.**Other Indiscipline Behaviours.**Academic Council may withdraw/expel anystudent on disciplinary ground if any form of indiscipline or unruly behavior is seen in him/her which may disrupt the academic environment/programme or is considered detrimental to MIST's image.

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

1.9.3 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 to approval of Academic Council of MIST, he will be allowed to apply fresh in future batch. If approved from the date of his/her registration.

CHAPTER 2

RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAMME AT MIST

2.1 Introduction

MIST has introduced a 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 the 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

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 the course coordinator and Head of the Department, Commandant MIST may allow relaxation in this regard. This relaxation is to be reported to the Academic Council of MIST.
b. Students will not face any level repeat for failing.
c. Students will get the 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.

2.2.1 Besides 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 to the study of several subjects in humanities and social sciences.

2.2.2 The first two years of bachelor's degree 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

There will be two terms (Spring Term I and Fall Term II) in an academic year.

2.4 Duration of Terms

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

2.5 Course Pattern and Credit Structure

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

2.6 Course Designation System

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:

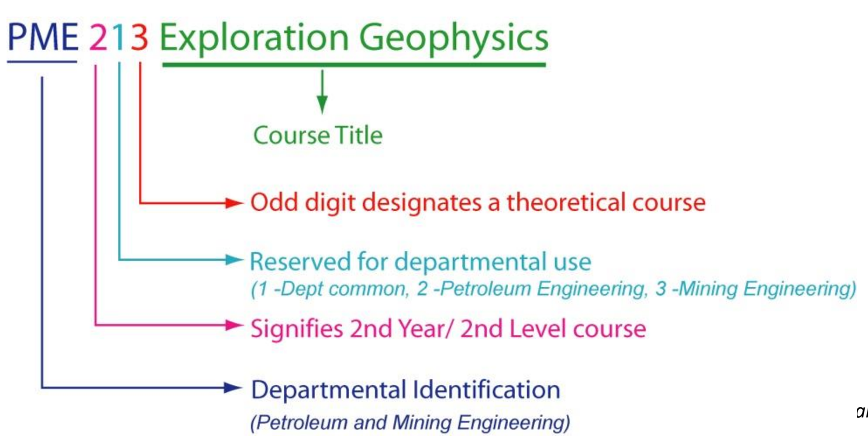
a. The left-most digit corresponds to the year/level in which the course is normally taken by the students. The second digit is reserved for departmental use. It usually identifies a specific area/group of study within the department.

b. The right-most digit is an odd number for theoretical courses and an even number for sessional courses.

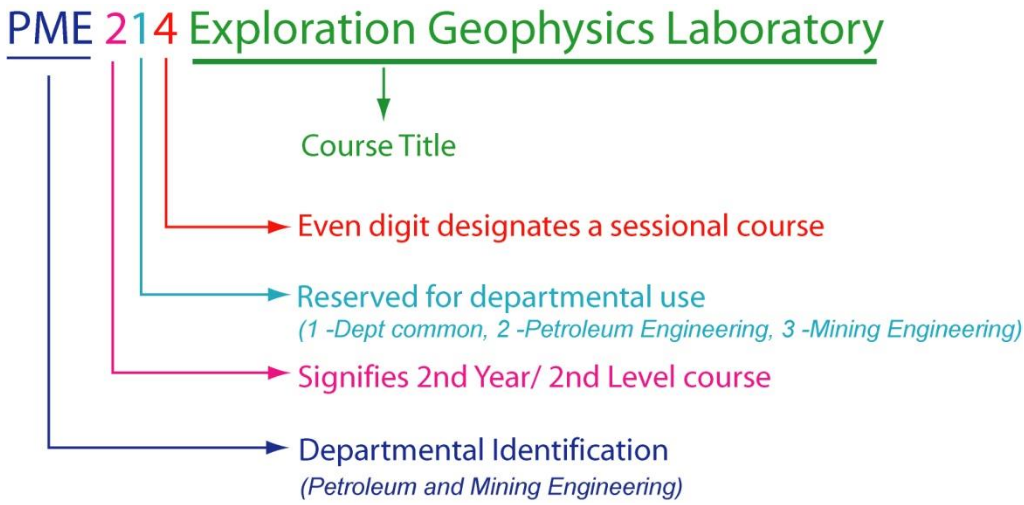
The course designation system is illustrated as Follows:

2.6.1 PME dept. Courses

(i) Theory

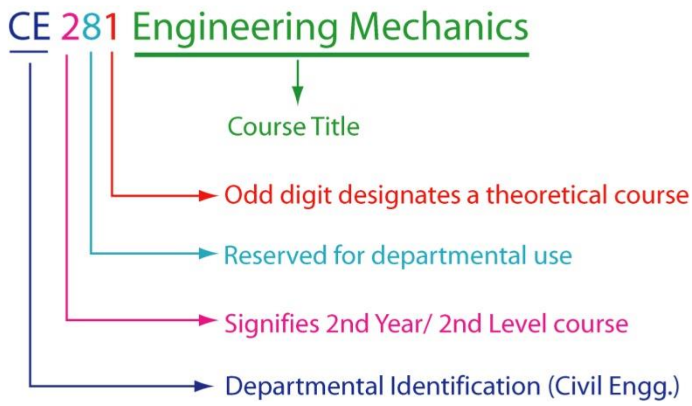


(ii) Sessional

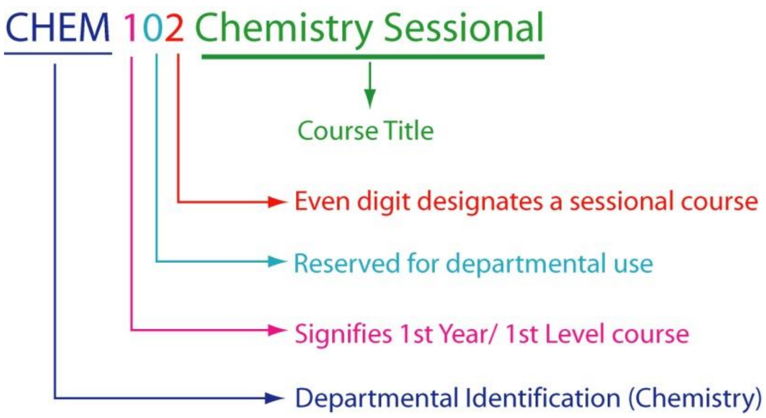


1.6.2 <u>Interdisciplinary Course</u>

(i) Theory



(ii) Sessional



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 curricula are divided into the following groups:

2.8.1 **PME Departmental Courses.**A number of courses are identified as departmental courses, which form the nucleus of the respective bachelor's degree program. A student has to complete the entire designated courses. The departmental courses are subdivided into departmental common courses, petroleum engineering courses and mining engineering courses.

2.8.2 **Other Departmental Courses.** Some courses will be tought by subject experts from other departments. The courses are subdivided into interdisciplinary engineering courses, and general educational and science courses.

2.8.3 **PME Departmental Courses for other Departments.**The Engineering Geology and Geomorphology course is being offered for other departments.

2.9 Course Offering and Instruction

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.

2.9.1 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 Students' Adviser

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.

2.11.1 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 the subsequent progress of the student.

2.11.2 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

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.

2.13 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 essential that all the students be present for registration at the specified time.

2.14 Pre-conditions for Registration

2.14.1 For first year students, department-wise enrollment/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.

2.14.2 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.

2.14.3 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.

2.15 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.

2.16 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.

2.17 Limits on the Credit Hours to be Taken

2.17.1 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.

2.17.2 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 Comdt, a lesser number of credit hours to suit individual requirements. Only graduating students may be allowed to register less than 15 Cr Hr without the approval of the Commandant. A list of all such cases to be forwarded to Register Office, ICT dept, and Controller of Exam Office by the respective Department.

2.18 Course Add/Drop

2.18.1 A student has some limited options to add or drop courses from the registration list. The addition of courses is allowed only within the first two weeks of a regular. Dropping a course is permitted within the first four weeks of a regular term. Add or drop is not allowed after registration of courses for Supplementary-I and Supplementary-II Examination.

2.18.2 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.

2.18.3 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.

2.19 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, the application may be considered during the term final examination in a 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.

2.20 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 the performance of the student at work during the class, viva-voce during laboratory hours, and quizzes. Besides that, in the end, there will be a final lab test. Each course has a certain number of credits, which describes its corresponding weightage. 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/ Remarks
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
	AB	Absent
	DC	Dis-collegiate
	VW	Voluntary withdrawn
	X	Project/ Thesis Continuatiom
	E	Expelled
	S	Satisfactory

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

2.21 <u>Marks Distrubtion</u>

2.21.1 <u>Theory</u>. Forty percent (40%) 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 the Office of the Controller of Examinations before the commencement of the final exam. The rest of the marks will be allotted to the Term Final Examination. The duration of the 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:

a..	Class Performance	5%
b.	Class Attendance	5%
c.	Class Test/ Assignment	20%
d.	Mid Term Assessment (Exam / Project)	10%
e.	Final Examination (Section A & B)	60%
	Total	**100%**

Note: Distribution of marks may change based on the decision of Academic Council of MIST.

2.21.2 **<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):

a.	Conduct of Lab Tests/Class Performance	25%
b.	Report Writing/ Programming	15%
c.	Mid-Term Evaluation (Exam/Project/Assignment)	20%
d.	Final Evaluation (Exam/Project/Assignment)	30%
e.	Viva Voce/ Presentation	10%
	Total	**100%**

Note: the above distribution of percentage is a general guideline. Department can rearrange to some extent if required

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

a.	Class performance/observation	10%
b.	Written Assignment	15%
c.	Oral Performance	25%
d.	Listening Skill	10%
e.	Group Presentation	30%
f.	Viva Voce	10%
	Total	**100%**

2.21.4 **Class Attendance**.

Class attendance may be considered as a part of continuous assessment.

2.21.5 **Collegiate and Non-collegiate**

Students having class attendance of 85% or above in individual subject will be treated as collegiate and less than 85% and up to 70% 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 70% 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.

2.22 **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, … , C_n and his grade points in these courses are G_1, G_2, … , G_n respectively then

$$GPA = \frac{\sum_{i=1}^{n} CiGi}{\sum_{i=1}^{n} Ci}$$

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, … , TC_n and his GPA in these terms are GPA_1, GPA_2, GPA_n respectively then

$$CGPA = \frac{\sum_{i=1}^{n} TCiGPAi}{\sum_{i=1}^{n} TCi}$$

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
PME 214	1.50	A	3.75	5.625
PME 213	3.00	A+	4.0	12.00
PHY 141	3.00	A-	3.50	10.50
CHEM 101	3.00	A+	4.00	12.00

MATH 101	3.00	B	3.00	9.00
GEBS 101	2.00	B-	2.75	5.50
EECE 262	1.50	B	3.00	4.50
ME 272	1.50	A+	4.00	6.00
CHEM 102	1.50	A	3.75	5.625
Total	20			70.75

GPA = 70.75/20.00 = 3.5375

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	20.00	3.73	74.60
1	2	20.00	3.93	78.60
2	1	20.00	3.96	79.20
2	2	20.00	4.00	80.00
Total		**80.00**		**312.40**

CGPA = 312.40/80 = 3.905

2.23 Minimum Earned Credit and GPA Requirement for Obtaining Degree

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

2.24 Minimum Earned Credit and GPA Requirement for Obtaining Degree (Additional Course)

Minimum credit hour requirements for the award of bachelor's degree in engineering (B.Sc. Engineering) and other discipline will be decided by the respective department (BUGS). However, total 161.5 credit hours for BSc in PME is needed to be elegible for graduation. This must include the specified core courses. The minimum GPA requirement for obtaining a Bachelor's degree in Engineering and Architecture is 2.20. A student may take additional courses with the consent of his Advisor in order to raise GPA, but he/she may take a maximum of 15 such additional credits beyond respective credit-hours requirements for Bachelor’s degree during entire period of study.

2.25 Impacts of Grade Earned

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.

2.25.1 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.

2.25.2 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.

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

2.25.4 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.

2.26 Classification of Students

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

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

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

b. **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.

c. **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.

2.27 Definition of Graduating Student.

Graduating students are those students who will have ≤ 24 credit hours for completing the degree requirement.

2.28 Performance Evaluation

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.

2.28.1 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.

2.28.2 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.

2.29 Application for Graduation and Award of Degree

A student who has fulfilled all the academic requirements for the 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.

2.30 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.

2.31 Attendance, Conduct and Discipline

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

2.31.1 **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.

2.31.2 **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.

2.32 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.

2.33 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).

2.34 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.

2.35 Types of Different Examinations (Subject to change for different academic session)

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

2.35.1 **Term Final Examination:**At the end of each normal term (after 22 wk 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.

2.35.2 **Supplementary Examination:** It will take place twice in a year. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun) / Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec) / Spring Term (Jan-Jun) end break, respectively. Students will be allowed to register for a maximum of two theory courses (Failed/Improvement) in Supplementary-I and maximum of one theory course (Failed/Improvement) in Supplementary-II.

2.35.3 **Improvement Examination:** It will be taken during Supplementary-I and Supplementary-II Examination. Questions will be same as the question of the regular examination of that Supplementary Examination (if any). Student can take maximum two subjects at a time (two subjects in supplementary-I and one subject in supplementary-II) 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 thetranscript.

2.36 Rules of Different Examinations (Subject to change for different academic session)

2.36.1 **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.

2.36.2 **Supplementary Examination.** Following rules to be followed:

a. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun) / Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec) / Spring Term (Jan-Jun) end break, respectively.

b. Students will be allowed to register for a maximum of two theory courses (Failed/Improvement) in Supplementary-I and maximum of one theory course (Failed/Improvement) in Supplementary-II.

c. No class will be conducted.

d. 40% marks will be considered from the previous exams.

e. Maximum grading in Supplementary Exam will be 'B+'.

f. No Sessional Exam will be conducted.

g. Examination will be taken on 60% marks like Term Final Examination.

h. If a student fails in a course more than once in regular terms, then for calculating 40% marks best one of all continuous assessment marks will be counted.

i. If anyone fails in the laboratory/sessional course, that course cannot be taken in the supplementary examination.

j. If any student fails in a course, he can clear the course retaking it 2nd time or, he can clear the examination appearing at the supplementary examination as any one fails twice in a course, can only retake it in the regular term for appearing third time. But anyone fails even after appearing third time. He/she has to take of Academic Council of MIST for appearing 4th (last) time in a course and need to pay extra financial penalty. If any student fails even 4th time in a course, will not be allowed to appear anymore in this same course.

k. Registration of Supplementary-I Exam to be done within 5th wk after completion of Fall Term (July to Dec) and registration of Supplementary-II exam to be done during the Mid-Term break of Spring Term (Jan to Jun), paying all the required fees.

l. There will be no provision for add/drop courses after registration.

m. Question Setting, Moderation, and Result Publication to be done following the same rules of Spring (Jan to Jun) / Fall (July to Dec) Term Final Exam as per existing Examination Policy.

n. Moderation of the questions for Supplementary-I will be done in the 5th week after completion of Fall Term (July to Dec) Final Exam and Supplementary II with the moderation of the questions of Spring Term (Jan to Jun).

o. Separate Tabulation sheet to be made.

p. Thesis: if a student cannot complete thesis in two consecutive terms, with the recommendation of the supervisor, he/she may continue for next one/two term within six academic years.

2.36.3 Improvement Examination. Following rules to be followed:

a. Improvement exam should be taken during the supplementary-I and supplementary-II examinations.

b. For Improvement examination, registration is to be done during the registration of supplementary-I and supplementary-II examinations by paying all the fees.

c. Question Setting, Moderation, and Result Publication to be done with courses of supplementary-I and supplementary-II examinations.

d. 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.

e. Highest garde of improvement examination will be ‘B+’

f. 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 (two courses at supplementary-I and one course at supplementary-II).

2.37 <u>Irregular Graduation</u>

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 of the top university-level programs among the engineering universities in Bangladesh. The Department of Petroleum & Mining Engineering has started 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 resourcesand to develop those resources for proper exploitation by solving engineering challenges. The program is designed to prepare graduates for the national and international fields 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, Mine Planning and Development, Mine Machineries and Maintenance, Mine Ventilation, Drilling and Blasting. In addition to lectures and practical sessions in the classroom, 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 advancedissues. Problems of military and national importance have consequently received great emphasis in the activities of this department.In addition to the above there will be opportunities for postgraduate studies and research leading to higher degrees i.e. M. Sc. (Engg), M. Engg, and Ph.D.

3.2 Vision and Mission

Vision:

To fulfill the growing energy and mineral demand in Bangladesh, we need highly skilled manpower having engineering background and research in Petroleum and Mining sectors. The Petroleum and Mining Engineering department of MIST would like to play a significant role in meeting up the needs and play a vital role in utilizing natural resources (sustainable resource engineering) in nation-building and to put its imprints across the globeby imparting quality education, promoting useful research and striving to induce social responsibilities, ethical values and leadership to enhance quality of life for people of the nation and the world.

Mission:

The mission of the Dept of PME is drawn from the vision of MIST. The three-pronged mission of the Dept of PME is as under.

No	Mission Statement
MN 1	To provide a high-quality learning environment for students in both undergraduate and postgraduate levels through a broad-based, rigorous curriculum, emphasizing theoretical and practical concepts to gain fundamental and specialized engineering knowledge, while they develop skills in critical thinking, communication, leadership, and lifelong learning.
MN 2	To create opportunities for students and faculty to conduct basic and applied research that contributes to society by advancing sustainable engineering principles and practices.
MN 3	To provide Petroleum and Mining engineering leadership and service to the nation, the profession, and society at large with strong professional values, and disciplined work ethics.

3.3 Program Educational Objectives (PEOs)

No	PEO Statement
PEO 1	Graduates of Petroleum and Mining Engineering will develop a sound background in fundamental science and engineering principles as applied to the fields of petroleum and mining engineering for a successful professional career.
PEO 2	Graduates of Petroleum and Mining Engineering acquire skills and abilities to excel in the area of petroleum and mining engineering both in industries and academics.
PEO 3	Graduates of Petroleum and Mining Engineering will understand sustainable engineering practices, Socio-ethical values and life-long learning.
PEO 4	Graduates of Petroleum and Mining Engineering possess awareness towards higher education, research & development and play a role to the leadership.

3.4 Program Outcomes (POs)

The Bachelor in Petroleum and Mining Engineering (PME) program contains the following outcomes considering the suggestion of Board of Accreditation for Engineering and Technical Education (BAETE), Bangladesh:

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

PO 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.
PO 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.
PO 4	**Investigation:** Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
PO 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.
PO 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.
PO 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.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.
PO 9	**Individual work and teamwork:** Function effectively as an individual and a member or leader of diverse teams as well as in multidisciplinary settings.
PO 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.
PO 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.
PO 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 Bloom's Taxonomy

Bloom’s Taxonomy is a classification system used to define and distinguish different levels of humancognitioni.e., thinking, learning, and understanding. Typically, Bloom’s Taxonomy is used toinform or guide the development of Assessments (tests and other evaluations of student learning),Curriculum (units, lessons, projects, and other learning activities), and instructional methods such asquestioning strategies. There are three learning domains of Bloom’s Taxonomy.

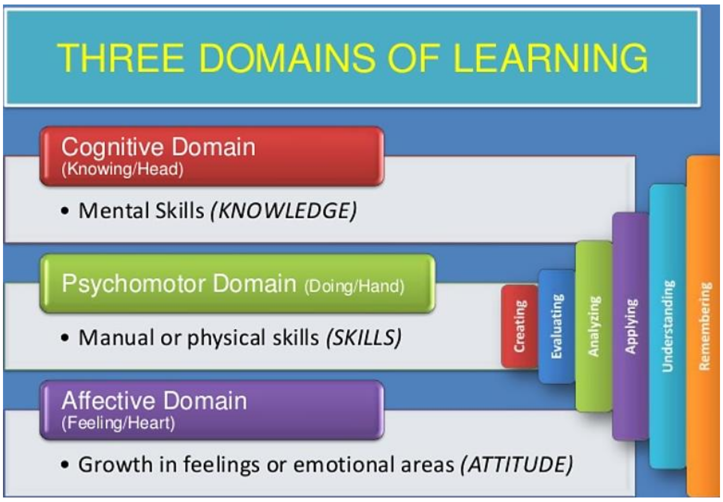


Figure 3.1: The Learning Domains of Bloom's Taxonomy (OBE Based Curriculam UGC 2020)

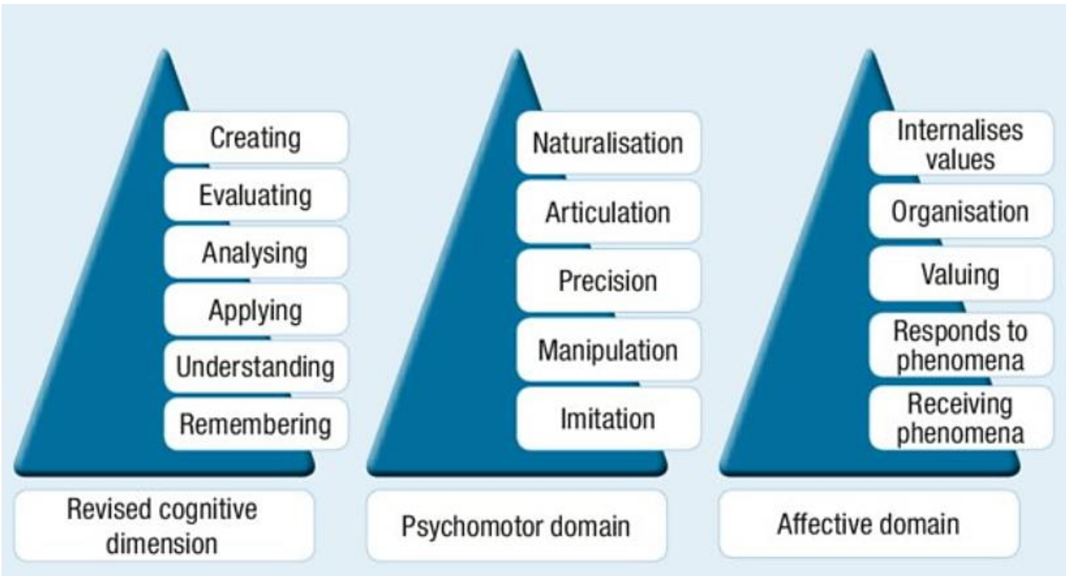


Figure 3.2: Three Domains of Bloom's Taxonomy (OBE Based Curriculam UGC 2020)

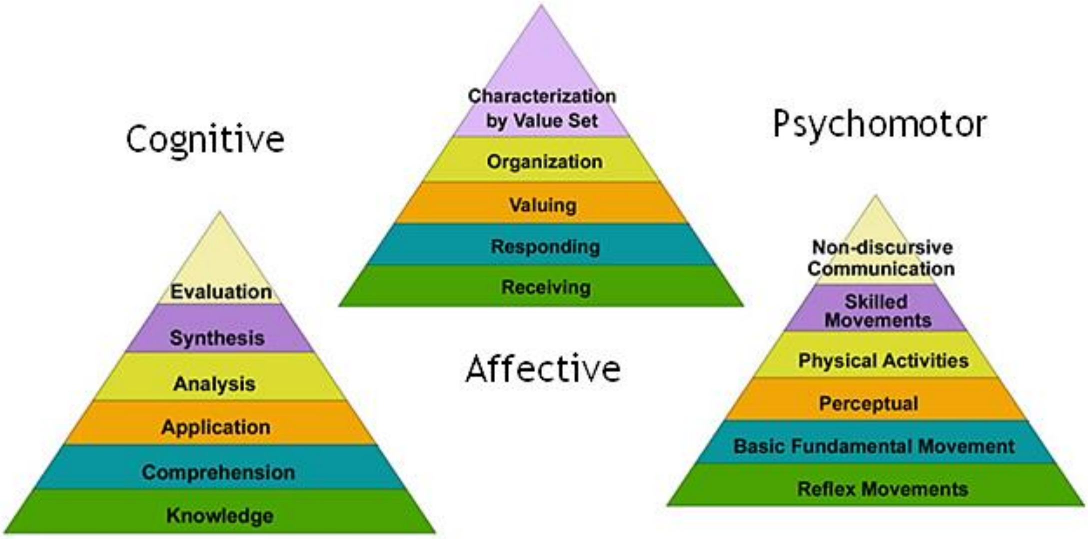


Figure 3.3: Levels of three Domains of Bloom's Taxonomy (OBE Based Curriculam UGC 2020)

3.6<u>Washington Accord</u>

The graduate attributes adopted by the Washington Accord signatories are generic tothe education of professional engineers in all engineering disciplines. They categorisewhat graduates should know, the skills they should demonstrate and the attitudes theyshould possess.The Washington Accord Graduate Attribute Profile has 12 elements, supported bya Knowledge Profile, WK1-WK8, and a definition of the Level of Problem Solving,WP1-WP7, which given below:

3.6.1 <u>Washington Accord Knowledge Profiles</u> (WK1 to WK8)

The Washington Accord Knowledge Profile has eight elements:

WK 1	A systematic, theory-based understanding of the **natural sciences** applicable to the discipline.
WK 2	Conceptually-based **mathematics**, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modeling applicable to the discipline.
WK 3	A systematic, theory-based formulation of **engineering fundamentals** required in the engineering discipline.
WK 4	Engineering **specialist knowledge** that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK 5	Knowledge that supports **engineering design** in a practice area.
WK 6	Knowledge of **engineering practice** (technology) in the practice areas in the engineering discipline.
WK 7	**Comprehension of** the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability.
WK 8	Engagement with selected knowledge in the **research literature** of the discipline.

3.6.2 Range of Problem Solving

Complex Engineering Problems have characteristic WP1 and some or all of WP2 to WP7:

WP 1	**Depth of Knowledge Required**: Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows a fundamentals-based, first principles analytical approach.
WP 2	**Range of conflicting requirements:** Involve wide-ranging or conflicting technical, engineering and other issues.
WP 3	**Depth of analysis required:** Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.
WP 4	**Familiarity of issues:** Involve infrequently encountered issues.
WP5	**Extent of applicable codes:** Are outside problems encompassed by standards and codes of practice for professional engineering.
WP6	**Extent of stakeholder involvement and conflicting requirements:** Involve diverse groups of stakeholders with widely varying needs.
WP7	**Interdependence:** Are high level problems including many component parts or sub-problems.

3.6.3 Range of Engineering Activities

Complex activities means activities or projects that have some or all of the following characteristics:

EA 1	**Range of resources:** Involve the use of diverse resources (and for this purpose resources includes people, money, equipment, materials, information and technologies)
EA 2	**Level of interactions:** Require resolution of significant problems arising from interactions between wide ranging or conflicting technical, engineering or other issues
EA 3	**Innovation:** Involve creative use of engineering principles and research-based knowledge in novel ways
EA 4	**Consequences to society and the environment:** Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
EA5	**Familiarity:** Can extend beyond previous experiences by applying principles-based approaches.

3.7 Relationship/Mapping between Mission of the Dept and the Institute

No.	Mission statement of PME	Mission of MIST			
		Mission statement 1	Mission statement 2	Mission statement 3	Mission statement 4
MN 1	Provide a high-quality learning environment for students in both undergraduate and postgraduate levels through a broad-based, rigorous curriculum, emphasizing theoretical and practical concepts to gain fundamental and specialized engineering knowledge, while they develop skills in critical thinking, communication, leadership and lifelong learning.	Yes	Yes	No	No

MN 2	Create opportunities for students and faculty to conduct basic and applied research that contributes to society by advancing sustainable engineering principles and practices.	No	Yes	Yes	Yes
MN 3	To provide Petroleum and Mining engineering leadership and service to the nation, the profession, and society at large with strong professional values, and disciplined work ethics.	No	Yes	Yes	No

3.8 Relationship/Mapping between PEO and Mission of the Dept

No.	Program Educational Objectives (PEOs) statement	Mission of PME Dept		
		Mission statement 1	Mission statement 2	Mission statement 3
PEO 1	Graduates of Petroleum and Mining Engineering will develop a sound background in fundamental science and engineering principles as applied to the fields of petroleum and mining engineering for a successful professional career.	Yes	No	Yes
PEO 2	Graduates of Petroleum and Mining Engineering acquire skills and abilities to excel in the area of petroleum and mining engineering both in industries and academics.	Yes	Yes	No
PEO 3	Graduates of Petroleum and Mining Engineering will understand sustainable engineering practices, Socio-ethical values and life-long learning.	No	Yes	Yes
PEO 4	Graduates of Petroleum and Mining Engineering possess awareness towards higher education, research & development and play a role to the leadership.	Yes	Yes	No

3.9 Relation between PEOs and POs

No.	PO statement	PEO 1	PEO 2	PEO 3	PEO 4
PO 1	Engineering knowledge: Apply the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization **(WK1,**	Yes	No	No	No

	WK2, WK3, WK4) to the solution of complex Petroleum and Mining engineering problems				
PO 2	Problem analysis: Able to identify, formulate, research literature and analyze complex Petroleum and Mining engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (**WK1, WK2, WK3, WK4**)	Yes	No	No	Yes
PO 3	Design/development of solutions: Able to design solutions for complex Petroleum and Mining engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental concerns **(WK5)**.	Yes	No	No	No
PO 4	**Investigation:** Able toconduct investigations of complex Petroleum and Mining Engineeringproblems using research-based knowledge **(WK8)** and research methods including design of experiments, analysis and interpretation of data,and synthesis of information to provide valid conclusions	Yes	No	No	No
PO 5	**Modern tool usage:** Able to create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex Petroleum and Miningengineering problems, with an understanding of their limitations **(WK6)**	Yes	Yes	No	No
PO 6	**The engineer and society:** Able toapply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex Petroleum and Mining engineering problems **(WK7)**	No	No	Yes	No
PO 7	**Environment and sustainability:** Able to understand and evaluatethe sustainability and impact of professional engineering work in the solution of complex Petroleum and Mining engineering problems in societal and	No	No	Yes	No

	environmental contexts **(WK7)**				
PO 8	**Ethics:** Able to apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice **(WK7)**	No	No	Yes	No
PO 9	**Individual work and teamwork:** Able tofunction effectively as an individual, and as a member or leader of diverse teams and in multi-disciplinary settings	No	No	No	Yes
PO 10	**Communication:** Able to communicate effectively about complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports, design documentation, make effective presentations, and give and receive clear instructions	No	Yes	No	Yes
PO 11	**Project management and finance:** Able todemonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's work as a member or leader in a team, to manage projects and in multidisciplinary environments	No	No	Yes	No
PO 12	**Life-long learning:** Able to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	No	No	Yes	Yes

3.10 Course Outcomes (COs):

The Course Outcomes (CO) are the resultant knowledge skills the student acquires at the end of a course. It defines the cognitive processes a course provides. Chapter 5, 6 and 7 contain the detailed Learning Outcomes for each of the courses under the heading of Learning Objectives (OBs) and COs.

3.11 Generic Skills

The graduates of the PME program are expected to have the following generic skills:

a. Ability to apply the principles and theory of nuclear engineering knowledge to the requirements, design and development of different nuclear systems with appropriate understanding.

b. Ability to define and use appropriate research methods and modern engineering tools.

c. Ability to apply critical thinking to solve complex engineering problems and design innovative solutions.

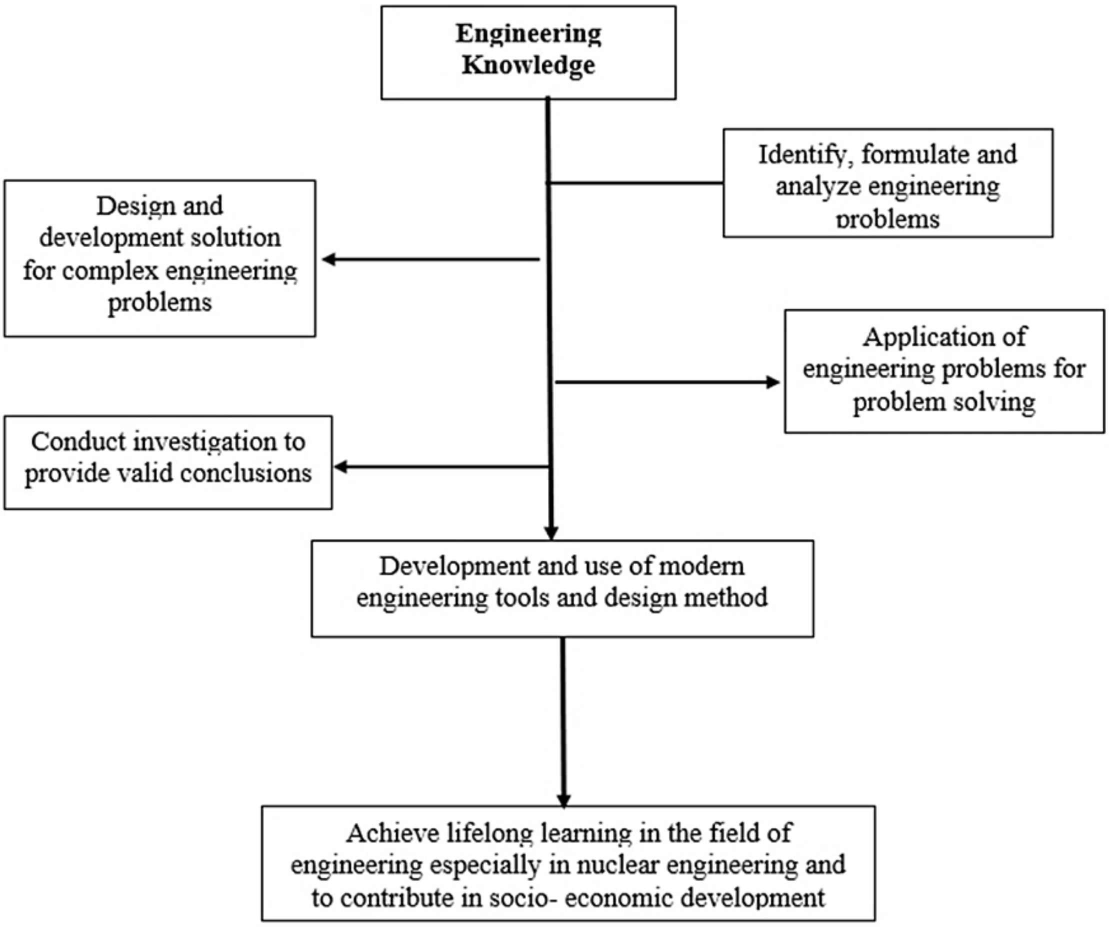
d. Ability to learn independently, be self- aware and self- manage their time and workload.

e. Ability to analyze real time problems and justify the appropriate use of technology.

f. Ability to work effectively as an individual, and as a member or leader of a team in diverse situations and exhibit social responsibility.

3.12 Curriculum/ Skill Mapping

The courses of PME program are designed in such a way that the corresponding Course Outcomes (COs) contribute to the 12 Program Outcomes (POs) which eventually achieves the mission and vision of the program. Chapter 5, 6 and 7 contain the mapping for each of the courses**.** However, generic curriculum/ skill mapping is shown below:



CHAPTER 4

COURSE CURRICULUM

OF BACHELOR IN PETROLEUM AND MINING ENGINEERING

4.1 General Education and Interdisciplinary Courses

Sr No	Category	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total
1	Language and General Education	LANG 102	Communicative English -I	L1 T2	1.5	3	Cr Hr 20.0 **and** ContHr**24.0**
2		LANG 202	Communicative English-II	L2 T1	1.5	3	
3		GES 101	Fundamentals of Sociology	L1 T2	2	2	
4		GEBS 101	Bangladesh Studies	L2 T2	2	2	
5		GEEA 201	Fundamentals of Economics and Accounting	L2 T2	3	3	
6		GELM 275	Leadership and Management	L2 T1	2	2	
7		GESL 317	Environment, Sustainability and Law	L3 T2	2	2	
8		GERM 352	Fundamentals of Research Methodology	L3 T1	1	2	
9		GEPM 477	Project Management and Finance	L4 T2	3	3	
10		GEEM 447	Engineering Ethics and Moral Philosophy	L4 T1	2	2	
11	Basic Science and Mathematical Courses	PHY 141	Waves and Oscillations, Optics, and Structure of Matter	L1 T1	3	3	Cr Hr**18.0 and** ContHr**21.0**
12		PHY 142	Physics Sessional	L1 T1	1.5	3	
13		CHEM 101	Fundamentals of Chemistry	L1 T2	3	3	
14		CHEM 102	Chemistry Sessional	L1 T2	1.5	3	
15		MATH 101	Differential and Integral Calculus	L1 T1	3	3	
16		MATH 103	Differential Equations and Matrix	L1 T2	3	3	
17		MATH 201	Vector Analysis, Laplace Transformation & Co-ordinate Geometry	L2 T1	3	3	
18	Interdisciplinary Courses	ME 176	Workshop Practice	L1 T1	1.5	3	Cr Hr**20.0 and** ContHr**26.0**
19		ME 180	Engineering Drawing and CAD	L2 T2	1.5	3	
20		CE 281	Engineering Mechanics	L2 T1	3	3	
21		CE 283	Strength of materials	L2 T1	3	3	
22		EECE 261	Fundamentals of Electrical and Electronic Engineering	L2 T1	3	3	
23		EECE 262	Fundamentals of Electrical and Electronic Engineering Laboratory	L2 T1	1.5	3	
24		CSE 271	Introduction to Computer	L2 T2	2	2	

			Programming				
25		CSE 272	Computer Programming Sessional	L2 T2	0.75	1.5	
26		ME 271	Fluid Mechanics	L2 T2	3	3	
27		ME 272	Fluid Mechanics Laboratory	L3 T2	0.75	1.5	

4.2 Departmental Core Courses

Sr No	Category	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total
1	**Departmental Common Courses**	PME 111	Geology for Petroleum and Mining Engineers	L1 T1	3	3	Cr Hr **25.5 and** ContHr **36.0(+)**
2		PME 112	Geology Laboratory	L1 T1	1.5	3	
3		PME 113	Introduction to Petroleum and Mining Engineering	L1 T1	3	3	
4		PME 211	Rock Mechanics for Petroleum and Mining Engineers	L2 T1	3	3	
5		PME 212	Rock Mechanics Laboratory	L2 T1	1.5	3	
6		PME 213	Exploration Geophysics	L2 T2	2	2	
7		PME 214	Exploration Geophysics Laboratory	L2 T2	1.5	3	
8		PME 311	Heat and Mass Transfer	L3 T1	2	2	
9		PME 310	Industrial Training	L3 T2	1	4 weeks	
10		PME 410	Thesis/Project	L4 T1	1	2	
11		PME 410	Thesis/Project	L4 T2	3	6	
12		PME 412	Capstone Project	L4 T1	1	2	
13		PME 412	Capstone Project	L4 T2	2	4	
14	**Petroleum Engineering Courses**	PME 121	Petroleum Engineering Thermodynamics	L1 T2	2	2	Cr Hr**43.0 and** ContHr**51.0**
15		PME 123	Reservoir Rock and Fluid Properties	L1 T2	3	3	
16		PME 124	Reservoir Rock and Fluid Properties Laboratory	L1 T2	1.5	3	
17		PME 222	Drilling Fluid Laboratory	L2 T1	1.5	3	
18		PME 321	Well Logging and Formation Evaluation	L3 T1	3	3	
19		PME 322	Well Logging and Formation Evaluation Laboratory	L3 T1	1.5	3	
20		PME 323	Drilling Engineering	L3 T1	3	3	
21		PME 324	Rig Floor Simulation Laboratory	L3 T1	1.5	3	
22		PME 325	Petroleum Production Engineering	L3 T2	3	3	
23		PME 327	Natural Gas Processing and LNG Technology	L3 T2	3	3	
24		PME 328	Natural Gas Processing, LNG, and LPG Laboratory	L3 T2	1.5	3	
25		PME 329	Reservoir Engineering	L3 T2	3	3	
26		PME 421	Well Test Analysis	L4 T1	3	3	
27		PME 423	Reservoir Modeling and Simulation	L4 T1	3	3	
28		PME 424	Reservoir Modeling and	L4 T1	1.5	3	

			Simulation Sessional				
29		PME 425	Petroleum Refining and LPG Technology	L4 T1	3	3	
30		PME 427	Transmission and Distribution of Natural Gas	L4 T2	3	3	
31		PME 429	Enhanced Oil Recovery Techniques	L4 T2	2	2	
32	**Mining Engineering Courses**	PME 231	Mining System	L2 T2	3	3	Cr Hr**33.5 and** ContHr**41.0**
33		PME 232	Mining SystemLaboratory	L2 T2	1.5	3	
34		PME 233	Shaft sinking and Tunneling	L2 T2	3	3	
35		PME 331	Mine Instrumentation and Machineries	L3 T1	3	3	
36		PME 332	Mine Instrumentation and Machineries Laboratory	L3 T1	1.5	3	
37		PME 333	Ground Water Managements in Mining	L3 T1	2	2	
38		PME 335	Mine survey	L3 T2	3	3	
39		PME 336	Mine Survey Laboratory	L3 T2	1.5	3	
40		PME 337	Rock Blasting and Explosive Technology	L3 T2	3	3	
41		PME 431	Mine ventilation and Environmental Engineering	L4 T1	3	3	
42		PME 432	Mine Ventilation and Environmental Engineering Laboratory	L4 T1	1.5	3	
43		PME 433	Mineral Processing	L4 T2	3	3	
44		PME 434	Minerals Processing Laboratory	L4 T2	1.5	3	
45		PME 435	Mine Planning and Design	L4 T2	3	3	

4.3 Distribution of Courses in Levels and Terms

Level-1, Term-1

Sl No	Course Code	Course Title	Contact hour/week	Credits
THEORY				
1	PHY 141	Waves and Oscillations, Optics, and Structure of Matter	3	3
2	MATH 101	Differential and Integral Calculus	3	3
3	PME 111	Geology for Petroleum and Mining Engineers	3	3
4	PME 113	Introduction to Petroleum and Mining Engineering	3	3
5	GES 101	Fundamentals of Sociology	2	2
SESSIONAL/LABORATORY				
1	PHY 142	Physics Sessional	3	1.5
2	ME 176	Workshop Practice	3	1.5
3	ME 180	Engineering Drawing and CAD	3	1.5

4	PME 112	Geology Laboratory	3	1.5
			26	**20**

Contact Hours= 14.0 (Theo) + 12.0 (Lab) = 26.0 hours/week *No of Theory Courses = 5*
Total Credits = 20.0 *No of Laboratory Courses = 4*

Level-1, Term-2

Sl No	Course Code	Course Title	Contact hour/week	Credits
THEORY				
1	PME 121	Petroleum Engineering Thermodynamics	2	2
2	CE 281	Engineering Mechanics	3	3
3	GEBS 101	Bangladesh Studies	2	2
4	MATH 103	Differential Equations and Matrix	3	3
5	CHEM 101	Fundamentals of Chemistry	3	3
6	PME 123	Reservoir Rock and Fluid Properties	3	3
SESSIONAL/LABORATORY				
1	CHEM 102	Chemistry Sessional	3	1.5
2	PME 124	Reservoir Rock and Fluid Properties Laboratory	3	1.5
3	LANG 102	Communicative English -I	3	1.5
			25	**20.5**

Contact Hours= 16 (Theo) + 9.0 (Lab) = 25 hours/week *No of Theory Courses = 6*
Total Credits = 20.5 *No of Laboratory Courses = 3*

Total Credit Hours in Level 1 is 40.5

Level-2, Term-1

Sl No	Course Code	Course Title	Contact hour/week	Credits
THEORY				
1	EECE 261	Fundamentals of Electrical and Electronic Engineering	3	3
2	MATH 201	Vector Analysis, Laplace Transformation & Co-ordinate Geometry	3	3
3	GELM 275	Leadership and Management	2	2
4	CE 283	Strength of Materials	3	3
5	PME 211	Rock Mechanics for Petroleum and Mining Engineers	3	3
SESSIONAL/LABORATORY				
1	LANG 202	Communicative English- II	3	1.5
2	EECE 262	Fundamentals of Electrical and Electronic Engineering Laboratory	3	1.5
3	PME 212	Rock Mechanics Laboratory	3	1.5
4	PME 222	Drilling Fluid Laboratory	3	1.5

			26	**20.0**

Contact Hours: 14.0 (Theo) + 12.0 (Lab) = 26.0 hours/week *No of Theory Courses = 6*
Total Credits = 20.0 *No of Laboratory Courses = 4*

Level-2, Term-2

Sl No	Course Code	Course Title	Contact hour/week	Credits
THEORY				
1	CSE 271	Introduction to Computer Programming	2	2
2	PME 213	Exploration Geophysics	2	2
3	ME 271	Fluid Mechanics	3	3
4	PME 231	Mining System	3	3
5	PME 233	Shaft sinking and Tunneling	3	3
6	GEEA 201	Fundamentals of Economics and Accounting	3	3
SESSIONAL/LABORATORY				
1	CSE 272	Computer Programming Sessional	1.5	0.75
2	PME 214	Exploration Geophysics Laboratory	3	1.5
3	PME 232	Mining SystemLaboratory	3	1.5
4	ME 272	Fluid Mechanics Laboratory	1.5	0.75
			25	**20.5**

Contact Hours: 16.0 (Theo) + 9.0 (Lab) = 25 hours/week *No of Theory Courses = 6*
Total Credits = 20.5 *No of Laboratory Courses = 4*

Total Credit Hours in Level 2is 40.5

Level-3, Term-1

Sl No	Course Code	Course Title	Contact hour/week	Credits
THEORY				
1	PME 331	Mine Instrumentation and Machineries	3	3
2	PME 333	Ground Water Managements in Mining	2	2
3	PME 321	Well Logging and Formation Evaluation	3	3
4	PME 323	Drilling Engineering	3	3
5	PME 311	Heat and Mass Transfer	2	2
SESSIONAL/LABORATORY				
1	PME 332	Mine Instrumentation and Machineries Laboratory	3	1.5
2	PME 322	Well Logging and Formation Evaluation Laboratory	3	1.5
3	PME 324	Rig Floor Simulation Laboratory	3	1.5
4	GERM 352	Fundamentals of Research Methodology	2	1
			24	**18.5**

Contact Hours: 13.0 (Theo) + 11.0 (Lab) = 24.0 hours/week *No of Theory Courses = 5*
Total Credits = 18.5 *No of Laboratory Courses = 4*

Level-3, Term-2

Sl No	Course Code	Course Title	Contact hour/week	Credits
THEORY				
1	PME 325	Petroleum Production Engineering	3	3
2	PME 327	Natural Gas Processing and LNG Technology	3	3
3	PME 329	Reservoir Engineering	3	3
4	PME 335	Mine survey	3	3
5	GESL 317	Environment, Sustainability and Law	2	2
6	PME 337	Rock Blasting and Explosive Technology	3	3
SESSIONAL/LABORATORY				
1	PME 328	Natural Gas Processing and LPG Laboratory	3	1.5
2	PME 336	Mine Survey Laboratory	3	1.5
3	PME 310	Industrial Training	4 weeks	1
			23+ 4 wks	**21**

Contact Hours: 17.0(Theo)+ 6.0 (Lab) = 23 hours/week + 4 weeks
Total Credits = 21.0

No of Theory Courses = 6
No of Laboratory Courses = 3

Total Credit Hours in Level 3is 39.5

Level-4, Term-1

Sl No	Course Code	Course Title	Contact hour/week	Credits
THEORY				
1	PME 421	Well Test Analysis	3	3
2	PME 423	Reservoir Modeling and Simulation	3	3
3	PME 431	Mine ventilation and Environmental Engineering	3	3
4	PME 425	Petroleum Refining and LPG Technology	3	3
5	GEEM 447	Engineering Ethics and Moral Philosophy	2	2
SESSIONAL/LABORATORY				
1	PME 410	Thesis/Project	2	1
2	PME 412	Capstone Project	2	1
3	PME 424	Reservoir Modeling and Simulation Sessional	3	1.5
4	PME 432	Mine Ventilation and Environmental Engineering Laboratory	3	1.5
			24	**19**

Contact Hours: 14.0 (Theo) + 10.0 (Lab) = 24.0 hours/week
Total Credits = 19.0

No of Theory Courses = 5
No of Laboratory Courses = 3

Level-4, Term-2

Sl No	Course Code	Course Title	Contact hour/week	Credits
		THEORY		
1	GEPM 477	Project Management and Finance	3	3
2	PME 427	Transmission and Distribution of Natural Gas	3	3
3	PME 429	Enhanced Oil Recovery Techniques	2	2
4	PME 433	Mineral Processing	3	3
5	PME 435	Mine Planning and Design	3	3
		SESSIONAL/LABORATORY		
1	PME 410	Thesis/Project	6	3
2	PME 412	Capstone Project	4	2
3	PME 434	Minerals Processing Laboratory	3	1.5
			27	**20.5**

Contact Hours: 14.0 (Theo) + 13.0 (Lab) = 27.0 hours/week
Total Credits = 20.5
No of Theory Courses = 5
No of Laboratory Courses = 2

Total Credit Hours in Level 4is 39.5

Total Credit Hours in PME program is 160.0

4.4 Summary of Theory and Sessional Courses- Level and Termwise

Level and Term	Hours/Week		**Total ContHr**	Credits		**Total Cr Hr**	**No. of Courses**	
	Theory	Sessional		Theory	Sessional		**Theory**	**Sessional**
L1 T1	14	12	**26**	14	6	**20**	5	4
L1 T2	16	9	**25**	16	4.5	**20.5**	6	3
L2 T1	14	12	**26**	14	6.0	**20.0**	5	4
L2 T2	16	9	**25**	16	4.5	**20.5**	6	4
L3 T1	13	11	**24**	13	5.5	**18.5**	5	4
L3 T2	17	6+4 wks	**23 + 4 wks**	17	4	**21**	6	3
L4 T1	14	10	**24**	14	5	**19**	5	4
L4 T2	14	13	**27**	14	6.5	**20.5**	5	3
Grand Total	118	82+ 4 wks	**200+ 4 wks**	118	42.0	**160.0**	43	29

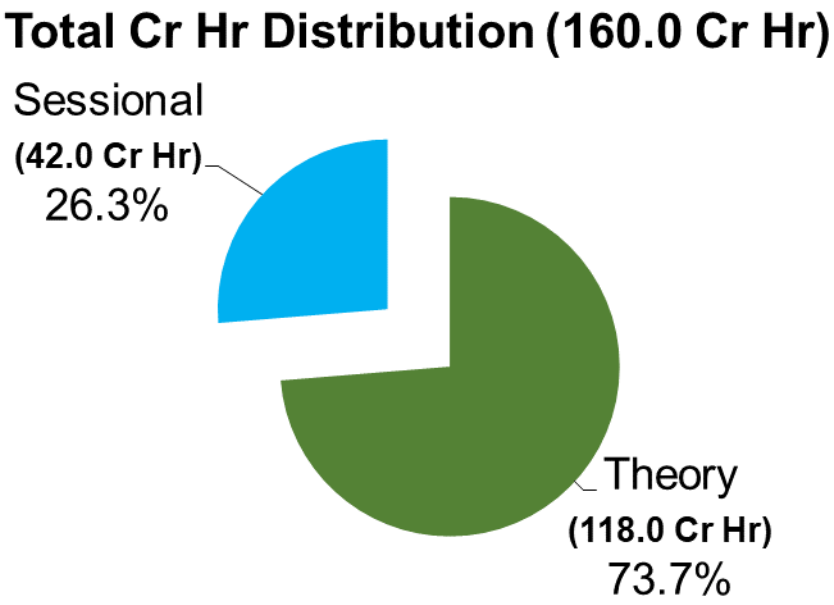


Fig. 4.4.1 Overall Theory and Sessional Credit Hour Distribution

4.5 Summary of Departmental Theory and Sessional Courses - Level and Termwise Credit Hours

Level/ Term	Theory	Sessional	Total
L1 T1	6.0	1.5	**7.5**
L1 T2	5.0	1.5	**6.5**
L2 T1	3.0	3.0	**6.0**
L2 T2	8.0	3.0	**11.0**
L3 T1	13.0	4.5	**17.5**
L3 T2	15.0	4	**19.0**
L4 T1	12.0	5	**17.0**
L4 T2	11.0	6.5	**17.5**
Total	**73**	**29.0**	**102.0**

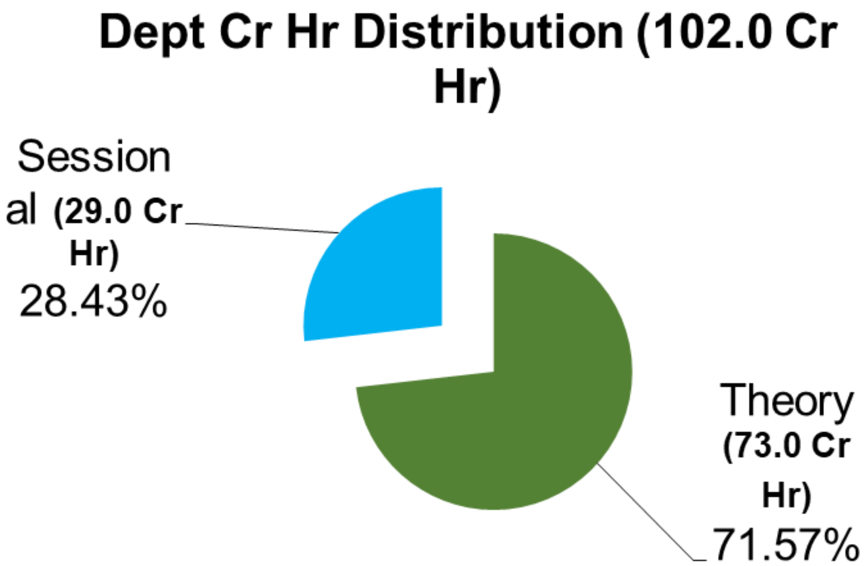


Fig. 4.5.1 Departmental Theory and Sessional Credit Hour Distribution

4.6 Summary of Credit Hours for Departmental, Inter-disciplinary, Basic Science. Mathematics, and General Education Courses

Level/ Term	Dept. courses	Inter-disciplinary	Basic Science	Mathematics	Language	General Education	Total
L1 T1	7.5	3	4.5	3	-	2	**20**
L1 T2	6.5	3	4.5	3	1.5	2	**20.5**
L2 T1	6.0	7.5	-	3	1.5	2	**20.0**
L2 T2	11	6.5	-	-	-	3	**20.5**
L3 T1	17.5	-	-	-	-	1	**18.5**
L3 T2	19.0	-	-	-	-	2	**21**
L4 T1	17	-	-	-	-	2	**19.0**
L4 T2	17.5	-	-	-	-	3	**20.5**
Total	**102.0**	**20**	**9**	**9**	**3**	**17**	**160.0**
% of Courses	**63.75**	**12.50**	**5.62**	**5.62**	**1.88**	**10.63**	**100%**

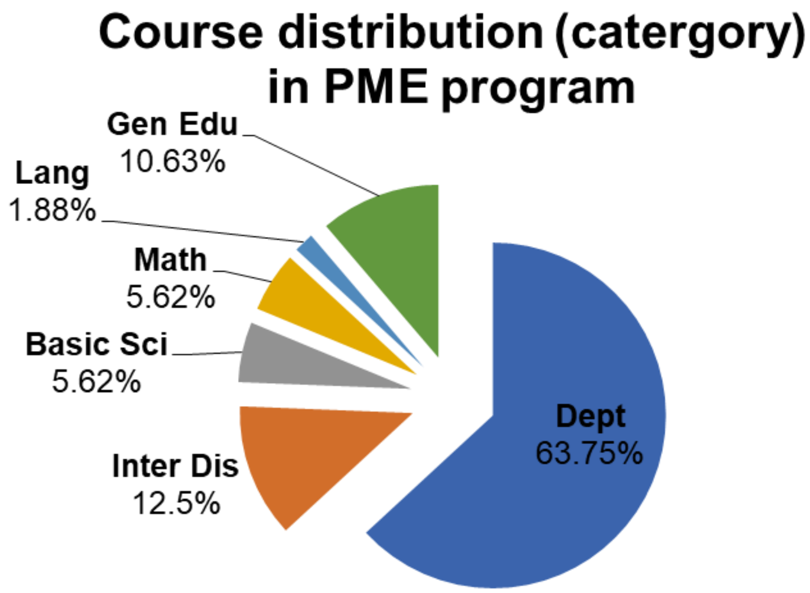


Fig. 4.6.1 Course distribution (Category) in PME program

4.7 Teaching Strategy

Multiple teaching and learning activities are necessary to achieve the intended outcomes, since students have different learning styles. It is therefore, the PME department planned to choose appropriate teaching and learning methods that will foster student's engagement in the learning process rather than students listening to the lectures passively. Student centered learning is about active participation of students in the classroom, and that active participation will be achieved by content/curriculum, teacher's interaction with the students and the environment that are directed towards students learning. The strategy includes:

a. **Face-to-Face Learning**

- Lecture /Presentation/ Discussion
- Practical / Tutorial / Studio
- Case Studies
- Assignment/Quiz
- Group discussion/projects
- Design and Research

b. **Self-Directed Learning**

- Non-face-to-face learning
- Revision
- Preparation of presentation
- Preparation of Lab Reports
- Preparation of Lab Test
- Engagement in Group Projects
- Preparation of Assignment/Quiz

- Preparation for final Examination

Details of teaching strategy for each of the courses under the heading of Teaching Learning Strategy is given in Chapter 5 and 6.

4.8 Assessment Strategy

Assessment of student achievement is an important aspect of Outcome-based education. Students will be assessed both directly and indirectly. Direct Assessment includes class tests, assignments, and Mid and Term final examinations. However, appropriate rubrics have been set to evaluate indirect assessment. Assessment process is aligned with the learning outcomes. Assessment supports the learners in their progress and validates the achievement of the intended learning outcomes at the end of the lecture/course/module. Assessment methods are adapted depending on the kind of outcomes that are aimed to be achived. The assessment strategy is given below:

a. Theory Based Courses

SL.	Components		Grading
1	Continuous Assessment (40%)	Class Attendance	05%
		Class Performance	05%
		Class Test/ Assignment	20%
		Mid-term Exam/ Project	10%
2	Final Examination		60%
	Total Marks		**100%**

b. Sessional Courses

The PME department offers different types of sessional courses which include laboratory investigations, design through use of modern tools and softwares, field survey, drawing etc. Thereby assessments vary depending on selected course. The following represents a typical assessment strategy for a regular sessional course-

SL.	Components		Grading
1	**Continuous Assessment (60%)**	Class Attendance	05%
		Conduct of Lab Test	20%
		Report Writing	15%
		Mid-term	20%
2	**Final Evaluation (40%)**	Exam	30%
		Viva Voce/ Presentation	10%
		Total Marks	**100%**

Details of assessment strategy for each of the courses under the heading of assessment Strategy are given in Chapter 5, 6 and 7.

CHAPTER 5

DEPARTMENTAL COURSES

5.1 Departmental Common Courses

Sr No	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total	Page No
1	PME 111	Geology for Petroleum and Mining Engineers	L1 T1	3	3	Cr Hr **26.5 and** ContHr **37.0(+)**	49 - 52
2	PME 112	Geology Laboratory	L1 T1	1.5	3		53 - 55
3	PME 113	Introduction to Petroleum and Mining Engineering	L1 T1	3	3		56 - 59
4	PME 211	Rock Mechanics for Mining and Petroleum Engineers	L2 T1	3	3		60 – 64
5	PME 212	Rock Mechanics Laboratory	L2 T1	1.5	3		65 – 67
6	PME 213	Exploration Geophysics	L2 T2	2	2		68 – 71
7	PME 214	Exploration Geophysics Laboratory	L2 T2	1.5	3		72 – 74
8	PME 311	Heat and Mass Transfer	L3 T1	2	2		75 – 79
9	PME 310	Industrial Training	L3 T2	1	4 weeks		80 – 82
10	PME 410	Thesis/Research Project	L4 T1	1	4		83 - 86
11	PME 410	Thesis/Research Project	L4 T2	3	6		
12	PME 412	Capstone Project	L4 T1	1	2		87 – 89
13	PME 412	Capstone Project	L4 T2	2	4		

PME111	Geology for Petroleum and Mining Engineers	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale:

This course provides engineers basic knowledge and understanding of geologic site characterization and the evaluation of conditions for the design, construction, and maintenance of petroleum and mining engineering operations. It aims at developing the fundamental understanding of rock-related issues in the exploration and exploitation of the earth's geological resources.

2. Learning objectives (OB):

a) To understand the earth.
b) To analyze the crustal materials- the minerals and rocks.
c) To understand geological structures and its importance in petroleum and mining engineering fields.

3. Course Contents:

Introduction to Geology: Major branches of geology, importance of geology to petroleum and mining engineering. **Historical geology:** Fundamental laws, age of earth, methods of age determination, geological time scale. **Physical geology:** Interior of the earth- crust, mantle, core. Internal processes of the earth; plate tectonics- plate movements, convergent, divergent and transform movements. Surface processes of the earth;erosion, transportation and deposition. **Mineralogy:** Properties of minerals, classification of minerals; silicate minerals and non silicate minerals.Major rock forming minerals- composition, properties and occurrences.**Petrology:** Igneous rock, sedimentary rock and Metamorphic rock; origin, composition and classification. Detail study of texture, structure and compositional properties of common sedimentary rocks- sandstone, shale, conglomerate, limestone; coal. Rocks of Bangladesh.**Structural geology:** Tectonic structures of earth; fold, faults, joints- definitions and elements. Classification of folds and faults, Origin, field study of folds, faults and joints. Domes and basin, unconformities. Faults and earthquakes.**Stratigraphy:S**trata and stratigraphic column. Stratigraphic classifications; lithostratigraphy, chronostratigraphy, biostratigraphy. Lithostratigraphic units- Group, Formation, and Member. Correlation of stratigraphic units. **Economic Geology**: Economic resources- Petroleum and mineral resources; Origin and occurrence of petroleum oil and natural gas, Prospect evaluation of petroleum oil and gas. Metalliferous deposits; ore formation and occurrences. Non-Metallic deposits; formation and occurrences of coal deposits. **Geology of Bangladesh:**Tectonic framework and tectonic divisions of Bangladesh. Stratigraphic units of Bangladesh; subdivisions and correlation. Geologic history and evolution of the Bengal Basin.**Maps and sections:** Topographic map,geologicalmap, engineering geological Maps. Mapping in small scale and large scale. Preparation of sections from map. Geological field mapping.

4. Course Outcomes (CO) and Skill Mapping

Course Outcome (CO)		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminologies, concepts and techniques of geology in exploration and exploitation of earth resources.	✓											
CO2	Analyze the technical issues in design, operation and interpretation of geological materials and structures		✓										
CO3	Prepare and interpret maps in exploration and exploitation processes.		✓										

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP	CA	KP	Assessment Methods
CO1	Recognize the main terminologies, concepts and techniques of geology in exploration and exploitation of earth resources.	PO1		-	-		CT/ MID/FExam
CO2	Analyze the technical issues in design, operation and interpretation of geological materials and structures.	PO2	C1,C2	-	-	KP1-KP3	CT/ MID/FExam
CO3	Prepare and interpret maps in exploration and exploitation processes.	PO2		-	-		ASG

CP- ***C****omplex* ***P****roblem/* ***WP***- ***W****ashington Accord Complex* ***P****roblem Solving;* ***CA***- ***C****omplex* ***A****ctivities/* ***EA***- ***E****ngineering* ***A****ctivities;* ***KP***- ***K****nowledge* ***P****rofile/* ***WK***- ***W****ashington Accord* ***K****nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final	21

	examination	
3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method

7. Lecture Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Introduction to Geology and Historical Geology**	
Lecture-1	Major branches of geology, importance of geology to petroleum and mining engineering.	
Lecture-2	Fundamental laws,age of the earth, fossils, methods of age determination.	
Lecture-3	The geological Time scale;overview of major eras and periods.	
Week-2	**Physical Geology**	
Lecture-4	Interior of the earth, Internal processes of the earth.	
Lecture-5	Plate tectonics.	
Lecture-6	Surface processes of the earth; erosion transportation and deposition.	
Week-3	**Mineralogy**	
Lecture-7	Properties of minerals.	
Lecture-8	classification of minerals- silicate minerals.	
Lecture-9	classification of minerals- non silicate minerals.	
Week-4	**Mineralogy**	
Lecture-10	Major rock forming minerals; composition.	
Lecture-11	Major rock forming minerals; properties .	
Lecture-12	Economic minerals.	
Week-5	**Petrology**	
Lecture-13	Igneous rocks; Origin, composition.	
Lecture-14	Igneous rocks; Classification.	
Lecture-15	Sedimentary rocks; texture, structure; classification- Clastic and Non clastic rocks.	
Week-6	**Petrology**	
Lecture-16	Clastic sedimentary rocks; sandstone, shale, conglomerate.	
Lecture-17	Non-clastic sedimentary rocks; limestone; dolomite, chart, coal.	
Lecture-18	Rocks of Bangladesh.	
Week-7	**Structural Geology**	
Lecture-19	Tectonic structures of earth.	
Lecture-20	Folds; Elements and origin, classification	
Lecture-21	Faults: Elements, origin, classification	CT-1
Week-8	**Structural Geology**	
Lecture-22	Relation of faults and earthquakes.	
Lecture-23	Study of fold and faults in the field.	
Lecture-24	Domes and basin, Unconformities.	
Week-9	**Stratigraphy**	
Lecture-25	**S**trata and stratigraphic column.	

Lecture-26	Classifications of stratigraphic units: Group, Formation, Member.	
Lecture-27	Correlation of stratigraphic units.	
Week-10	**Economic Geology**	
Lecture-28	Study of economic resources; petroleum resources, mineral resources.	
Lecture-29	Origin and occurrences of petroleum oil and gas.	
Lecture-30	Prospect analysis of oil and gas.	
Week-11	**Economic Geology**	
Lecture-31	Metallic deposits: Nature, formation and occurrences.	
Lecture-32	Non-metallic deposits: Nature, formation and occurrences.	
Lecture-33	Prospect evaluation of metallic and non-metallic deposits.	CT-2; MID
Week-12	**Geology of Bangladesh**	
Lecture-34	Tectonic framework and tectonic divisions of Bangladesh.	
Lecture-35	Stratigraphic units of Bangladesh; subdivisions and correlation.	ASG
Lecture-36	Geologic history and evolution of the Bengal Basin.	
Week-13	**Maps and Sections**	
Lecture-37	Topographic map.	
Lecture-38	Geologicalmap.	
Lecture-39	Engineering geological maps.	
Week-14	**Maps and Sections**	
Lecture-40	Mapping in small and large scale.	
Lecture-41	Preparation of sections from map.	CT-3
Lecture-42	Geological field mapping.	

8. Assessment Strategy

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1. Continuous Assessment (40%)	1.1 Class Participation	10%	-	A1, A2, P1,P2, C1, C2
	1.2 Class Test/ Assignment	20%	CO1, CO2, CO3	
	1.3 Mid term	10%		
2. Final Exam (60%)		60%		
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Earth: An Introduction to Physical Geology; EJ Tarbuck, FK Lutgens et al. 2019, 528 pp.
2. Physical Geology; LL Don and J Sheldon. 1954, 466 pp.
3. Basic Petroleum Geology: Peter K. Link. 2001, 425 pp.
4. Energy Resources of Bangladesh; B Imam. 2013, 324 pp.
5. Developments in Geotechnical Engineering. Volume 10, 1976, Pages 19-34
6. Structural Geology; MP Billings. 1972, 606 pp.
7. Supplied Material

PME 112	**Geology Laboratory**	
		3.00 Co Hr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

This course is intended to introduce students to the breadth of practical-geosciences aimed at understanding the Earth from a petroleum and mining engineering point of view. In this course, the student will learn the skills to classify and identify the common minerals, rocks, fossils, and geologic features in their fields of application.

2. Learning objectives (OB)

a) Use of physical properties and microscopic study in rocks and minerals identification.
b) To prepare geologic and maps, and to extract geologic information.
c) To prepare models from geologic information for petroleum and mining applications.

3. Course Contents

Rock identification: physical properties, thin-section preparation, mineral identification: common minerals, microscopic study of sedimentary rock, microscopic study of igneous rock, microscopic study of metamorphic rock, geologic map, rock structures and deformations, chronology, stratigraphy and structure of subsurface rock, stratigraphy and structure of surface rock.

4. Course Outcomes (CO) and Skill Mapping

Course Outcome (CO)		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Identify the rocks and minerals.	✓											
CO2	Extract geologic information for petroleum and mining engineering applications from geologic maps	✓											
CO3	Prepare stratigraphic and structural models for petroleum and mining applications		✓										

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP	CA	KP	Assessment Strategys
CO1	Identify the rocks and minerals.	PO1	C2, C3		-	KP1-KP3	R, Q
CO2	Extract geologic information for petroleum and mining engineering applications from geologic maps	PO1		-	-		R, Q

CO3	Prepare stratigraphic and structural models for petroleum and mining applications	PO2	- -	R, Pre

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**i**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1.Face-to-Face Learning	1.1 Lecture	13
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
2.Self-Directed Learning	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
3.Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		74

TEACHING METHODOLOGY
Lecture, Experiment, Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule

Lecture	Experiments	Assessments	
Week-1	Rock identification based on physical properties.	R	
Week-2	Thin section preparation for microscopic study.	R	
Week-3	Identification of common rock forming minerals from microscopic study.	R	
Week-4	Identification of sedimentary rocks from microscopic study.	R	
Week-5	Identification of igneous rocks from microscopic study.	R	
Week-6	Identification of metamorphic rocks from microscopic study.	R	
Week-7	Interpretation of geologic information from maps.	R	
Week-8	Interpretation of geologic structures and its application.	R	
Week-9	Preparation of statigraphic-sequences from given information.	R	
Week-10	Modeling for stratigraphy and structure of subsurface rock.	R	ASG
Week-11		R	ASG
Week-12		R	ASG
Week-13	Field study: stratigraphy and structure of the exposed rock.	R	ASG
Week-14	Quiz and presentation		

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1, CO2 CO3	A3,A4,P1,P2, C1, C2
	1.2 Assignment	30%		
	1.3 Presentation	25%		
2. Lab quiz (25%)		25%		
		100%		

C*: Cognitive domain;* ***A****: Affective domain;* ***P****: Phychomotor domain*

9. Materials Recommended

1. Laboratory Manual for Introductory Geology; ALudman and S Marshak. 2018, 528 pp.
2. The Illustrated Guide to Rocks & Minerals; J Farndon. 2018, 256 pp.
3. Rocks and Minerals; C Pellant. 2010, 256 pp.
4. Rock Identification Field Guide; P Nurre. 2014, 146 pp.
5. Structural Geology; MP Billings. 1972, 606 pp.
6. Introduction to Optical Mineralogy; W Nesse. 2012, 384 pp.
7. Supplied materials.

PME113	**Introduction to Petroleum and Mining Engineering**	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. **Rationale:**

As a foundation for advanced courses to be understood within a larger engineering context in subsequent years, the course seeks to give students an overall comprehension of petroleum and mining engineering.

2. **Learning objectives (OB):**
   a) To describe basic terminology of petroleum and mining engineering.
   b) To know the importance of petroleum and mining engineering.
   c) To have a cross idea of the petroleum engineering and mining methods.

3. **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.

Introduction to Mining Engineering: Mining's contribution to civilization; Mining Technology; Advancement in Mining Technology. **Surface Mining Engineering:** Classification of methods; Open pit mining; Quarrying; Open cast (strip) mining; Auger mining; Placer mining; Solution mining. **Underground Mining Engineering:** Unsupported methods; Classification, Room-and –pillar mining, Stope- and- pillar mining, Shrinkage stoping, Sublevel stoping. Supported methods; Classification, Cut-and –fill stoping, Stull stoping, Square-set stoping. Caving methods; Classification, Longwall mining, Sublevel caving, Block caving. **Novel methods and technology:** Classification of methods; Hydraulic mining and transport; Methane drainage, Underground gasification, Mining for oil, Ocean mining and other methods.

4. **Course Outcomes (CO) and Skill Mapping**

Course Outcomes (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of petroleum and mining engineering	✓											

5. **Mapping of Course Outcomes (CO) and General Skills**

Course Outcomes (CO)		POs	Bloom's Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of petroleum and mining engineering	PO1	C1, C2	-	-	KP1-KP3	CT/ MID/ FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	**Petroleum Exploration:** Introduction to petroleum system; History of petroleum; Importance of petroleum industry.	
Lecture-2	Introduction to survey;Gravimetric survey; Magnetic survey; Seismic Survey; Applications.	
Lecture-3	Introduction to Mining Engineering.	
Week-2		
Lecture-4	Exploration well drilling.	
Lecture-5	Drilling Engineering:Wellbore configuration; Types of wells.	
Lecture-6	Surface Mining Engineering; classification.	
Week-3		
Lecture-7	Onshore and Offshore Drilling Rig and its components.	
Lecture-8	Classification of Drilling Rigs.	
Lecture-9	Surface Mining Engineering; Open pit mining, Quarrying.	CT-1
Week-4		

Lecture-10	Drilling Rig Specification; Power system.	
Lecture-11	Hoisting system; Rotary system.	
Lecture-12	Surface Mining Engineering; Open cast (strip) mining, Auger mining.	
Week-5		CT-2
Lecture-13	Drill Bit; Types of drill bit; Configuration of drill bit.	
Lecture-14	Circulating system.	
Lecture-15	Surface Mining Engineering; Placer mining.	
Week-6		
Lecture-16	Drilling Fluidand its application.	
Lecture-17	The principal components in mud preparation, injection, cleaning & treatment system.	
Lecture-18	Underground Unsupported Mining Engineering; Classification, Room – and- pillar mining.	
Week-7		
Lecture-19	**Reservoir Engineering:**Types of petroleum reservoir; Reservoir rocks; reservoir rock properties.	
Lecture-20	Reservoir fluid properties; Phase diagram.	
Lecture-21	Underground Unsupported Mining Engineering; Stope- and-pillar mining.	
Week-8		
Lecture-22	Reservoir fluid properties.	
Lecture-23	Mining Engineering: Roles and responsibility of mining engineers.	
Lecture-24	Surface mining: mechanical extraction method.	
Week-9		MID
Lecture-25	Reservoir Classification.	
Lecture-26	Surface mining: aqueous extraction method.	
Lecture-27	Underground Unsupported Mining Engineering; Shrinkage stoping. sublevel stoping.	
Week-10		
Lecture-28	Drive mechanism of reservoir.	
Lecture-29	UndergroundSupported Mining Engineering; Classifications.	
Lecture-30	UndergroundSupported Mining Engineering; Cut- and- fill stoping.	
Week-11		
Lecture-31	Fundamentals of reservoir fluid flow; Flow Regime.	
Lecture-32	UndergroundCaving Mining Engineering; Classifications.	
Lecture-33	UndergroundCaving Mining Engineering; Longwall mining.	
Week-12		
Lecture-34	Production Engineering:Introduction to petroleum production system; Production methods.	
Lecture-35	UndergroundCaving Mining Engineering; Sublevel caving.	
Lecture-36	UndergroundCaving Mining Engineering; Block caving.	
Week-13		CT-3
Lecture-37	Overview of surface and subsurface equipment, tools, devices, hardware.	
Lecture-38	Novel Mining Engineering; Classifications, Hydraulic mining	

	and transportation.	
Lecture-39	Novel Mining Engineering; Underground gasification, Ocean Mining.	
Week-14		
Lecture-40	Properties of produced fluids.	
Lecture-41	Overview of surface mining methods.	
Lecture-42	Overview of underground mining methods.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10%	CO1	A1, A2,P1,P2, C1, C2
	1.2 Class Test/ Assignment 1-3	20%		
	1.3 Mid term	10%		
2. Final Exam (60%)		60%		
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Applied Drilling Engineering; AT Bourgoyne Jr, KK Millheim, ME Chenevert & FS Young Jr. 2016, 502 pp.
2. Drilling Fluids Tom S. Carter; SME Mining Engineering Handbook
3. Introduction to Mining Engineering; HL Hartman, JM Mutmansky.2002, 592 pp.
4. SME Mining Engineering Handbook; Society for Mining, Metallurgy, and Exploration (U.S.). 2011. 1840 pp.

PME 211	Rock Mechanics for Mining and Petroleum Engineers
	3.00 Co Hr; 3.00 Cr Hr
Pre-requisite: None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The goal of the course is to give students an understanding of how rocks and rock masses behave mechanically in relation to the force fields in their physical environments when mining and petroleum activities are taking place.

2. Learning objectives (OB)

a) To understand about the physical and mechanical properties of rock in the stress fields of petroleum and mining.
b) To comprehend the technical issues due to activities in rock.

3. 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 stress and the stability of the openings:** 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 support design. **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; Sand and particle productions, Basics of coupled reservoir simulation and the link to 4D seismic.**Well bore stability**: Preventing wellbore instability during drilling, Quantitative risk assessment, Role of rock strength anisotropy, Mud/rock interaction, Maximizing the frac gradient, Mud penetration and time-dependent wellbore failure, preventing sand production.**Critically stressed faults and fluid flow**: Fractured reservoirs and permeability anisotropy, Identification of critically stressed faults and breakout rotations, Intentionally induced microseismicity to enhance permeability, Fault slip/blown trap, Dynamic constraints on hydrocarbon migration.**Effects of reservoir depletion:** Stress changes in depleting reservoirs, Deformation in depleting reservoirs, Deformation and stress changes outside of depleting reservoirs.**Hydraulic Fracturing**: Initiation and growth of hydraulic fractures; Fracturing during water injection; Applications.

4. Course Outcomes (CO) and Skill Mapping

Course Outcome (CO)		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the theories relating to the physical properties of rocks, deformation, and failure of rocks under stress conditions (tension, uniaxial compression, triaxial compression)	✓											
CO2	Evaluate the design requirements for excavations in the mining and petroleum fields		✓										

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Explain the theories relating to the physical properties of rocks, deformation, and failure of rocks under stress conditions (tension, uniaxial compression, triaxial compression)	PO1	C1, C2	CP1	-	KP1, KP4	CT/ MID/FExam
CO2	Evaluate the design requirements for excavations in the mining and petroleum fields	PO2			-		CT/ MID/FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment		

	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method

7. Lecture Schedule

Lecture	Lecture Topic	Assessments
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**	
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, Wellbore stability**	
Lecture-19	Methods of stress measurements in fields. Stress controlled instability.	CT-1 CT-2

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 mass characterization, Wellbore 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	**Roof control, Wellbore stability**	
Lecture-25 Lecture-26	Roof control plan.	
Lecture-27	Effects of plasticity on borehole stability.	
Week-10	**Slope stability, Problems during production**	
Lecture-28 Lecture-29	Slope stability.	
Lecture-30	Sand and Particle Production; Basic mechanisms.	
Week-11	**Pillar and bolt design, Critically stressed faults and fluid flow**	
Lecture-31	Design of entry, Pillar, and bolt systems.	
Lecture-32	Identification of critically stressed faults and breakout rotations.	
Lecture-33	Fault slip/blown trap, Dynamic constraints.	
Week-12	**Stresses around excavations, Effects of reservoir depletion**	
Lecture-34	Stresses around excavations.	CT-3
Lecture-35	Deformation in depleting reservoirs.	
Lecture-36	Deformation and stress changes outside of depleting reservoirs.	
Week-13	**Ground reaction curve, Hydrofracturing**	
Lecture-37	Convergence and stress measurements.	MID
Lecture-38	Initiation and growth of hydraulic fractures.	
Lecture-39	Applications	ASG
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10%	CO1, CO2	A1, A2,P1,P2, C1, C2
	1.2 Class Test/ Assignment 1-3	20%		
	1.3 Mid term	10%		
2. Final Exam (60%)		60%		
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Rock Mechanics for underground mining; BHG Brady and ET Brown. 2004, 628 pp.
2. Rock Mechanics and Engineering Volume 2: Laboratory and Field Testing; XT Feng. 2016, 324 pp.
3. Fundamentals of Rock Mechanics; JC Jaeger, NGW Cook and RW Zimmerman. 2007, 475 pp.
4. Petroleum Production Systems; MJ. Economides, AD Hill, CE Economides, D Zhu. 2012, 752 pp.
5. Supplied materials.

PME 212	**Rock Mechanics Laboratory**	
		3.00 Co Hr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The module's purpose is to assess the rock's engineering attributes and characterize its rockmass while taking into account its natural environment for application in mining and petroleum domains.

2. Learning objectives (OB)

a) To determine the physical and mechanical properties of rock and rockmass.
b) To know about the influencing factors on physical and mechanical properties.
c) To do excavation design for mining and petroleum fields.

3. Course Contents

Engineering properties of rock, in-situ sampling procedure of coal, fracture-influence on permeability, dynamic properties, strength of irregular shaped samples, slake durability, properties of joints, Simulation of excavation in rock and rockmass.

4. Course Outcomes (CO) and Skill Mapping

Course Outcome (CO)		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To determine the engineering properties for characterization of rocks considering different in-situ conditions.		✓										
CO2	Apply the engineering properties to design excavations in rock.			✓									

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	To determine the engineering properties for characterization of rocks considering different in-situ conditions	PO2	C2, C3	-	-	KP1, KP4	R/ Q
CO2	Apply the engineering properties to design excavations in rock and assessment of performance prediction	PO3		-	-		R/ Q/ASG

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal

exam, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities	Engagement (hours)
1. Face-to-Face Learning	
1.1 Lecture	13
1.2 Experiment/ Modeling	21
1.3 Student-Centered Learning	7
2. Self-Directed Learning	
2.1 Lab reports	14
2.2 Quiz	4
2.3 Preparation/ quiz	7
3. Formal Assessment	
3.1 Continuous Assessment	7
3.2 Presentation	1
	74

TEACHING METHODOLOGY
Lecture, Experiment, Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule

<table>
<tr><th>Lecture</th><th>Experiments</th><th colspan="2">Assessments</th></tr>
<tr><td>Week-1</td><td>Sample preparation</td><td rowspan="12">R</td><td rowspan="11"></td></tr>
<tr><td>Week-2</td><td>Determination of mechanical properties</td></tr>
<tr><td>Week-3</td><td>In-situ sampling procedure</td></tr>
<tr><td>Week-4</td><td>Effective porosity and permeability measurement</td></tr>
<tr><td>Week-5</td><td>Determination of fracture-influence on permeability</td></tr>
<tr><td>Week-6</td><td>Determination of dynamic properties of rocks</td></tr>
<tr><td>Week-7</td><td>Determination of joints properties</td></tr>
<tr><td>Week-8</td><td>Determination of strength of irregular shaped rock samples</td></tr>
<tr><td>Week-9</td><td>Determination of slaking properties of rocks</td></tr>
<tr><td>Week-10</td><td rowspan="4">Excavation design in rock and rockmass</td></tr>
<tr><td>Week-11</td></tr>
<tr><td>Week-12</td><td>ASG</td></tr>
<tr><td>Week-13</td><td colspan="2">Q</td></tr>
<tr><td>Week-14</td><td colspan="3">Pre</td></tr>
</table>

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (75%)	1.1 Lab Participation	5%		
	1.2 Repot	15%	CO1, CO2	A3, A4, P3-P5 C2, C3
	1.3Assignment	30%		
	1.4 Presentation	25%		
2. Lab quiz (25%)		25%		
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Rock Mechanics and Engineering Volume 2: Laboratory and Field Testing; XT Feng. 2016, 324 pp.
2. Fundamentals of Rock Mechanics; JC Jaeger, NGW Cook and RW Zimmerman. 2007, 475 pp.
3. Manuals.
4. Supplied materials.

PME213	**Exploration Geophysics**	
		2.00 Co Hr; 2.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale:

The course aims to demonstrate how fundamental geophysical techniques are based on physics concepts and the mathematics that express them, as well as how certain typical geophysical techniques are used in the mining and petroleum fields.

2. Learning objectives (OB):

a) Theoretical background and methods used to acquire/ process relevant data.

b) Data processing and interpretation.

c) Use combined data to get a more comprehensive picture of the subsurface.

3. Course Contents:

Seismic Method: 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 ; Pre-stack, post-stack, 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.**Gravity Method:**Concept, Theory, unit of gravity, Rock density, Instruments, Gravity reduction; Drift correction, Latitude correction, Free air correction, Bouguer correction, Elevation correction, Tidal correction, Applications. **Magnetic Method:**Concept, Theory, Earth's magnetic field, Rock Magnetism, Survey instruments, Data reduction, Application.**Resistivity Method:**Electrode configuration, instruments, applications, Profiling and sounding.

4. Course Outcomes (CO) and Skill Mapping

Course Outcome (CO)		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the fundamental principles behind different geophysical methods of survey	✓											
CO2	Process, analyze, and interpretof geophysical data		✓										

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Explain the fundamental principles behind different geophysical methods of survey	PO1	C1, C2	-	-	KP1-KP4	CT/ MID/ FExam
CO2	Process, analyze, and	PO2		-	-		

	interpretof geophysical data	

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ignment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	28
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	28
	2.2 Revision of lecture at home	14
	2.3 Preparation for final examination	14
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		89

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:Lecture Topic

Lecture	Lecture Topic	Assessments
Week-1		CT-1
Lecture-1	**Seismic Technology:** The nature of seismic data; What is propagating?	
Lecture-2	Gravity method: Gravitational Force, Gravitational Acceleration, Units Associated With Gravitational Acceleration	
Week-2		
Lecture-3	What causes seismic reflections and how they relate to rock properties including pore filling material.	
Lecture-4	Gravity method: How is the Gravitational Acceleration, g, Related to Geology?Density Variations of Earth Materials, A Simple Model.	
Week-3		
Lecture-5	The wavelet in the seismic data and its limit of resolution ;	
Lecture-6	Gravity method: How do we Measure Gravity, Falling Body Measurements, Pendulum Measurements, Mass and Spring Measurements.	
Week-4		

Lecture-7	Seismic velocities as they relate to rock properties and the imaging process.	
Lecture-8	Gravity method: Factors that Affect the Gravitational Acceleration.	
Week-5		
Lecture-9	The relationship between seismic velocities and pore pressure.	
Lecture-10	Gravity method: Factors that Affect the Gravitational Acceleration.	
Week-6		
Lecture-11	Pore pressure prediction.	
Lecture-12	Gravity method: Isolating Gravity Anomalies of Interest.	
Week-7		MID
Lecture-13	Seismic data processing and seismic migration.	
Lecture-14	Gravity method: Gravity Anomalies Over Bodies With Simple Shapes.	
Week-8		
Lecture-15	Prestack, poststack, time and depth imaging.	
Lecture-16	Magnetic Method: Concept, Theory, Earth's magnetic field.	
Week-9		
Lecture-17	Direct hydrocarbon indicators and AVO.	
Lecture-18	Magnetic Method: Rock Magnetism, Survey instruments.	
Week-10		CT-2
Lecture-19	Seismic inversion for rock and fluid properties.	
Lecture-20	Magnetic Method: Data reduction.	
Week-11		
Lecture-21	Seismic inversion for rock and fluid properties.	
Lecture-22	Magnetic Method: Application.	
Week-12		
Lecture-23	Seismic attributes.	
Lecture-24	Resistivity Method: Concept.	
Week-13		CT-3
Lecture-25	Time lapse reservoir monitoring (4D seismic surveys).	
Lecture-26	Resistivity Method: Electrode configuration, instruments.	
Week-14		
Lecture-27	Recent developments in seismic acquisition, processing, and interpretation.	
Lecture-28	Resistivity Method: Profiling and sounding, applications.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10%	-	A1, A2, P1, P2 C1, C2
	1.2 Class Test/ Assignment	20%	CO1, CO2	
	1.3 Mid term	10%		
2. Final Exam (60%)		60%		

100%

C: Cognitive domain; A: Affective domain; P: Phychomotor domain

9. Materials Recommended

1. Exploration Geophysics; MR Gadallah, R Fisher. 2009, 266 pp.
2. Seismic Amplitude: An Interpreter's Handbook;R Simm& M Bacon. 2014, 281 pp.
3. Geology & Geophysics in Oil Exploration; M Sroor. 2010, 70 pp.
4. Field Geophysics; J Milsom& A Eriksen. 2011, 287 pp.

PME214	Exploration GeophysicsLaboratory	
		3.00 Co Hr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale:

The course is designed to exhibit practical applications for major geophysical instruments and techniques.

2. Learning objectives (OB):

a) To design the geophysical survey operation and formation evaluation process.
b) To practice geophysical survey tools and survey interpretation software.
c) To apply geophysical code and standards in geophysical survey design and operation.

3. Course Contents:

Design, data acquisition and interpretation of geophysical survey.

4. Skill Mapping (CO – PO Mapping)

Course Outcome (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Critically evaluate geophysical techniques, acquisition procedures, and survey designs for various subsurface targets	✓											
CO2	Process and analyze collected geophysical data.		✓										

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Critically evaluate geophysical techniques, acquisition procedures, and survey designs for various subsurface targets	PO1	C3, C4	-	-	KP1-KP4	R/ Q
CO2	Process and analyze collected geophysical data.	PO2		-	-		R/ Q/ Pre

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities	Engagement (hours)
1. Face-to-Face Learning	
1.1 Lecture	13

	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
2. Self-Directed Learning		
	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
3. Formal Assessment		
	3.1 Continuous Assessment	7
	3.2 Presentation	1
		74

TEACHING METHODOLOGY
Lecture, Experiment, Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:Lecture Topic

Lecture	**Experiments**	Assessments
Week-1	Processing of raw seismic data	R
Week-2	Basic steps in interpretationof seismic data	R
Week-3	Case study: 2D seismic survey	R
Week-4		R
Week-5	Case study: 3D seismic survey	
Week-6		R
Week-7	MID	
Week-8	Perform data acquisition fromResistivity survey	R
Week-9		R
Week-10		R
Week-11	1-D Resistivity inversions	R
Week-12	Interpretation of 2-D Resistivity data	R
Week-13	Interpretationof gravity data	R
Week-14	Presentation	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (75%)	1.1 Lab Participation	5%	CO1, CO2	A3, A4, P3 – P5 C3, C4
	1.2 Repot	45%		
	1.3Assignment 1.4 Presentation	25%		
2. Lab quiz (25%)		25%		
		100%		

__C__: Cognitive domain; __A__: Affective domain; __P__: Phychomotor domain

9. Materials Recommended

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.

PME311	**Heat Transfer and Mass Transfer**	
		2.00 Co Hr; 2.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

a) To describe heat and mass transfer process.
b) To analyze heat and mass transfer process.
c) To understand the problems in designing the heat and mass transfer systems.
d) To investigate the problems inheat and mass transfer operation in process.

3. Course Contents:

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 andlaminar 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 typequestions; Mass transfer coefficients: Introduction to mass transfer coefficient, Equimolarcounter-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 transfertheory, Overall mass transfer coefficients,. **Absorption and adsorption**:Introduction to absorption, Design of packed tower, Design of packed tower based on overallmass transfer coefficient, Counter-current multi-stage absorption (Tray absorber), Continuouscontact equipment, Absorption with chemical reaction, Absorption accompanied by irreversiblereactions, Absorption resistance. **Distillation**: Introductionto distillation, Distillation columns and their process calculations, Continuous distillation columns,Analysis of binary distillation in trayed

towers: McCabe-Thele Method, Determination of thestripping section operating line (SOL), Analysis of binary distillation by Ponchon-Savarit Method,Stepwise procedure to determine the number of theoretical trays, Introduction toMulticomponent Distillation,
Humidification and air conditioning: Basic concepts, Adiabatic saturation temperature, Humidification anddehumidification operations and design calculations, Mechanical Draft Towers: forced drafttowers and induced draft towers, Design calculations of cooling tower, Key points in the designof cooling tower and Step-by-step design procedure of cooling tower, Evaporation loss of waterin cooling tower, Example problems on humidification, Example problems on dehumidification;Multicomponent absorption.Application of mass transfer software.

4. Skill Mapping (CO – PO Mapping)

Course Outcome (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of heat and mass transfer process	✓											
CO2	Analyze problems in design, operation of heat and mass transfer process		✓										
CO3	Apply the fundamentals to design heat and mass transfer systems and process			✓									
CO4	Investigate problems in heat and mass transfer systems and process			✓									

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of heat and mass transfer process	PO1	C1, C2, C3	-	-	2 3	CT
CO2	Analyze problems in design, operation of heat and mass transfer process	PO2	C3	-	-	3 4	CT, TERM
CO3	Apply the fundamentals to design heat and mass transfer systems and process	PO3	C3,C4	1	-	3 4	MID
CO4	Investigate problems in heat and mass transfer systems and process	PO3	C3,C4	1	-	3 4	CT,TERM

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Assig**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131
TEACHING METHODOLOGY *Lecture and Discussion, Problem Based Method*		

7. Lecture Schedule

Lecture	Lecture Topic	Assessments
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.	
Week-2		
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.	
Lecture-4	**Convection**: Different types of flow and convection, boundary layer concepts, dimensional analysis of forced and natural convection.	
Week-3		
Lecture-5	**Radiation**: Basic concept of Radiation, **Heat Exchanger**: Basic types of heat exchanger.	
Lecture-6	LMTD, NTU	
Week-4		
Lecture-7	Heat exchanger efficiency, Fouling, Scaling of exchanger surface.	
Lecture-8	Extended surfaces	
Week-5		
Lecture-9	Continuation of extended surfaces	
Lecture-10	Introduction of thermal oil recovery processes, Steam Assisted Gravity Drainage (SAGD).	
Week-6		
Lecture-11	Cyclic Steam Stimulation (CSS), Steamflooding.	
Lecture-12	In Situ Combustion and Microwave heating, Application of heat transfer software.	
Week-7		

Lecture-13 Lecture-14	Mathematical Problem Solving Continuation of Mathematical Problem Solving	
Week-8		
Lecture-15	Introduction to Mass transfer operation, Assignment and short type questions;Diffusion: Fick's law of diffusion, Steady state molecular diffusion in fluids under stagnant andlaminar flow conditions.	
Lecture-16	Diffusion through variable cross-sectional area, Diffusion coefficient:measurement and prediction, Measurement of liquid-phase diffusion coefficient.	
Week-9		
Lecture-17	Multicomponent diffusion, Diffusivity in solids and its applications, Assignment and short typequestions; Mass transfer coefficients: Introduction to mass transfer coefficient. Equimolarcounter-diffusion of A and B (NA = -NB), Correlation for convective mass transfer coefficient,Correlation of mass transfer coefficients for single cylinder.	
Lecture-18	Theories of mass transfer,Penetration theory, Surface Renewal Theory, Boundary Layer Theory, Interphase mass transfertheory, Overall mass transfer coefficients.	
Week-10		
Lecture-19	Absorption and adsorption:Introduction to absorption, Design of packed tower, Design of packed tower based on overallmass transfer coefficient, Counter-current multi-stage absorption (Tray absorber).	CT-2
Lecture-20	Continuouscontact equipment, Absorption with chemical reaction, Absorption accompanied by irreversiblereactions, Absorption resistance. Distillation: Introductionto distillation, Distillation columns and their process calculations.	
Week-11		
Lecture-21	Continuous distillation columns, Analysis of binary distillation in trayed towers: McCabe-Thele Method.	
Lecture-22	Determination of thestripping section operating line (SOL), Analysis of binary distillation by Ponchon-Savarit Method. Stepwise procedure to determine the number of theoretical trays.	MID/ASG
Week-12		
Lecture-23	Introduction toMulticomponent Distillation.	
Lecture-24	Humidification and airconditioning: Basic concepts, Adiabatic saturation temperature.	
Week-13		
Lecture-25	Humidification anddehumidification operations and design calculations.	CT-3
Lecture-26	Mechanical Draft Towers: forced drafttowers and induced draft towers, Design calculations of cooling tower.	
Week-14		
Lecture-27	Key points in the designof cooling tower and Step-by-step design	

Lecture-28	procedure of cooling tower. Evaporation loss of waterin cooling tower, Example problems on humidification, Example problems on dehumidification;Multicomponent absorption.Application of mass transfer software.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3
	1.3 Mid term	15%	CO3	C3
4. Final Exam (60%)		60%	CO2,CO4	C3,C4
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Heat and Mass Transfer: Fundamentals & Applications5th Edition By Yunus A. Cengel& Afshin J. Ghajar
2. Heat and Mass Transfer by R.K. Rajput
3. Fundamentals of Heat and Mass. Transfer by Frank P. Incropera.
4. Mass-transfer operations by Robert Ewald Treybal.

PME310	**Industrial Training**	
		4.00 Wks; 1.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale:

The purpose of the course is to provide students the chance to use the knowledge they have learned in the classroom in actual scenarios. They will be able to observe how engineering ideas are used to address issues and how they are used in the actual world. Additionally, it will give students the chance to network with experts in their industry, which may lead to beneficial relationships and employment prospects.

2. Learning objectives (OB):

a) To apply theoretical knowledge to practical problems.
b) To understand the industrial environment and to become familiar with the processes and procedures used in the industry.

3. Course Contents:

The students will visit to study different petroleum and mining installations and prepare a report on it and finally present their work.

4. Skill Mapping (CO – PO Mapping)

Course Outcome (CO)		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To apply theoretical knowledge to practical problems.		✓										
CO2	To learn the importance of individual and teamwork in problem-solving skills									✓			
CO3	To understand the industrial environment and to become familiar with the processes and procedures (communication) used in the industry										✓		
CO4	To acquire the field experience for further development to succeed in their future career												✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	To apply theoretical knowledge to practical problems.	PO2	C1, C2	-	-	-	R, Pre, Learning aptitude evaluation
CO2	To learn the importance of individual and teamwork in problem-solving skills	PO9		-	-	-	

CO3	To understand the industrial environment and to become familiar with the processes and procedures (communication) used in the industry	PO10		-	-	-
CO4	To acquire the field experience for further development to succeed in their future career	PO12		-	-	-

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	15
	1.2 Practical / side visit	30
	1.3 Student-Centered Learning	5
2. Self-Directed Learning	2.1 Non-face-to-face learning	7
	2.2 overview of reports	7
	2.3 Preparation for presentation	2
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Presentation	3
		71

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method

7. Lecture Schedule:

Lecture	Topics	Assessments
Week-1	Training in Mining Industries (Geology and Hydrogeology, Mine Development, Dewatering System, Mechanical and Electrical parts, Production and Transportation.	Report, Presentation, Learning aptitude evaluation
Week-2	Training in Petroleum Industries (Gas Fields).	
Week-3	Training in Petroleum Industries (LPG, LNG, Refining).	
Week-4	Training in BAPEX, GSB, Petrobangla and relevant organizations.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Evaluation from industry (50%)	1.1 Attendance 1.2 Learning aptitude evaluation (in field)	10%	CO1,CO2, CO3,CO4	A3 – A5, P6, P7, C1, C2
	1.3 Evaluation from industry	40%		
2. Internal Examiner (50%)	2.1 Daily reports	10%		
	2.2 Presentation	20%		
	2.3 Final Report	20%		
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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. Supplied materials.

PME 410	Thesis/Project
	L4T1 *(2.00 ContHr; 1.00 Cr Hr)* +L4T2 *(6.00 ContHr; 3.00 Cr Hr)*
Pre-requisite:	GERM 352 **Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The course is designed to assist the graduate students in acquiring the fundamental knowledge to deal with thepetroleum or mining related problems in an integrated and comprehensive manner. This course is designed to help the students develop research competencies to critically evaluate the existing literature and be able to conduct a research work with proper technical documentation and oral presentation.

2. Learning objectives (OB)

a) To formulate a research problem related to petroleum or mining related problems through literature review.
b) To set objectives and select proper methods to solve the formulated research problem individually or with team members under the guidance of respective supervisor.
c) Try to find solutions to the research problem and present the results through presentation and thesis report.

3. Course Contents

In Research Project I,the students are expected to define his/her thesis topic, conduct an appropriate literature review, and prepare the research methodology to show the viability of a chosen topic. Whereas, they need to conduct (experiment/ simulation or both) and present (oral/ document) the research outcomes in Research Project II.

Term I: **A research proposal**; Introduction, literature review, research methodology, probable outcomes.

Term II: **Conducting a research**; Following the approved procedures and methods; **Data analysis and thesis write-up**; **Presentation**.

4. Course Outcomes (CO) and Skill Mapping

Course Outcome CO)		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Able to learn the theoretical knowledge to understand the current research problems related to petroleum or mining engineering.		✓										
CO2	Able to formulate a methodology of the selected research problem.				✓								✓
CO3	Able to conduct research on the selected problem					✓							✓
CO4	Able to work efficiently as a team member and communicate with effective soft skills									✓			
CO5	Able to communicatethrough clear researchwriting conform tostandardthesis format and										✓		

	performsverbal presentation.	
CO6	Able to understand and maintain the ethical issues related to scientific work	✓
PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning		

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Able to learn the theoretical knowledge to understand the current research problems related to petroleum or mining engineering.	PO2					Report, Presentation
CO2	Able to formulate a solution of the selected research problem.	PO4, PO12					Report, Presentation
CO3	Able to conduct research on the selected problem	PO5, PO12					Thesis report
CO4	Able to work efficiently as a team member and communicate with effective soft skills	PO9	C1, C2, C5, C6	CP1, CP3	CA3, CA4, CA5	KP6, KP8	Presentation
CO5	Able to communicate through clear researchwriting conform tostandardthesis format and performsverbal presentation.	PO10					Thesis report, Presentation
CO6	Able to understand and maintain the ethical issues related to scientific work	PO8					Thesis report

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

CP- ***C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Discussion/ Presentation	42
	1.2 Experiment/ Simulation	42
	1.3 Student-Centered Learning	28
2. Self-Directed Learning	2.1 Non-face-to-face learning	56
	2.2 Preparation of Reports	28
	2.3 Preparation of Thesis	42
3. Formal Assessment	3.1 Continuous Assessment	
	3.2 Final Presentation	1
		239
TEACHING METHODOLOGY *Discussion, Experiment/ Simulation, Data analysis, Cooperative and collaborative method*		

7. Course Schedule

Weeks	Tasks Research Project I (L4T1)	Assessment	Tasks Research Project II (L4T2)	Assessment
Week-1	Discussion (Topics): Supervisor and student	Presence	Sample/ Data collection	Report
Week-2	Discussion (Topics): Supervisor and student		Sample/ Data collection	
Week-3	Literature review: topics	Report	Experiment/ Simulation	Report
Week-4	Literature review: topics		Experiment/ Simulation	
Week-5	Literature review: topic		Experiment/ Simulation	
Week-6	Literature review: topics		Data Analysis	
Week-7	Topic selection: Supervisor and student	Presentation	Discussion (Research progress): Supervisor and student	Presentation
Week-8	Discussion (Problem statement and research objective: Supervisor and student	Report	Experiment/ Simulation	Report
Week-9	Literature review: Methodology	Report	Experiment/ Simulation	

Week-10	Literature review: Methodology		Discussion (Data Analysis): Supervisor and student	
Week-11	**Literature review**: Methodology		Discussion (Research progress): Supervisor and student	Presentation
Week-12	Discussion (Methodology): Supervisor and student	Presentation	Preparation of thesis (draft)	Thesis (Draft)
Week-13	Finalization of Methodology: Supervisor and student			
Week-14	Report: Introduction, problem statement, necessary data type methodology, probable outcomes		Correction of Thesis (Draft)	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Supervisor (70%)	1.1 Discussion/ Presentation	5%	CO1, CO2	A3- A5, C1, C2, C5, C6
	1.2 Proposal	10%	CO2,CO4, CO5, CO3, CO5, CO6	
	1.3 Progress reports	20%		
	1.4 Thesis writing	25%		
	1.5 Presentation	10%		
2. Internal Examiner (30%)	2.1 Presentation	10%	CO2, CO4, CO3, CO5, CO6	
	2.2 Thesis	20%		
		100%		

C: Cognitive domain; A: Affective domain; P: Phychomotor domain

9. Materials Recommended

1. Relevant journal papers and reports.
2. Supplied materials.

PME 412	**Capstone Project**	
	L4T1 ***(2.00 Cont Hr; 1.00 Cr Hr)*** **+L4T2** ***(4.00 Cont Hr; 2.00 Cr Hr)***	
Pre-requisite:	Petroleum/ Mining Courses	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

As a culminating event, the capstone project allows students to apply and integrate the range of skills and information they have learned throughout their petroleum and mining engineering degree to solve real-world engineering problems. Its primary goal is to demonstrate one's expertise in a particular area of petroleum or mining engineering. It usually integrates and utilizes the technical knowledge and skills developed throughout study. Students work in small groups to complete a comprehensive engineering design project that involves ideation and implementation. Critical thinking, problem-solving ability, teamwork, and effective communication are all necessary for this attempt.

2. Learning objectives (OB)

d) To apply engineering principles and methodologies to solve complex engineering problems.
e) To design, develop, and implement an engineering project in accordance with industry standards and best practices.
f) To generate exceptional, unique work that advances the student's education and career.
g) To demonstrate proficiency in project management, including planning, scheduling, and resource allocation.
h) To communicate effectively through written reports, oral presentations, and technical documentation.
i) To work collaboratively in a team environment to achieve project goals and objectives.

3. Course Contents

In capstone project course, the students are expected to define his/her project topic, conduct an appropriate literature review, and prepare the methodology to show the viability of a chosen topic (reservoir engineering, drilling engineering, petroleum production engineering, enhanced oil/gas recovery, underground mining, surface mining, unconventional mining, rock engineering, mine instrumentation and machineries, etc.), compilation of all project documentation, including design reports, technical drawings, test data, and construction of physical prototypes or models to validate design concepts.

Level 4; Term I:

Introduction to Capstone Project: Overview of the capstone project objectives, requirements, and expectations; Introduction to project management principles and tools; Formation of project teams and selection of project topics.

Literature Review and Background Research: Conducting a comprehensive review of relevant literature and previous research; Gathering background information and data related to the project topic; Identifying key challenges, opportunities, and potential solutions.

Petroleum/Mining Project Planning and Proposal: Definition of project scope, objectives, and deliverables; Development of project plans, timelines, and milestones; Writing project proposals and obtaining approval from faculty advisors.

Conceptual Design and Analysis: Generation of initial design concepts and alternatives; Evaluation and comparison of design options using engineering analysis techniques; Selection of the most feasible and optimal design solution.

Level 4; Term II:

Detailed Design and Engineering: Development of detailed engineering drawings, specifications, and plans; Incorporation of feedback from stakeholders, advisors, and industry experts; Implementation of design revisions and refinements as necessary.

Prototype Development (if applicable): Construction of physical prototypes or models to validate design concepts; Testing and evaluation of prototype performance against design criteria; Iterative refinement of prototype design based on test results.

Implementation and Testing: Execution of the project plan and implementation of the final design solution; Conducting rigorous testing and validation to ensure functionality, reliability, and safety; Documentation of testing procedures, results, and any modifications made.

Final Report and Presentation: Compilation of all project documentation, including design reports, technical drawings, and test data; Preparation of a comprehensive final report highlighting the project's objectives, methodology, results, and conclusions; Delivery of a formal presentation to faculty and peers summarizing the project outcomes.

9. Course Outcomes (CO) and Skill Mapping

Course Outcome CO)		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Capacity for design solutions for petroleum or mining engineering problems.			✓									
CO2	Able to create, select and apply appropriate techniques, resources and modern engineering tools.					✓							
CO3	Able to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.						✓						

CO4	Able to understand the impact of engineering solutions in sustainability contexts.							✓					
CO5	Able to function effectively as an individual and a member or leader of team.									✓			
CO6	Able to communicate effectively about complex engineering activities with the engineering community and with society at large. Also, be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.										✓		
CO7	Able to estimate total cost of a project and design cost effective project.											✓	

10. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Capacity for design solutions for petroleum or mining engineering problems.	PO3	C2, C3, C5, C6	CP5-CP7	CA1, CA2	KP4, KP5	Report, Presentation
CO2	Able to create, select and apply appropriate techniques, resources and modern engineering tools.	PO5					
CO3	Able to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	PO6					
CO4	Able to understand the impact of engineering solutions in sustainability contexts.	PO7					

CO5	Able to function effectively as an individual and a member or leader of team.	PO9
CO6	Able to communicate effectively about complex engineering activities with the engineering community and with society at large. Also, be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.	PO10
CO7	Able to estimate total cost of a project and design cost effective project.	PO11

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

11. Teaching- Learning Strategy

Activities		Engagement (hours)
4. Face-to-Face Learning	1.1 Discussion/ Presentation	42
	1.2 Model Preparation	42
	1.3 Student-Centered Learning	28
5. Self-Directed Learning	2.1 Non-face-to-face learning	56
	2.2 Preparation of Reports	28
	2.3 Preparation of Final report	42
6. Formal Assessment	3.1 Continuous Assessment	
	3.2 Final Presentation	1
		239

TEACHING METHODOLOGY
Discussion, physical model preparation/ Simulation, Data analysis, Cooperative and collaborative method

12. Course Schedule

Weeks	Tasks Capstone Project I (L4T1)	Assessment	Tasks Capstone Project II (L4T2)	Assessment
Week-1	Discussion (Topics): Supervisor and student	Presence	Sample/ Data collection	Report
Week-2	Discussion (Topics): Supervisor and student		Sample/ Data collection	
Week-3	Literature review: topics	Report	Discussion: Supervisor and student	Presentation Report
Week-4	Literature review: topics		Model preparation	Report
Week-5	Literature review: topic			
Week-6	Literature review: topics			
Week-7	Topic selection: Supervisor and student	Presentation		
Week-8	Discussion (Problem statement and research objective: Supervisor and student	Report		
Week-9	Literature review: Methodology	Report		
Week-10	Literature review: Methodology		Discussion on the model: Supervisor and student	Presentation
Week-11	Literature review: Methodology			
Week-12	Discussion (Methodology): Supervisor and student		Preparation of Write up	Report (Draft)
Week-13	Finalization of Methodology: Supervisor and student	Presentation		
Week-14	Report: Introduction, problem statement, necessary data type methodology, probable outcomes		Final Demonstration of the prepared model	

13. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Supervisor (70%)	1.1 Discussion/ communication	5%	CO1- CO7	A3- A5, P3- P7, C2, C3, C5, C6
	1.2 Model	45%		
	1.3 Report	20%		
4. Internal Examiner (30%)	2.4 Presentation	10%		
	2.5 Model	20%		
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Relevant subject materials.
2. Supplied material

CHAPTER 5

DEPARTMENTAL COURSES

5.2 Petroleum Engineering Courses

Sr No	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total	Page No
1	PME 121	Petroleum Engineering Thermodynamics	L1 T2	2	2	Cr Hr**43.5 and** ContHr**52.0**	94 – 98
2	PME 123	Reservoir Rock and Fluid Properties	L1 T2	3	3		99 – 104
3	PME 124	Reservoir Rock and Fluid Properties Laboratory	L1 T2	1.5	3		105 – 107
4	PME 222	Drilling Fluid Laboratory	L2 T1	1	2		108 – 110
5	PME 321	Well Logging and Formation Evaluation	L3 T1	3	3		111 – 114
6	PME 322	Well Logging and Formation Evaluation Laboratory	L3 T1	1.5	3		115 – 117
7	PME 323	Drilling Engineering	L3 T1	3	3		118 – 123
8	PME 324	Rig Floor Simulation Laboratory	L3 T1	1.5	3		124 – 126
9	PME 325	Petroleum Production Engineering	L3 T2	3	3		127 – 132
10	PME 327	Natural Gas Processing and LNG Technology	L3 T2	3	3		133 – 137
11	PME 328	Natural Gas Processing and LNG Laboratory	L3 T2	1.5	3		138 – 140
12	PME 329	Reservoir Engineering	L3 T2	3	3		141 – 147
13	PME 421	Well Test Analysis	L4 T1	3	3		148 – 152
14	PME 423	Reservoir Modeling and Simulation	L4 T1	3	3		153 – 158
15	PME 424	Reservoir Modeling and Simulation Sessional	L4 T1	1.5	3		159– 162
16	PME 425	Petroleum Refining and LPG Technology	L4 T1	3	3		163– 167
17	PME 427	Transmission and Distribution of Natural Gas	L4 T2	3	3		168 – 173
18	PME 429	Enhanced Oil Recovery Techniques	L4 T2	2	2		174 – 177

PME121	**Petroleum Engineering Thermodynamics**	
		2.00 Co Hr; 2.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. **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.

2. **Learning objectives (OB):**
   d) To describe thermodynamic properties of fluids.
   e) To analyze thermodynamic properties of fluids.
   f) To design the process of estimating thermodynamic properties of fluids.
   g) To operate the process of estimating thermodynamic properties of fluids.
   h) To employ in learning of the process of estimating thermodynamic properties of fluids in context of technological change.

3. **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, Indicated power, brake power and mechanical efficiency calculations, Fuel and combustion. **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. Study of compressor, condenser, expansion device and evaporator used in a refrigeration system. equations of state for realistic thermodynamics properties, departure functions, equilibrium and stability criteria, fugacity, and single component phase equilibrium (vaporization, melting,sublimation). Application in gas processing, petroleum refining, LPG, LNG, EOR.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of thermodynamic properties of fluids.	✓											
CO2	Analyze problems for operation and interpretation of thermodynamic properties of fluids.		✓										
CO3	Thermodynamics System design.			✓									

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of thermodynamic properties of fluids	PO1	C1	1 2 3	-	-	CT,MID,F Exam
CO2	Analyze problems in design, operation and interpretation of thermodynamic properties of fluids	PO2	C1,C2,C3	1 2 3	1	1	CT,MID,F Exam
CO3	Thermodynamics system design.	PO3	C2,C3	5	1	1	CT,MID,F Exam

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
4. Face-to-Face Learning		
	1.1 Lecture	28
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
5. Self-Directed Learning		
	2.1 Non-face-to-face learning	28
	2.2 Revision of lecture at home	14
	2.3 Preparation for final examination	14
6. Formal Assessment		

	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		89

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
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. Polytrophic and isentropic processes; Thermodynamic equilibrium; Zeroth law of thermodynamics.	
Week-2		
Lecture-3	**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.	
Lecture-4	Application of the first law to some common closed system processes.	
Week-3		
Lecture-5	The first law as applied to open system, steady flow energy equation.	
Lecture-6	applications of the steady flow energy equation.	
Week-4		
Lecture-7	**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.	
Lecture-8	triple point and critical point.	
Week-5		CT-2
Lecture-9	tables of thermodynamic properties of steam, Mollier Diagram., EOS	
Lecture-10	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.	
Week-6		
Lecture-11	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-12	Thermodynamics temperature scale; Entropy, Temperature-entropy diagrams for gases and vapors.	
Week-7		
Lecture-13	Entropy changes for a perfect gas undergoing various reversible processes, Perfect Gas: Equation of state of a perfect gas;	

	Internal energy.	
Lecture-14	enthalpy and specific heat capacities of a perfect gas.	
Week-8		
Lecture-15	Coefficient of volume expansion and isothermal compressibility for a perfect gas.	
Lecture-16	Various reversible processes undergone by a perfect gas; Perfect gas mixtures, Gibbs-Dalton law; Relations involving pressure.	
Week-9		CT-3/MID
Lecture-17	Volume and composition, internal energy, enthalpy and specific heats of mixtures.	
Lecture-18	**Internal Combustion Engines**: Introduction of petrol and diesel engines, Fuel and combustion	
Week-10		
Lecture-19	Indicated power, brake power and mechanical efficiency calculations, Air standard Otto and Diesel cycles; p-v and T-s diagrams of cycles.	
Lecture-20	**Vapor Power Cycles**: Vapor power cycle, calculations of cycle efficiency.	
Week-11		
Lecture-21	**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-22	**Vapor Compression Refrigeration Systems**: Actual cycle and its analysis. Study of compressor, condenser, expansion device and evaporator used in a refrigeration system.	
Week-12		
Lecture-23	**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-24	Applications of the First and Second Laws of Thermodynamics with strong emphasis on material, Energy balance equations analysis, energy and entropy balances to solve engineering problems involving pure components	
Week-13		CT-4
Lecture-25	Cycles (Rankine, Brayton, refrigeration, etc.) analysis, equations of state for realistic thermodynamicproperties, departure functions	
Lecture-26	component phase equilibrium (vaporization, melting,sublimation).	
Week-14		
Lecture-27 Lecture-28	Application in gas processing, petroleum refining, LPG, LNG, EOR.	

8. Assessment Method

Components	Grading	Course Outcome (CO)	Blooms Taxonomy

3. Continuous Assessment (40%)	1.1 Class Participation	10%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO2,CO3	C1, C2
	1.3 Mid term	10%	CO1,CO2	C2, C3
4. Final Exam (60%)		60%	CO1, CO2	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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 123	Reservoir Rock and Fluid Properties	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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, fluid saturation, relative permeability, capillary pressure & wettability of the rock and then the initial hydrocarbon in place using volumetric method. In addition, establish various petrophysical relations and relevant equations.

2. Learning objectives (OB):

1. To describe reservoir fluid and petrophysical properties of formation.
2. To analyze reservoir core, fluid and well logs for estimation of petrophysical properties of formation.
3. To design the core analysis, reservoir fluid, well log operation and formation evaluation process.

3. Course Contents:

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

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

Core Photography: Principles, test procedures, application & interpretation.

Electrical Resistivity Analysis of Core: Electrical resistivity properties & measurements in porous media are presented through different examples using various measurement techniques and effects on different media on it.

Relative Permeability: Basic concepts, Oil-water system; Oil-gas system; Water-gas system; Saturation function. Relative permeability measurements to two or three phases.Imbibition & drainage process.

Capillary Pressure & Wettability: 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 omit; Saturation-height functions; Surface phenomena, capillarity, wettability, and omit; The competition between capillary & gravity forces; Relationships between initial & residual saturations; Interpretation of single & multiple pore system rocks; omit; Capillary pressure vs. NMR; Seal capacity.

Rock Compressibility: Some basic aspects of rock compressibility related to reservoir rock & fluids. The examples are related to the behaviour of porous reservoir rocks & core samples under lab conditions.Rock Compaction Function-Newman correlation, Hall correlation, Knaap correlation.

Statistical Core Analysis Techniques: Core analyses in statistics, explains about hydraulic units, global hydraulic elements, the key geostatistical concept &measure of reservoir heterogeneity and their applications, quantitative&statistical analyses and their graphical representation in histograms, the two main petrophysical parameters viz, porosity & permeability frequency distribution.

Overview of Reservoir Fluid Properties: Compositional analysis, volumetric phase behavior properties, production simulation between reservoir & surface facilities.

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 (EOS) 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; Multi-stage Separator Test; Constant Composition Expansion (CCE); Bubble Point Estimation; Differential Liberation Expansion (DLE); Constant Volume Depletion (CVD); 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 & Correlations; EOS Predictions; Hydrates.

Preparation for Reservoir Engineering & Simulation Studies:Fundamentals of hydrocarbon phase behavior: single, two & multi-component systems, classification of reservoirs & fluids, location of gas-oil contact; Characterizing hydrocarbon-plus fractions: generalized correlations, Natural gas properties: behavior and properties of ideal & real gases, wet gases and their behavior, analysis of gas condensate behavior; PVT properties of crude oils: crude oil properties, surface & 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 & depth; EOS and phase equilibria. Application of reservoir fluid modeling.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of core analysis, reservoir fluid, well logging & formation evaluation	✓											
CO2	Analyze problems in design, operation and interpretation of core analysis, reservoir fluid, well logging and formation evaluation		✓										

CO3	Investigate problems in core analysis, reservoir fluid, well logging and formation evaluation operation	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Bloom's Taxonomy	KP (WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of core analysis, reservoir fluid, well logging and formation evaluation	PO1	C1, C2, C3	1 2 3			CT, FExam
CO2	Analyze problems in design, operation and interpretation of core analysis, reservoir fluid, well logging and formation evaluation	PO2	C4	4	2	1	MID, FExam
CO3	Investigate problems in core analysis, reservoir fluid, well logging and formation evaluation operation	PO4	C4, C5	4 5 6	4	2 3	FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
1.Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2.Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	3.3 Preparation for final examination	21
3.Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
Week-1		CT-1
Lecture-1	Overview of Reservoir Rock Properties: Porosity, permeability, fluid saturation.	
Lecture-2	Core resistivity, compressibility, relative permeability, capillary pressure and wettability.	
Lecture-3	Coring and Core Analysis:Coring & core analysis objectives; Coring hardware & maximizing core recovery; Core-handling, wellsite procedures, and preservation methods; Sidewall coring & analysis.	
Week-2		
Lecture-4	Organizing effective laboratory programs; Porosity, permeability & 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 & electrical properties), an introduction to rock mechanics.	
Week-3		
Lecture-7	Core Photography: Principles, test procedures, application & interpretation.	
Lecture-8	Relative permeability, capillary pressure & wettability of rocks, and reservoir fluid distribution; Data integration in reservoir simulation; Design of coring & core analysis program; NMR Core Analysis.	
Lecture-9	Electrical Resistivity Analysis of Core: Electrical resistivity properties & measurements in porous media are presented through different examples using various measurement techniques and effects on different media on it.	
Week-4		
Lecture-10	Capillary Pressure & Wettability:Capillary pressure applications in reservoir characterization; Rock properties from mercury/air capillary pressures.	
Lecture-11	Relationships between initial & residual saturations.	
Lecture-12	Capillary pressure data representativeness; Capillary forces in reservoir rocks, their measurement.	
Week-5		CT-2
Lecture-13	Capillary pressure data fitting methods; Representing a large number of capillary curves (averaging).	
Lecture-14	Permeability from capillary pressure curves and omit; Saturation-height functions; Surface phenomena, capillarity.	
Lecture-15	Wettability & IFT; The competition between capillary & gravity forces. Relationships between initial & residual saturations.	
Week-6		
Lecture-16	Interpretation of single & multiple pore system rocks; omit; Capillary pressure vs. NMR ; Seal capacity.	

<table>
<tr><td>Lecture-17</td><td>Relative Permeability:Imbibition and drainage process; Oil-water system; Oil-Gas system.</td><td rowspan="13"></td></tr>
<tr><td>Lecture-18</td><td>Water-Gas system; omit, Stone model; Saturation function.</td></tr>
<tr><td>Week-7</td><td></td></tr>
<tr><td>Lecture-19</td><td>Rock Compressibility: Some basic aspects of rock compressibility related to reservoir rock & fluids. The examples are related to the behaviour of porous reservoir rocks & core samples under lab conditions. Rock Compaction Function- Newman correlation, Hall correlation, Knaap correlation.</td></tr>
<tr><td>Lecture-20</td><td>Statistical Core Analysis Techniques: Core analyses in statistics, explains about hydraulic units, global hydraulic elements, the key geostatistical concept & measure of reservoir heterogeneity and their applications, quantitative & statistical analyses and their graphical representation in histograms, the two main petrophysical parameters viz, porosity & permeability frequency distribution.</td></tr>
<tr><td>Lecture-21</td><td>Overview of Reservoir Fluid Properties: Compositional analysis, volumetric phase behavior properties, production simulation between reservoir & surface facilities.</td></tr>
<tr><td>Week-8</td><td></td></tr>
<tr><td>Lecture-22</td><td>Volumetric and Phase Behavior of Oil and Gas Systems:Reservoir-Fluid Composition.</td></tr>
<tr><td>Lecture-23</td><td>Phase Diagrams for Simple Systems; Retrograde Condensation; Classification of Oilfield Systems.</td></tr>
<tr><td>Lecture-24</td><td>Gas & Oil Properties and Correlations:Properties, Nomenclature, and Units; Gas Mixtures; Oil Mixtures.</td></tr>
<tr><td>Week-9</td><td></td><td rowspan="17">CT-3/MID</td></tr>
<tr><td>Lecture-25</td><td>IFT and Diffusion Coefficients; K-Value Correlations.</td></tr>
<tr><td>Lecture-26</td><td>Equation-of-State Calculations:Cubic EOS’s; Two-Phase Flash Calculation; Phase Stability.</td></tr>
<tr><td>Lecture-27</td><td>Saturation-Pressure Calculation; Equilibrium in a Gravity Field, Compositional Gradients; Matching an EOS to Measured Data.</td></tr>
<tr><td>Week-10</td><td></td></tr>
<tr><td>Lecture-28</td><td>Heptanes-Plus Characterization: Experimental Analyses.</td></tr>
<tr><td>Lecture-29</td><td>Molar Distribution; Inspection-Properties Estimation; Critical-Properties Estimation.</td></tr>
<tr><td>Lecture-30</td><td>Recommended C7 Characterizations.</td></tr>
<tr><td>Week-11</td><td></td></tr>
<tr><td>Lecture-31</td><td>Grouping and Averaging Properties.</td></tr>
<tr><td>Lecture-32</td><td>Conventional PVT Measurements:Wellstream Compositions; Multistage-Separator Test.</td></tr>
<tr><td>Lecture-33</td><td>CCE; Bubble Point Estimation.</td></tr>
<tr><td>Week-12</td><td></td></tr>
<tr><td>Lecture-34</td><td>DLE; CVD; Due Point Estimation; Composition variation with depth.</td></tr>
<tr><td>Lecture-35</td><td>Black-Oil PVT Formulations:Traditional Black-Oil Formulation: MBO Formulation.</td></tr>
</table>

Lecture-36	Applications of MBO Formulation; Partial-Density Formulation; Modifications for Gas Injection.	
Week-13		CT-4
Lecture-37	Water/Hydrocarbon Systems: Properties and Correlations; EOS Predictions; Hydrates.	
Lecture-38	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.	
Lecture-39	Natural gas properties: behavior and properties of ideal and real gases, wet gases and their behavior, analysis of gas condensate behavior.	
Week-14		
Lecture-40	PVT properties of crude oils: crude oil properties, surface and interfacial tension, properties of reservoir water, understanding laboratory data, CCE test, DL 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.	

8. Assessment Method

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1.Continuous Assessment (40%)	1.1 Class Participation	10%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3, C4
	1.3 Mid term	10%	CO1,CO2,CO3	C1, C2, C3
2.Final Exam (60%)		60%	CO1, CO2, CO3, CO4,CO5,CO6,CO7	C1, C2, C3, C5
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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

PME 124	**Reservoir Rock and Fluid Properties Laboratory**	
		3.00 Co Hr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

1. To describe reservoir cores, fluids and petrophysical properties of formation.
2. To analyze reservoir cores, fluids and well logs for estimation of petrophysical properties of formation.
3. To operate core analysis, reservoir fluid and well log operation in both cased & open hole.

3. Course Contents:

Preparation of Reservoir Fluid Sample and Determine composition of reservoir fluid sample by Gas Chromatograph. Perform PVT analysis (CCE, BP, DLE) for reservoir oil sample. Perform PVT analysis (CCE, DP, CVD) for reservoir gas sample.Perform PVT analysis (CCE, DP, CVD) for reservoir gas condensate sample.Perform multistage separator test for reservoir oil sample.Preparation of core sample by Cutting, Plugging & Trimming.Measurement of porosity in the core sample.Measurement of permeability in the core sample.Measurement of capillary pressure in the core sample.Measurement of relative permeability in the core sample.Determination of wettability and interfacial tension.Processing of core analysis data for reservoir modeling.

4. Course Outcomes (CO) and Skill Mapping

COs		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of drilling fluid	✓											
CO2	Analyze the properties of Reservoir rock and fluid					✓							
CO3	Compare the PVT analysis of various reservoir fluid									✓			

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of well drilling	PO1	C1, C2, C3	1 2 3			Mid Quiz, FQuiz
CO2	Analyze the	PO5	C4	4	2	1	Mid Quiz,

	properties of reservoir rock fluid						FQuiz
CO3	Compare the PVT analysis of various reservoir fluid	PO9	C4, C5, C6	4 5 6	345	123	ASG, FQuiz

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Assig**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	14
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
2. Self-Directed Learning	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
3. Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		75

TEACHING METHODOLOGY
Lecture, Numerical Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture Schedule:

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

8. Assessment Strategy

<table>
<tr><th colspan="2">Components</th><th>Grading</th><th>Course Outcome (CO)</th><th>Blooms Taxonomy</th></tr>
<tr><td rowspan="4">1. Continuous Assessment (75%)</td><td>1.1 Lab Participation</td><td>5%</td><td></td><td>A1, A2</td></tr>
<tr><td>1.2 Repot</td><td>15%</td><td>CO1, CO3</td><td>C2, C3, C4P1, P2, P3</td></tr>
<tr><td>1.3Assignment</td><td>30%</td><td rowspan="2">CO3</td><td rowspan="2">C3, C4, C5, A3, A4, A5, P4, P5, P6</td></tr>
<tr><td>1.4 Presentation</td><td>25%</td></tr>
<tr><td>2. Lab quiz (25%)</td><td></td><td>25%</td><td>CO1,CO2</td><td>C1, C2</td></tr>
<tr><td></td><td></td><td>100%</td><td></td><td></td></tr>
</table>

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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

PME 222	**Drilling Fluid Laboratory**	
		3.00 Co Hr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. 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

2. Learning objectives (OB):

1. To describe drilling process.
2. To describe drilling fluid preparation.
3. To analyze drilling fluid properties.

3. Course Contents:

Preparation of Drilling Fluid by Blender and Determination of mud density by Mud Balances. Determination of mud viscosity by Marsh Funnel Viscometer. Determination of mud viscosity by Rheometer. Determination of mud P^H by P^H meters. Determination of mud Resistivity by Resistivity Meters. Determination of mud filtration tendency by Filter Press unit, Analyzing drilling fluid Properties by using machine learning.

4. Course Outcomes (CO) and Skill Mapping

COs		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of drilling fluid	✓											
CO2	Analyze the properties of drilling fluid					✓							
CO3	Explain the impacts of drilling fluid properties in drilling.									✓			

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of well drilling	PO1	C1, C2, C3	1 2 3	-	-	Mid Quiz, FQuiz
CO2	Analyze the properties of drilling fluid	PO5	C4	4	2	1	Mid Quiz, FQuiz
CO3	Explain the impacts of drilling fluid properties in drilling.	PO9	C4, C5, C6	4 5 6	345	123	ASG, FQuiz

__CP__- __C__omplex __P__roblem/ __WP__- __W__ashington Accord Complex __P__roblem Solving; __CA__- __C__omplex __A__ctivities/ __EA__- __E__ngineering __A__ctivities; __KP__- __K__nowledge __P__rofile/ __WK__- __W__ashington Accord __K__nowledge Profile.

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ignment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
4. Face-to-Face Learning	1.1 Lecture	14
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
5. Self-Directed Learning	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
6. Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		75

TEACHING METHODOLOGY
Lecture, Numerical Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

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

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (75%)	1.1 Lab Participation	5%		A1, A2
	1.2 Repot	15%	CO1, CO3	C2, C3, C4P1, P2, P3
	1.3Assignment 1.4 Presentation	30% 25%	CO3	C3, C4, C5, A3, A4, A5, P4, P5, P6
4. Lab quiz (25%)		25%	CO1,CO2	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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 321	**Well Logging and Formation Evaluation**	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

1. To describe petrophysical properties of formation
2. To analyze well logs for estimation of petrophysical properties of formation
3. To apply petrophysical code and standards in well logging design and operation

Course Contents:

Wireline Well Logging: Wireline well logging process, tools, sensors, Open-hole wireline logging; Cased-hole wireline logging. **Logging environment:** Geological Environment; Lithology, Reservoir Rocks. Borehole environment; Borehole condition, Invasionand Resistivity Profiles. **The Spontaneous Potential Log:** Basic principle, Application, Determination of formation water resistivity and shale volume. **Resistivity Logs:** Induction electrical log, Dual induction focused log, Laterolog, Dual Laterolog-Microspherically Focused Log, Microlog, Microlaterolog and Proximity log, Resistivity derived porosity. **Porosity logs:** Sonic log, Density log, Neutron log, Combination of Neutron-Density log. **Gamma Ray Log:** Basic principles, limitation, application,Shale volume calculation. **Caliper Log:** Basic principle, application, uncertainties. **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 ; Log Quality Control; Working with NMR data (various exercises throughout the course).**Production and special type of logging:** Mud Logging; Borehole Images. **Log interpretation and analysis Techniques:** a) Conventional interpretation techniques, Reconnaissance Technique, Archie Water Saturations, Quick-look Methods, Bulk Volume Water, Saturation Crossplots, Permeability from Logs. b) Cross-plotting methods: Pickett plot, Neutron-Density, Sonic-Density and sonic-Neutron, M-N and MID lithology Plot etc. c) Interpretation of shaly sand, clean sand formation and gas bearing formation.

4. Course Outcomes (CO) and Skill Mapping

COs		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of well-logging and formation evaluation	✓											
CO2	Analyze log data to estimate rock properties and probable formation	✓											

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)	POs	Bloom's Taxonomy	KP (WK)	CP (WP)	CA (EA)	Assessment Methods

CO1	Recognize the main terminology, concepts and techniques of well logging and formation evaluation	PO1	C1, C2, C3	1	-	-	CT, FExam
CO2	Analyze log data to estimate rock properties and probable formation	PO1	C3	1,2	-	-	CT, FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**i**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
Week-1	**Wireline Well Logging:**	CT-1
Lecture-1	Wireline well logging process, tools, sensors,	
Lecture-2	Open-hole wireline logging; Cased-hole wireline logging.	
Lecture-3		
Week-2	**Logging environment:**	
Lecture-4	Geological Environment.	
Lecture-5	Lithology, Reservoir Rocks.	
Lecture-6		
Week-3	**Logging environment:**	
Lecture-7	Borehole environment; Borehole condition.	
Lecture-8	Invasionand Resistivity Profiles.	
Lecture-9		
Week-4	**The Spontaneous Potential Log:**	
Lecture-10	Basic principle, Application.	

Lecture-11	Determination of formation water resistivity and shale volume.	
Lecture-12		
Week-5	**Resistivity Logs:**	
Lecture-13	Induction electrical log, Dual induction focused log.	
Lecture-14	Laterolog, Dual Laterolog- Microspherically Focused Log, Microlog.	
Lecture-15	Microlaterolog and Proximity log, Resistivity derived porosity.	
Week-6	**Porosity logs:**	CT-2
Lecture-16	Sonic log, Density log.	
Lecture-17	Neutron log, Combination of Neutron-Density log.	
Lecture-18		
Week-7	**Gamma Ray Log:**	
Lecture-19	Basic principles, limitation,	
Lecture-20	Application,Shale volume calculation.	
Lecture-21		
Week-8	**Nuclear Magnetic Resonance (NMR):**	
Lecture-22	Basics of NMR technology ; Rock typing from NMR core data and its relationship to logs.	
Lecture-23	Pore geometry and what it means for the interpretation of NMR data ; NMR logs.	
Lecture-24	Log Quality Control; Working with NMR data (various exercises throughout the course).	
Week-9	**Production and special type of logging:**	
Lecture-25	Mud Logging.	
Lecture-26		
Lecture-27	Borehole Images.	
Week-10	**Log interpretation and analysis Techniques:**	CT-3/MID
Lecture-28	Conventional interpretation techniques, Reconnaissance Technique,	
Lecture-29	Archie Water Saturations, Quick-look Methods, Bulk Volume Water.	
Lecture-30	Saturation Crossplots, Permeability From Logs.	
Week-11	**Log interpretation and analysis Techniques:**	
Lecture-31	Cross-plotting methods: Pickett plot, Neutron-Density.	
Lecture-32	Sonic-Density and sonic-Neutron.	
Lecture-33	M-N and MID lithology Plot etc.	
Week-12	**Log interpretation and analysis Techniques:**	
Lecture-34	Interpretation of shaly sand, clean sand formation and gas bearing formation.	
Lecture-35		
Lecture-36		
Week-13	**Caliper Log:**	
Lecture-37	Basic principle, application, uncertainties.	
Lecture-38		
Lecture-39		
Week-14	**Review**	

Lecture-40 Lecture-41 Lecture-42	Review topics	

8. Assessment Method

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1. Continuous Assessment (40%)	1.1 Class Participation	10%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3, C4
	1.3 Mid term	10%	CO2	C1, C2, C3
2. Final Exam (60%)		60%	CO1, CO2	C1, C2, C3, C5
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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 322	Well Logging and Formation EvaluationLaboratory
	3.00 Co Hr; 1.50 Cr Hr
Pre-requisite: None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

Well logging, also known as borehole logging, is the practice of making a detailed record of awell. A log of the natural radioactivity of the formation along the borehole, measured in APIunits. Although there are now developed some memory "Open Hole" compact formationevaluation tool combinations. This laboratory’s aim is to train students in well logging operations and formation evaluation with the help of software and modern technology.

2. Learning Objectives (OB)

1. To design the well log operation and formation evaluation process.
2. To operate well log operation in cased hole and open hole.
3. To practice well logging tools and well logs interpretation software.
4. To apply petrophysical code and standards in well logging design and operation.
5. To learn about the modern tools and up-to-date technologies in well logging and formation evaluation.
6. To employ in learning of petrophysics in context of technological change.

3. Course Contents

Introduction of well logging equipment and recording devices and theirworking principle; Demonstration of data acquisition, processing and interpretation of Spontaneous Potential log, Resistivity and Induction log, Gamma Ray log, Porosity log, Nuclear Magnetic Resonance log, Caliper log, Acoustic log, Sonic log, Density log; Estimation of formation porosity, permeability and shale content; Machine learning in well logging.

4. Course Outcome (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Design well logging and formation evaluation operation and interpretation			✓									
CO2	Investigate problems in well logging and formation evaluation operation				✓								
CO3	Understand the Application of software and modern tools in well logging and formation evaluation					✓							

5. Mapping of Course Outcomes(COs) and General Skills

Course Outcomes(COs)	POs	Blooms	CP	CA	KP	Assessment

			Taxonomy	(WP)	(EA)	(WK)	Methods
CO1	Design well logging and formation evaluation operation and interpretation	PO3	C2 A1	1	-	2,3,5	MID,Q
CO2	Investigate problems in well logging and formation evaluation operation	PO4	C3 A2	3	-	5,6	MID,Q
CO3	Understande the Application of software and modern tools in well logging and formation evaluation	PO5	C3	7	5	5,6	Proj, ASG

***CP-C**omplex**P**roblem/**WP-W**ashingtonAccordComplex**P**roblemSolving;**CA-C**omplex**A**ctivities/**EA-E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam, **CS**- Case Study.

6. Teaching Learning Strategy

Activities		**Engagement (Hours)**
1. Face to Face Learning	1.1 Lecture	14
	1.2 Practical/Tutorial	21
	1.3 Student Centered Learning	7
2. Self-Directed Learning	2.1 Lab report	14
	2.2 Quiz	4
	2.3 Preparations: Assignment, Quiz	7
3. Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		75

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method,
Problem Based Learning.

7. Teaching Schedule

Lecture	Lecture Topic
Week 1	Introduction of well logging equipment and recording devices and theirworking principle
Week 2	Introduction of well logging equipment and recording devices and theirworking principle
Week 3	Demonstration of data acquisition, processing and interpretation of Spontaneous Potential log, Resistivity and Induction log
Week 4	Demonstration of data acquisition, processing and interpretation of

	Gamma Ray log
Week 5	Demonstration of data acquisition, processing and interpretation of Porosity log, Nuclear Magnetic Resonance log, Caliper log
Week 6	Demonstration of data acquisition, processing and interpretation of Acoustic log, Sonic log, Density log
Week 7	**Mid Quiz**
Week 8	Estimation of formation porosity
Week 9	Estimation of formation permeability
Week 10	Estimation of formation shale content
Week 11	Machine learning in well logging
Week 12	Machine learning in well logging
Week 13	**Presentation/Project Work**
Week 14	**Final Quiz**

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (75%)	1.1 Lab Participation and Report	20%	CO1, CO2	C2, C3,A1,A2
	1.2 Assignment	30%	CO1, CO2, CO3	C2, C3,A1,A2
	1.3 Presentation	25%		
2. Lab Quiz (25%)		25%	CO1, CO2	C2, C3,A1,A2
		100%		

__C__: Cognitive domain; __A__: Affective domain; __P__: Psychomotor domain

9. Materials Recommended

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 323	**Drilling Engineering**	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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

2. Learning objectives (OB):
1. To describe the drilling process
2. To understand drilling systems and the components of the drilling process
3. To analyze the drilling operation
4. To investigate the problems of drilling operations in onshore and offshore fields

3. 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**. 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 in fluxing pore fluid; Hydraulic friction during killing; Killing using 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.
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; Wellhead equipment.
Stuck Pipe Prevention: Stuck pipe prevention; 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 well site activities; Enhance knowledge of organizational learning systems and transfer lessons learned; Perform technical limit analysis to improve well site 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.

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.

Optimized Pressure Drilling: Managed Pressure Drilling; Rotating Control Devices; Underbalanced Applications.

Optimization: Drilling Optimization; Drill Bit Optimization; Fluids Optimization. Introduction of Machine learning in ROP optimization.

Special Topics: Advanced Well Control topics causes of kicks, kick detection, shut-in procedures, Underbalanced Drilling, Introduction to UBD, UBD techniques, benefits of UBD equipment, Selecting an appropriate candidate, and UBD well engineering; HPHT.

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.

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.

4. Course Outcomes (CO) and Skill Mapping

COs		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of well drilling	✓											
CO2	Analyze problems in design, operation and interpretation of well drilling		✓										
CO3	Apply the fundamentals to design the well drilling operation		✓										

CO4	Investigate problems in well drilling operation	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Bloom's Taxonomy	KP (WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of well drilling	PO1	C3	2 3		-	CT, MID, FExam
CO2	Analyze problems in design, operation and interpretation of well drilling	PO2	C3,C4	3 4	1	-	CT, MID, FExam
CO3	Apply the fundamentals to design the well drilling operation	PO2	C4	3 4	1	-	CT, MID, Assignmen t . FExam
CO4	Investigate problems in well drilling operation	PO4	C3, C4	3 4	1	-	MID, Assignmen t .

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
1. Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	**Lecture Topic**	Assessments
Week 1	**Drilling Overview**	
Lecture-1	Rig systems; Hydrostatics; Drill string; Casing; Drilling hydraulics; Cementing; Well control; Pore pressure and fracture gradient; Drill bits; Well planning**.**	CT-1/ Assignment
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**.**	
Lecture-3		
Week 2	**Keeping Wellbore within Maximum and Minimum Pressure; ECD-Control**	
Lecture-4	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).	
Lecture-5		
Lecture-6		
Week 3	**Standard Killing Methods**	
Lecture-7	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 in fluxing pore fluid; Hydraulic friction during killing; Killing using 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		
Lecture-9		
Week 4	**Drill String Vibration and Mitigation**	
Lecture-10	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-11		
Lecture-12		
Week 5	**Casing and Cementing**	
Lecture-13	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; Wellhead equipment.	CT-2 /Assignment
Lecture-14		
Lecture-15		
Week 6	**Drill String Design and Optimization**	
Lecture-16	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	
Lecture-17		
Lecture-18		

	sensors, Vibration operating limit tables.	
Week 7	**Directional, Horizontal, and Multilateral Drilling**	
Lecture-19 Lecture-20 Lecture-21	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.	
Week 8	**Managing Wellsite Operations**	
Lecture-22 Lecture-23 Lecture-24	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;	Mid Term/ Assignment
Week 9	**Planning of Design Operation**	
Lecture-25 Lecture-26 Lecture-27	Dissect the drilling plan and apply total task analysis to well site activities; Enhance knowledge of organizational learning systems and transfer lessons learned; Perform technical limit analysis to improve well site 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.	
Week 10	**Drilling Practices**	
Lecture-28 Lecture-29 Lecture-30	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.	
Week 11	**Optimization of drilling Components**	
Lecture-31	**Optimized Pressure Drilling:** Managed Pressure Drilling; Rotating Control Devices; Underbalanced Applications.	
Lecture-32 Lecture-33	**Optimization**: Drilling Optimization; Drill Bit Optimization; Fluids Optimization. Introduction of Machine learning in ROP optimization.	
Week 12	**Special Topics**	
Lecture-34 Lecture-35 Lecture-36	Advanced Well Control topics causes of kicks, kick detection, shut-in procedures, Underbalanced Drilling, Introduction to UBD, UBD techniques, benefits of UBD equipment, Selecting an appropriate candidate, and UBD well engineering; HPHT.	CT-3 / Assignment

Week 13	**Survey Management**	
Lecture-37	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.	
Lecture-38		
Lecture-39		
Week 14	**Special Offshore Safety Issues**	
Lecture-40	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-41		
Lecture-42		

9. Materials Recommended

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 324	Rig Floor Simulation Laboratory
	3.00 Co Hr; 1.50 Cr Hr
Pre-requisite: None	**Curriculum structure:** Outcome Based Education (OBE)

10. Rationale

Drilling engineering is a subset of petroleum engineering. Drilling engineers design andimplement procedures to drill wells as safely and economically as possible. They workclosely with the drilling contractor, service contractors, and compliance personnel, as well aswith geologists and other technical specialists. Rig floor simulation helps drilling professionals to conduct the drilling operation in a safe and optimized way.

11. Learning Objectives (OB)

a. To design the drilling operation.
b. To operate drilling operation in onshore and offshore fields.
c. To know about drilling tools and drilling design software
d. To apply Drilling codes and standards
e. To employ in learning of well drilling in context of technological change

12. Course Contents

Onshore drilling: Perform well killing operation by volumetric method, driller’s method, wait and weight method; concurrent method; Case Study.
Offshore drilling: Perform well killing operation by volumetric method, driller’s method, wait and weight method; concurrent method; Case Study.
Casing design and problem related to casing design; Cementation for borehole stability.

13. Course Outcome(CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Design drilling operations for oil and gas fields			✓									
CO2	Investigate problems in drilling operations of oil and gas fields				✓								
CO3	Learn the Application of software and modern tools in drilling operations					✓							

14. Mapping of Course Outcomes(COs) and General Skills

Course Outcomes(COs)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Design drilling operations for oil and gas fields	PO3	C2 A1	1	-	2,3,5	MID,Q
CO2	Investigate problems in drilling operations of oil	PO4	C3 A2	3	-	5,6	MID,Q

	and gas fields						
CO3	Learn the Application of software and modern tools in drilling operations	PO5	C3	7	5	5,6	Proj, ASG

***CP-C**omplex**P**roblem/**WP-W**ashingtonAccordComplex**P**roblemSolving;**CA-C**omplex**A**ctivities/**EA-E**ngineering **A**ctivities; **KP- K**nowledge **P**rofile/ **WK- W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Midt**erm exam, **CS**- Case Study.

15. Teaching Learning Strategy

Activities		Engagement (Hours)
4. Face to Face Learning	1.1 Lecture	14
	1.2 Practical/Tutorial	21
	1.3 Student Centered Learning	7
5. Self-Directed Learning	2.1 Lab report	14
	2.2 Quiz	4
	2.3 Preparations: Assignment, Quiz	7
6. Formal Assessment	6.1 Continuous Assessment	7
	6.2 Presentation	1
		75

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Learning.

16. Teaching Schedule

Lecture	Lecture Topic
Week 1	Introduction
Week 2	Perform well killing operation by volumetric method, driller’s method(Onshore drilling)
Week 3	Perform well killing operation by wait and weight method; concurrent method(Onshore Drilling)
Week 4	Case Study.
Week 5	Case Study.
Week 6	Cementation for wellbore stability
Week 7	**Mid Quiz**
Week 8	Perform well killing operation by wait and weight method, concurrent method(Offshore Drilling)
Week 9	Perform well killing operation by volumetric method, driller’s method (Offshore Drilling)

Week 10	Case Study.
Week 11	Casing design & problems regarding casing design
Week 12	Casing design & problems regarding casing design
Week 13	**Presentation/Project Work**
Week 14	**Final Quiz**

17. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (75%)	1.1 Lab Participation and Report	20%	CO1,CO2	C2,C3,A1,A2
	1.2 Assignment	30%	CO1,CO2,CO3	C2,C3,A1,A2
	1.3 Presentation	25%		
4. Lab Quiz (25%)		25%	CO1,CO2	C2,C3,A1,A2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Psychomotor domain*

18. Materials Recommended

a. Fundamentals of Drilling Engineering by Robert F. Mitchell and Stefan Z. Miska.
b. Applied Drilling Engineering by T. Bourgoyne Jr, K.K. Millheim, M.E. Chenevert &F.S. Young Jr.
c. Managed Pressure Drilling by Barkim Demirdal.
d. Advanced Drilling and Well Technology by Bernt Aadnoy, Iain Cooper, StefanMiska, Robert F. Mitchell, and Michael L. Payne.
e. Advanced Well Control by David Watson, Terry Brittenham and Preston L. Moore

PME 325	Petroleum Production Engineering	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

1.To describe petroleum production process and operation.

2. To analyze petroleum production process and operation.

3. To investigate the different problems in petroleum production process and operation.

4. To employ in learning of petroleum production process and operation in context of technological change.

3. 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. 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,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**. Well Stimulation:** 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 ;**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 ; Gravel pack performance ; Horizontal well completions. **Water Technology in Oil and Gas Production:** 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, Water injection and disposal systems.**Troubleshooting Oil and Gas Processing Facilities:** 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.Well completion complexity, **Workovers techniques:** Stimulation application, surfactants, solvents, acidizing, fracturing &deep perforating; Formation & sand control, screens, chemical consolidation, gravel packing, frac-pack, new & novel techniques .

4. Course Outcomes (CO) and Skill Mapping

CO-PO MAPPING													
COs		PROGRAM OUTCOMES (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Recognize the main terminology, concepts and techniques of petroleum production process and operation.	√											
CO2	Analyze problems in design, operation and interpretation of petroleum production process and operation.		√										
CO3	Apply the fundamentals to design the petroleum production process and operation		√										
CO4	Investigate problems in petroleum production process and operation				√								

5.Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and	PO1	C3	2 3		-	CT, MID, FExam

	techniques of petroleum production process and operation						
CO2	Analyze problems in design, operation and interpretation of petroleum production process and operation	PO2	C3,C4	3 4	1	-	CT, MID, FExam
CO3	Apply the fundamentals to design the petroleum production process and operation	PO2	C4	3 4	1	-	CT, MID, Assignmen t . FExam
CO4	Investigate problems in petroleum production process and operation	PO4	C3, C4	3 4	1	-	MID, Assignmen t .

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Weeks	Topics	Remarks
Week 1	**Overview of Production system**	
1	**Production System:** Introduction to petroleum production system**;** Overview of surface and subsurface equipment, tools, devices.	CT-1/ Assignment
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.	
3		
Week 2	**Overview of artificial lift system**	
4	**Artificial Lift Systems:** Overview of artificial lift technology; Criteria for selection of artificial lift system; Reservoir performance: .	
5		
6	Inflow and outflow relationships; Artificial lift screening.	
Week 3	**Production Modeling and Optimization**	
7	Review of reservoir inflow characterization and modeling tools.	
8	Inflow performance relationships, numerical vs. analytical modeling, steady-state, pseudo steady-state and transient reservoir flow, Review of multiphase flow modeling in wellbores,steady-state flow models vs. transient flow models.	
9	Tuning of multiphase flow models, Flow assurance issues (i.e. hydrates, asphaltenes, waxes, scales)	
Week 4	**Production optimization techniques**	
10	Production optimization techniques and solutions to boost oil production**.**	
11		
12		
Week 5	**Formation damage and their solution**	
13	Formation damage, Non-acid damage removal techniques.	CT-2 /Assignment
14	Acidizing, Objectives, types, additives , Acidizing placement techniques and the pressure chart , Quality control and safety	
15	Hydraulic fracturing materials and their importance to success, including gel and slick water treatments	
Week 6	**Multiphase flow analysis**	
16	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).	
17	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.	
18	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 ;	
Week 7	**Fluid dynamics and flow behaviour analysis**	
19	Steady state and transient multiphase flow modeling ; Hydrate, paraffin and asphaltene control ; Corrosion, erosion and sand control.	
20	Fluid property and phase behavior modeling ; Equations of state, Fugacity and equilibrium; Viscosities of oils.	
21	Thermal modeling ; Multiphase pressure boosting ; Slugging: hydrodynamic, terrain induced & ramp up ; Commissioning, Start-up, and Shutdown Operations.	
Week 8	**Production logging**	
22	Problem identification and solution with production logs ; Temperature logs ; Radioactive tracer logs ; Spinner flowmeter logs ; Log combinations for injection well profiling.	
23	Deflector or basket flowmeters ; Fluid density logs ; Fluid capacitance logs ; Slip velocity correlations ; Multiphase log interpretation ; Noise logs .	
24	Ultrasonic pulse-echo logs ; Pulsed neutron logs for flow identification ; Horizontal well production logs.	
Week 9	**Prevention of sand influx**	
25	Sand control techniques; Radial flow and formation damage; Causes and effects of sand production ; Predicting sand production .	
26	Gravel pack design; Slotted liners and wire wrapped screens; Gravel pack completion equipment and service tools ;	Mid Term/ Assignment
27	Well preparation for gravel packing. Gravel pack performance; Horizontal well completions.	
Week 10	**Sand influx prevention technique design**	
28	Perforating for gravel placement techniques;	
29	Frac packing; Open hole gravel packing	
30	Perforation prepacking and enhanced prepacking;	
Week 11	**Water influx prevention**	
31	Water-formed scales; Corrosion control; Water treatment microbiology	
32	Produced water discharge/disposal and treatment principles. Produced water treating equipment,	
33	Theory of water treatment operation, advantages and disadvantages, Water injection and disposal systems.	
Week 12	**Troubleshooting of production system**	
34	Troubleshooting checklists for main processes and major equipment types.; Tubing, packers & completion equipment.	
35	Completion process and problems regarding completion. Zonal isolation	CT-3 / Assignment
36	Safety & flow control devices required for the process	
Week 13	**Overview of different completion systems**	
37	Open hole completions; Basic completion types ; Perforating ; Open & cased hole logging.	

38	Formation damage & treatment; Completion fluids.	
39	Multiple completions; Completion performance and completion skin factor.Well completion complexity.	
Week 14	**Introduction of Novel techniques**	
40	Stimulation application, surfactants, solvents, acidizing, fracturing &deep perforating	
41	Formation & sand control, screens, chemical consolidation,	
42	Gravel packing, frac-pack, new & novel techniques.	

8. Assessment Method

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1. Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1	C1, C2
	1.3 Mid term	15%	CO3	C2, C3
2. Final Exam (60%)		60%	CO2, CO4	C1, C2, C3, C4
		100%		

C: Cognitive domain; A: Affective domain; P: Phychomotor domain

9. Materials Recommended

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
7. www.spe.org

PME 327	**Natural Gas Processing and LNG Technology**	***3.00 Co Hr; 3.00 Cr Hr***
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

1. To describe natural gas and LNG processing.
2. To analyze natural gas and LNG process and operation.
1. To design natural gas and LNG process and operation.
2. To operate natural gas and LNG process and operation.
3. To apply code and standards in natural gas and LNG process and operation.

3. Course Contents:

Natural Gas Conditioning: Physical properties of hydrocarbons. 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, De-ethanizer ,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; Cold energy of LNG.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of natural gas and LNG process and operation	✓											
CO2	Analyze problems for operation and interpretation of natural gas and LNG process.		✓										
CO3	Design natural gas and LNG process plant.			✓									

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of natural gas and LNG process and operation	PO1	C1	1 2 3 4	-	-	CT,MID,F Exam
CO2	Analyze problems for operation and interpretation of natural gas and LNG process.	PO2	C1,C2	1 2 3 4	1	1	CT, MID,FExa m
CO3	Design natural gas and LNG process plant	PO3	C1,C2,C3	5	1	1	CT,MID,F Exam

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ignment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1.Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	2.3 Student-Centered Learning	-
2.Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	1.3 Preparation for final examination	21
3.Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
Week-1		CT-1
Lecture-1	**Natural Gas Conditioning:** Physical properties of hydrocarbons	
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/MID
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 tank.	
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 Issue.s.	
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, $CO2$ and $H2S$ 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, Prospect in Bangladesh.	
Lecture-41	**Application of natural gas engineering software**: Aspen Hysis, PIPESIM.	
Lecture-42	Cold energy of LNG.	

8. Assessment Method

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1.Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO3	C1, C3,
	1.3 Mid term	15%	CO1, CO2	C1, C2
2.Final Exam (60%)		60%	CO1, CO2	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

5. Fundamentals of Natural Gas Processing by Arthur J. Kidnay
6. Handbook of Natural Gas Transmission and Processing by Saeid Mokhatab, William A. Poe and John Y. Mak
7. Handbook of Liquefied Natural Gas by Saeid Mokhatab

PME 328	Natural Gas Processing, LNG and LPG Laboratory	
		3.00 Co Hr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

1. To describe natural gas, LNG and LPG processing.
2. To analyze natural gas, LNG and LPG process and operation.
3. To design natural gas, LNG and LPG process and operation.
4. To operate natural gas, LNG and LPGprocess and operation.
5. To practice natural gas, LNG and LPG process and operation software.
6. To apply code and standards in natural gas, LNG and LPG process and operation.
7. To employ in learning of natural gas, LNG and LPGprocess and operation in context of technological change.

3. Course Contents:

Determination of gas composition of inlet and outlet gas of gas process plant by chromatograph.Simulation of process operation of the natural gas dehydration process (Glycol dehydration).Simulation of process operation of the natural gas dehydration process (Solid Desiccant dehydration).Simulation of process operation of the Natural Gas Liquids (NGL) recovery process.Simulation of process operation of Liquid Natural Gas (LNG) production. Simulation of process operation of Liquid Natural Gas (LNG) regasification. Determination of composition of LPG by chromatograph. Determination of density of LPG by hydrometer. Determination of heating value of LPG by calorimeter. Simulation of process operation of the LPG production. 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.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Examine difficult issues for the purpose of operating and interpreting LNG, LPG, and natural gas processes.			✓									
CO2	Modeling of natural gas, LNG process plant using modern tools.					✓							

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Examine difficult issues for the purpose of operating and interpreting LNG, LPG, and natural gas processes.	PO3	C1, C2, C3 P2, P3 A1,A2	1 2 3			R,Q
CO2	Modeling of natural gas, LNG process plant using modern tools.	PO5	C4, C3 P6	4	2	1	R, Q, Pre, ASG

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities	Engagement (hours)
4. Face-to-Face Learning	
1.1 Lecture	14
1.2 Practical / Tutorial	21
1.3 Student-Centered Learning	7
5. Self-Directed Learning	
2.1 Non-face-to-face learning	14
2.2 Revision of lecture at home	4
2.3 Preparation for final examination	7
6. Formal Assessment	
3.1 Continuous Assessment	7
3.2 Final Examination	1
	75

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. 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	Case Study: Observing a natural process plant to observe the main processing unit, process control system, utilities system, ./ LNG plant/ LPG plant.
Week-14	Safety system Analysis

8. Assessment Method: R, Q, ASG

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1.Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1,CO2	C1, C2 P2,P3,P6
	1.2 Assignment 1-3	30%	CO1, CO2	C1, C2
	1.3 presentation	25%	CO1,CO2	C1, C2 A1,A2
2.Lab Quiz (25%)		25%	CO1	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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 329	**Reservoir Engineering**	***3.00 Co Hr; 3.00 Cr Hr***
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale:

Reservoirengineeringisabranchofpetroleumengineeringthatappliesscientificprinciples tothefluidflowthroughporousmediumduringthedevelopmentandproductionofoiland gas reservoirs 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, andwater in reservoir rock. Reservoir engineers are particularly interested in generating accurate reserve estimates for 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.

2. Learning objectives (OB):

a. Todescribepetroleumreservoirandrecoveryprocess.
b. Toanalyzepetroleumreservoirsystemandrecoveryprocess.
c. To evaluate petroleum reservoir system

2.Course Contents:

Fundamentals of Reservoir Engineering: Fundamentals of reservoir fluid flow; Reservoir fluid distribution; Two- phase flow model; Three-phase flow model. **Analysis of reservoir rock properties:** Darcy's law; Flow equation; Averaging Techniques for analyzing reservoir properties; The Klinkenberg Effect; relative permeability and effective permeability relation with water saturation; **Reservoir Classification:** Classification of reservoirs; Oil reservoirs, Gas reservoirs. **Reservoir Drive Mechanisms:** Reservoir drive mechanisms; Rock and liquid expansion drive, Depletion drive, Gas cap drive, Water drive, Gravity drainage drive, Combination drive; Reservoir types as per drive mechanisms; Recovery by different drive mechanisms. **Reserve Estimation Methods:** Volumetric method, Material Balance method, Decline Curve method, Reservoir Simulation method.**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 solution gas drive, gas cap drive, water drive; Material balance for different reservoir condition;Gas recovery factor and gas production forecasting; Reserve estimation by material balance**. Flow Through Porous Media and Flow Equations:** Reservoir geometry; 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. **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.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of petroleum reservoir and recovery process	✓											

CO2	Analyze recovery factor in different reservoir conditions	✓	
CO3	Estimate future recovery from reservoir		✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Bloom's Taxonomy	KP (WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of petroleum reservoir and recovery process	PO1	C1	1	-	-	CT, FExam
CO2	Analyze recovery factor in different reservoir conditions	PO1	C2, C3, C4, C5	1 2 3	1	-	CT, FExam
CO3	Estimate future recovery from reservoir	PO2	C3, C4	1 2 3	1	-	CT, MID

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities	Engagement (hours)
1.Face-to-Face Learning	
1.1 Lecture	42
1.2 Practical / Tutorial	-
1.3 Student-Centered Learning	-
2.Self-Directed Learning	
2.1 Non-face-to-face learning	42
2.2 Revision of lecture at home	21
2.3 Preparation for final examination	21
3.Formal Assessment	
3.1 Continuous Assessment	2
3.2 Final Examination	3
	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
Week-1	**Fundamentals of Reservoir Engineering**	CT-1
Lecture-1	Fundamentals of reservoir fluid flow.	
Lecture-2 Lecture-3	Reservoir fluid distribution; Two- phase flow model; Three-phase flow model.	
Week-2	**Analysis of reservoir rock properties**	
Lecture-4	Darcy's law; Flow equation; Averaging Techniques for analyzing reservoir properties;	
Lecture-5 Lecture-6	The Klinkenberg Effect; relative permeability and effective permeability relation with water saturation;	
Week-3	**Reservoir Drive Mechanisms**	
Lecture-7 Lecture-8	Reservoir drive mechanisms; Rock and liquid expansion drive, Depletion drive, Gas cap drive, Water drive, Gravity drainage drive, Combination drive; Reservoir types as per drive mechanisms; Recovery by different drive mechanisms. Reservoir types as per drive mechanisms; Recovery by different drive mechanisms.	
Lecture-9	Classification of reservoirs; Oil reservoirs, Gas reservoirs.	
Week-4	**Reserve Estimation Methods**	CT-2
Lecture-10 Lecture-11 Lecture-12	Volumetric method, Material Balance method, Decline Curve method, Reservoir Simulation method.	
Week-5	**Material Balance**	
Lecture-13 Lecture-14	Development of general material balance equation;	
Lecture-15	Havlena-Odeh linear material balance equation and examples; Oil recovery material balance; Gas material balance; Material balance for solution gas drive, gas cap drive, water drive; Material balance for different reservoir condition; Gas recovery factor and gas production forecasting; Reserve estimation by material balance.	
Week-6	**Flow Through Porous Media and Flow Equations:**	
Lecture-16	Reservoir geometry; Derivation fluid flow equations; continuity equation.	
Lecture-17 Lecture-18	Darcy´s equation, fluid and rock equations, initial and boundary conditions, analytical solution, steady and transient states, Diffusivity equation.	
Week-7	**Rate Decline Analysis**	CT-3/MID
Lecture-19	Conventional decline curve equations; exponential, hyperbolic and harmonic rate versus time and rate versus cumulative production relationships.	
Lecture-20	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-21	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.	
Week-8	**Immiscible Displacement**	
Lecture-22	Fluid displacement process; Fractional flow.	
Lecture-23	Buckley Leverett and Welge analysis; Vertical and diffuse flow.	
Lecture-24	Buckley-Leverett 1D displacement; Oil recovery by Buckley-Leverett-Welge method; Segregated flow and oil recovery; Dietz model; Vertical sweep efficiency; Dykstra-Parsons model.	
Week-9	**Production Forecasting**	
Lecture-25	Types of forecasts.	
Lecture-26	Purposes; Methods.	
Lecture-27	Tools; Practices and procedures.	
Week-10	**Aquifers**	CT-4
Lecture-28	Schilthuis, Hurst van Everdingen, Carter Tracy.	
Lecture-29	Fetkovitch methods of aquifer analysis and description.	
Lecture-30	Natural water influx; Steady state models; Van Everdingen-Hurst unsteady state model; History matching; Carter-Tracy model.	
Week-11	**Petroleum Resources Management System**	
Lecture-31	Petroleum resources definitions, classification, and categorization guidelines; Seismic applications.	
Lecture-32	Assessment of petroleum resources using deterministic procedures.	
Lecture-33	Probabilistic reserves estimation; Aggregation of reserves; Evaluation of petroleum reserves and resources; Production measurement and operational issues; Resources entitlement and recognition.	
Week-12	**Reservoir Characterization**	
Lecture-34	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-35	Geostatistics in reservoir characterization, applicable techniques, data viability and applicability, multiple working models, ranking of models with multi-source data.	
Lecture-36	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.	
Week-13	**Reservoir Management**	
Lecture-37	Definition of reservoir management; an integrated, interdisciplinary team effort; Goal setting, planning,	

	implementing, monitoring, and evaluating reservoir performance.	
Lecture-38	Field development and field operating plans to optimize profitability; Efficient monitoring of reservoir performance; Minimizing drilling of unnecessary wells; Wellbore and surface systems.	
Lecture-39	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.	
Week-14	**Role of Reservoir Engineers in Managing Asset Values**	
Lecture-40	Asset life cycles.	
Lecture-41	Professional roles.	
Lecture-42	Hydrocarbon reservoir descriptions; Reservoir Engineering Ethics.	

8. Assessment Method

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (40%)	1.1 Class Participation	5%	-	-
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3, C4, C5
	1.3 Mid term	15%	CO1, CO2, CO3	C1, C2, C3, C4, C5
2.Final Exam (60%)		60%	CO1, CO2, CO3	C1, C2, C3, C4, C5
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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 421	**Well Test Analysis**	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

a) To describe petrophysical properties of formation.
b) To analyze well test for estimation of petrophysical properties of formation.
c) To design the well test operation and formation evaluation process.
d) To operate well test operation in cased hole and open hole.
e) To employ in learning of petrophysics in context of technological change.

3. Course Contents:

Objectives of Well Tests: Determine formation productivity/deliverability, reservoir geometry/size/drainage area, inter-well communication, and perforation efficiency**.**

Types of Well Tests: Drill stem test, multi-rate production/ injection well testsand interference/pulse tests; Drawdown Test; Pressure Buildup Test; Injection Test; Fall-off Test; Interference, pulse and vertical permeability testing, Drill Stem Test(DST)
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; 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;
Naturally Fractured Reservoirs (NFR): Well test in Naturally Fractured Reservoirs (NFR), Layered reservoir; Analytical & Numerical well test simulation; Anisotropy; 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 ; 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, 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.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of well test analysis	✓											
CO2	Analyze problems in design, operation and interpretation of well test analysis		✓										
CO3	Apply the fundamentals in well test analysis operation and interpretation			✓									
CO4	Investigate problems in well test analysis				✓								

5.Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of well test analysis operation	PO1	C3	2 3		-	CT, MID, FExam
CO2	Analyze problems in design, operation and interpretation of well test analysis process and operation	PO2	C3, C4	3 4	1	-	CT, MID, FExam
CO3	Apply the fundamentals to design the well test analysis process and operation	PO2	C4	3 4	1	-	CT, MID, Assignmen t . FExam
CO4	Investigate problems in well test analysis	PO4	C3, C4	3 4	1	-	MID, Assignmen t.

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**-*

***E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2.Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3.Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
Week-1	**Objectives of Well Tests**	CT-1
Lecture-1 Lecture-2 Lecture-3	Determine formation productivity/deliverability, reservoir geometry/size/drainage area, inter-well communication, and perforation efficiency**.**	
Week-2	**Well Tests Operation and Equipment**	
Lecture-4 Lecture-5 Lecture-6	Well tests equipment, tools, devices; Data acquisition system; Equipment selection and layout; Equipment calibration; Sequence of operation; Data recording and processing.	
Week-3	**Well Test Interpretation Model**	
Lecture-7 Lecture-8 Lecture-9	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;	
Week-4	**Well Test Interpretation Model**	
Lecture-10 Lecture-11 Lecture-12	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.	
Week-5	**Well Test Interpretation Model**	CT-2

Lecture-13	Fluid Flow in porous media: Diffusivity equation in Rectangular.	
Lecture-14		
Lecture-15	Cylindrical and Spherical Coordinates; Line source solution of diffusivity equations. Initial and Boundary conditions; Skin, wellbore storage, radius of investigation.	
Week-6	**Naturally Fractured Reservoirs (NFR)**	
Lecture-16	Well test in Naturally Fractured Reservoirs (NFR), Layered reservoir; Analytical & Numerical well test simulation; Anisotropy; Principle of Superposition and Image Wells; Solution of diffusivity equations for linear, radial and spherical flow; Straight line, Pressure Type Curves,	
Lecture-17		
Lecture-18		
Week-7	**Pressure derivatives**	
Lecture-19	Pressure Derivatives and Deconvolution Well Test Interpretation Methods; Modeling and Interpretation of Multirate Testing and Variable rate Testing.	
Lecture-20		
Lecture-21		
Week-8	**Well Test Analysis**	
Lecture-22	Radial Flow; Log-log Type Curve Analysis; Pressure Transient Testing for Gas Wells	
Lecture-23		
Lecture-24		
Week-9	**Reservoir behaviour analysis**	CT-3/MID
Lecture-25	Flow Regimes and the Log-log Diagnostic Plot; Bounded Reservoir Behavior; Wellbore and Near-wellbore Phenomena; Estimation of Average Drainage Area Pressure	
Lecture-26		
Lecture-27		
Week-10	**Well Test Analysis methods**	
Lecture-28	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.	
Lecture-29		
Lecture-30		
Week-11	**Well Test Analysis methods**	
Lecture-31	Estimation of Average Drainage Area Pressure.	
Lecture-32	Hydraulically Fractured Wells; Horizontal Wells.	
Lecture-33	Naturally Fractured Reservoirs.	
Week-12	**Different types of reservoirs**	
Lecture-34	Hydraulically Fractured Wells; Horizontal Wells ; Naturally Fractured Reservoirs.	
Lecture-35		
Lecture-36		
Week-13	**Analysis of Well test Using Type curve**	CT-4
Lecture-37	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	
Lecture-38		
Lecture-39		

	reservoirs; Faults; Channel sands; Use of pressure and its time derivative in type curve matching.	
Week-14	**Well Tests Report**	
Lecture-40	Well test description; System evaluation; Discussion of each event; Gauge comparison; Analysis results; Well test data summary; Historical comparisons; Production improvement recommendations; Conclusions.	
Lecture-41		
Lecture-42		

8. Assessment Method

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1	C1, C2
	1.3 Mid term	15%	CO3	C2, C3
2. Final Exam (60%)		60%	CO2, CO4	C1, C2, C3, C4
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Transient Well Testing by Medhat M. Kama
2. Modern Well Test Analysis, A Computer Aided Approach by Horne
3. Applied Well Test Interpretation by John P. Spivey and W. John Le

PME 423	**Reservoir Modeling and Simulation**	***3.00 Co Hr; 3.00 Cr Hr***
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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

2. Learning objectives (OB):

1. To describe simulation models of petroleum reservoirs.
2. To analyze simulation models of petroleum reservoirs.
3. To design the simulation models of petroleum reservoirs.
4. To operate reservoir modeling data processing.
5. To practice reservoir modeling and simulation software.
6. To apply code and standards in reservoir modeling and simulation.
7. To employ in learning of reservoir modeling and simulation in context of technological change.

3. 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; Petro-physical 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, Petro-physical properties model, Vertical Lift model; Production profile model,Buckley Leveret 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 Streakmtubes, 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 crosss-treamline 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/RateAllocations ; 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.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of reservoir modeling and simulation	✓											
CO2	Analyze the problems for operation and interpretation of reservoir modeling and simulation.		✓										
CO3	Solve the challenging problems for reservoir simulation and modelling.			✓									
CO4	Investigate the operational problem of natural gas and LNG process.				✓								

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of reservoir modeling and simulation	PO1	C1	1 2 3 4	-	-	CT,MIDFExam

CO2	Analyze the problems for operation and interpretation of reservoir modeling and simulation.	PO2	C2	1 2 3 4	-	-	CT,MIDFE xam
CO3	Solve the challenging problems for reservoir simulation and modelling	PO3	C3	5	1	1	ASG
CO4	Investigate the operational problem of natural gas and LNG process	PO4	C2,C3	4 5	1	1	CT,MID,F Exam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**i**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1.Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2.Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3.Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
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		
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.	CT-2
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	PVT experiments, aquifer representation.	
Lecture-22		
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		
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.	CT-3/MID
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 ; Stream functions and Stream tubes ; 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 cross streamline 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/RateAllocations ; Improved Waterflood Management.	
Lecture-36	Waterflood Field Tracer Interpretation ; Hybrid Methods: Sector Models and Streamtubes ; Miscible Flood Modeling and Predictions.	
Week-13		ASG
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		
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.	

8. Assessment Method

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO3	C2, C3
	1.3 Mid term	15%	CO1,CO2	C1, C2, C3
2.Final Exam (60%)		60%	CO1, CO2,CO4	C1, C2, C3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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 424	**Reservoir Modeling and Simulation Sessional**	
		3.00 Co Hr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB):

1. To describe simulation models of petroleum reservoirs.
2. To analyze simulation models of petroleum reservoirs.
3. To design the simulation models of petroleum reservoirs.
4. To operate reservoir modeling data processing.
5. To practice reservoir modeling and simulation software.
6. To apply code and standards in reservoir modeling and simulation.
7. To employ in learning of reservoir modeling and simulation in context of technological change.

3. 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 caseSimulation Sector Modeling. **Simulation Results Displayin**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:**Development of reservoir geomodel and simulation model of gas field. Development of reservoir geomodel and simulation model of oil field.

4. Course Outcomes (CO) and Skill Mapping

COs		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Reservoir modeling using the modern tools.					√							
CO2	Perform individual and teamwork for solving the engineering problem.									√			

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Using the modern tools for reservoir modeling.	PO5	C1, C2, C3 A1, A3, P5	1 2 3	-	-	R, Q
CO2	Perform individual and teamwork for complex engineering problem.	PO9	A2, A3 P2, P3 C3, C4	4	-	-	R, Q, pre

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1.Face-to-Face Learning		
	1.1 Lecture	14
	1.2 Practical / Modeling	21
	1.4 Student-Centered Learning	7
2.Self-Directed Learning		
	2.1 Lab Reports	14
	2.2 Quiz	4
	2.4 Preparation	7
3.Formal Assessment		
	3.1 Continuous Assessment	7
	3.2 Final presentation	1
		75

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. 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	Overall discussion for reservoir modeling and simulation process

8. Assessment Method: R, Q, Pre, ASG

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1,CO2	A1, A2,A3
	1.2 Assignment	30%	CO2	C1, C2 P2,P3,P5
	1.3 Presentation	25%	CO1,CO2	C1, C2
2.Lab Quiz (25%)		25%	CO1	C3, C4
		100%		

C: *Cognitive domain;* ***A***: *Affective domain;* ***P***: *Phychomotor domain*

9. **Materials Recommended**

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 425 Petroleum Refining and LPG Technology

3.00 Co Hr; 3.00 Cr Hr

Pre-requisite: None

1. **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.

2. **Learning objectives (OB):**
   a. To describe petroleum refining and LPG process and operation.
   b. To design the petroleum refining and LPG process and operation procedures.
   c. To operate petroleum refining and LPG process and operation.
   d. To practice petroleum refining and LPG process and operation software.

3. **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.

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, 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.

Liquid Petroleum Gas (LPG): Physical and chemical composition/ properties, application of LPG in relevant country, Product specifications, 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.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of petroleum refining and LPG process and operation	✓											
CO2	Apply fundamentals in petroleum refining and LPG Technology design			✓									
CO3	Analyze problems in design, operation and interpretation of petroleum refining and LPG process and operation		✓										

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of petroleum refining and LPG process and operation	PO1	C1, C2, C3		-	1, 2, 3	CT, FExam
CO2	Apply fundamentals in petroleum refining and LPG Technology design	PO4	C4, C5, C6	3,4,5	1	4,5,6	CT, MID
CO3	Analyze problems in design, operation and interpretation of petroleum refining and LPG process and operation	PO2	C4,	2	1	4	CT, FExam

CP- ***C****omplex* ***P****roblem/* ***WP***- ***W****ashington Accord Complex* ***P****roblem Solving;* ***CA***- ***C****omplex* ***A****ctivities/* ***EA***- ***E****ngineering* ***A****ctivities;* ***KP***- ***K****nowledge* ***P****rofile/* ***WK***- ***W****ashington Accord* ***K****nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Assig**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
2. Self-Directed Learning	2.1 Assignments 2.2 Revision of lectures 2.2 Preparation: Exam	42 21 21
3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		CT_1
Lecture-1	Crude Oil: Introduction of crude oil; Properties,API gravity,	
Lecture-2	Watson Characterization factor.	
Lecture-3	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 method	
Week-2		
Lecture-4	Operating procedures, and troubleshooting.	
Lecture-5	Atmospheric crude distillation, Vacuum distillation, Thermal cracker.	
Lecture-6	Hydrotreaters, Fluidized catalytic cracker, Separators, Naphtha splitter, Reformer.	
Week-3		
Lecture-7	Alkylation and isomerization, Gas treating, Blending pools,	
Lecture-8	Stream splitters.	
Lecture-9	Hydrorefining, catalytic reforming, hydrocracking, Coking, Polymer gasoline. Processing Unit: Crude Distillation Unit; Catalytic Reforming Unit; Hydrodesulphurization Unit.	
Week-4		CT_2
Lecture-10	Asphaltic Bitumen Plant i)Vacuum Distillation Unit ii)Bitumen	
Lecture-11	Blowing Unit.	
Lecture-12	Long Residue Visbrear Unit; Mild Hydrocracker Unit; NGC (Natural Gas Condensate) unit. Unit Operation and Process Control: Principles of unit operation;	
Week-5		
Lecture-13	Process controlling methods; Process control parameters.	
Lecture-14	Pressure, flow rate, Description of DCS.	
Lecture-15	Products: Description and use of refinery products, RG (Refinery Gas).	
Week-6		
Lecture-16	LPG (Liqueified Petroleum Gas, SBP (Special Boiling Point Solvent).	
Lecture-17	HSFO (High Sulfur Fuel Oil), LSFO (Low Sulfur Furnace Oil), BITUMEN.	
Lecture-18	Transportation, distribution and storage of refinery products.	
Week-7		
Lecture-19	Physical and chemical composition, properties	
Lecture-20	Application of LPG in relevant country	
Lecture-21	Product specification	
Week-8		
Lecture-22	LPG Production: LPG Transportation: Ship, rail, tanker trucks,	

Lecture-23 Lecture-24	intermodal tanks, cylinder trucks, pipelines and local gas reticulation systems.	MID
Week-9		
Lecture-25 Lecture-26 Lecture-27	LPG Storage: Butane Lighters, Disposable Butane Cartridges. Small BBQ Bottles, Forklift Gas Bottles, Large Bottles, Large Tanks. Storage in Intermodal ISO Tank Containers.	
Week-10		
Lecture-28 Lecture-29 Lecture-30	Mounded Tanks. Storage Spheres, Horton Spheres. Underground Storage Caverns, LPG Bottling.	
Week-11		CT_4
Lecture-31 Lecture-32 Lecture-33	Process Safety: Historical Incident & Problem Areas ; Risk Analysis Basics; Process Hazards Analysis Techniques – Overview. Layers of Protection; Inherently Safer Design.	
Week-12		
Lecture-34 Lecture-35 Lecture-36	Hazards Associated with Process Fluids. Leakage and Dispersion of Hydrocarbon Releases, Combustion Behavior of Hydrocarbons.	
Week-13		
Lecture-37 Lecture-38 Lecture-39	Sources of Ignition , Hazards Associated with Specific Plant Systems. Plant Layout & Equipment Spacing ; Pressure Relief and Disposal Systems. Process Monitoring and Control ; Safety.	
Week-14		
Lecture-40 Lecture-41 Lecture-42	Instrumented Systems. Fire Protection Principles, Explosion Protection. Application of Petroleum Refining and LPG Technology.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3, C4
	1.3 Mid term	15%	CO2, CO3	C1, C2, C3
2. Final Exam (60%)		60%	CO1, CO2, CO3	C1, C2, C3, C5
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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 427	**Transmission and Distribution of Natural Gas**	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale:

Transmission and Distribution of Natural Gas course is designed to provide individuals with the knowledge and skills necessary to understand, operate, and manage the systems thattransport natural gas from production sources to end-users. Covering critical infrastructure, safety protocols, regulatory compliance, and technological advancements, it ensures a skilled workforce capable of managing the evolving demands of the global energy landscape.

2. Learning objectives (OB):

1. To understand various natural gas transmission & distribution systems and their components.
2. To analyze different types of natural gas transmission & distribution systems and operation.
3. To practice natural gas transmission & distribution system design and operation software.
4. To apply code and standards in natural gas transmission & distribution system design and operation.

3. Course Contents:

Fundamentals:

Introduction and overview; Basic properties of natural gas; Modes of natural gas transportation; Route survey; Route selection; Horizontal directional drilling (HDD).

Calculating the pressure drop:

General flow equation; Various correlations for friction factor and transmission factors, such as Colebrookand AGA; Other flow equations, such as Panhandle and Weymouth.

Natural gas transportation and distribution through pipeline:

Pipe Design; Series and parallel pipelines; Equivalent lengths in series piping and equivalent diameters in parallel piping; Pipe looping; The effects of intermediatedelivery volumes and injection rates along a distribution pipeline; The effectof gas temperature on the pressure drops in a transmission pipeline.

Compressorstations required to transport gas in a pipeline; Centrifugal and positivedisplacement compressors; Typical performance characteristics of a centrifugal compressor; Isothermal, adiabatic, and polytropic compression processes; Calculation of horsepower required; The discharge temperature of the compressedgas and its impact on pipeline throughput, along with the necessity of gas cooling.

Mechanicalstrength of a pipeline; The effects of pipe diameter, wall thickness, material of construction, and specific safety requirementsdictated by design codes and state regulations; Hydrostatictesting requirements and classification of pipelines based upon their proximity tohuman dwellings and industrial establishments and population density; Mainline valves; Overpressure protection; Road and Railroad Crossings; Stream and River Crossings; Cathodic Protection

Economic aspects of gas pipeline systems; Determining theoptimum pipe size for a particular gas flow rate, taking into account the initial capitalcost and annual operating and maintenance cost.Various capital cost components; Recurring annual costs such as operation and maintenance, fuel, and administrativecosts; Calculation methodology for determining transportation cost or tariff.

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.

Offshore Gas TransmissionSystem: Fundamentals of offshore gas transmission system; high pressure pipeline.

Gas Distribution System Planning: Measurement Principles and Meter Fundamentals: Smart Gas Metering System; Pressure Regulation Principles; Overpressure Protection; Pressure Regulation Sizing and Selection; Gas Supply Planning; Gas Control Operations; Load Estimating; Monitoring System Pressure.

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).

4. Course Outcomes (CO) and Skill Mapping

COs		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of natural gas transmission and distribution system.	✓											
CO2	Analyze problems in design, operation and interpretation of natural gas transmission and distribution systems.		✓										
CO3	Apply fundamentals of design natural gas transmission and distribution systems.		✓										
CO4	Investigate problems in natural gas transmission & distribution system operation.				✓								

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Bloom's Taxonomy	KP(WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of	PO1	C1, C2	1, 2	-	-	CT, MIDFExam

	natural gas transmission and distribution system.						
CO2	Analyze problems in design, operation and interpretation of natural gas transmission and distribution systems.	PO2	C3, C4	3, 4	-	-	CT, MID FExam
CO3	Apply fundamentals of design natural gas transmission and distribution systems.	PO2	C3, C4	3, 4	-	-	CT, MID FExam
CO4	Investigate problems in natural gas transmission & distribution system operation.	PO4	C4	3,4	1	-	ASG, MID

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
1.Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2.Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3.Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	**Lecture Topic**	Assessments
Week-1		CT-1
Lecture-1	Introduction and overview; Basic properties of natural gas	
Lecture-2	Modes of natural gas transportation	

Lecture-3	Route survey; Route selection; Horizontal directional drilling (HDD)	
Week-2		
Lecture-4	General flow equation;	
Lecture-5	Various correlations for friction factor and transmission factors, such as Colebrookand AGA;	
Lecture-6	Other flow equations, such as Panhandle and Weymouth	
Week-3		
Lecture-7	Pipe Design; Series and parallel pipelines;	
Lecture-8	Equivalent lengths in series piping and equivalent diameters in parallel piping; Pipe looping;	
Lecture-9	The effects of intermediatedelivery volumes and injection rates along a distribution pipeline;	
Week-4		
Lecture-10	The effectof gas temperature on the pressure drops in a transmission pipeline	
Lecture-11	Compressor stations required to transport gas in a pipeline; Centrifugal and positive displacement compressors;	
Lecture-12	Typical performance characteristics of a centrifugal compressor; Isothermal, adiabatic, and polytropic compression processes; Calculation of horsepower required.	
Week-5		CT-2
Lecture-13	The discharge temperature of the compressed gas and its impact on pipeline throughput, along with the necessity of gas cooling	
Lecture-14	Mechanicalstrength of a pipeline; The effects of pipe diameter, wall thickness, material of construction, and specific safety requirementsdictated by design codes and state regulations	
Lecture-15	Hydrostatic testing requirements and classification of pipelines based upon their proximity to human dwellings and industrial establishments and population density	
Week-6		
Lecture-16	Mainline valves	
Lecture-17	Overpressure protection; road and railroad crossings; stream and river crossings.	
Lecture-18	Cathodic protection	
Week-7		
Lecture-19	Economic aspects of gas pipeline systems.	
Lecture-20	Determining theoptimum pipe size for a particular gas flow rate, taking into account the initial capitalcost and annual operating and maintenance cost.Various capital cost components	
Lecture-21	Recurring annual costs such as operation and maintenance, fuel, and administrativecosts; Calculation methodology for determining transportation cost or tariff	
Week-8		

Lecture-22	Introduction of Scada system; Supervisory control and data acquisition; Monitoring of all transmission parameters:	
Lecture-23	Gas flow at supply and off-take points, line pressure, movement of gas and condensate volumes and gas quality.	
Lecture-24	Pipeline integrity monitoring, leak detection and alarm,	
Week-9		CT-3/MID
Lecture-25	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	
Lecture-26	Measurement Principles and Meter Fundamentals:	
Lecture-27	Pressure Regulation Principles; Overpressure Protection; Pressure Regulation Sizing and Selection;	
Week-10		
Lecture-28	Gas Supply Planning; Gas Control Operations; Network Analysis; Safety; Load Estimating; Monitoring System Pressure.	
Lecture-29	Fundamentals Of Offshore Gas Transmission System.	
Lecture-30	High Pressure Pipeline.	
Week-11		
Lecture-31	Gas Distribution System Planning: Measurement Principles and Meter Fundamentals.	
Lecture-32	Positive Displacement Diaphragm Meters.	
Lecture-33	Positive Displacement Rotary Meters.	
Week-12		
Lecture-34	Gas Turbine Meters.	
Lecture-35	Ultrasonic Meters; Pressure Regulation.	
Lecture-36	Principles; Overpressure Protection.	
Week-13		CT-4
Lecture-37	IEE, EIA, SIA, RP/RAP of Transmission and Distribution projects.	
Lecture-38		
Lecture-39	Customer service operations and safety.	
Week-14		
Lecture-40	Fundamentals of simulation software (PIPESIM, HYSIS).	
Lecture-41	Application of simulation software (PIPESIM, HYSIS) in pipeline design.	
Lecture-42		

8. Assessment Method

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1.Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3, C4
	1.3 Mid term	15%	CO4	C4
2.Final Exam (60%)		60%	CO2, CO3	C3, C4
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Text and Reference Books:

1. Gas Pipeline Hydraulics by E. Shashi Menon
2. Natural Gas Production Engineering by Chi U. Ikoku
3. Natural Gas Transmission and Distribution Engineering by YAN MING QING & LIAN LE MING
4. Handbook of Natural Gas Transmission and Processing by Saeid Mokhatab, William A. Poe and James G. Speight
5. Natural Gas Transmission and Distribution Business by Pramod Paliwal and Sudhir Yadav
6. Handbook of Natural Gas Transmission and Processing: Principles and Practices by Saeid M.

PME 429 **Enhanced Oil and Gas Recovery Techniques**

2.00 Co Hr; 2.00 Cr Hr

Pre-requisite: None **Curriculum structure:**Outcome Based Education (OBE)

1. **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.

2. **Learning objectives (OB):**
   1. To describe enhanced oil and gas recovery process.
   2. To analyze enhanced oil and gas recovery process.
   3. To design the enhanced oil and gas recovery process.
   4. To operate enhanced oil and gas recovery operation.
3. **Course Contents:**

   Enhanced Oil Recovery Fundamentals: Reservoir life cycle and recovery process ; primary recovery phase: recovery targets and ways to improve ; secondary recovery phases: immiscible gas injection, waterflooding, recovery targets, ways to improve ; Miscible methods ; Chemical methods ; Thermal methods ; Technical challenges; facilities and modifications.

   Drive Mechanism: All mechanisms, flow regime, Buckley Leverett Theorem

   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 ; Injector monitoring ; Producer monitoring ; Integrated monitoring ; Effect of water impurities ; Surface processing of injection and produced water ; 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.

4. **Course Outcomes (CO) and Skill Mapping**

COs		**Program Learning Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of enhanced oil and gas recovery process	✓											
CO2	Apply fundamentals in			✓									

	enhanced oil and gas Technology design	
CO3	Investigate problems in enhanced oil and gas recovery process	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)		POs	Bloom's Taxonomy	KP (WK)	CP (WP)	CA (EA)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques of enhanced oil and gas recovery process	PO1	C1, C2, C3	1 2 3			CT, FExam
CO2	Apply fundamentals in enhanced oil and gas Technology design	PO3	C4	4	2	1	MID, FExam
CO3	Investigate problems in enhanced oil and gas recovery process	PO4	C4, C5	4 5 6	4	1	FExam

CP *- **C**omplex **P**roblem/* ***WP*** *- **W**ashington Accord Complex **P**roblem Solving;* ***CA*** *- **C**omplex **A**ctivities/* ***EA*** *- **E**ngineering **A**ctivities;* ***KP*** *- **K**nowledge **P**rofile/* ***WK*** *- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
1.Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2.Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3.Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Lecture Schedule:

Lecture	Lecture Topic	Assessments
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	Miscible methods, Chemical methods; Thermal methods.	
Week-3		
Lecture-5	Technical challenges , Facilities modifications	
Lecture-6	Mechanisms, Flow regime, Buckley Leverett Theorem	
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.	
Lecture-8	Integrated monitoring; Effect of water impurities.	
Week-5		
Lecture-9	Surface processing of injection and produced water ; Enhanced water floods	
Lecture-10	Water flood planning, Many case histories.	
Week-6		
Lecture-11	Enhanced Oil Recovery with Gas Injection: Reservoir characterization and phase behavior.	CT-2 and MID
Lecture-12	Flow regimes and sweep.	
Week-7		
Lecture-13	Immiscible gas/water flood mechanisms.	
Lecture-14	First contact miscibility mechanisms.	
Week-8		
Lecture-15	Multi-contact miscibility mechanisms.	
Lecture-16	Reservoir simulation and performance forecasting.	
Week-9		
Lecture-17	Performance and monitoring of field projects.	
Lecture-18	**Chemical Enhanced Oil Recovery:** Review of Areal and Vertical sweep efficiencies; Heterogeneity and vertical sweep efficiency.	
Week-10		
Lecture-19	Residual oil saturation ; Enhanced Oil Recovery (EOR) Methods ; Chemical EOR Methods	
Lecture-20	Polymer Flooding: Polymers and their properties; Laboratory screening.	
Week-11		
Lecture-21	Polymer flood field design and example field results.	
Lecture-22	Overview of reservoir simulators for polymer flooding.	CT-3
Week-12		
Lecture-23	Surfactant/polymer (SP) methods: Surfactantbrine-oil phase	

	behavior.	
Lecture-24	Microemulsion properties; Capillary desaturation and oil mobilization.	
Week-13		
Lecture-25	Laboratory screening; Field examples and designs; Reservoir simulators for SP.	
Lecture-26	Alkaline/Surfactant/Polymer (ASP) methods.	
Week-14		
Lecture-27	Effect of alkali on phase behavior; Laboratory screening.	
Lecture-28	Field examples and designs; Reservoir simulators for ASP.	

8. Assessment Method

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1.Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3, C4
	1.3 Mid term	15%	CO3	C1, C2, C3
2.Final Exam (60%)		60%	CO1, CO2, CO3	C1, C2, C3, C5
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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.

CHAPTER 5

DEPARTMENTAL COURSES

5.3 Mining Engineering Courses

Sr No	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total	Page No
1	PME 231	Mining System	L2 T2	3	3	Cr Hr**33.5 and** Cont Hr**41.0**	179 – 182
2	PME 232	Mining SystemLaboratory	L2 T2	1.5	3		183 - 185
3	PME 233	Shaft sinking and Tunneling	L2 T2	3	3		186 - 189
4	PME 331	Mine Instrumentation and Machineries	L3 T1	3	3		190 - 194
5	PME 332	Mine Instrumentation and Machineries Laboratory	L3 T1	1.5	3		195 - 197
6	PME 333	Ground Water Managements in Mining	L3 T1	2	2		198 - 202
7	PME 335	Mine survey	L3 T2	3	3		203 - 206
8	PME 336	Mine Survey Laboratory	L3 T2	1.5	3		207 – 209
9	PME 337	Rock Blasting and Explosive Technology	L3 T2	3	3		210 - 213
10	PME 431	Mine ventilation and Environmental Engineering	L4 T1	3	3		214 - 218
11	PME 432	Mine Ventilation and Environmental Engineering Laboratory	L4 T1	1.5	3		219 - 221
12	PME 433	Mineral Processing	L4 T2	3	3		222 - 225
13	PME 434	Minerals Processing Laboratory	L4 T2	1.5	3		226 – 228
14	PME 435	Mine Planning and Design	L4 T2	3	3		229 - 233

PME 231	**Mining System**	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

3. Rationale

The course aims to facilitate comprehension of the underlying principles and systematic methodologies utilized in the evaluation of geological deposits, along with the extraction techniques employed for mineral resources, while taking into account the various elements constituting a mining system.

4. Learningobjectives (OB)

a) To calculate reserve/ resource of a geologic deposit.
b) To understand the components of the underground and surface mining systems.

3. 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:** Introduction to mining: Elements of mining, development of mining technology, stages in the Life of a Mine, Unit operation of mining, consequences of mining, governments influence and regulation.**Stages of mining:** prospecting, development, exploration etc, calculation of ore reserve estimate. **Unit Operation of mining:** fundamental operation and cycles, drilling, blasting, loading and excavation, explosives. **Open Pit Mining:**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:** Methods (classification and selection), Equipment selection, Support components and accessories, Support configurations and their effects, Strata control in coal mines; Mine subsidence: Mechanics of development of subsidence, Subsidence monitoring, Subsidence damage, Groundwater management.**Basics of Mineral Processing:** Introduction, Acceptance into the mill, Crushing, Seizing and sorting, Methods of separation, Unit processes and machineries.**Basics of Reclamation:** Removal of plant and buildings, Reclamation of trailing dumps, Monitoring of discharges.**Unconventional Mining Systems:** Principles and technologies:Coal Bed Methane (CBM), Underground Coal Gasification (UCG), Subsurface Cultivation and Gasification (SCG), Sea Bed Mining, Borehole mining, Hydraulic mining, Mining in space.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Outline the theories and calculations of mineral exploration.	✓											
CO2	Comprehend the components of the underground and surface mining	✓											

	system by understanding the theories and calculations.	
CO3	Implement the parameters to design an underground and surface mining systems.	✓

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping of Course Outcomes (CO) andGeneral Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Outline the theories and calculations of mineral exploration.	PO1	C1, C2	CP1	-	KP1-KP4	CT/ MID/ FExam
CO2	Comprehend the components of the underground and surface mining system by understanding the theories and calculations.	PO1			-		CT/ MID/ FExam
CO3	Implement the parameters to design an underground and surface mining systems.	PO2			-		ASG

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting, **CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:**Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
7. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
8. Self-Directed		

Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
9. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method(PBL)

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Mineral exploration**	
Lecture-1	Regional and detail exploration	
Lecture-2	Resource and reserve; Relation between resource, reserve and	
Lecture-3	exploration	
Week-2	**Mineral exploration**	
Lecture-4		
Lecture-5	Methods of exploration and reserve estimation	
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	**Rock breakage in 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**	
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**	
Lecture-16	Pit limit and stripping ratio	
Lecture-17 Lecture-18	Slope stability	
Week-7	**Mechanical excavations**	
Lecture-19	Mechanical excavations: principles	
Lecture-20 Lecture-21	Mechanical excavations: selection of machineries	CT_1
Week-8	**Mining Methods**	
Lecture-22	Classification	
Lecture-23	Detail of the methods	
Lecture-24	Method selection	
Week-9	**Support systems**	
Lecture-25	Support components and accessories	
Lecture-26	Selection of supports	
Lecture-27	Support configurations and their effects	CT_2

Week-10	**Strata control in coal mine**	
Lecture-28	Theories of strata behavior	
Lecture-29	Subsidence monitoring	
Lecture-30	Ground water management	
Week-11	**Basics of Mineral Processing**	
Lecture-31	Introduction, Acceptance into the mill	
Lecture-32	Crushing, Seizing and sorting	
Lecture-33	Methods of separation, Unit processes and machineries	
Week-12	**Basics of Reclamation**	MID
Lecture-34	Removal of plant and buildings	
Lecture-35	Reclamation of trailing dumps	
Lecture-36	Monitoring of discharges	
Week-13	**Unconventional Mining Systems**	ASG
Lecture-37	Coal Bed Methane (CBM), Underground Coal Gasification (UCG)	
Lecture-38	Subsurface Cultivation and Gasification (SCG)	
Lecture-39	Hydraulic mining	
Week-14	**Unconventional Mining Systems**	
Lecture-40	Sea Bed Mining	
Lecture-41	Borehole mining	
Lecture-42	Mining in space	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
5. Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2 C1, C2, C3
	1.2 Class Test/ Assignment	20%	CO1, CO3	
	1.3 Mid term	10 %		
6. Final Exam (60%)		60%	CO1, CO2	
		100%		

C: Cognitive domain; A: Affective domain; P: Phychomotor domain

9. Materials Recommended

a) Rock Mechanics for Underground Mining; BHG Brady and ET Brown. 2004, 628 pp.
b) Mining. Boky. 1967, 753 pp.
c) Introduction to Mining Engineering; HL Hartman, JM Mutmansky.2002, 592 pp.
d) Underground Mining Methods: Engineering Funadamentals and International Case Studies; WA Hustrulid, William A Hustruid, R C Bullock. 2001, 718 pp.
e) Open pit Mine Planning and design;William A Hustruid, M Kuchta, RK Martin. 2013, 1308 pp.
f) Mineral Processing; BA Wills, JA Finch. 1987, 512 pp.
g) Assessment, Restoration and Reclamation of Mining Influenced Soils; J Bech, C Bini, M Pashkevich. 2017, 520 pp.
h) Supplied materials.

PME 232	Mining System Laboratory	
		3.00 ContHr; 1.50Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The module's purpose is to use numerical simulation to address engineering problems in mining systems and to create physical models based on the simulation's results.

2. Learning objectives (OB)

a) To simulate a portion of a mining system using boundary elements or finite elements.
b) To resolve technical problems with a mining system's component.
c) To create a physical model based on the results of the simulation.

3. Course Contents

Numerical modeling; (i)Openings of a surface and underground mine (ii) Support design (iii) Stress filed affect (iv) Influence of multiple materials(v)Influence of planes of weakness on stability.**Physical modeling**; To make physical model of a part of mining system based on simulation results. Examples (i) Room and pillar (ii) Longwall mining (iii) Open pit mining (iv) UCG method (v) Shaft sinking (vi) Sea Bed Mining (vii) Borehole mining (viii) Hydraulic mining (ix) Mining in space etc.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Apply numerical simulation for a mining system	✓											
CO2	To solve the engineering issues of a mining system		✓										
CO3	Apply the simulation outcomes to prepare a physical model			✓									

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Apply numerical simulation for a mining system	PO1	C2, C3	CP1, CP2	CA1, CA2	KP4, KP5	R, Q
CO2	To solve the engineering	PO2					R, Q, Pre

	issues of a mining system			
CO3	Apply the simulation outcomes to prepare a physical model	PO3		Physical model, R, Pre

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create
CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components
CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity
KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
1. Face-to-Face Learning	1.1 Lecture	13
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
2. Self-Directed Learning	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
3. Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		74

TEACHING METHODOLOGY
Lecture, Numerical Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Modeling	Experiments	Assessments	
Week-1	Numerical modeling	Excavations for surface and underground mine	R	ASG
Week-2				
Week-3		Support design		
Week-4		Gravity and dynamic Stress		
Week-5		Multiple materials		
Week-6		Plane of weakness		
Week-7	Physical modeling	A part of a mining system based on outcomes of simulations		ASG
Week-8				
Week-9				

Week-10				
Week-11				
Week-12				
Week-13				Q
Week-14				Pre

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1, CO2	C2, C3, A3, A4, P3-P5
	1.2 Physical model	50%	CO3	
	1.3 Presentation	15%		
2. Lab quiz (25%)		15%	CO2	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Manuals of numerical analysis (RS3, Examine 3D etc.)
b) Supplied materials for physical models.
c) Supplied materials.

PME 233 **Shaft Sinking and Tunneling**

3.00 ContHr; 3.00 Cr Hr

Pre-requisite: None **Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The goal of the course is to help students comprehend the fundamentals of site preparation as well as the components and building techniques of the vertical and lateral development of underground openings.

2. Learning objectives (OB)

a) Site investigation techniques.
b) Shaft and tunnel construction techniques.
c) Preliminary analyses for shaft and tunnel.
d) Ground improvement techniques and lining system.

3. 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.**Shaft sinking methods:** Shape and size of Shaft, Surface plants, conventional and unconventional methods. **Freezing method:** Principles, Physical and mechanical characteristics of frozen rocks, Refrigerants, Diameter of periphery and number of boreholes,Refrigerate-equipment ability and its work time, Temperature of freezing pipe, Ice wall thickness, Shaft boring machine. **Hoisting system:** Components Hoisting types, Design of hoisting system, Total tension in hoisting rope, Maximum static load, Maximum dynamic load. **Introduction to tunneling:** Philosophy of tunneling, Nature of the ground, Tunnel cross section terminology. **Site investigation for tunneling:** Ground investigation, Ground characteristics/parameters, Site investigation report. **Preliminary analysis for tunnel:** Stability of ground, Coefficient of lateral earth pressure, Preliminary analytical method. Preliminary numerical modeling. **Tunnel construction techniques:** Open face construction without a shield, Partial face boring machine, tunneling shields, Tunnel boring machines, Drill and blast tunneling, NATM and spray, Cut and cover tunnels, Immersed tube tunnels, Jacket box tunneling, Pipe jacking and micro tunneling.**Ground improvement techniques and lining:** Ground improvement and stabilization techniques, Tunnel lining systems.**Tunnel boring machines:** Types, working principles and selection criterion. **Soft ground tunneling:** Tunnel behavior, undrained stability, drained stability.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the theories and procedures of shaft sinking and tunneling methods	✓											
CO2	Apply the knowledge in shaft and tunnel design		✓										

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Explain the theories and procedures of shaft sinking and tunneling methods	PO1	C1, C2	CP1	-	KP1-KP4	CT/ MID/ FExam
CO2	Apply the knowledge in shaft and tunnel design	PO2			-		CT/ MID/ FExam

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Access to mineral deposit**	
Lecture-1 Lecture-2	Vertical shaft.	
Lecture-3	Inclined shaft.	
Week-2	**Access to mineral deposit**	
Lecture-4	Adit.	
Lecture-5	Tunnel, drift.	
Lecture-6	Factors affect the choice of the openings.	
Week-3	**Shaft locations, stress and supports**	
Lecture-7	Technical factors to choose shaft location.	
Lecture-8	Shaft models.	
Lecture-9	Optimization of shaft location.	
Week-4	**Shaft locations, stress and supports**	
Lecture-10	Formation 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, Freezing mass theory, Physical and mechanical characteristics of frozen rocks (Pumping and caisson method).	
Week-6	**Hoisting system**	
Lecture-16	Components.	CT_1
Lecture-17	Types.	
Lecture-18	Design of hoisting system.	
Week-7	**Hoisting system**	
Lecture-19	Total tension in hoisting rope.	
Lecture-20	Maximum static load.	
Lecture-21	Maximum dynamic load.	
Week-8	**Introduction to tunneling**	CT_2
Lecture-22	Philosophy of tunneling.	
Lecture-23	Nature of the ground.	
Lecture-24	Tunnel cross section terminology.	
Week-9	**Site investigation for tunneling**	
Lecture-25	Ground investigation.	
Lecture-26	(Geological and Engineering) Ground characteristics/parameters.	
Lecture-27	Site investigation report.	
Week-10	**Preliminary analysis for tunnel**	
Lecture-28	Stability of ground, Coefficient of lateral earth pressure.	
Lecture-29	Tunnel construction techniques	
Lecture-30	Tunnel construction techniques	
Week-11	**Ground improvement techniques and lining**	
Lecture-31	Stabilization techniques	
Lecture-32	Stabilization techniques	
Lecture-33	Stabilization techniques	
Week-12	**Tunnel boring machines (TBM)**	CT_3

Lecture-34 Lecture-35 Lecture-36	Types Working principles Selection criterion	MID
Week-13 Lecture-37 Lecture-38 Lecture-39	**Soft ground tunneling** Tunnel behavior	
Week-14 Lecture-40 Lecture-41 Lecture-42	**Soft ground tunneling** Undrained stability and drained stability	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2 C1, C2, C3
	1.2 Class Test/ Assignment	20%	CO1, CO2	
	1.3 Mid term	10 %		
2. Final Exam (60%)		60%		
		100%		

C: Cognitive domain; A: Affective domain; P: Phychomotor domain

9. Materials Recommended

a) Practical Shaft Sinking; F Donaldson. 2018, 160 pp.
b) Vertical and Decline Shaft Sinking: Good Practices in Technique and Technology; J Kicki, J Sobczyk, P Kaminski. 2015, 208 pp.
c) Introduction to Tunnel Construction; DN Chapman, N Metje, A Stark. 2017, 455 pp.
d) Supplied materials.

PME 331	**Mine Instrumentation and Machinery**	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The course's objective is to assist students in comprehending the principles and evaluation for picking mine monitoring instruments as well as the assessment criteria, principles, and methods for selecting machinery for both surface and deep mines.

2. Learning objectives (OB)

a) To understand the principles, application-fields, and data analysis of mine monitoring instruments.
b) To know the detail functions, application fields, and selection method of mine machinery.

3. Course Contents

Introduction to Measurement: Significance of measurement, Terminologies, Calibration; fundamental methods, Standard and dimensions; generalized measurement systems, error analysis. **Response of Measurement Systems:** Amplitude, Frequency and phase response, Static and dynamic characteristics; zero-order, first-order and second-order systems. **Digital Techniques in Measurement:** Digital mechanical inputs, Number systems; Fundamental elements of digital circuitry; analog to digital and digital to analog conversion. **Data Processing:** Analog indicators; Digital counters, high-speed imaging. **Displacement Measurement:** Gage blocks, Measuring microscope; Displacement & differential transducers.**Stress and Strain Measurement:** Stress measurement, Strain measurement.**Pressure Measurement:** Manometry; bourdon-tube gages, Pressure transducers; high- and low-pressure measurement. **Mine Monitoring instruments**: Stress meter, Extensometer and field strain, Joint meter, Vibrating ware sensor and micro-seismic sensor, Hydraulic sensor and piezometer, Optic fiber sensor and Electrochemical gas sensor.**Ground movements and monitoring:** Ground deformation in ground, Effects of tunneling on surface and subsurface, Instrumentation for tunnel and ground.**Mine Machinery:** Fundamental concepts of equipment economics, Shearer: components, support system, transportation, Dozers: performance characteristics, pushing materials, land clearing, ripping rock, Scrapers: 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. Longwall machineries: Chocks, AFC, Cutting machines.**Conveyors:** Techno-economics Indices, transport by gravity, Scraper chain conveyor, Belt conveyor, Special belt conveyor (cable belt) Shaker and Vibrating conveyors.**Rope haulage:** Equipment of rope of haulage, Principle of rope way, Rope haulage calculations, Scope of application of a rope haulage, Construction of aerial ropeway, Calculation plan and profile of ropeways.**Rail Track:** Construction of rail track, Mines car, Choice of car, Resistant to motion of car, Motion of car under gravity, Man-riding cars. **Locomotive Haulage:** Types of mine locomotives, shuttle cars.**Underground Hydraulics:** Theory of transportation, Hydraulic breaking, Hydraulic transportation by gravity and by pumps, Stowing-material transport.**Maintenance of**

Mining Machinery: Maintenance, Management and safety, Remote monitoring and control in mines and automation.**Fundamentals of Machine Learning for Predictive Data Analytics:** Algorithms, Worked Examples, and Case Studies.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the basics of a measurement system	✓											
CO2	Comprehend the principles and application-fields of mine monitoring instruments	✓											
CO3	Explain the mine transportation system and layouts	✓											
CO4	Analyze and select mine machinery for surface and underground mine		✓										

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Explain the basics of a measurement system	PO1	C1, C2	CP1	-	KP1-KP4	CT/ MID/ FExam
CO2	Comprehend the principles and application-fields of mine monitoring instruments	PO1			-		CT/ MID/ FExam
CO3	Explain the mine transportation system and layouts	PO1			-		CT/ MID/ FExam
CO4	Analyze and select mine machinery for surface and underground mine.	PO2			-		ASG/FExam

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

CP- ***C**omplex **P**roblem/* ***WP***- ***W**ashington Accord Complex **P**roblem Solving;* ***CA***- ***C**omplex **A**ctivities/* ***EA***- ***E**ngineering **A**ctivities;* ***KP***- ***K**nowledge **P**rofile/* ***WK***- ***W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Introduction and Response of Measurement Systems**	
Lecture-1	Significance of measurement, fundamental methods, generalized measurement systems.	
Lecture-2	Amplitude, Frequency and phase response.	
Lecture-3	Static and dynamic characteristics;zero-order, first-order and second-order systems.	
Week-2	**Digital Techniques and Processing in Measurement**	
Lecture-4	Digital mechanical inputs, Number system.	
Lecture-5	Fundamental elements of digital circuitry; conversions.	
Lecture-6	Analog indicators; Digital counters, high-speed imaging.	
Week-3	**Displacement, Stress and Strain, Pressure Measurement**	
Lecture-7	Gage blocks, Measuring microscope; Displacement & differential transducers.	
Lecture-8	Stress measurement, Strain measurement.	
Lecture-9	Manometry; bourdon-tube gages, Pressure transducers; high and low pressure measurement.	
Week-4	**Mine Monitoring instruments**	
Lecture-10	Types.	
Lecture-11	Working principles.	
Lecture-12	Applications.	
Week-5	**Mine Machinery**	
Lecture-13	Fundamental concepts of equipment economics.	
Lecture-14	Influencing factors.	
Lecture-15	Planning.	CT_1

Week-6	**Mine Machinery: Shearer**	
Lecture-16	Chocks.	
Lecture-17	AFC.	
Lecture-18	Cutting machines.	
Week-7	**Mine Machinery: Dozers, Scrapers**	
Lecture-19	Performance characteristics.	
Lecture-20	Ripping rock, Analysis of design parameters.	
Lecture-21	Selection criterion.	
Week-8	**Mine Machinery: Excavators**	
Lecture-22 Lecture-23	Front shovels, hoes, loaders. Tracks and hauling equipment capacities, Size affected productivity.	
Lecture-24	Performance calculation, Safety, analysis of design parameters, Selection of excavators.	
Week-9	**Mine Machinery: cranes**	
Lecture-25	Mobile cranes, tower cranes.	
Lecture-26	Rigging, safety, analysis of design parameters.	
Lecture-27	Selection of cranes.	
Week-10	**Min Machinery: Draglines, Maintenance of Mining Machinery**	
Lecture-28 Lecture-29	Draglines and clamshells; description, factors affecting production Analysis of design parameters and selection.	
Lecture-30	Maintenance management and safety.	
Week-11	**Conveyors and locomotive Haulage**	
Lecture-31 Lecture-32	Scraper chain conveyor, belt conveyor, special belt conveyor.	
Lecture-33	Shaker and vibrating conveyors. Scrapper haulage. Types of mine locomotives,shuttle cars.	
Week-12	**Rope haulage**	
Lecture-34	Equipment of rope of haulage, principle of rope way.	
Lecture-35	Rope haulage calculations, scope of application of a rope haulage.	
Lecture-36	Construction of aerial ropeway, calculation plan and profile of ropeways.	
Week-13	**Rail Trackand Underground Hydraulics**	CT_2;
Lecture-37	Construction of rail track, Types of mine locomotives, mines car.Choice of car, resistant to motion of car.	MID
Lecture-38	Motion of car under gravity, man-riding cars.	
Lecture-39	Hydraulic transportation by gravity and by pumps.	ASG
Week-14	**Fundamental of Machine learning**	
Lecture-40	Algorithms	
Lecture-41 Lecture-42	Work examples	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2 C1, C2
	1.2 Class Test/ Assignment	20%	CO1, CO2, CO4	
	1.3 Mid term	10 %		
2. Final Exam (60%)		60%	CO1, CO3,CO4	
		100%		

C*: Cognitive domain;* ***A****: Affective domain;* ***P****: Phychomotor domain*

9. Materials Recommended

a) Mechanical Measurements: TG Beckwith, RD Marangoni and JH Lienhard. 2006. 684 pp.
b) SME Mining Engineering Handbook, SME.Peter Darling. 2011, 1840 pp.
c) Surface and Underground Excavations: Methods, Techniques and Equipment, RR tatiya. 2013, 904 pp.
d) Mining Engineering; Boky.
e)Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies; John D. Kelleher, Brian Mac Namee, and Aoife D'Arcy. 2015,
f) Supplied materials.

PME 332	Mine Instrumentation and Machinery Laboratory	
		3.00 ContHr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The module's functions include identifying possible monitoring zones, comprehending the operation and potential applications of sensors, and choosing the appropriate mining equipment for a certain application.

2. Learning objectives (OB)

1. Applications of sensors in mining.
2. Numerical analysis to detect the zones of monitoring.
3. Mine machineryselection for operations.

3. Course Contents

Monitoring stress concentration, detection of convergence and strain, monitoringof joint deformation, vibration and micro-seismic measurement, pressure of water body, safety monitoring, detection of gas concentration, numerical simulation for potential zones of monitoring, pump selection, analytical methods of selection of mine machineries.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Comprehend the principles and applications of sensors in mining applications					✓							
CO2	Detect the potential monitoring zones	✓											
CO3	Selection criterionofmine machinery for mining operations	✓											

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Strategy
CO1	Comprehend the principles and applications of sensors in mining applications	PO5	C3, C4, C5	CP1	CA1, CA2	KP4, KP6	R/ Q
CO2	Detect the potential monitoring zones	PO1					R/ ASG

CO3	Select mine machinery for mining operations	PO1	R/Q

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

7. Teaching- Learning Strategy

Activities		**Engagement (hours)**
7.Face-to-Face Learning	1.1 Lecture	14
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
8.Self-Directed Learning	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
9.Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		75

TEACHING METHODOLOGY
Lecture, Numerical Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

9. Teaching Schedule

Lecture	Experiments	Assessments	
Week-1	Stress meter: Application to measure the stress in mine area.	R	
Week-2	(i) Extensometer and field strain gauge: Application to determine convergence and strain in a mine area. (ii) Joint meter: Monitoring of joints in a mine area.		
Week-3	(i) Vibrating ware sensor and micro-seismic sensor: Detection of vibration and seismic activities in mine area. (ii) Hydraulic sensor and piezometer: Detection of hydraulic pressure and status of water body in a mine areal.		Q

Week-4	(i) Optic fiber sensor: Safety monitoring in explosive and hazardous environment such as underground coal mines.		
Week-5	Mine physical model preparation of a vulnerable portion.	ASG	
Week-6	Numerical analysis of the model.		
Week-7			
Week-8	Evaluation and interpretation of zones of damage.		
Week-9	Selection of sensors for monitoring.		
Week-10	Analytical methods of selection of mine-machineries in conditions.		
Week11			
Week-12			
Week-13	Machine Learning for Predictive Data Analytics		
Week-14			Pre

10. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
5. Continuous Assessment (75%)	1.1 Lab Participation	5%		A3, A4, P3, P4, P5 C3, C4, C5
	1.2 Repot	40%	CO1, CO2, CO3	
	1.3Assignment	30%	CO2	
6. Lab quiz (25%)		25%	CO1, CO2	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

11. Materials Recommended

a)Manuals.
b) Simulation software Examine 3D, RS3.
c) Supplied material.

PME 333	Ground Water Management in Mining
	2.00 ContHr; 2.00 Cr Hr
Pre-requisite: None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The goal of the course is to learn the properties of groundwater and aquifers in order to construct the best mine dewatering and water management systems possible by recognizing the risk of ground water inundation, vulnerability and remediation.

2. Learning objectives (OB)

a) Understand the theories of groundwater flow and characterization of aquifer.
b) Design a pump house, pump installation and maintenance, and determination of the pump performance.
c) Predict the aquifer vulnerability and contamination risk, and remediation.
d) Apply the knowledge to design an optimum mine management system.

3. Course Contents

Ground water basics: Water and its properties, Aquifer Types and Classification Criteria, Hydraulic Head, Storage and Release Capacity, Flow Capacity, Leakage Between Different Aquifers, Field Applications of Darcy's Law, The Groundwater Flow Equation, Analytical Solutions of the Groundwater Flow Equation, **Aquifer characterization:** Aquifer Test Classification and Planning, Aquifer Tests, Recovery Tests, Slug Test, Other Methods for the Determination of Parameters.**Well Testing:** Operating Conditions of a Well Test,Theoretical Foundations and Interpretation of Step-Drawdown Tests, Well Productivity and Efficiency, Estimation of the Coefficients.**Make of water- sump design**: pump house: Introduction, Make of water, Capacity of water lodgment, Pump house design, Water lodgment 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**: Performance testing, Methods of measuring flow rate, Flow calculation, Flow time.**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.**Groundwater recharge:** Developing a conceptual model of recharge processes, Challenges in estimating recharge, estimation methods, Linking estimation methods to conceptual models ofgroundwater recharge. **Aquifer Vulnerability and Contamination Risk:** Vulnerability Assessment Strategies, Comparison of Different Vulnerability Assessment Strategies, Contamination Risk, Contamination Risk Reduction. **Remediation of Contaminated Groundwater:** Free Product Recovery, Subsurface Containment, Pump and Treat, Air Sparging and Biosparging, Permeable Reactive Barriers, In Situ Flushing, In Situ Oxidation, In Situ Bioremediation.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Understand the theories of groundwater flow and characterization of an aquifer	✓											
CO2	Design a pump house, pump installation and maintenance, and determination of the pump performance		✓										
CO3	Predict the aquifer vulnerability and contamination risk, and remediation		✓										
CO4	Apply the knowledge to design an optimum mine management system.		✓										

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

<table>
<tr><th colspan="2">Course Outcomes(CO)</th><th>POs</th><th>Blooms Taxonomy</th><th>CP (WP)</th><th>CA (EA)</th><th>KP (WK)</th><th>Assessment Methods</th></tr>
<tr><td>CO1</td><td>Understand the theories of groundwater flow and characterization of an aquifer</td><td>PO1</td><td rowspan="4">C1, C2, C3</td><td rowspan="4">CP1</td><td>-</td><td rowspan="4">KP1 - KP4</td><td>CT/ MID/ FExam</td></tr>
<tr><td>CO2</td><td>Design a pump house, pump installation and maintenance, and determination of the pump performance</td><td>PO2</td><td>-</td><td>CT/ MID/ FExam</td></tr>
<tr><td>CO3</td><td>Predict the aquifer vulnerability and contamination risk, and remediation</td><td>PO2</td><td>-</td><td>ASG</td></tr>
<tr><td>CO4</td><td>Apply the knowledge to design an optimum mine management system</td><td>PO2</td><td>-</td><td>ASG</td></tr>
</table>

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	28
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	28
	2.2 Revision of lecture at home	14
	2.3 Preparation for final examination	14
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		89

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Ground water basics**	
Lecture-1	Water and its properties, Aquifer Types and Classification Criteria.	
Lecture-2	Hydraulic Head, Storage and Release Capacity. Flow Capacity, Leakage Between Different Aquifers.	
Week-2	**Ground water basics**	
Lecture-3	Field Applications of Darcy's Law.	
Lecture-4	The Groundwater Flow Equation, Analytical Solutions of the Groundwater Flow Equation.	
Week-3	**Aquifer characterization**	
Lecture-5	Aquifer Test Classification	
Lecture-6	and Planning. Aquifer Tests.	
Week-4	**Aquifer characterization**	
Lecture-7	Recovery Tests.	
Lecture-8	Slug Test. Other Methods for the Determination of Parameters.	CT-1
Week-5	**Well Testing**	
Lecture-9	Operating Conditions of a Well Test.	
Lecture-10	Step-Drawdown Tests, Well Productivity and Efficiency Estimation of the Coefficient.	
Week-6	**Make of water- sump design- pump house**	
Lecture-11	Pump house design.	
Lecture-12	Water lodgment design.	

	Design of water passage.	
Week-7 Lecture-13 Lecture-14	**Mine water occurrence- Pumping status – Pump classification – pumping scheme** Water occurrence, Effects. Status of pumping in underground mines Pump classification.	
Week-8 Lecture-15 Lecture-16	**Mine water occurrence- Pumping status – Pump classification – pumping scheme** Mine pumps and duty requirements. Properties of mine water, coast. Pumping scheme- single horizontal operation, Pumping scheme- multi horizontal operation.	
Week-9 Lecture-17 Lecture-18	**Pump characteristics- system head curve- Operating point** Characteristics of pumps. Resistance correction, operating point. Various operating conditions and characteristics curve, Joint operation of pumps.	
Week-10 Lecture-19 Lecture-20	**Pump testing and manufacturing testing facilities** Quality control test for raw material, Test carried out on critical parts. Final assembly test. Performance testing.	
Week-11 Lecture-21 Lecture-22	**Pump testing and manufacturing testing facilities** Methods of measuring flow rate. Flow time. Flow calculation.	CT-2
Week-12 Lecture-23 Lecture-24	**Installation and maintenance of pump** Foundation of pump, Pump installation. Coupling, Pipes for mine drainage, Pump suction design. Maintenance of pump, Critical speed, trouble shooting.	
Week-13 Lecture-25 Lecture-26	**Groundwater recharge** Conceptual model of recharge processes. Challenges in estimating recharge, estimation methods. Linking estimation methods to conceptual models.	ASG
Week-14 Lecture-27 Lecture-28	**Aquifer Vulnerability and Contamination Risk** Vulnerability Assessment Strategy. Comparison of Different Vulnerability Assessment strategy. Contamination Risk, Contamination Risk Reduction.	ASG

8.Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2 C1, C2, C3
	1.2 Class Test/ Assignment	20%	CO3, CO4	
	1.3 Mid term	10 %	CO1, CO2	
2. Final Exam		60%	CO1, CO2	

(60%)	100%

C: Cognitive domain; A: Affective domain; P: Phychomotor domain

9. Materials Recommended

a) Groundwater Engineering; J Zhou, JYN Zhou and et al. 2017, 420 pp.
b) Ground water engineering; RSethi and AD Molfetta. 2019, 445 pp.
c)Pump handbook; IJ Karassik JP Messina and et al. 2008, 1824 pp.
d) Supplied materials.

PME 335	**Mine Survey**	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The module is designed to comprehend the operations, theories, and calculations of survey instruments to evaluate and analyze the measured data for mining applications.

2. Learning objectives (OB)

1. To understand the principles of distance, height, angle, area and volumes measurement of survey instruments.
2. Evaluate and analyze the measured data to solve technical problems of a mine.

3. 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. **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.**Geodetic survey**: Introduction to geodesy, Geodetic surveying and GPS, Deformation monitoring surveys.**Total station:** Instrumentation and operation, Measurements, Prism constant, combined total station measurement, Computations, Differential leveling.**3D Laser Scanning:** Introduction, Measurement principles, Accuracy, resolution, and point density, Registration of point cloud, Applications. **Leveling applications**: Establishing TBM, Contouring plans by level and staff, Sections and cross sections, Precise leveling, Reciprocal leveling.**Traversing:** Definition and application, Procedure, Field notes reduction, Set-out and adjustment of control points, Sources of errors.**Strike and dip to an embedded plane:** Strike and dip, Driving strike and dip of a plane, Direction of any slope over the dipping surface, Horizontal angles projected on to an inclined plane.**Curve setting:** Elements, laying of simple circular curves on surface and belowground,Transition curve and super elevation.**Map Projections:** Definitions, UTM, Transformation methods, least square solution, Applications.**U/G Surveying: -Correlation**: Methods of correlation - direct traversing in inclined shaft, correlation in vertical, single and two shafts. **Stope Surveying:** Purpose, methods of survey in moderately and steeply inclined ore bodies, flat and vertical ore bodies/seams.**Development surveys:** Setting a point of known coordinate, control of direction and gradient in drifts, tunnels, raises and winzes, application oflasers, Problems of underground traversing. **Remote sensing, Photogrammetry, satellite imaging, GIS** application to mining**.**

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the theories, operations, and calculations of survey instruments	✓											
CO2	Evaluate and analyze the measured data to solve technical problems and assessment of the performance of mine operations		✓										

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Explain the theories, operations, and calculations of survey instruments	PO1	C1, C2	CP1	-	KP1 – KP3	CT/ MID /FExam
CO2	Evaluate and analyze the measured data to solve technical problems and assessment of the performance of mine operations	PO2			-		CT/ MID /FExam

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**sig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities	Engagement (hours)
1. Face-to-Face Learning	

	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Understand the earthand surveying**	
Lecture-1 Lecture-2	Understand the earth, earth surface and surveying.	
Lecture-3	The basic principles of mine surveying.	
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	**Height measurement**	
Lecture-10	Leveling definition, Bench marks, Types of leveling.	
Lecture-11	Principles of leveling, Modern surveyor’s levels.	
Lecture-12	The leveling stuff, Level accessories, Leveling fieldwork.	
Week-5	**Angular measurement**	
Lecture-13	The basic construction of theodolite.	
Lecture-14	Reading systems- Optical theodolites, Electronic theodolites.	
Lecture-15	Setting on an angle, Measuring angles, Adjustments.	
Week-6	**Total station**	
Lecture-16	Instrumentation and operation.	
Lecture-17	Measurements.	
Lecture-18	Computations, Differential leveling.	
Week-7	**Leveling applications**	
Lecture-19	Sections and cross sections.	
Lecture-20	Establishing TBM Precise leveling, Reciprocal leveling.	
Lecture-21	Contouring plans by level and staff.	CT-1
Week-8	**3D Laser Scanning**	CT-2

Lecture-22	Measurement principles, Accuracy, resolution.	
Lecture-23	Point density, Registration of point cloud.	
Lecture-24	Applications.	
Week-9	**Areas and volumes**	
Lecture-25	Areas from drawing and plans, survey field notes, co-ordinates.	
Lecture-26	Volumes from cross sections.	
Lecture-27	Volume from contours, spot heights.	
Week-10	**Traversing, and strike and dip to an embedded plane**	
Lecture-28	Traversing: Definition and application, Procedure, Field notes reduction.	
Lecture-29	Traversing: Set-out and adjustment of control points, Sources of errors.	
Lecture-30	Driving strike and dip of a plane, Direction of any slope over the dipping surface, Horizontal angles projected on to an inclined plane.	
Week-11	**Circular and vertical curves**	
Lecture-31	Definition and applications.	
Lecture-32	Elements.	
Lecture-33	Calculations.	
Week-12	**Coordinate transformation and least square solutions**	
Lecture-34	Definitions.	
Lecture-35	Transformation methods, Least square solution.	
Lecture-36	Applications.	
Week-13	**Geodetic survey**	
Lecture-37	Introduction to geodesy.	CT-3
Lecture-38	Geodetic surveying and GPS.	
Lecture-39	Remote sensing, Photogrammetry, satellite imaging.	MID
Week-14	**Application to underground mine**	
Lecture-40	Horizontal surveys of underground working.	
Lecture-41	Tunnel and shaft surveying, Correlation of surface surveys with underground surveys.	
Lecture-42	Shaft plumbing, Transfer of height and coordinates.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1,A2, P1, P2 C1, C2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	
	1.3 Mid term	10 %	CO1, CO2	
2.Final Exam (60%)		60%	CO1, CO2	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Surveying; BC Punmia, AK Jain and AK Jain. 2005, 551 pp.
b) Basic Surveying; RE Paul. 1997, 352 pp.

c)Mine Surveying-I; P Rangaswamy, 2016, 245 pp.
d) Supplied materials

PME 336	**Mine Survey Laboratory**	
		3.00 ContHr; 1.50 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The module is designed to comprehend the principles of the measurements, calculations, and mapping which serve to ascertain and document the information at all the stages from prospecting to exploitation and utilizing mineral deposits both in surface and underground working.

2. Learning objectives (OB)

a)To learn about the theories, calculations, and methods of measurement to determine mine area, resource/ reserve of a mineral deposit.
b)To determine the basic information for the planning, opening direction, and control of mine workings to ensure economical and safe mining operations.
c)To determine the design parameters and performance prediction of an open-pit or underground mine.

3. Course Contents

Coordinate conversion and transformations, trigonometric leveling, long chord method, Rise and fall method, Collimation method, Traverse survey, Tachometric survey or stadia survey, Contouring, 3-Dimensional lithological, stratigraphic and structural modeling.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the principles of measurements to determine the mine area, mine reserve, contouring, and subsurface conditions by using various survey methods and software analysis	✓											
CO2	Apply the knowledge in assessment and quantification of performance prediction of mine operations		✓										

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)	POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods

CO1	Explain the principles of measurements to determine the mine area, mine reserve, contouring, and subsurface conditions by using various survey methods and software analysis	PO1	C2, C3	CP1	-	KP2 – KP3	R, Q
CO2	Apply the knowledge in assessment and quantification of performance prediction of mine operations	PO2			-		R, Pre

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	13
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
2. Self-Directed Learning	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
3. Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		74

TEACHING METHODOLOGY
Lecture, Experiment, Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method, software exercise

7. Teaching Schedule

<table>
<tr><th>Lecture</th><th>Experiments</th><th colspan="2">Assessments</th></tr>
<tr><td>Week-1</td><td>Determination of mine area using coordinate conversion and transformations</td><td rowspan="13">R</td><td rowspan="8"></td></tr>
<tr><td>Week-2</td><td>Determination of height of a skip shaft by trigonometric leveling by theodolite</td></tr>
<tr><td>Week-3</td><td>Determination of mine area using the theodolite traverse surveying method</td></tr>
<tr><td>Week-4</td><td>Setting out rail road in mine by offsets from long chord method</td></tr>
<tr><td>Week-5</td><td>Determination of the difference in level between points on the ground using rise and fall method</td></tr>
<tr><td>Week-6</td><td>Determination of the reduced level of different points on the ground using line of collimation method</td></tr>
<tr><td>Week-7</td><td>Determination of mine area using the theodolite traverse surveying method</td></tr>
<tr><td>Week-8</td><td>Determination of the elevation using tachometric survey or stadia survey</td></tr>
<tr><td>Week-9</td><td rowspan="2">Determination of mine area, mapping and contouring by GIS software</td><td rowspan="4">ASG</td></tr>
<tr><td>Week-10</td></tr>
<tr><td>Week-11</td><td>Determination of 3-Dimensional lithological and stratigraphic modelling of a mine field by Rockwork software</td></tr>
<tr><td>Week-12</td><td>Determination of 3D coal seam cross section and analysis of mineable seam of a coal field by Rockwork software</td></tr>
<tr><td>Week-13</td><td>Determination of coal reserve and recovery rate of a mine field by Rockwork software</td><td>Q</td></tr>
<tr><td>Week-14</td><td colspan="3">Presentation</td></tr>
</table>

8. Assessment Strategy

<table>
<tr><th colspan="2">Components</th><th>Grading</th><th>Course Outcome (CO)</th><th>Blooms Taxonomy</th></tr>
<tr><td rowspan="4">1.Continuous Assessment (75%)</td><td>1.1 Lab Participation</td><td>5%</td><td></td><td rowspan="5">A3, A4, P3, P4, P5
C2, C3</td></tr>
<tr><td>1.2 Report</td><td>15%</td><td>CO1</td></tr>
<tr><td>1.3Assignment</td><td>30%</td><td rowspan="2">CO2</td></tr>
<tr><td>1.4 Presentation</td><td>25%</td></tr>
<tr><td colspan="2">2.Lab quiz (25%)</td><td>25%</td><td>CO1</td></tr>
<tr><td colspan="2"></td><td>100%</td><td></td><td></td></tr>
</table>

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Manuals
b) Supplied materials.

PME 337	Rock Blasting and Explosive Technology	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The course's objectives are to provide an explanation of drilling and blasting concepts and techniques as well as an analysis of the parameters for the best blast design taking into account explosive technologies and environmental concerns in the mining industry.

2. Learning objectives (OB)

a) To understand the basics of drilling for blasting, and commercial explosive for mining application.
b) To design an optimum blasting for surface and underground mining.
c) To predict the environmental issues due to blasting activities and use of explosives.

3. Course Contents

Basics of drilling for blasting: Theories of rock drilling, Mechanics of rock breakage in drilling, Rock drillability and purpose; Drilling machines and applications. **Basics of explosives:** Types of explosives and blasting agents, Properties of explosives, Explosive selection criterion. **Basics of blasting:** Mechanism of blasting, Initiation and Priming, Initiation systems, Electric initiation, Detonating cord initiation, Cap and fuse initiation, Nonelectric initiation systems, Priming. Blasthole loading, General loading procedures, loading the small and large diameter blastholes. **Blast design:** Properties and geology of rock mass, Surface blasting, Blasthole diameter, Types of blast patterns, Burden, Subdrilling, Collar distance, Spacing, Hole depth, Delays, Powder factor, Secondary blasting, Underground blasting; Opening cuts, Blasting rounds, Delays, Powder factor, Coal mine blasting. Controlled blasting techniques; Line drilling, Presplitting, Smooth blasting, Cushion blasting. **Underwater blasting:** Methods of execution, Types of explosives, Calculations of charges and drilling patterns, charging the blastholes and priming system. **Optimization of fragmentation:** Economical aspects of drilling and blasting, Model for determining coast optimization, Prediction of fragmentation; Probabilistic analysis of optimization models. **Environmental issues and safety of blasting**: Flyrock, Causes, protective measure, Ground vibrations, Causes, reduction, Airblast, Causes, reduction, Dust and gases, Explosives storage and transportation, Borehole loading, Disposal of explosive materials .

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Comprehend the theories relating to drilling for blasting, detonation, and rock fragmentation	✓											
CO2	Evaluate the design parameters and			✓									

	apply them in optimum blast design for surface and underground mining	
CO3	Explain the environmental issues and reclamation for safety blasting	✓

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Comprehend the theories relating to drilling for blasting, detonation, and rock fragmentation	PO1	C1, C2, C3	CP1	-	KP1-KP4	CT/ MID/ FExam
CO2	Evaluate the design parameters and apply them in optimum blast design for surface and underground mining	PO3			-		CT/ MID/ FExam
CO3	Explain the environmental issues and reclamation for safety blasting	PO2			-		CT/ MID/ FExam

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

CP- ***C****omplex* ***P****roblem/* ***WP***- ***W****ashington Accord Complex* ***P****roblem Solving;* ***CA***- ***C****omplex* ***A****ctivities/* ***EA***- ***E****ngineering* ***A****ctivities;* ***KP***- ***K****nowledge* ***P****rofile/* ***WK***- ***W****ashington Accord* ***K****nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21

	2.3 Preparation for final examination	21
3. Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Basics of drilling for blasting**	
Lecture-1	Theories of rock drilling; Mechanics of rock breakage in drilling.	
Lecture-2	Rock drillability and purpose.	
Lecture-3	Drilling machines and applications.	
Week-2	**Basics of explosives**	
Lecture-4	Types of explosives and blasting agents.	
Lecture-5	Properties of explosives.	
Lecture-6	Explosive selection criterion.	
Week-3	**Basics of blasting**	
Lecture-7	Mechanism of blasting; Initiation and Priming	
Lecture-8	Initiation systems.	
Lecture-9	Electric initiation, Detonating cord initiation, Cap and fuse initiation Nonelectric initiation systems, Priming.	
Week-4	**Blasthole loading**	
Lecture-10	General loading procedures.	
Lecture-11	Loading the small blasthole.	
Lecture-12	Loading large diameter blastholes.	
Week-5	**Blast design**	
Lecture-13	Properties and geology of rock mass; Surface blasting.	
Lecture-14	Blasthole diameter, Types of blast patterns, Burden.	
Lecture-15	Subdrilling, Collar distance, Spacing, Hole depth, Delays, Powder factor, Secondary blasting.	
Week-6	**Blast design**	
Lecture-16 Lecture-17 Lecture-18	Underground blasting; Opening cuts, Blasting rounds, Delays, Powder factor.	
Week-7	**Blast design**	
Lecture-19	Coal mine blasting.	
Lecture-20	Controlled blasting techniques.	
Lecture-21	Line drilling.	CT-1
Week-8	**Blast design**	CT-2
Lecture-22	Presplitting.	
Lecture-23	Smooth blasting.	
Lecture-24	Cushion blasting.	MID
Week-9	**Underwater blasting**	
Lecture-25	Methods of execution and types of explosives.	ASG

Lecture-26	Calculations of charges and drilling patterns.	
Lecture-27	Charging and priming system.	
Week-10	**Optimization of fragmentation**	
Lecture-28	Economical aspects of drilling and blasting.	
Lecture-29	Model for determining coast optimization.	
Lecture-30	Prediction of fragmentation.	
Week-11	**Optimization of fragmentation**	
Lecture-31	Probabilistic analysis of optimization models.	
Lecture-32 Lecture-33	Rock fragment size analysis.	
Week-12	**Environmental issues and safety of blasting**	
Lecture-34	Flyrock; Causes, protective measure.	
Lecture-35	Ground vibrations; Causes, reduction.	
Lecture-36	Airblast; Causes, reduction.	
Week-13	**Environmental issues and safety of blasting**	
Lecture-37	Dust and gases.	
Lecture-38	Explosives storage and transportation.	
Lecture-39	Borehole loading, Disposal of explosive materials.	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2 C1, C2, C3
	1.2 Class Test/ Assignment	20%	CO1,CO2, CO3	
	1.3 Mid term	10 %		
2.Final Exam (60%)		60%		
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Rock Blasting and Explosives Engineering; PA Persson, R Holmberg, J Lee. 1993, 560 pp.
b) Engineering Rock Blasting Operations; CSTubarao. 2011, 195 pp.
c) Supplied materials.

PME 431	**Mine Ventilation and Environmental Engineering**	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The goal of the course is to get an understanding of mining legislation, mine fan design and installation, mining impurities and their measures, mine ventilation system calculations, and common environmental issue resolution methods.

2. Learning objectives (OB)

a) To learn about the theories and calculations of a mine ventilation system.
b) To understand the mine environmental impurities and its measurement.
c) To evaluate the requirements for selecting and installation of mine fans.
d) To analyze the ways to overcome the typical environmental issues.

3. Course Contents

Mine ventilation systems: Component of mine ventilation, Characteristics curve of mine airways, ventilation resistivity, dependency of resistance, Change in resistance, Equivalent Orifice (EO), Regulator, Leakage of air path, ventilation pressure, Mine characteristics curve, Mine ventilation design calculations and ventilation network analysis. **Mine Environment:** Classification of mine impurities, Threshold limit values, Mine gases (General Properties, physiological effects, permissible concentration, measurement), Environmental Pollution due to mining industry, Hazards in mining field of outburst, explosion, fires, fume, dust, radiation, and noises.**Ventilation measurements and surveys:** Temperature measurement, air specific-weight determination, velocity measurement, air pressure measurement, ventilation surveys: air quality and temperature survey, pressure survey, continuous monitoring and remote control.**Mine Fan:** Functional groups of mine fan, Design requirements, Fan pressure and system pressure requirement. Fan depression, Axial flow fan and centrifugal fan; Fan performance and test; Fan operation; Choice of Fan; Underground booster fans; Auxiliary Fans; Layout of installation.**Mine Environmental Engineering:** Control of mine fires and explosion: prevention strategies, mine monitoring, responses to fires and explosions. Heat sources and effects in mines: need for air conditioning in mines, sources of heat in mines, physiological effects of heat and humidity, heat indexes and standards. Mine air conditioning system: psychometric processes, chilled water sources, other heat-transfer processes, mine cooling load, mine cooling plants, mine heating system.**Ventilation economics**: Basics of economic design, effects of airway characteristics on power consumption, economic design of airways, economic design of overall network.**Mine legislation:** Mine act, Bangladesh labor act, ISRM mining management, Assessment of environmental contamination and restoration.**Mine reclamation:** Classification and environmental impact of mine dumps, multi-analytical approach for the assessment of toxic element distribution, environmental risk assessment using geophysical and geochemical techniques, reclamation by containment, mine water discharges

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the theories and elements of a mine ventilation system	✓											
CO2	Explain the mine environmental impurities and its measurement	✓											
CO3	Evaluate design parameters for selection and installation of the mine fans		✓										
CO4	Analyze the environmental issues and remediation of a mine ventilation system			✓									

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

<table>
<tr><th colspan="2">Course Outcomes(CO)</th><th>POs</th><th>Blooms Taxonomy</th><th>CP (WP)</th><th>CA (EA)</th><th>KP (WK)</th><th>Assessment Methods</th></tr>
<tr><td>CO1</td><td>Explain the theories and elements of a mine ventilation system</td><td>PO1</td><td rowspan="4">C1, C2</td><td rowspan="4">CP1, CP4</td><td>-</td><td rowspan="4">KP1-KP4</td><td>CT/ MID/ FExam</td></tr>
<tr><td>CO2</td><td>Explain the mine environmental impurities and its measurement</td><td>PO1</td><td>-</td><td>CT/ MID/ FExam</td></tr>
<tr><td>CO3</td><td>Evaluate design parameters for selection and installation of the mine fans</td><td>PO2</td><td>-</td><td>ASG, FExam</td></tr>
<tr><td>CO4</td><td>Analyze the environmental issues and remediation of a mine ventilation system</td><td>PO3</td><td>-</td><td>ASG</td></tr>
</table>

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Mine ventilation systems**	
Lecture-1	Component of mine ventilation.	
Lecture-2	Characteristics curve of mine airways.	
Lecture-3		
Week-2	**Mine ventilation systems**	
Lecture-4	Ventilation resistivity.	
Lecture-5	Equivalent Orifice (EO), Regulator.	
Lecture-6	Leakage of air path.	
Week-3	**Mine ventilation systems**	
Lecture-7	Ventilation pressure.	
Lecture-8	Mine characteristics curve.	
Lecture-9	Ventilation network analysis.	
Week-4	**Mine environment**	
Lecture-10	Classification of mine impurities, Threshold limits values.	
Lecture-11	Mine gases (General Properties, physiological effects,	
Lecture-12	permissible concentration, measurement).	
Week-5	**Mine environment**	
Lecture-13	Environmental Pollution due to mining.	
Lecture-14	Outburst, explosion, fires, fume.	
Lecture-15	Dust, radiation, and noises.	
Week-6	**Ventilation measurements and surveys**	
Lecture-16	Procedures for conducting the test for air quantity, pressure and	CT-1

Lecture-17 Lecture-18	air quality, airway resistance, loss of air distribution.	
Week-7	**Mine Fan**	
Lecture-19	Basics of mine fan and design requirements.	
Lecture-20	Fan pressure and system pressure requirements.	
Lecture-21	Axial flow fan and centrifugal fan.	
Week-8	**Mine Fan**	CT-2 Q ASG
Lecture-22	Fan performance and test.	
Lecture-23	Pressure loss.	
Lecture-24	Mine resistance and equivalent orifice.	
Week-9	**Mine Fan**	
Lecture-25	Fan operation and choice of Fan.	
Lecture-26	Underground booster and auxiliary fans.	
Lecture-27	Layout of installation.	
Week-10	**Mine Environmental**	
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	Control of mine fires and explosion.	
Lecture-32	Heat sources and effects in mines.	
Lecture-33	Mine air conditioning system.	
Week-12	**Ventilation economics**	
Lecture-34	Basics of economic design.	
Lecture-35	Characteristics of power consumption.	
Lecture-36	Economic design of overall network.	
Week-13	**Mine Legislation**	
Lecture-37	Mine act.	
Lecture-38	Bangladesh labor act.	
Lecture-39	ISRM mining management.	
Week-14	**Mine reclamation**	
Lecture-40 Lecture-41	Classification and environmental impact of mine dumps.Assessment of toxic element mine Reclamation by containment.	
Lecture-42	Assessment of toxic element mine Reclamation by containment.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2 C1, C2
	1.2 Class Test/ Assignment	20%	CO1, CO4	
	1.3 Mid term	10 %	CO1, CO2	
2.Final Exam (60%)		60%	CO1, CO2, CO3	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Mine Ventilation; DC Panigrahi. 2009, 1078 pp.
b) Mine Environmental Engineering; M Sengupta. 19889, 328 pp.
c)Mine Ventilation Engineering; CJ Hall. 1981, 344 pp.
d)Practical Mine Ventilation Engineering; JCJ Tien. 1999, 460 pp.
e)Advanced Mine Ventilation; P Thakur. 2019, 528 pp.

PME 432	**Mine Ventilation and Environmental Engineering Laboratory**
	3.00 ContHr; 1.50 Cr Hr
Pre-requisite: None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The module is designed to understand and carry out different measurements of a mine environment and to analyze ventilation network and ventilation circuits to build a mine ventilation model.

2. Learning objectives (OB)

1. To understand the basics of mine environmental survey instruments.
2. To design a mine ventilation system.
3. To perform ventilation circuit analysis.

3. Course Contents

Measurement of airborne dust particles, measurement of ashquantity, measurement of radiation level, measurement of sound level, Building a mine ventilation model, Simulation of different ventilation conditions.

6. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Carry out the measurements of a mine environment	✓											
CO2	Evaluate the design parameters for mine ventilation		✓										
CO3	Apply the knowledge to design an optimum mine ventilation system			✓									

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

7. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Carry out the measurements of a mine environment	PO1	C3, C4, C5	CP1, CP3	-	KP3 - KP5	R,Q
CO2	Evaluate the design	PO2			-		R, Q, Pre

	parameters for mine ventilation			
CO3	Apply the knowledge to design an optimum mine ventilation system	PO3	-	R, ASG

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**sig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

8. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	13
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
2. Self-Directed Learning	2.1 Lab reports	13
	2.2 Quiz	4
	2.3 Preparation/ quiz	7
3. Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		73

TEACHING METHODOLOGY
Lecture, Experiment, Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

9. Teaching Schedule

Lecture	Experiments	Assessment
Week-1	Measurement and analysis of gas concentration.	R
Week-2		
Week-3	Building mine ventilation models.	
Week-4		

Week-5			
Week-6	Creating pressure for flow.	R	
Week-7			
Week-8			
Week-9	Simulating airflow in models.		
Week-10			
Week-11			
Week-12	Simulation to minimize the effect of dust, temperature gas concentration	ASG	Q
Week-13			
Week-14		Presentation	

8. **Assessment Strategy**

Components		**Grading**	**Course Outcome (CO)**	**Blooms Taxonomy**
1.Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1, CO2	A3, A4, P3, P4, P5, C3, C4, C5
	1.2 Assignment	30%	CO3	
	1.3 Presentation	25%	CO3	
2.Lab quiz (25%)		25%	CO1, CO2	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Manuals of the measuring instruments
b) Documents of VentSim
c) Supplied materials.

PME433	**Minerals Processing**	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale:

The aim of this course is to give students a thorough grasp of the essential procedures involved in separating valuable minerals from ore to produce a concentrated, marketable product.

2. Learning objectives (OB):

i) To describe minerals processing system and operation.

j) To analyze minerals processing system and operation.

k) To design the minerals processing system and operationprocedures.

3. Course Contents:

Fundamentals of Mineral Processing,Mineral sampling, Size reduction: Crushing and Grinding,Characterization of Particles,Mathematical Modeling in Comminution,Screening, Classification.

Separation processes: Division of feed into products, Quantitative and qualitative analysis of upgrading, Delineation of separation,Separation processes, Hydraulic and air separation,Thin stream separation, Gravity separation, Magnetic separation, Eddy current separation,Flotation, Coagulation, Flocculation, Oil agglomeration.

Coal formation and properties, Coal processing for power plant and other uses, Clean coal technology, Heavy mineral separation.

4. Course Outcomes (CO) and Skill Mapping

COs		Program Learning Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques of minerals processing	✓											
CO2	Understand the operation and interpretation of minerals processing system		✓										
CO3	Design minerals processing system and operation procedures		✓										

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)	POs	Bloom's Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods

CO1	Recognize the main terminology, concepts and techniques of minerals processing	PO1	C1, C2	CP1	-	KP1-KP4	CT, FExam
CO2	Understand the operation and interpretation of minerals processing system	PO2			-		CT, FExam
CO3	Design minerals processing system and operation procedures	PO2			-		CT, MID

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
2. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision of lecture at home 2.3 Preparation for final examination	42 21 21
3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3 **131**

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule:

Lecture	Lecture Topic	Assessments
Week-1	**Introduction to mineral processing**	CT-1
Lecture-1	Basic definition, Process frame of minerals	
Lecture-2	Operation stages	
Lecture-3	Size control, enrichment and operation and environment	
Week-2	**Mineral sampling**	
Lecture-4	Mineral particles differing in size, Mineral particles of different density	
Lecture-5	Incremental Sampling, Continuous Sampling of Streams	

Lecture-6	Sampling Ores of Precious Metals, Sampling Nomographs	
Week-3	**Particle Size Estimation and Distributions**	
Lecture-7	Methods of size estimation.	
Lecture-8	Particle size distribution	
Lecture-9	Combining size distributions	
Week-4	**Size Reduction and Energy Requirement**	
Lecture-10	Design of Size Reduction Processes	
Lecture-11	Energy for Size Reduction - Work Index	
Lecture-12	Estimation of Work Index for crushers and grinding mills	
Week-5	**Crushers**	CT-2
Lecture-13	Jaw Crusher	
Lecture-14	Gyratory and Cone Crusher, Roll crushers	
Lecture-15	Mills	
Week-6	**Mathematical Modelling in Comminution**	
Lecture-16	Basis for Modelling Comminution Systems	
Lecture-17	Mathematical models of comminution processes	
Lecture-18	Modelling Crushing and Grinding Systems	
Week-7	**Screening and classification**	
Lecture-19	Basic Design features in Screens	
Lecture-20	Capacity and Screen Selection of Straight Screens, Operation of Curved Screens	
Lecture-21	Design Features of Mechanical Classifiers	
Week-8	**Solid - Liquid Separation**	
Lecture-22	Design Features of Thickeners, Thickener Design-Batch Process	
Lecture-23	Thickener Design-Continuous Thickeners, Operation of thickeners, Thickeners in Circuits	
Lecture-24	Design Features of Filters, Filtration in Mineral Processing Circuits	
Week-9	**Gravity Separation**	MID
Lecture-25	Particle Settling Rates, Gravity Separation Operations.	
Lecture-26	Jigs, Differential Motion Table Separators	
Lecture-27	Flowing Film Concentrators, Dense (or Heavy) Media Separation, Gravity Separation Performance	
Week-10	**Flotation**	
Lecture-28	Flotation reagents, Flotation Equipment, Flotation Circuits	
Lecture-29	Flotation Kinetics, Factors Affecting the Rate of Flotation	
Lecture-30	Application of Kinetic Equations, Other Flotation Models	
Week-11	**Magnetic and electromagnetic separation**	
Lecture-31	Basics	
Lecture-32	Drum separator	
Lecture-33	Cross-belt separator	
Week-12	**Coagulation, Flocculation and Oil agglomeration**	
Lecture-34	Coagulation	
Lecture-35	Flocculation	
Lecture-36	Oil agglomeration	
Week-13	Coal properties, coal processing and clean coal technology	ASG
Lecture-37	Coal properties	

Lecture-38	Coal processing
Lecture-39	clean coal technology
Week-14	**Heavy mineral separation**
Lecture-40	Heavy mineral properties and uses
Lecture-41	Gravity separation
Lecture-42	Heavy mineral processing

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2, C1, C2
	1.2 Class Test/ Assignment	20%	CO1, CO2, CO3	
	1.3 Mid term	10 %		
2.Final Exam (60%)		60%		
		100%		

Cognitive domain (C1-C6); Affective domain (A1-A5); Phychomotor domain (P1-P7)

9. Materials Recommended

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 434	**Minerals Processing Laboratory**	
		3.00 ContHr; 1.50Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The purpose of this course is to teach students how to identify minerals and comprehend the fundamental unit operations of mineral processing, which are typically related to the production of mineral and metal ores and the use of coal.

2. Learning objectives (OB)

1. Identify the minerals by using microscope.
2. Characterization of coal
3. Understand the basic mineral processes.

3. Course Contents

Slide preparation and identification of minerals, selection of crusher, particle size analysis, forth floatation of coal, proximate analysis, simulation of mineral processes.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To identify minerals in rock using microscopes	✓											
CO2	To characterize the coal	✓											
CO3	To design the mineral separation flowchart to adapt the successive separation processes			✓									

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	To identify minerals in rock using microscopes	PO1	C2, C3	CP1	-	KP3, KP4	R, Q

CO2	To characterize the coal	PO1	-	R, Q
CO3	To design the mineral separation flowchart to adapt the successive separation processes	PO3	-	R, ASG, Pre

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

CP- ***C****omplex* ***P****roblem/* ***WP***- ***W****ashington Accord Complex* ***P****roblem Solving;* ***CA***- ***C****omplex* ***A****ctivities/* ***EA***- ***E****ngineering* ***A****ctivities;* ***KP***- ***K****nowledge* ***P****rofile/* ***WK***- ***W****ashington Accord* ***K****nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	14
	1.2 Experiment/ Modeling	21
	1.3 Student-Centered Learning	7
2. Self-Directed Learning	2.1 Lab reports	14
	2.2 Quiz	4
	2.3 Preparation for quiz	7
3. Formal Assessment	3.1 Continuous Assessment	7
	3.2 Presentation	1
		75

TEACHING METHODOLOGY
Lecture, Numerical Modeling, Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Experiments	Assessments		
Week-1	Slide preparation for mineral identification.	R	Q1	
Week-2	Identification of minerals using microscopes.			
Week-3	Selection of crusher and crushing of rock.			
Week-4	Particle size analysis.			
Week-5	Sample preparation and frothfloatation of coal.			
Week-6	Proximate analysis of coal.			
Week-7			Q2	
Week-8	Simulation of coagulation and flocculation process.			
Week-9	Simulation of filtration and thickening process.			
Week-10	Simulation of electrostatic separation process.			

Week-11	Simulation of magnetic separation process.			
Week-12	Simulation of solid-liquid separation process.			
Week-13	Simulation of material balance calculations for mineral processing circuitand flow sheet design process.			ASG
Week-14				Pre

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1, CO2, CO3	A3, A4, P3, P4, P5, C2, C3
	1.2Assignment	30%		
	1.3 Presentation	25%	CO3	
2.Lab quiz (25%)		25%	CO1	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Mineral processing technology; B Wills. 2015, 512 pp.
b)Mineral Processing Plant Design, Practice, and Control; AL Mular, DJ Barratt, DN Halbe. 2002, 2500 pp.
c) Principles of Mineral Processing; MC Fuertenau, KN Han. 2003, 573 pp.
d) Mineral Processing Design and Operation: An Introduction; AGupta and DS Yan. 2006, 718 pp.
e) Principles of Mineral Dressing; AM Gaudin. 2006, 554 pp.
f) Modeling and Simulation of Mineral Processing Systems; RP King. 2001, 416 pp.
g) Supplied Materials.

PME 435	Mine Planning and Design	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The main objective of the course is to clarify the ideas and techniques needed for developing a mine plan for a geologic deposit in a systematic manner.

2. Learning objectives (OB)

a) To understand the principles and stages of mine planning.
b) To understand the technical aspects of open-pit and underground mine.
c) To prepare a mine model for a geologic deposit.

3. 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, Mine development phases, reserve estimation, Critical path presentation, Mine reclamation. **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, dewatering system analysis. Equipment selection.**Underground mine:** 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. **Models for Method selection:** UBC method, Entropy method, Vikor method, Mining Method Selection Tool (MMST), Models based on fuzzy TOPSIS.**Machine learning:**Application of ML algorithm in mine planning.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the theories and calculations for reserve estimation	✓											
CO2	Evaluate the technical aspects of the open-pit and underground mine		✓										
CO3	Apply the knowledge to select and make a plan of mining method for a geologic deposit		✓										

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/development of solutions, **PO4**: Investigation, **PO5**: Modern Tools, **PO6**: The Engineer and Society, **PO7**: Environment and Sustainability, **PO8**: Ethics, **PO9**: Individual and Team Work, **PO10**: Communication, **PO11**: Project Management and Finance, **PO12**: Life Long Learning

5. Mapping Of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Explain the theories and calculations for reserve estimation	PO1	C1, C2, C3	CP1, CP2	-	KP2-KP5	CT/ MID/ FExam
CO2	Evaluate the technical aspects of the open-pit and underground mine	PO2			-		CT/ MID/ FExam
CO3	Apply the knowledge to select and make a plan of mining method for a geologic deposit	PO2			-		ASG

C1: Remember, **C2:** Understand, **C3:** Apply, **C4:** Analysis, **C5:** Evaluate, **C6:** Create

CP1: KP3-KP6, KP8**, CP2:** Wide ranging/conflicting**, CP3:** No obvious solution**, CP4:** Infrequent issues**, CP5:** Outside problems**, CP6:** Diverse groups, **CP7:** Many components

CA1: Range of resources, **CA2:** Level of interaction, **CA3:** Innovation, **CA4:** Consequences, **CA5:** Familiarity

KP1: Science, **KP2:** Math, **KP3:** Eng fundamentals, **KP4:** Eng specialization, **KP5:** Design, **KP6:** Technology, **KP7:** Society, **KP8:** Research

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**General Mine Planning and design principles**	
Lecture-1	Principles of mine planning.	
Lecture-2	Stages of planning of new mines.	
Lecture-3	Stages of mine renovation.	
Week-2	**Exploration and reserve estimation**	
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	**Surface layout of a mine**	
Lecture-7	Types of mines.	
Lecture-8	Surface layouts.	
Lecture-9	Surface mine (mountain-top layout and sub-surface layout).	
Week-4	**Pit bottom and layout of an underground working**	
Lecture-10	Pit-bottom layout.	
Lecture-11	Layout of underground workings.	
Lecture-12	Detail of production face.	
Week-5	**Mine phases**	
Lecture-13	Mine development phases.	
Lecture-14	The planning phase.	
Lecture-15	Accuracy of estimates.	
Week-6	**Critical path analysis and the reclamation**	
Lecture-16	Critical path presentation.	
Lecture-17		
Lecture-18	Mine reclamation.	
Week-7	**Environmental planning**	
Lecture-19	Environmental planning procedure.	
Lecture-20	Environmental impact assessment.	
Lecture-21	Environmental management planning.	CT-1
Week-8	**Mining revenues and costs**	
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.	CT-2
Lecture-32	Stripping ratios, geometric sequencing Pit limits.	
Lecture-33	Dewatering system analysis. Equipment selection.	

Week-12	**Underground mine**	MID ASG
Lecture-34	Fundamental.	
Lecture-35	Access design.	
Lecture-36	Ventilation and dewatering system analysis andequipment.	
Week-13	**Miningmethod selection**	
Lecture-37	UBC method, Entropy method.	
Lecture-38	Vikor method, Mining Method Selection Tool (MMST).	
Lecture-39	Models based on fuzzy TOPSIS.	
Week-14		
Lecture-40	Review	
Lecture-41	Review	
Lecture-42	Review	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1.Continuous Assessment (40%)	1.1 Class Participation	10 %	-	A1, A2, P1, P2 C1, C2, C3
	1.2 Class Test/ Assignment	20%	CO1, CO3	
	1.3 Mid term	10 %	CO1, CO2	
2.Final Exam (60%)		60%	CO1, CO2	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

a) Open pit Mine Planning and Design;WA Hustruid, M Kuchta, RK Martin. 2013, 1308 pp.
b)Underground Mining Methods: Engineering Fundamentals and International Case Studies; WA Hustrulid, WA Hustruid, R C Bullock. 2001, 728 pp.
c) Introduction to Mining Engineering; HL Hartman, JM Mutmansky. 2002, 592 pp.
d) Supplied materials.

CHAPTER 6

OTHER DEPARTMENTAL COURSES

6.1 Interdisciplinary Engineering Courses

Sr No	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total	Page No
1	ME 176	Workshop Practice	L1 T1	1.5	3	Cr Hr **20.0 and** ContHr **26.0**	234 - 237
2	ME 180	Engineering Drawing and CAD	L2 T2	1.5	3		238 – 240
3	CE 181	Engineering Mechanics	L1 T2	3	3		241 – 244
4	CE 283	Strength of materials	L2 T1	3	3		245 – 249
5	EECE 261	Fundamentals of Electrical and Electronic Engineering	L2 T1	3	3		250 – 254
6	EECE 262	Fundamentals of Electrical and Electronic Engineering Laboratory	L2 T1	1.5	3		255 – 257
7	CSE 271	Introduction to Computer Programming	L2 T2	2	2		258 - 261
8	CSE 272	Computer Programming Sessional	L2 T2	0.75	1.5		262 – 265
9	ME 271	Fluid Mechanics	L2 T2	3	3		266 – 270
10	ME 272	Fluid Mechanics Laboratory	L3 T2	0.75	1.5		271 - 273

ME 176	**Workshop Practice**	
		3.00 ContHr; 1.50Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

To help the students to explore various welding techniques and put theory into practice. Our mission is to expose students to the construction of different mechanical machines and analyze their performance. This course is targeted to verify the working principle of types of welding, casting, molding and also to gain knowledge of different manufacturing parts from lathe, drilling, milling and drilling machine etc. and relate them with their theoretical knowledge.

2. Learning objectives (OB)

1. The student will be able to use different manufacturing (machining, welding, foundry, sheetmetal working, etc.) processes required to manufacture a product from the raw materials.
2. He will be able to use different measuring, marking, cutting tools used in workshop.
3. He will be aware of the safety precautions while working in workshop.

3. Course Contents

Experiments:

1) Design and making patterns for casting
2) Mold making, casting and assembly of final project
3) Study of electric arc welding
4) Study of Resistance Welding/Spot Welding
5) Study of Welding joints and welding positions
6) Study of Gas Welding/cutting
7) Study of TIG and MIG Welding
8) Manufacturing machine components by using a Lathe machine
9) Manufacturing machine components by using a Shaper machine
10) Manufacturing machine components by using a Milling Machine
11) Manufacturing machine components by using a Drilling Machine

4. Course Outcomes (CO) and Skill Mapping

COs	PROGRAM OUTCOMES (PO)											
	1	2	3	4	5	6	7	8	9	10	11	12

CO1	**Identify** the basics concepts of Safety and precaution systems, tool handing and different types of manufacturing processes with modern tools	✓		
CO2	**Develop** practical skills by performing different manufacturing processes individually and/or in a team.		✓	
CO3	**Justify** results obtained in the form of technical reports, projects and presentations			✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	**Identify** the basics concepts of Safety and precaution systems, tool handing and different types of manufacturing processes with modern tools	PO5	P3	-	-	1	R, Q, LT
CO2	**Develop** practical skills by performing different manufacturing processes individually and/or in a team.	PO9	P3	-	-	1	R, Q, LT
CO3	**Justify** results obtained in the form of technical reports, projects and presentations	PO10	C4	-	-	1	R, Q, LT

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		**Engagement (hours)**
4. Face-to-Face Learning	1.1 Lecture	14
	1.2 Experiment/ Modeling	28
	1.3 Student-Centered Learning	-

5. Self-Directed Learning	2.1 Preparation: Lab reports a. Preparation: Lab test b. Preparation: Presentation c. Preparation: quiz d. Group projects	10 10 5 10 20
7. Formal Assessment	3.1 Continuous Assessment 3.2 Presentation	14 1
		112

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

7. Teaching Schedule

Lecture	Experiments
Week-1	Design and making of pattern for casting
Week-2	Mold making, casting and assembly of final project
Week-3	Study of electric arc welding
Week-4	Study of Resistance Welding/Spot Welding
Week-5	Study of Welding joints and welding positions
Week-6	Study of Gas Welding/cutting
Week-7	Study of TIG and MIG Welding
Week-8	Manufacturing of machine component by using Lathe machine
Week-9	Manufacturing of machine component by using Shaper machine
Week-10	Manufacturing of a machine component by using Milling Machine
Week-11	Manufacturing of a machine component by using Drilling Machine
Week-12	Final Lab Report Submission
Week-13	Viva
Week-14	Quiz Test

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (60%)	1.1 Lab Participation and report	30%	CO1, CO2	C1, C2, P1, P2, P3, P4, P5
	1.2Lab test 1.3Lab test	30%	CO2, CO3	C2, C3, A5 A1, A2, A3, A4
4. Lab quiz (40%)		40%	CO2	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Machine Shop Practice – James Anderson, W. A. Chapman.
2. Callister W. D., Material Science & Engineering, John Wiley & Sons.

ME 180	Basic Engineering Drawing and CAD	
		3.00 ContHr; 1.50Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

This course is designed for learners to learn engineering drawing skills both manual and computer based as a means of accurately and clearly communicating ideas, information and instructions and use them to communicate with others through engineering drawings and solve complex problems of real world.

2. Learning objectives (OB)

1. To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions.
2. To enable the students to read various professional drawing that will enhance their exposure to real engineering practices.
3. To enable students to acquire requisite knowledge, techniques and attitude required for advanced study of engineering drawing.

3. Course Contents

Introduction; Instruments and their uses; First and third angle projections; Orthographic drawings; Isometric views; Sectional views and conventional practices; Introduction to AutoCAD/Solid Works, Real life drawing inspection and identification

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Demonstrate proficiency in using drawing instruments for sketches.					✓							
CO2	Analyze the 2D and 3D views for various sample objects individually and/or in a team.									✓			
CO3	Justify sketches obtained in the form of drawing reports, and projects.										✓		

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Demonstrate proficiency in using	PO5	C3, A3	-	-	4	T, Q

	drawing instruments for sketches.						
CO2	Analyze the 2D and 3D views for various sample objects individually and/or in a team.	PO9	C3, A3	-	-	4,6	T, Q
CO3	Justify sketches obtained in the form of drawing reports, and projects.	PO10	C3, A3	-	-	4	T, ASG, F

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
6. Face-to-Face Learning	1.1 Lecture	14
	1.2 Experiment/ Modeling	28
	1.3 Student-Centered Learning	-
7. Self-Directed Learning	2.1 Preparation: Lab reports	10
	a. Preparation: Lab test	10
	b. Preparation: Presentation	5
	c. Preparation: quiz	10
	d. Group projects	20
8. Formal Assessment	3.1 Continuous Assessment	14
	3.2 Presentation	1
		112

TEACHING METHODOLOGY
Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

7. Teaching Schedule

Lecture	Experiments	Assessments
Week-1	Introduction	MID
Week-2	First and third angle projections.	
Week-3	Orthographic drawings.	
Week-4	Orthographic drawings.	
Week-5	Isometric views.	
Week-6	Isometric views.	
Week-7	Mid-term Exam.	
Week-8	Sectional views and conventional practices.	FExam

Week-9	Solid Works Practice – Orthographic Drawing.	
Week-10	Solid Works Practice – Orthographic Drawing.	
Week-11	Solid Works Practice – Orthographic Drawing.	
Week-12	Actual drawing reading practice – Power plant layout, Cooling tower sectional view, Steam generator sectional view	
Week-13	Actual drawing reading practice – Pump cut sectional view, Welding joints ISO symbol, Fluid power and control ANSI symbol.	
Week-14	Final Exam	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1, CO2,CO3	C1, C2, P1, P2, P3, P4, P5
	1.2 Presentation 1.3 Lab test 1.3 Lab test	20% 30%	CO1,CO2, CO3	C2, C3, A5 A1, A2, A3, A4
2. Lab quiz (25%)		30%	CO1,CO2, CO3	C1, C2
		100%		

C: *Cognitive domain;* ***A***: *Affective domain;* ***P***: *Phychomotor domain*

9. Materials Recommended

1. Lab Handbook
2. Mechanical Engineering Drawing – A C Mandal, M Quamrul Islam

CE 181	**Engineering Mechanics**	***3.00 ContHr; 3.00 Cr Hr***
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

Purpose of this course is to provide students the basic concept and in-depth knowledge in the field of mechanics of rigid body which will be helpful for their future study/ courses.

2. Learning objectives (OB)

1. Understanding different force systems and their basic mathematics in order to solve statically determinate stationary rigid bodies, external / internal forces in a statically determinate beam, trusses and frames composed of pin connected members and forces developed in the cables and supports.
2. To apprehend the problems involving belt, rope and gear train and their real application (in a limited scale).
3. To determine geometric properties like centorids of line, area and volume, Moment of inertia of areas and masses and corresponding radius of gyration of single and composite areas.
4. Solve different problems with the concept of linear impulse-momentum and principle of work-energy.

3. Course Contents

Coplanar and non-coplanar force systems; concepts of free body diagram, equations for static equilibrium; internal forces and moments, analyses of two-dimensional frames and trusses; friction, Belt, rope and chain drive: power transmitted by belt; gear train: simple and compound gear train; centroids of lines, areas and volumes; moments of inertia of areas and masses; plane motion; liner momentum and impulse, principle of work and energy.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Ability to understand free body diagram of different types of rigid bodies.	✓											
CO2	Ability to apply equations of equilibrium to analyze statically determinate rigid bodies.		✓										
CO3	Ability to **estimate** the geometric properties like centroids, moment of inertia etc. of different objects.	✓											
CO4	Ability to **apply** the principles of impulse and momentum and principle of work-energy		✓										

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes (CO)	POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods

CO1	Ability to understand free body diagram of different types of rigid bodies.	PO1	C2	1	-	3	CT, ASG
CO2	Ability to apply equations of equilibrium to analyze statically determinate rigid bodies.	PO2	C3	1	-	3, 4	CT, ASG, MID, Q, FExam
CO3	Ability to **estimate** the geometric properties like centroids, moment of inertia etc. of different objects.	PO1	C3	1	-	3, 4	CT, ASG, MID, Q, FExam
CO4	Ability to **apply** the principles of impulse and momentum and principle of work-energy	PO2	C3	1	-	3	FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**i**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
10. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
11. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision of lecture at home 2.3 Preparation for final examination	18 33 22
12. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		120

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method(PBL)

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	Resultant and Components of Forces.	
Lecture-2	Types of Forces and Introduction to Coplanar Concurrent Forces	
Lecture-3	Centroids: Definitions of centroids, centre of mass and centre of gravity, Formulas of centroids for line, area and volume.	
Week-2		
Lecture-4	Concept of Equilibrium.	
Lecture-5	Free Body Diagrams.	

Lecture-6	Principle of symmetry and centroid, centroid by summation method.	CT_1
Week-3		
Lecture-7	Moments and parallel coplanar forces	
Lecture-8	Moments and parallel coplanar forces	
Lecture-9	Centroid by Integration, practice centroid of lines by integration, Centroid of plane triangle, Centroid of sector of a circle, Centroid of area without axis of symmetry.	
Week-4		
Lecture-10	Moments and parallel coplanar forces	
Lecture-11	Moments and parallel coplanar forces	
Lecture-12	Centroid of a volume (right circle cone, cylinder, hemisphere etc.)	
Week-5		
Lecture-13	Analysis of Truss by Method of Section	
Lecture-14	Concept of Moments	
Lecture-15	Centroid of composite area	
Week-6		
Lecture-16	Concept of Parallel Force System.	
Lecture-17	Determination of Reaction Forces, Forces on Members of Frames	
Lecture-18	Centroid of composite area, Centroid of composite volume.	
Week-7		
Lecture-19	Analysis of 2D Frames	
Lecture-20	Analysis of 2D Frames	
Lecture-21	Theorem of Pappus and Guldinus	
Week-8		
Lecture-22	Analysis of Truss by Joint-to-Joint Method	
Lecture-23	Concept of Rectangular and Polar moment of Area and radius of gyration, Parallel axis and perpendicular axis theorem (Transfer formula, rectangular to polar)	
Lecture-24	Practice problems of Rectangular Moment of Inertia and radius of gyration with axis of symmetry (Rectangle, triangle etc)	
Week-9		
Lecture-25	Analysis of Truss by Method of Section	
Lecture-26	Moment of inertia of areas by integration	
Lecture-27	Moment of inertia of composite areas	
Week-10		
Lecture-28	Concept of Friction	
Lecture-29	Maximum and Minimum Moment of Inertia by formula and Mohr's circle	
Lecture-30	Moment of inertia of mass and practice problems (Sphere, thin disk, cone)	
Week-11		
Lecture-31	Analysis of Wedges	
Lecture-32	Moment of Inertia of Composite areas	
Lecture-33	Moment of inertia of mass and practice problems (Sphere, thin disk, cone)	CT_2
Week-12		
Lecture-34	Belt, rope and chain drive: power transmitted by belt	MID
Lecture-35	Plane motion	
Lecture-36	Problem solving on plane motion	
Week-13		ASG

Lecture-37	Gear train: simple gear train	
Lecture-38	Principle of impulse and momentum	
Lecture-39	Problems solving on impulse and momentum	
Week-14		
Lecture-40	Gear train: compound gear train	
Lecture-41	Principle of work and energy	
Lecture-42	Problems solving on principle of work and energy	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
8.Continuous Assessment (40%)	1.1 Class Participation	5%	CO1, CO2, CO3, CO4	C2, C3
	1.2 Class Test/ Assignment 1-3	20%		
	1.3 Mid term	15%		
9.Final Exam (60%)		60%	CO2, CO3, CO4	C3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. “Analytic Mechanics” by – Faires& Chambers (3rd Edition).
2. “Engineering Mechanics” by – Singer.
3. “Engineering Mechanics: Statics”, 13th Ed., Hibbeler.
4. “Engineering Mechanics: Dynamics”, 13th Ed., Hibbeler.
5. “Fundamentals of Physics:, 9th Ed., Halliday, Resnick and Walker.

CE 283	Strength of Materials	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite: CE 181		**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

In this course students will be introduced to basic solid mechanics including stress, strain, deformation, different loads, behavior of structures under various loading.

2. Learning objectives (OB)

1. Gain a fundamental understanding of the concepts of stress and strain by analysis of solids and structures. Study engineering properties of materials, force-deformation, and stress-strain relationship.
2. Analyse axial members, torsional members, and beams for axial force, shear, torsion and moment.
3. Determine stress, strain, deformation of various structural components.
4. To gain knowledge about the effect (state of stress) on beam due to combined loading and the transformation stresses and construction Mohr's circles of stress
5. To understand Euler's buckling theory and its application in compressive members.

3. Course Contents

Properties and uses of cement, sand and stone, Concept of stress and Strain, Hook's law, stress-strain diagram, behaviour of ductile and brittle materials, Poisson's ratio; Modulus of rigidity and bulk modulus; Axial and transverse load; deformation due to tension, compression and thermal change, Beam static: axial force, shear force and bending moment diagram, symmetric and unsymmetric bending of beam, shear stress of beam, deflection of beam using direct integration and moment area method; Stresses in thin-walled pressure vessels.

Elastic analysis of circular shaft, solid non circular and thin-walled tubular members subjected to torsion, closely coil helical spring; Buckling of columns: Euler's buckling of columns; Stress transformation: Mohr's circle of stress.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To **apply** the formal theory of solid mechanics to calculate forces, deflections, moments, stresses, and strains in a wide variety of structural members subjected to tension, compression, torsion, bending, both individually and in combination.	✓											
CO2	To **understand** the concepts of stress at a point, strain at a point, and the stress-strain relationships for linear, elastic, homogeneous, isotropic materials.	✓											

CO3	To **determine** principal stresses and angles, maximum shearing stresses and angles, and the stresses acting on any arbitrary plane within a structural element.	✓
CO4	Understand the fundamental buckling phenomena of axially loaded members	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	To **apply** the formal theory of solid mechanics to calculate forces, deflections, moments, stresses, and strains in a wide variety of structural members subjected to tension, compression, torsion, bending, both individually and in combination.	PO1	C3	1	-	1,3	CT, ASG, MID, Q, FExam
CO2	To **understand** the concepts of stress at a point, strain at a point, and the stress-strain relationships for linear, elastic, homogeneous, isotropic materials.	PO1	C2	2	-	1,2	CT, ASG, MID, Q, FExam
CO3	To **determine** principal stresses and angles, maximum shearing stresses and angles, and the stresses acting on any arbitrary plane within a structural element.	PO2	C3	1	-	3, 4	CT, ASG, MID, Q, FExam
CO4	Understand the fundamental buckling phenomena of axially loaded members	PO2	C2	1	-	3	FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
13.	Face-to-Face Learning	

	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 15 -
14. Self-Directed Learning	2.1 Individual Learning 2.2 Preparation for final examination	36 22
15. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		120

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method(PBL)

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	Introduction, properties and uses of cement, sand and stone,	
Lecture-2	Properties and uses of cement, sand and stone,	
Lecture-3	Beam static: reactions	
Week-2		
Lecture-4	Concept of stress and Strain	
Lecture-5	Hook's law, stress-strain diagram, behaviour of ductile and brittle materials	
Lecture-6	Axial force, shear force and bending moment of beam	
Week-3		
Lecture-7	Poisson's ratio, Modulus of rigidity and bulk modulus	
Lecture-8	Axial and transverse load	
Lecture-9	Calculation of reactions, axial force, shear and bending moment	
Week-4		
Lecture-10	Deformations due to tension, compression	
Lecture-11	Thermal stress and strain	
Lecture-12	Axial force, shear and bending moment diagrams	
Week-5		
Lecture-13	Stress transformation	
Lecture-14	Stress transformation	
Lecture-15	Axial force, shear and bending moment diagrams	
Week-6		
Lecture-16	Stress transformation: Mohr's circle of stress	
Lecture-17	Stress transformation: Mohr's circle of stress	
Lecture-18	Axial force, shear and bending moment diagram	
Week-7		
Lecture-19	Elastic analysis of circular subjected to torsion	
Lecture-20	Elastic analysis of circular members subjected to torsion	CT_1

Lecture-21	Flexural stresses in beams	
Week-8		
Lecture-22	Elastic analysis of solid non circular members subjected to torsion	
Lecture-23	Flexural stresses in beams	
Lecture-24	Flexural stresses in beams	
Week-9		
Lecture-25	Behaviour of closely coil helical spring	
Lecture-26	Shear stresses in beams	
Lecture-27	Shear stresses in beams	
Week-10		
Lecture-28	Behaviour of closely coil helical spring	
Lecture-29	Shear stresses in beams	
Lecture-30	Deflection of beam using direct integration	
Week-11		
Lecture-31	Buckling of columns	
Lecture-32	Deflection of beam using direct integration	
Lecture-33	Deflection of beam using direct integration	CT_2
Week-12		MID
Lecture-34	Buckling of columns	
Lecture-35	Deflection of beam using moment area method	
Lecture-36	Deflection of beam usingmoment area method	
Week-13		CT-3/ASG
Lecture-37	Buckling of columns: Euler's buckling of columns	
Lecture-38	Deflection of beam using moment area method	
Lecture-39	Stresses in thin-walled pressure vessel	
Week-14		
Lecture-40	Buckling of columns: Euler's buckling of columns	
Lecture-41	Stresses in thin-walled pressure vessel	
Lecture-42	Stresses in thin-walled pressure vessel	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
10. Continuous Assessment (40%)	1.1 Class Participation	10%	CO1, CO2, CO3	C2, C3
	1.2 Class Test/ Assignment 1-3	20%		
	1.3 Mid term	10%		
11. Final Exam (60%)		60%	CO1	C3
			CO2	C2
			CO3	C3
			CO4	C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. "Engineering Mechanics of Solids" by –Egor P. Popov (2nd Edition).
2. "Mechanics of Materials" by – Beer, Johnston and Dewolf (4th Edition).
3. "Mechanics of Materials " by – R.C. Hibbeler (7th Edition).
4. "Mechanics of Materials " by – Ferdinand L. Singer and Andrew Pytel (4th Edition).
5. "Strength of Materials " by – W A nash (4th Edition).

EECE-261	**Fundamentals of Electrical and Electronic Engineering**	***3.00 ContHr; 3.00 Cr Hr***
Pre-requisite: None		**Curriculum structure:** Outcome Based Education (OBE)

1. 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.

2. Learning objectives (OB)

1. To develop the basics of electrical circuits and different problems solving techniques.
2. To familiarize students with basic electronic device.
3. To impart the basic operating principle of electrical machines like DC motor, DC generator and Transformer etc.
4. To impart the basic knowledge of electrical control system and instrumentation.

3. Course Contents

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

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be proficient enough to apply basic circuit laws and conclude which is the most effective analysis technic to analyse and solve dc and ac circuit.			✓									
CO2	Be familiarized with electronic devices and become expert in comparing the input and output characteristics.	✓											
CO3	Be able to describe the principle of operation, explain the construction, classify as per construction or operation of the electrical machines.	✓											
CO4	Be familiar with electrical control system, concept of feedback, criteria for sensors and transducers selection and select appropriate measurement methods for engineering tasks.	✓											

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Be proficient enough to apply basic circuit laws and conclude which is the most effective analysis technic to analyse and solve dc and ac circuit.	PO3	C5	-	-	1, 2	CT, FExam
CO2	Be familiarized with electronic devices and become expert in comparing the input and output characteristics.	PO1	C4	1	-	3	CT, ASG, FExam
CO3	Be able to describe the principle of operation, explain the construction, classify as per construction or operation of the electrical machines.	PO1	C2	-	-	1	CT, MID, FExam
CO4	Be familiar with electrical control system, concept of feedback, criteria for sensors and transducers selection and select appropriate measurement methods for engineering tasks.	PO1	C2	1	-	3	CT, FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
2. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision of lecture at home 2.3 Preparation for final examination	42 21 21
3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
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., Fossil Power	
Lecture-3	Gas and Nuclear power generation.	
Week-2		
Lecture-4 Lecture-5	**DC Networks**: Kickoff's laws, Node voltage and mesh current methods.	
Lecture-6	Delta-star and star-delta conversion. Superposition principle	
Week-3		
Lecture-7	Thevenin's and Norton's theorems	
Lecture-8	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	
Lecture-15	Three phase four wire circuits	CT_1

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 Lecture-20	**Electrical Measuring Instruments**: DC PMMC instruments, Shunt and multipliers, Multimeters, Moving iron ammeters and voltmeters	
Lecture-21	Dynamometers, Wattmeter AC watthour meter, Extension of instrument ranges.	
Week-8		
Lecture-22 Lecture-23	**Electrical Machines:** DC generators: Construction, operation and types	CT2
Lecture-24	DC motors: Operation, classification, characteristics and applications Transformers: Operation and classification.	
Week-9		
Lecture-25 Lecture-26	Three Phase Induction Motors: Working principle, characteristics and starting, Alternators.	
Lecture-27	Working principle and synchronization 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. Switchgears, Earthing methods.	
Lecture-32 Lecture-33	Protective devices: over current and over voltage.	MID
Week-12		
Lecture-34	**Control and Instrumentation:** Introduction to control system.	
Lecture-35	Open loop and closed loop system, remote control, sequence control.	CT3
Lecture-36	Introduction to programmable logic controller, embedded controller.	
Week-13		
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.	CT4
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.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	5%	CO1, CO2, CO3, CO4	C2, C4, C5
	1.2 Class Test/ Assignment 1-3	20%		
	1.3 Mid term	15%		
2. Final Exam (60%)		60%	CO1, CO2, CO3, CO4	C2, C4, C5
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Introductory Circuit Analysis (10th edition)- Robert Boylested
2. Electric Circuits (9th Edition) -- James William Nilsson
3. Electronic Device and Circuit Theory by Robert L. Boylestad
4. Basic Electrical and Electronics Engineering by Sabyasachi Bhattacharya
5. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N.O. Sadiku
6. A Textbook of Electrical Technology - B. L. Theraja
7. The Engineering Handbook by Richard C. Dorf
8. Control Systems Engineering by Norman S. Nise
9. ‘A Course in Electrical and Electronic Measurements and Instrumentation’ by A. K. Sawhney,

EECE 262 Fundamentals of Electrical and Electronic Engineering Laboratory

3.00ContHr; 1.50Cr Hr

Pre-requisite: EECE 261 **Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

Electrical Engineering lab is designed to impart into the students the basic concepts of electrical engineering encompassing the practical implementations of DC and AC circuits. At the beginning of this course, students will get to know the projection of fundamental DC circuit using the basic equipment along with the observation of the basic theorems as well as the AC circuit concepts will be experimented accompanying the showcase of various types of filter and their characteristics. In the following part of the lab, some basic electronics experiment using diode and transistor will be done. In the last part of the course, the students will be familiarized with various electrical machines like DC and Ac motor and generator.

2. Learning objectives (OB)

1. To introduce the students to basic DC circuit laws and solving of complex circuits using basic circuit theorems.
2. To impart into the students with the AC circuit hardware construction and operation.
3. To familiarize the students with different type of filter construction and their characteristics.
4. To give in depth knowledge on the basic electronics circuit using diode and transistor.
5. To introduce the students to different type of Dc and AC motor and generators.

3. Course Contents

In this course, students will perform experiments to practically verify the theories and concepts learned in EECE 261 using different hardware equipment and simulation software.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Achieving the quality to construct DC, AC and electric circuits and justify the basic laws as well as to modify the complex circuits into simple circuits.									✓			
CO2	Attaining the competency to reproduce the basic filters and explain their characteristics										✓		
CO3	Acquiring the proficiency to demonstrate the DC and AC machine like motor and generator characteristics with basic component									✓			

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Achieving the quality to construct DC, AC and electric circuits and justify the basic laws as well as to modify the complex circuits into simple circuits.	PO9	A4	-	-	2	R, Q, CT
CO2	Attaining the competency to reproduce the basic filters and explain their characteristics	PO10	P3	-	-	3	R, Q, CT
CO3	Acquiring the proficiency to demonstrate the DC and AC machine like motor and generator characteristics with basic component	PO9	A3	-	1	3	R, Q, CT

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**i**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	12
	1.2 Experiment/ Modeling	30
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Preparation: Lab reports	24
	2.2 Preparation: Lab test	6
	2.3 Preparation: Presentation	5
	2.4 Preparation: quiz	6
	2.5 Group projects	26
3. Formal Assessment	3.1 Continuous Assessment	10
	3.2 Presentation	1
		120

TEACHING METHODOLOGY
Lecture followed by practical experiments and discussion, Co-operative and Collaborative

Method, Project Based Method

7. Teaching Schedule

Lecture	Experiments
Week-1	Verification of KVL and KCL.
Week-2	Verification of Thevenin's Theorem.
Week-3	Familiarization with alternating current (ac) waves and study of RLC series circuit.
Week-4	Different types of filters and its characteristics with different input frequency.
Week-5	Study the diode characteristics and rectifier circuit.
Week-6	Study of N-P-N CB (Common base) and CE (Common emitter) transistor characteristics.
Week-7	Regulation of the Transformer in Various Loads.
Week-8	Study the properties of Three-Phase Alternator in various loads.
Week-9	Study the properties of DC Shunt Motor.
Week-10	Study the properties of DC Separately Excited and Self-Excited Shunt Generator.
Week-11	P Study the properties of Squirrel-Cage Induction Motor.
Week-12	Quiz
Week-13	Lab test + Viva
Week-14	Presentation

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (75%)	1.1 Lab Participation and report	20%	CO1, CO2, CO3	A4, P3, A3
	1.2 Lab test 1.3 Lab test	40%	CO1, CO2, CO3	A4, P3, A3
4. Lab quiz (25%)		40%	CO1, CO2, CO3	A4, P3, A3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Introductory Circuit Analysis- Robert Boylested
2. Electronic Device and Circuit Theory by Robert Boylestad
3. Basic Electrical and Electronics Engineering by Sabyasachi Bhattacharya
4. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N.O. Sadiku
5. A Textbook of Electrical Technology - B.L.Theraja
6. Control Systems Engineering by Norman S. Nise
7. A Course in Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney.

CSE 271 **Introduction to Computer Programming**

2.00 ContHr; 2.00 Cr Hr

Pre-requisite: None **Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The Introduction to Computer Programming Language course is designed to introduce the fundamental principles, mechanism of programming skills and develop basic programming skills to program design and development. The course begins with introductory concepts of structured programming language and then covers other important topics related to structured programming language. It also deals with basic operations of C++ language.

2. Learning objectives (OB)

1. To describe algorithm and solve problems using computers.
2. To know about various syntax, semantics of computer programming languages.
3. To develop basic programming skills with respect to program design and development.

3. Course Contents

Introduction to computer programming: Programming Concepts, Program Development Stages, Structured Programming Language; **Number System:** binary, octal, decimal and hexadecimal systems; **Basic programming Structures:** Data types and their memory allocation, Operators, Expressions, Basic Input/output; **Control Structure:** “if else”, “switch”, Flow Charts, Loop, Nested Loop; **Arrays:**One-dimensional array, Multi-dimensional array, Character array/ string; **Function:**Function definition, Function declaration, Function call;**Pointer:** Different types of pointers, Pass pointer as arguments, Call by value vs call by reference; **Dynamic Memory Allocation:** Malloc, Calloc, Free, Realloc; **User defined data types:** Structures, Unions, Enumerations; **Bitwise operations:** AND, OR, NOT, XOR, Left shift, Right Shift; File I/O; Header files, Preprocessor; Error Handling; **Introduction to C++:** Basic Ideas of OOP- encapsulation, inheritance and polymorphism, Classes and objects.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Describe algorithm and solve problems using computers.	✓											
CO2	Analyse the fundamental principles, typical characteristics and mechanisms of a computer programming language.		✓										
CO3	Develop basic programming skills with respect to program design and development.			✓									

CO4	Able to develop the communication skill by presenting topics on Computer Programming Language.	✓

5. Mapping of Course Outcomes (CO) and General Skills

	Course Outcomes(CO)	POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO 1	Describe algorithm and solve problems using computers.	PO 1	C1,C2, C3	1	1	1	CT
CO 2	Analyse the fundamental principles,typicalcharacteristics and mechanisms of a computer programming language.	PO 2	C2-C4	3	2	2	CT, FExam, MID
CO 3	Apply theoretical and practical skills in real life problems through case studies and develop basic programming skills with respect to program design and implementation.	PO 3	C3-C5	1,3	5	3	, FExam
CO 4	Performance analysis and optimization of computer programs by applying various algorithms and techniques.	PO 4	C4-C6	3	5	4	Pre

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
16. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
17. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision of lecture at home 2.3 Preparation for final examination	42 21 21
18. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1 Lecture-1 Lecture-2	Programming Concepts, Program Development Stages, Structured Programming Language.	
Week-2 Lecture-3 Lecture-4	Number System: binary, octal, decimal and hexadecimal systems; Data types and their memory allocation.	
Week-3 Lecture-5 Lecture-6	Operators, expressions, Basic Input/output; Control Structure: “if else”, “switch”, Flow Charts.	CT_1
Week-4 Lecture-7 Lecture-8	Control Structures: Loop(for,while,do-while).	
Week-5 Lecture-9 Lecture-10	Control Structures: Nested Loop.	
Week-6 Lecture-11 Lecture-12	Arrays, Multidimensional Arrays.	CT_2
Week-7 Lecture-13 Lecture-14	String and string manipulation.	
Week-8 Lecture-15 Lecture-16	Function, parameter passing convention.	
Week-9 Lecture-17 Lecture-18	Pointer, linear linked list, circular linked list.	
Week-10 Lecture-19 Lecture-20	Dynamic Memory Allocation.	
Week-11 Lecture-21 Lecture-22	User defined data types: structures, unions, enumerations. File I/O; Header files, Preprocessor directives.	MID
Week-12 Lecture-23 Lecture-24	Error Handling; Bitwise Operations. Performance analysis and time-space complexity, Bitwise Operations.	
Week-13 Lecture-25 Lecture-26	Introduction to C++: Basic Ideas of OOP- encapsulation, inheritance and polymorphism.	CT_3
Week-14		

Lecture-27 Lecture-28	Introduction to C++: Classes and objects.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
12. Continuous Assessment (40%)	1.1 Class Participation	10%	CO4	A2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3, C4
	1.3 Mid term	10%	CO2	C4
13. Final Exam (60%)		60%	CO2, CO3	C4, C6
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Teach Yourself C - Herbert Schidlt.
2. Programming in Ansi C - E Balagurusamy.
3. C: The Complete Reference - Herbert Schildt.
4. C Programming Language – Dennis M. Ritche.

CSE 272	**Introduction to Computer Programming Sessional**
	1.50ContHr; 0.75Cr Hr
Pre-requisite: None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The Introduction to Computer Programming Sessional course is designed to practically introduce the fundamental principles, mechanism of programming skills and develop basic programming skills to program design and development. The course begins with introductory concepts of structured programming language and then covers other important topics related to structured programming language. It also deals with basic operations of C++ language.

2. Learning objectives (OB)

1. To learn basic idea of programming languages.
2. To learn how to program with C, C++.
3. To learn how to think about the problems, their solutions and translating it to programming language.

3. Course Contents

Basic programming Structures: Mathematical problems using printf, scanf, Data types and their memory allocation, Operators, Expressions, Basic Input/output, Data type conversion; Control Structure: Practice problems on "if else", "switch", Flow Charts, Loop, Nested Loop;**Arrays:**Practice problems on One-dimensional array, Multi-dimensional array, Character array/ string; Function: Practice problems on Function, Parameter Passing Convention; **Pointer**: Practice problems on Different types of pointers, Pass pointer as arguments, Call by value vs call by reference;**Dynamic Memory Allocation:**Dynamically allocate memory using Malloc, Calloc, Free, Realloc;**User defined data types:**Practice problems on Structures, Unions, Enumerations; File I/O; Header files, Preprocessor; Error Handling;**Introduction to C++**: classes and objects.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Discuss algorithm and solve problems using computers.	✓											
CO2	Practically analyze the fundamental principles, typical characteristics and mechanisms of a structured programming language.		✓										
CO3	Apply practical knowledge to develop basic programming skills with respect to program design and development.			✓									
CO4	Develop communication skills by presenting project topic on										✓		

Computer Programming.

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Discuss algorithm and solve problems using computers.	PO1	C1, C2, C3	1	3	5	Q, CT, ASG
CO2	Practically analyze the fundamental principles, typical characteristics and mechanisms of a structured programming language.	PO2	C4	3	-	7	Q, CT, ASG
CO3	Apply practical knowledge to develop basic programming skills with respect to program design and development.	PO3	C3, C6	1, 3	3	7	ASG
CO4	Develop communication skills by presenting project topic on Computer Programming.	PO10	-	4	5	4	Pre

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Assig**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
8. Face-to-Face Learning	1.1 Lecture	-
	1.2 Experiment/ Modeling	42
	1.3 Student-Centered Learning	-
9. Self-Directed Learning	2.1 Preparation: Lab reports	-
	a. Preparation: Lab test	-
	b. Preparation: Presentation	-
	c. Preparation: quiz	-
	d. Group projects	-

14.	Formal Assessment	3.1 Continuous Assessment 3.2 Presentation	4 3
			49

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Experiments
Week-1	Mathematical problems using printf, scanf; Introduction to data types, mathematical problems using data types, data type conversion.
Week-2	
Week-3	Practice problems on "if else", "else if", "switch"; Practice problems on Nested "if else".
Week-4	
Week-5	Practice problems on Loop- For, Do While, Nested Loop; Practice problems on Nested Loop, Array, Multidimensional Array, string
Week-6	
Week-7	Practice problems on Function, Parameter Passing Convention; Practice problems on Pointer, Dynamic Memory Allocation.
Week-8	
Week-9	Practice problems on User Defined Data Types: Structure, Union; Practice problems on Dynamic memory allocation, File I/O.
Week-10	
Week-11	Practice problems on Error Handling; Problems on C++: Objects and Classes. Mini Project Allocation
Week-12	
Week-13	Mini Project demonstration and group presentation
Week-14	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
5. Continuous Assessment (75%)	1.1 Lab Participation	10%	CO1	C1, C2, C3
	1.2 Lab test	20%	CO1, CO2	C1, C2, C3, C4
	1.3 Assignment	10%	CO3	C3, C6
	1.4 Online test 1 1.5Online test 2	40%	CO1, CO2	C1, C2, C3, C4
6. Lab quiz (25%)		20%	CO2,CO4	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Teach Yourself C - Herbert Schidlt.
2. Programming in Ansi C - E Balagurusamy.
3. C: The Complete Reference - Herbert Schildt.
4. C Programming Language – Dennis M. Ritche.

ME 271	**Fluid Mechanics**	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

5. Rationale

To give fundamental knowledge of fluid, its properties and behaviour 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. To introduce the students to different fluid power driven machineries and components, Fluid turbo-machinery theory, performance characteristics of centrifugal and axial flow fans, compressors, pumps and turbines, fluid vibrations and sound, water hammer, introduction to fluid power controls and fluid amplifiers, operating principle and design.

6. Learning objectives (OB)

1. To introduce fundamental aspects of fluid flow behavior.
2. 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.

3. 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, centre 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 Bernoulli‘s‘ equation. Energy equation with or without losses, comparison of energy equation with Bernoulli‘s 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.

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 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.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology, concepts and techniques applicable to Fluid Mechanics	✓											
CO2	Demonstrate the ability to use fundamental equations related to fluids in solving fluid flow problems	✓											
CO3	Explain various fluid machineries along with their performance parameters	✓											
CO4	Solve different problems related to fluid machineries.		✓										

10. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Recognize the main terminology, concepts and techniques applicable to Fluid Mechanics	PO1	C1,C2, C3	1,4,6	-		Q, ASG, FExam
CO2	Demonstrate the ability to use fundamental equations related to fluids in solving fluid flow problems	PO1	C2, C3	2,5,6	-		Q, ASG, FExam
CO3	Explain various fluid machineries along with their performance parameters	PO1	C2, C3, C4	1,3	1, 2		Q, ASG, FExam
CO4	Solve different problems related to fluid machineries.	PO2	C4	2,5	1		Q, FExam

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

11. Teaching- Learning Strategy

Activities			Engagement (hours)
19.	Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
20.	Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision of lecture at home 2.3 Preparation for final examination	75
21.	Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	5.5
			122.5

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method(PBL)

12. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	**Introduction**: Fundamental concepts, Viscosity, Compressibility, Surface tension and capillarity.	
Lecture-2 Lecture-3	Vapor pressure, Manometers and other pressure measuring devices.	
Week-2		
Lecture-4 Lecture-5	**Fluid Statics**: Pressure at a point, pressure gradient, Pressure on flat and curved surfaces immersed in fluids, center of pressure.	
Lecture-6	Buoyancy and flotation.	
Week-3		
Lecture-7	Metacentre and metacentric height.	
Lecture-8	Stability of submerged and floating bodies.	
Lecture-9	**Kinematics of Fluid Flow**: Velocity and acceleration of fluid particles, types of fluid flow, systems and control volumes.	
Week-4		
Lecture-10	One and two dimensional flow; continuity equation.	
Lecture-11 Lecture-12	Eulers' equation and Bernoulli's' equation.	
Week-5		
Lecture-13 Lecture-14 Lecture-15	Energy equation with or without losses, comparison of energy equation with Bernoulli's equation, kinetic energy correction factor.	
Week-6		
Lecture-16	Flow measuring devices.	
Lecture-17 Lecture-18	Flow through sharp edged orifice, the pitot tube, the venturi-meter, the flow nozzle and orifice meter.	
Week-7		
Lecture-19 Lecture-20	**Fluid Machinery**: Introduction to roto-dynamic and positive displacement machinery; Euler's pump turbine equation.	CT_1

Lecture-21	Degrees of reaction.	
Week-8 Lecture-22 Lecture-23 Lecture-24	Impulse and reaction turbine classification performance of Pelton wheel.	
Week-9 Lecture-25 Lecture-26 Lecture-27	Francis turbine and Kaplan turbine.	
Week-10 Lecture-28 Lecture-29 Lecture-30	Characteristic curves, governing of turbines selections and model test of turbine.	
Week-11		
Lecture-31	**Reciprocating Pumps**: Working principle of reciprocating pump.	
Lecture-32	Types of reciprocating pumps.	
Lecture-33	Work done by reciprocating pump.	CT_2
Week-12		
Lecture-34	Co-efficient of discharge, Slip.	
Lecture-35	Cavitation of reciprocating pumps.	MID
Lecture-36	Effect of acceleration of piston on velocity and pressure in the suction and delivery pipes.	
Week-13		
Lecture-37	**Centrifugal Pumps**: Work done and efficiency of centrifugal pumps, Advantage over reciprocating pumps, Types of centrifugal pumps.	ASG
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.	

13. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
15. Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment 1-3	20%	CO3	C1, C2, C3
	1.3 Mid term	15%	CO1, CO2	C1, C2, C3
16. Final Exam (60%)		60%	CO1, CO2,CO4	C1, C2, C3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

14. **Materials Recommended**

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.

ME 272 **Fluid Mechanics Laboratory**

1.50ContHr; 0.75Cr Hr

Pre-requisite: None **Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

This course provides an introduction to the principles of fluid mechanics of mechanical systems. The focus is to illustrate practical engineering applications of these principles in relation to simple fluid systems. The learning approach is to apply engineering principles to performance analysis and prediction of simple fluid systems. This will provide a basis for understanding how performance can be improved. Student will acquire an understanding of the essential theoretical basis of the fluid mechanics and machinery sciences and their application to a range of problems of relevance to practical engineering.

2. Learning objectives (OB)

1. To introduce the principles of fluid mechanics of mechanical systems
2. To illustrate practical engineering applications of these principles in relation to simple fluid systems
3. To understand the basic principles and analysis of both static and dynamic fluid systems and their machinery applications

3. Course Contents

Verification of Bernoulli's equation. Determination of coefficient of discharge of orifice meter and venturi meter. Determination of head loss due to friction. Study of the characteristics of centrifugal pump. Study of propeller turbine characteristics

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Demonstrate proficiency in using different types of equipment for analyzing the performance parameters of various fluid flow device					✓							
CO2	Perform experiments individually and collaboratively within a team by collecting and interpreting experimental data									✓			
CO3	Demonstrate the ability of writing and presenting the information collected from experiments										✓		

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)	POs	Blooms	CP	CA	KP	Assessment

			Taxonomy	(WP)	(EA)	(WK)	Methods
CO1	Identify how properties of fluids change with temperature and their effect on pressure and fluid flow.	PO1	C3	-	-	1	R, Q, LT
CO2	Illustrate practical engineering applications of these principles in relation to simple fluid systems.	PO1	C2	-	-	1	R, Q, LT
CO3	Evaluate and design fluid engineering systems	PO2	C5	-	-	5	R, Q, LT
CO4	Build simple solutions to a range of problems in basic fluid flows.	PO4	C3	-	-	3	R, Q, CT

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**i**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
10. Face-to-Face Learning	1.1 Lecture 1.2 Experiment/ Modeling 1.3 Student-Centered Learning	14 28 -
11. Self-Directed Learning	2.1 Preparation: Lab reports a. Preparation: Lab test b. Preparation: Presentation c. Preparation: quiz d. Group projects	10 10 5 10 20
4.Formal Assessment	3.1 Continuous Assessment 3.2 Presentation	14 1
		112

TEACHING METHODOLOGY
Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

7. Teaching Schedule

Lecture	Experiments
Week-1	Introductory class

Week-2	
Week-3	Verification of Bernoulli's equation
Week-4	
Week-5	Determination of coefficient of discharge of orifice meter and venturi meter
Week-6	
Week-7	Determination of head loss due to friction
Week-8	
Week-9	Study of the characteristics of centrifugal pump
Week-10	
Week-11	Study of propeller turbine characteristics
Week-12	
Week-13	Quiz,Viva
Week-14	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
7. Continuous Assessment (75%)	1.1 Lab Participation and report	30%	CO1, CO2	C1, C2, P1, P2, P3, P4, P5
	1.2 Lab test 1.3 Lab test	30%	CO2, CO3	C2, C3, A5 A1, A2, A3, A4
8. Lab quiz (25%)		40%	CO2	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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
5. Supplied materials

CHAPTER 6

OTHER DEPARTMENTAL COURSES

6.2 General Educational and Science Courses

Sr No	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total	Page No
1	LANG 102	Communicative English –I	L1 T2	1.5	3	Cr Hr 20.0 **and** ContHr **24.0**	275 – 278
2	LANG 202	Communicative English- II	L2 T1	1.5	3		279 – 282
3	GES 101	Fundamentals of Sociology	L1 T1	2	2		283 – 287
4	GEBS 101	Bangladesh Studies	L2 T2	2	2		288 – 292
5	GEEA 201	Fundamentals of Economics and Accounting	L2 T2	3	3		293 – 297
6	GELM 275	Leadership and Management	L2 T1	2	2		298 – 301
7	GESL 317	Environment, Sustainability and Law	L3 T2	2	2		302 – 305
8	GERM 352	Fundamentals of Research Methodology	L3 T1	1	2		306 – 310
9	GEPM 477	Project Management and Finance	L4 T2	3	3		311 – 315
10	GEEM 447	Engineering Ethics and Moral Philosophy	L4 T1	2	2		316 – 319
11	PHY 141	Waves and Oscillations, Optics, and Structure of Matter	L1 T1	3	3	Cr Hr**18.0 and** ContHr **21.0**	320 – 325
12	PHY 142	Physics Sessional	L1 T1	1.5	3		326 – 329
13	CHEM 101	Fundamentals of Chemistry	L1 T2	3	3		330 – 333
14	CHEM 102	Chemistry Sessional	L1 T2	1.5	3		334 – 337
15	MATH 101	Differential and Integral Equations	L1 T1	3	3		338 – 342
16	MATH 103	Differential Equations and Matrix	L1 T2	3	3		343 – 346
17	MATH 201	Vector Analysis, Laplace Transformation & Co-ordinate Geometry	L2 T1	3	3		347 – 351

LANG 102	**Communicative English – I**	
		3.00ContHr; 1.50Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The English language course is designed for the students to develop their competence in communication skills for academic purposes emphasizing speaking, reading, listening and writing. The approach will be communicative and interactive and will involve individual, pair and group work. Students will be exposed to diverse text types to refine their reading skills, engaging in activities and discussions that foster effective writing type. The course incorporates a wide range of reading texts to develop students' critical thinking whichisoneof the mostessential elementsrequired towrite agoodpieceofacademicwriting. Special emphasis is placed on the various forms of essay including descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, student should demonstrate proficiency in communication across diverse contexts, engage in group activities, and deliver formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communicationskills. addionally, the Couse emphasizes providing constructive feedback on students' oral performances.

2. Learning objectives (OB)

1 To develop the four basics skills of English language, i.e. listening, speaking, reading and writing.
2 To enhance students' interpersonal skills through participation in various group interactions and activities.
3 To improve students' pronunciation to enhance comprehensibility in both speaking and listening.
4 To gain proficiency in crafting well- organized paragraphs and learn to edit and revise both their own as well as peer's writing.

3. Course Contents

Speaking: Introduction to Language: Introducing basic skills of language. English for Science andTechnologySelf-introductionandintroducingothers:Howaspeakershouldintroduce himselftoanystranger/unknownperson/acrowd.Name,familybackground,education, experience,anyspecial quality/interest,likings/disliking,etc.Askingandansweringquestions, expressing likings and disliking; (food, fashion etc.) Asking and giving directions Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event Practicing storytelling, Narrating personal experiences/Anecdotes Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation) **Listening:** Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand; Listening to short conversations between two persons/more than two. **Reading:** Reading techniques: scanning, skimming, predicting, inference; Reading Techniques: analysis, summarizing and interpretation of texts. **Writing:** Introductory discussion on writing, prewriting, drafting; Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event Paragraph writing, Compare-contrast and cause- effect paragraph

1. Course Outcomes (CO) and Skill Mapping

Cos		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Communicate** inEnglish quickly and smartly usingthe techniques learntinthe class.	✓											
CO2	**Understand**thetechniques of academicreadingandwriting	✓											
CO3	**Communicate** ideas and opinions effectivelywithinthe shortestpossibletime										✓		
CO4	**Excel** in oral and written communication/Presentation competency										✓		

2. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	**Communicate** inEnglish quickly and smartly usingthe techniques learntinthe class.	PO1	C2	-	-	1	Assignment, Quiz
CO2	**Understand**the Techniquesof academicreadingand writing	PO1	C3	-	-	1	Project/ Assignment, Quiz
CO3	**Communicate** ideas and opinions effectivelywithinthe shortestpossibletime	PO10	C4	-	-	1	Project, Assignment, Quiz
CO4	**Excel** in oral and written communication/ Presentation competency	PO10	C5			2	Project/ Assignment, Quiz

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

4. Teaching- Learning Strategy

Activities		**Engagement (hours)**
3. Face-to-Face Learning	1.1 Lecture 1.2 Assignment 1.3 Student-Centered Learning	- 42 42
4. Self-Directed Learning	2.1 Preparation: Report 3.2 Preparation: quiz 3.3 Preparation: viva	30 - -
3. Formal Assessment	3.1 Continuous Assessment 3.2 Quiz 3.2 Final Exam	04 - -
		88

TEACHING METHODOLOGY
Class Lecture, Pop quiz, Case study, Laboratory visits

5. Teaching Schedule

Lecture	Topics
Week-1	Self-introductionandintroducingothers:Howaspeakershould introducehimselftoanystranger/unknownperson/acrowd; Name,familybackground,education,experience,anyspecial quality/interest,likings/disliking,etc.
Week-2	Askingandansweringquestions,expressinglikingsanddisliking; (food, fashion etc.) Asking and giving directions
Week-3	Discussingeverydayroutinesandhabits,makingrequests/offers/ invitations/excuses/apologies/complaints
Week-4	Describingpersonality,discussingandmaking plans(fora holidayoranoutingtothecinema),Describingpictures/any incident / event
Week-5	Practicingstorytelling,Narratingpersonalexperiences/Anecdotes
Week-6	Telephone conversations (role play in group or pair); Situational talksdialogues:Practicingdifferentprofessionalconversation (roleplayofdoctor-patientconversation,teacher-student conversation)
Week-7	Listening and understanding: Listening, note taking andanswering questions; Students will listen to recorded text, note downimportantinformationandlateronwillanswertosome Questions
Week-8	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand
Week-9	Listeningtoshortconversationsbetweentwopersons/morethan Two

Week-10	Readingtechniques:scanning,skimming,predicting,inference;
Week-11	Readingtechniques:scanning,skimming,predicting,inference;
Week-12	Introductorydiscussiononwriting,prewriting, drafting;
Week-13	Topicsentence,paragraphdevelopment,paragraphstructure, describingaperson/scene/picture,narratinganevent
Week-14	Paragraphwriting,Compare-contrastandcause-effectparagraph

6. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
5. Lab exam (100%)	1.1 Listening Test	15%	CO1, CO2, CO3 CO4	-
	1.2 Descriptive writing	20%		C2, C3, C4
	1.3 Public speaking	20%		
	1.4 Reading	15%		
	1.5 Presentation	30%	CO1,CO2,CO3,CO4	C2,C3,C4
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

7. Materials Recommended

1. Langan, J. (2005). College Writing Skills with Readings (6th Ed). McGraw-Hill Publication.
2. Interactions 1 (Reading), John Langan, Latest edition, McGraw-Hill Publication
3. Jones, L.(1981). Functions of English. (Student's Book, 2nd Ed.) Melbourne, Australia: Cambridge University Press.
4. Dixon, R.J. (1987). Complete course in English. (Book 4). New Delhi, India: Prentice Hall of India. (For book presentation).
5. From Paragraph to Essay - Maurice Imhoof and Herman Hudson.
6. Headway Series – Advanced Level (2 parts with CDs): Oxford University Press Ltd.
7. Speak like Churchill stand like Lincoln - James C. Humes.
8. Cambridge IELTS Practice Book.
9. Selected Sample Reports and Selected Research Articles.

LANG202	**Communicative English - II**	***3.00ContHr; 1.50Cr Hr***
Pre-requisite:	**LANG 101**	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

The English language course is designed for the students to develop their competence in communication skills for academic purposes especially in reading and writing. The approach will be communicative and interactive and will involve individual, pair and group work. Students will be exposed to different types of texts to develop efficient reading skill. Reading will also involve activities and discussions leading to effective writing. The course incorporates a wide range of reading texts to develop students' critical thinking which is one of the most essential elements required to write a good piece of academic writing. Emphasis is particularly put on the various forms of essay writing such as descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, students are expected to be able to communicate at various situations, participate in group activities and prepare formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communication skills. In addition, the course emphasizes on providing constructive feedback on students' oral performances.

2. Learning objectives (OB)

1. To develop English language skills to communicate effectively and professionally.
2. To strengthen students' presentation skills.
3. To develop competency in academic reading and writing.

3. Course Contents

Reading: Reading Comprehension: Practice using different techniques. Academic reading: comprehension from departmental or subject related passages. Vocabulary for Engineers (some common Engineering terms for both general and dept specific). Reading subject specific text to develop vocabulary. **Writing:** Writing semi-formal, Formal/official letters, Official E-mail. Applying for a job: Writing Cover Letter and Curriculum Vitae. Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading. Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing. Analyzing and describing graphs or charts. Practicing analytical and argumentative writing.**Speaking:** Public Speaking: Basic elements and qualities of a good public speaker. Set Speech and Extempore Speech: How to get ready for any speech – set or extempore. Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.**Listening:** Listening to long lecture on some topics. Listening and understanding speeches/lectures of different accent.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Understand the techniques of academic reading and become acquainted with technical vocabularies	✓											
CO2	Understand the techniques of effective academic writing such as research article/report writing	✓											
CO3	Communicate effectively within the shortest possible time to present any report and research work										✓		
CO4	Analyze any problem critically, analyze and interpret data and synthesize information to provide valid conclusions										✓		

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Understand the techniques of academic reading and become acquainted with technical vocabularies	PO1	C2	-	-	1, 3	Q, FExam Pre, ASG, FExam
CO2	Understand the techniques of effective academic writing such as research article/report writing	PO1	C2	-	-	1	
CO3	Communicate effectively within the shortest possible time to present any report and research work	PO10	C3	-	-	1	
CO4	Analyze any problem critically, analyze and interpret data and synthesize information to provide valid conclusions	PO10	C3			1	

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**i**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
5. Face-to-Face Learning	1.1 Lecture 1.2 Assignment 1.3 Student-Centered Learning	- 42 42
6. Self-Directed Learning	2.2 Preparation: Report 3.4 Preparation: quiz 3.5 Preparation: viva	30 -
4. Formal Assessment	3.1 Continuous Assessment 3.2 Quiz 3.2 Final Exam	04
		88

TEACHING METHODOLOGY
This course is mostly activity based. Students will often be engaged in interactive discussion. The tasks and activities include pair work, group work, brainstorming, guesswork, describing picture/graph/diagrams, word puzzle, making jokes, storytelling, role play, responding to reading, writing and listening texts.

7. Teaching Schedule

Lecture	Topics
Week -1	ReadingComprehension:Practiceusingdifferenttechniques
Week -2	Academicreading:comprehensionfromdepartmentalorsubject related passages
Week -3	VocabularyforEngineers(somecommonEngineeringtermsforboth general and dept specific) Readingsubjectspecific texttodevelop vocabulary
Week -4 Week -5	Writingsemi-formal, Formal/officialletters,OfficialE-mail Applyingforajob:WritingCoverLetterandCurriculumVitae Practicing storytelling, Narrating personal experiences/Anecdotes
Week -6 Week -7	Essaywriting:writingsteps,principlesandtechniques,outlining,revising, editing, proofreading; Narrativeanddescriptivewriting:comparison-contrastandcause– effect, argumentative and opinion expression, assignment writing;
Week -8	Analyzinganddescribinggraphsor charts
Week -9	Practicinganalyticaland argumentativewriting
Week -10	PublicSpeaking:Basicelementsandqualitiesofagoodpublicspeaker

Week -11	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.
Week -12	Individual/Grouppresentation:Howtobereadyforpresentation, preparescriptforgoodspeech,preparingpowerpointslides,etc.Selectedbooks/Selectedstoriesforpresentation.
Week -13	Listeningtolonglectureonsometopics
Week -14	Listeningandunderstandingspeeches/lecturesofdifferentaccents

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (100%)	1.1 Listening	15%	CO1, CO2, CO3, CO4	L1, L2, L3, L4
	1.2 Argument/ analytical writing	20%		
	1.3 Reading	15%		
	1.4 Speaking	20%		
	1.6 Group Presentation	30%	CO1, CO2, CO3, CO4	L1, L2, L3, L4
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Jones, L. (1981). Functions of English. (Student’s Book, 2nd Ed.) Melbourne, Australia: Cambridge University Press.
2. Dixon, R.J. (1987). Complete course in English. (Book 4). New Delhi, India: Prentice Hall of India. (For book presentation).
3. Langan, J. (2005). College Writing Skills with Readings (6th Ed). McGraw-Hill Publication.
4. Interactions 1 (Reading), John Langan, Latest edition, McGraw-Hill Publication.
5. Headway Series — Advanced Level (2 parts with CDs): Oxford University Press Ltd.
6. Speak like Churchill stand like Lincoln - James C. Humes.
7. Cambridge IELTS Practice Book.
8. Selected Sample Reports and Selected Research Articles.

GES 101	Fundamentals of Sociology
	2.00 ContHr; 2.00 Cr Hr
Pre-requisite: None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

2. Learning objectives (OB)

1. Toequipstudentswithfactualknowledgethatwillenablethemtounderstand the basic nature, scope, and perspective of sociology; the stages of the social research process, and methodologies.

2. To analyze different cultures and civilizations, and societal and cultural issues in national and global contexts.

3. To evaluate different social problems, economic life, and environmental issues for sustainable development.

3. Course Contents

a. Main Contents: Understanding society, social phenomena, and social change

b.Detail Contents: Nature and scope of Sociological imagination, Perspectives of sociology, Stages of social research and research method, Culture and civilization, Socialization and self-development, Globalization and social changes, Media and individual, Social organizations and social problems, social stratification, the industrial revolution, Capitalism and socialism, Work and economic life, Environment, and human activities, Climate change and global risk, Population and human society, Urbanization and city development, Social changes, and technology.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Beabletounderstandthebasic nature,scope,andperspectivesofsociology.												
CO2	Beproficientin applyingsociologicalimaginationtothecontextofsocial problemsof BDsociety.			✓									
CO3	Beabletounderstandthestagesof social research processes andmethodologies.			✓									
CO4	Beskilledenoughtoanalyzedifferent cultures, civilizations, anddifferentsocialproblemsand designsolutionsforthose.			✓									

CO5	Be able to understand and analyzesocial stratification, different socialsystems,socialism, and capitalismand relatethemto Bangladeshisociety.	✓
CO6	Beabletoapplycontextualknowledgetoassesssocietalandculturalissuesin an environmental contextfor sustainabledevelopment.	✓

5. Mapping of Course Outcomes (CO) and General Skills

	Course Outcomes(CO)	POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	**Understand**thebasicnature,scope,andperspectives ofsociology	PO6	L2	1		7	M
CO2	**Apply**sociological-imaginationtothecontextofsocial problemsof BDsociety	PO6	L3	1		7	M
CO3	**Understand**thestagesofsocial research processes and methodologies	PO6	L2	1		7	F
CO4	**Analyze** differentcultures,civilizations,anddifferentsocial problems anddesign solutionsfor those	PO6	L4	3		7	M
CO5	**Understand**socialstratification,differentsocial systems,socialism,capitalismand relatethemto BDsociety	PO6	L2	1		7	F
CO6	**Understand** contextual knowledgeto assess societal and cultural issues in an environmentalcontextforsustainable development	PO6	L2	1		7	F

CP- ***C****omplex* ***P****roblem/* ***WP***- ***W****ashington Accord Complex* ***P****roblem Solving;* ***CA***- ***C****omplex* ***A****ctivities/* ***EA***- ***E****ngineering* ***A****ctivities;* ***KP***- ***K****nowledge* ***P****rofile/* ***WK***- ***W****ashington Accord* ***K****nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ig**n**ment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	28

	1.2 Practical / Tutorial	10
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision of the previous lecture at home 2.3 preparation for final examination	8 10 18
3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	3 3
		80

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1 Lecture-1 Lecture-2	 Definition, nature and scope of sociology. Sociological imagination.	
Week-2 Lecture-3 Lecture-4	 Perspectives of sociology. Orientation of sociological theories.	
Week-3 Lecture-5 Lecture-6	 Social research and its process. Research designs and techniques.	CT_1
Week-4 Lecture-7 Lecture-8	 Introducing culture and its variations. civilization	
Week-5 Lecture-9 Lecture-10	 Defining family and its changes. Socialization process and development of self.	
Week-6 Lecture-11 Lecture-12	 Introducing globalization and its impact on human life. Factors responsible to globalization.	MID
Week-7 Lecture-13 Lecture-14	 Media and its impact in modern society. Addressing social problems of Bangladesh.	

Week-8		CT_2
Lecture-15	Introducing social groups and organizations.	
Lecture-16	Introducing bureaucracy and good governance.	
Week-9		
Lecture-17	Introducing social stratifications and social inequality.	
Lecture-18	Poverty and its types and dimensions.	
Week-10		
Lecture-19	Industrial revolution and aftermath.	
Lecture-20	Urbanization and city development.	
Week-11		CT_3
Lecture-21	Capitalism: features and influence.	
Lecture-22	Socialism: features and influence.	
Week-12		
Lecture-23	Environment and human activities.	
Lecture-24	Climate change and global risk.	
Week-13		
Lecture-25	Population of Bangladesh: problem or prospect.	
Lecture-26	Crime and deviance: a brief analysis.	
Week-14		
Lecture-27	Review 1	
Lecture-28	Review 2	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (40%)	1.1 Class Participation	5%	CO3,CO4	L2,L4
	1.2 Class Test/ Assignment 1-3	20%	CO1,CO2,CO3	L1,L2,L3
	1.3 Mid term	15%	CO4,CO5	L2,L4
4. Final Exam (60%)		60%	CO1	L1,L2
			CO2	L3
			CO3	L2
			CO4	L4
			CO5	L2
			CO6	L3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Sociology in Modules: by – Richard Schaefer, 2nd edition, 2013.
2. Sociology - Primary Principles: by CN Shankar Rao.
3. Anthony Giddens- 5th edition.
4. Relevant journal.

.

GEBS 101 **Bangladesh Studies**	***2.00 ContHr; 2.00 Cr Hr***
Pre-requisite: None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

This course has been designed for undergraduate engineering students to help them learn therich history of Bangladesh, and to provide them with basic knowledge of historical eventswhich eventually led to the formation of Bangladesh and constitution of Bangladesh, currenttrendsineconomicdevelopment,legislation,citizencharter,culturalaspectswhichwill makethemresponsiblecitizen.

2. Learning objectives (OB)

1. To equip students with factual knowledge that will enable them to learn the history of Bangladesh.
2. To trace the historical roots of Bangladesh as an independent state focusing on the social, cultural and economic developments that have taken place since its independence.
3. To promote an understanding of the development of Bangladesh and its culture.
4. To create an awareness among the students about the Geography, Economy, Politics and Culture of Bangladesh.

3. Course Contents

a. Main Contents: Impact of Geography, History, Environment, Economy, Constitution and Culture of Bangladesh in Engineering Application

b. Detail Contents:

Bangladesh Geography: Location, Area, Boundary, Physiography, River system, Forest and Climate, Demography of Bangladesh, Maritime zones. History: Overview of the ancient Bengal, anthropological identity of the Bengali race, main trends in the history of medieval Bengal, Bengal under the East India Company, religious and social reform movements, nationalist movements, division of the Indian sub-continent, language movement 1948-1952, education movement of 1962, six-point movement of 1966, mass uprising of 1969, war of independence and emergence of Bangladesh in 1971, Constitution of Bangladesh, Pre and post liberation development in the field of engineering and technology, Bangladesh’s contribution to world peace and its security, engineering developments in Bangladesh (Kaptai Dam, Padma bridge, power plants, Karnaphuli River Tunnel etc.) and its impact on socio-economic aspect. Environment, Economy and Culture : Land, Characteristics of tropical monsoon climate, Forests and biomass, Fish, Minerals, Health, Education, Agriculture, Industries, NGOs, Population, Sociological and Cultural aspects of Bangladesh, Economy and National development, Development and Progress of the Millennium Development Goals (MDGs), Public Administration in Bangladesh, State of Good Governance in Bangladesh, Art and Literature, Main traditional cultural events,Vision-2021, Digitalization, Tourism and Natural Resources, Bangladesh and International Relations.

4. Course Outcomes (CO) and Skill Mapping

COs	PROGRAM OUTCOMES (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12

CO1	Be able to identify specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically analyse plurality of cultural identities of Bangladesh.	✓
CO2	Be proficient to explain the economy and patterns of economic changes through qualitative and quantitative analysis.	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Identify specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically analyse plurality of cultural identities of Bangladesh.	PO6	L1, L2	1	-	7	T,FExam
CO2	Explain the economy and patterns of economic changes through qualitative and quantitative analysis.	PO6	L1, L2	7	-	7	

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Assig**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	28 10 -
2. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision 2.3 Preparation for final examination	8 10 18

3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	3 3 **80**

TEACHING METHODOLOGY
Class Lecture, Pop quiz, Case study, Problem solving

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	Introductory class: Brief discussion on the total syllabus, basic requirements of the course, methods of assessment of the course.	
Lecture-2	Bangladesh Geography: Location, Area, Boundary, Physiography, River System, Forest and Climate, Demography of Bangladesh.	
Week-2		
Lecture-3	Overview of the ancient Bengal; anthropological identity of the Bengali race; main trends in the history of medieval Bengal.	
Lecture-4	Bengal under the East India Company.	
Week-3		
Lecture-5	Religious and Social reform movements.	
Lecture-6	Nationalist movements, division of the Indian sub-continent.	CT_1
Week-4		
Lecture-7		
Lecture-8	Language movement 1948-1952, Education movement of 1962	
Week-5		
Lecture-9	Six-point movement of 1966; Mass uprising of 1969.	
Lecture-10	War of Independence and Emergence of Bangladesh in 1971.	
Week-6		MID
Lecture-11	Constitution of Bangladesh	
Lecture-12		
Week-7		
Lecture-13	Bangladesh's contribution to world peace and security, Pre and post liberation development of engineering and technology	
Lecture-14	Bangladesh's contribution to world peace and security, Pre and post liberation development of engineeringandtechnology	
Week-8		
Lecture-15	Land, Characteristics of tropical Monsoon climate . Forests and biomass, Fish.	
Lecture-16	Engineering development in Bangladesh (Kaptai Dam, Padma bridge, power plants, Karnaphuli River Tunnel etc.) and its impact on socio-economic aspect	
Week-9		

Lecture-17 Lecture-18	Minerals, Health and Education. Agriculture, Industries.	
Week-10 Lecture-19 Lecture-20	 NGOs, Population, Sociological and Cultural aspects of Bangladesh. Economy and national development.	CT_2
Week-11 Lecture-21 Lecture-22	 Development and Progress of the Millennium Development Goals (MDGs). Ultimate Disposal of Solid Waste: Method Public Administration in Bangladesh, State ofGood Governance in Bangladesh	
Week-12 Lecture-23 Lecture-24	 Art and Literature. Traditional cultural events.	
Week-13 Lecture-25 Lecture-26	 Vision-2021, Digitalization. Tourism and Natural Resources.	CT_3
Week-14 Lecture-27 Lecture-28	 Bangladesh and International Relations. Revision of the course	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
5. Continuous Assessment (40%)	1.1 Class Participation	5%	CO2	L2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2	L1,L2
	1.3 Mid term	15%	CO2	L2,L4
6. Final Exam (60%)		60%	CO1	L1,L2
			CO2	L1,L2,L4
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Bangladesh Studies: Md. Shamsul Kabir Khan and Daulatunnahar Khanam
2. The Constitution of the People's Republic of Bangladesh
3. Discovery of Bangladesh: Akbar Ali Khan.
4. History of Bangladesh, Vols, 1-3: Sirajul Islam.
5. History of Modern Bengal, Vol, 1: R C Majumdar.
6. Dynastic History of Bengal: Dr. Abdul Mumin Chowdhury.

7. A History of Bangladesh: William Van Schendel.
8. A History of Sufism in Bengal: Dr. Enamul Huq.
9. Geography of Bangladesh: Harun Er Rashid.
10. Banglapedia: National Encyclopedia of Bangladesh, Vols, 1-10: Sirajul Islam.
11. History of Bengal: (Mughal Period 1526-1765): R. A. Chandra.
12. Land of Two Rivers: Nitesh Sengupta.

GEEA 201 **Fundamentals of Economics and Accounting**	***3.00 ContHr; 3.00 Cr Hr***
Pre-requisite: None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

This course is to understand the fundamentals of economics and accounting for engineers.

2. Learning objectives (OB)

1. To introduce fundamental principles and concepts of accounting, including the accounting equation and the double-entry bookkeeping system.
2. To help students develop the competency to apply cost accounting tools to make informed business decisions, including Absorption costing and Variable costing, CVP Analysis, Job Order Costing and Process costing and Relevant Costing.
3. To help students effectively use the concept of elasticity & determine the structure of the market based on information provided in financial reports.
4. Students will be introduced to various macroeconomic aggregates & variables such as GDP, GNI, NNI, unemployment, per capita debt, inflation, productivity and the major challenges associated with the measurement of these aggregates.
5. Students will be acquainted with basic accounting principles and concepts including accounting equations, recording of financial transactions, preparation of financial statement and worksheet etc.
6. To help students demonstrate the utilization of basic theories of economics in predicting the outcome of price adjustments decisions of a firm & decisions regarding forming cartels.
7. To explain the preparation and interpretation of financial statements, such as Statement of Financial Position, Statement of Comprehensive Income, Statement of Changes in Equity.
8. To help students develop a comprehensive understanding of cost accounting principles and concepts, including cost classification and cost behavior.
9. Students will be introduced to the basics of externalities and the role of efficient property right enforcement and anti-trust laws in the development of the economy.

3. Course Contents

Financial Accounting: Objectives and importance of accounting, branches of accounting, accounting as an information system, computerized system and application in accounting. Recording Systems: Double entry mechanism, accounts and their classification, accounting equation, accounting cycle journal, ledger, trial balance. Preparation of financial statements considering adjusting and closing entries. Accounting concepts and conventions. Financial statements analysis and interpretation: Ration analysis- tests for profitability, liquidity, solvency and overall measure.**Costs and Management Accounting:** Cost concept and classification. Segregation of mixed costs. Overhead costs: Meaning and classification, allocation of overhead cost, overhead recovery method. Job order costing: Preparation of job cost sheet and quotation price. Inventory valuation: Absorption costing and variable costing technique. Cost volume profit analysis: Meaning, breakeven analysis, contribution margin approach, sensitivity analysis. Short term investment decision: Relevant and differential. Cost analysis: Long term investment decisions: Capital budgeting, various techniques of evaluation of capital investment, investment appraisal under uncertainty, risk management, capital rationing.**Microeconomics:** Definition of economics; Fundamentals of economics;Market and government in a modern economy; Basic elements of supply and demand;Indifference curve & consumer equilibrium; Choice and utility; indifference curve technique; Analysis of cost; Short run long run theory ofproduction; Analysis of MarketStructures; Externalities; Optimization; Theory of distribution.**Macroeconomics:** key concept of macroeconomics;Key macroeconomic aggregates; National income analysis;Inflation, Unemployment;Exchange rate; Fiscal and monetary policy. Development: Theories of developments;Economics of transitioning to renewable energy;Economic problem of developing countries; Planning in Bangladesh.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Understand the fundamental principles of accounting and economics	✓											
CO2	Understand financial reporting and analysis	✓											
CO3	Be able to apply basics of economics in optimization of a firm's decision using cost behavior & cost control.											✓	
CO4	Apply quantitative measurements to solve business problems related to depreciation, interest rate, future value of money and to be able to make better business decisions.											✓	
CO5	Apply cost accounting and economics tools for making informed business decisions											✓	

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Understand the fundamental principles of accounting and economics	PO1	C1	-	-	1	CT, MID, FExam
CO2	Understand financial reporting and analysis.	PO1	C1	-	-	1	MID, FExam
CO3	Be able to apply basics of economics in optimization of a firm's decision using cost behavior & cost control.	PO11	C2	-	-	2	CT, MID, FExam, ASG
CO4	Apply quantitative measurements to solve business problems related	PO11				2	

	to depreciation, interest rate, future value of money and to be able to make better business decisions.		
CO5	Apply cost accounting and economics tools for making informed business decisions	PO11	2

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
2. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision	84 21
3. Formal Assessment	3.1 Continuous Assessment 3.2 Mid- Term 3.2 Final Examination	2 1 3
		153

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	Meaning, history and definition of accounting.	
Lecture-2	The users and uses of accounting, ethics in financial reporting	
Lecture-3	Definition of economics in various predominant schools of economics.	
Week-2		
Lecture-4 Lecture-5	The cost principle, monetary unit assumption and the economic entity assumption . Accounting equation and its components.	
Lecture-6	Utility, Indifference curves & MRS.	
Week-3		
Lecture-7	Understand the four financial statements and how they are prepared.	
Lecture-8	Explain account, debit, credit and how it helps in the recording	CT_1

	process.	
Lecture-9	Consumer equilibrium & Short-run producer equilibrium	
Week-4		CT_2
Lecture-10	Journal	
Lecture-11	T-account, Ledger, Trial balance.	
Lecture-12	Demand curve related basic idea and Mathematical Application.	
Week-5		
Lecture-13	Introduction to Adjusting Accounts.	
Lecture-14	Time period assumption, the accrual basis of accounting, Worksheet.Adjusting entries for deferrals, adjusting entries for accruals.	
Lecture-15	Supply and Demand. Movement along the curve & shift.	
Week-6		
Lecture-16	Process of closing the books.	
Lecture-17	Completion of the Accounting Cycle.	
Lecture-18	Elasticity	
Week-7		
Lecture-19	Financial Statement Analysis.	
Lecture-20	Horizontal analysis,Vertical analysis.	
Lecture-21	Analysis of Cost	
Week-8		MID
Lecture-22	Perfectly Competitive Market	
Lecture-23	Theory of cost, Short run and long run cost curve.	
Lecture-24	Definition, features of managerial accounting. Differences between financial accounting and managerial accounting .Three classes of manufacturing costs.	
Week-9		
Lecture-25	Job Order Cost AccountingTheory of Investment.	
Lecture-26	Monopoly and Monopolistic Market	
Lecture-27	National Income & its Calculation.	
Week-10		
Lecture-28	Oligopoly (Cartel)	
Lecture-29	Various price indices & Inflation.	
Lecture-30	Process costing, Job order costing and Process costing.	
Week-11		CT_3
Lecture-31	Externalities	
Lecture-32	Functions of money & fractional reserve banking.	
Lecture-33	Absorption costing, Variable costing.Differences between variable costing and absorption costing through calculation.	
Week-12		
Lecture-34	Tackling externalities in industrial development.	
Lecture-35	Monetary Policy	
Lecture-36	Master budget, Budget. Sales budget, direct material budget, direct labor budget.	
Week-13		
Lecture-37	Fiscal Policy	

Lecture-38	Theory of Employment.	
Lecture-39	Budget of different projects, Cash budget, Human factors in budgeting.	
Week-14		
Lecture-40	Service department costing.	
Lecture-41	Natural Gas: Price control; Oil: The Cartel problem	
Lecture-42	Economics of transitioning to renewable energy	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
4. Continuous Assessment (40%)	1.1 Class Participation	5%	CO1, CO3	C1, C2
	1.2 Class Test/ Assignment 1-3	20%		
	1.3 Mid term	15%		
5. Final Exam (60%)		60%	CO1, CO2, CO3,CO4,CO5	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Financial Accounting IFRS edition by Weygand, Kimmel &Kieso (3th e)
2. Managerial Accounting by Garrison, Ray H.; Noreen, Eric W. (10th Edition)
3. Schaum's Outline of Microeconomics – McGraw-Hill by Dominick Salvatore (4rth Ed.)
4. Introduction to Macroeconomics with Applications to Bangladesh Economy by Kazi Iqbal & Amin Bin Hasib
5. Schaum's Outline Engineering Economics – McGraw-Hill by Jose Sepulveda, William Souder & Byron Gottfried

GELM 275 Leadership and Management

2.00 ContHr; 2.00 Cr Hr

Pre-requisite: None **Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The course is designed to make students understand the overlapping connection between engineering and management in an organization through the study of varied management practices and leadership styles.

2. Learning objectives (OB)

1. To expose students to different views and styles of leadership.
2. To introduce different management functions and approaches.
3. To understand how an organization functions collaboratively with managers and engineers.
4. To study the business aspects of production and service industries.
5. To solve real-world management problems as an engineer.

3. Course Contents

Leadership: Leaders vs. managers, leadership styles, leadership theories, traits of effective leaders, creative leadership, conflicts negotiation, engineer as a leader, effective delegation skills, leadership and power, manpower control, motivation and theories, performance appraisal, effective communication styles, leadership and organization culture intercultural aspects of leadership, group dynamics, participative management, and case studies on leadership. **Management, Planning and Control:** Management functions, types and roles and responsibilities, management skills, management approaches, organizational planning, organizational development models. **Marketing Management:** Marketing concepts & organization, industrial and consumer selling, channel & advertising decisions, and new product strategy. **Operations management:** Demand and supply forecasting, inventory control, and quality management. **Information Technology and Management:** Management information system (MIS), enterprise resource planning (ERP). **Case Studies:** Solving real-world leadership and management problems.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To understand the role of an engineer as a leader in the business environment						✓		✓		✓		
CO2	To analyze real-life complex decision-making problems and solve those using engineering knowledge and leadership skills				✓					✓	✓	✓	
CO3	To familiarize students with the fundamental concepts of human resource management, marketing management, operations management, and financial management	✓								✓	✓		

CO4	To evaluate managerial decision options and choose the best one using managerial skills	✓	✓	✓	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	To understand the role of an engineer as a leader in the business environment	PO1, PO6, PO8, PO10	C1, C2	-	-	7	Q, ASG, FExam
CO2	To analyze real-life complex decision-making problems and solve those using engineering knowledge and leadership skills	PO2, PO4, PO9, PO10, PO11	C1, C2	-	-	7	
CO3	To familiarize students with the fundamental concepts of human resource management, marketing management, operations management, and financial management	PO1, PO9, PO10					
CO4	To evaluate managerial decision options and choose the best one using managerial skills	PO2, PO8, PO9, PO10					

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	28
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning	2.1 Non-face-to-face learning	12
	2.2 Revision	14
	2.3 Preparations: Assignment	14
3. Formal Assessment	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		71

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		CT_1
Lecture-1	Leaders vs. managers, leadership styles, leadership theories	
Lecture-2	Case studies.	
Week-2		
Lecture-3	Traits of effective leaders, creative leadership.	
Lecture-4	Case Studies.	
Week-3		
Lecture-5	Conflicts negotiation, engineer as a leader, effective delegation skills .	
Lecture-6	Case studies.	
Week-4		
Lecture-7	Leadership and power, manpower control, motivation and theories, performance appraisal.	
Lecture-8	Case studies.	
Week-5		
Lecture-9	Effective communication styles, leadership and organization culture intercultural aspects of leadership.	
Lecture-10	Case studies.	
Week-6		
Lecture-11	Group dynamics, participative management	
Lecture-12	Case studies.	
Week-7		
Lecture-13	Management functions, types and roles and responsibilities, management skills.	
Lecture-14	Case studies.	
Week-8		MID/ Pro
Lecture-15	Management approaches, organizational planning, organizational development models.	
Lecture-16	Case studies.	
Week-9		
Lecture-17	Marketing concepts & organization, industrial and consumer selling.	
Lecture-18	Case studies.	
Week-10		CT_2
Lecture-19	Channel & advertising decisions, and new product strategy.	
Lecture-20	Case studies.	
Week-11		
Lecture-21	Demand and supply forecasting.	
Lecture-22	Inventory control.	
Week-12		
Lecture-23 Lecture-24	Quality management.	

Week-13		
Lecture-25	Management information system (MIS).	
Lecture-26	Enterprise resource planning (ERP).	
Week-14		
Lecture-27	Course review	
Lecture-28	Course review	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	5%	CO1, CO3, CO4	C1-C2, C4, A2, P4
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO3	C1-C2, C4, P4
	1.3 Mid term	15%	CO1, CO3	
2. Final Exam (60%)		60%	CO1, CO2, CO3, CO4	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Engineering Management (Revised Edition) – A.K. Gupta.
2. Industrial Engineering and Production Management - Martand T. Telsang.
3. Leadership in Organizations – Gary Yukl.
4. Developing Management Skills – David A. Whetten and Kim S. Cameron.

GESL 317 **Environment, Sustainability and Law**	***2.00 ContHr; 2.00 Cr Hr***
Pre-requisite: None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

This course provides an overview to different aspects of Environmental, Sustainability and Law in Petroleum and Mining Engineering. The interconnectedness of the environmental system is emphasized. Petroleum and Mining Engineers should know the laws that are imposed in these industries to protect the environmental hazards and to ensure safe workplace. Students will pay attention to the choice of technologies and tools, ranging from low-cost to advanced options which will be useful in their professional life.

2. Learning objectives (OB)

1. To develop a basic understanding of Environment, Sustainability and law in Petroleum and Mining engineering.
2. To learn the criteria and standards to maintain in Petroleum and Mining industries and their relation to public health and environment.
3. To familiarize with the laws related to environment in Petroleum and Mining Industries to run a sustainable operation.
4. To learn the use of advance technologies to mitigate the environmental hazards in petroleum and mining industries.

3. Course Contents

Introduction to Environment, Sustainability and Law;

Environment in Petroleum and Mining Industries: 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 effect; Estimation process for CO2 emissions for fuel combustion; Computation of CO2 emission related to energy use; Concept of carbon cycle; Clean Development Mechanism (CDM); Initial Environment Examination (IEE);Concept of Environmental Impact Assessment (EIA)

Health Hazards in Petroleum and Mining Industries: 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; Dust impact Human health; Noise issues in industries impact Human health.

Safety System in Petroleum and Mining Industries: Hazards Analysis (HA); Safe work practices and procedures; HAZOP (Hazardous Operation) practices and procedure; 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.

Laws for Petroleum and Mining Industries: Environmental Management Plan (EMP); Environmental management and ISO 14000; Environment and Sustainable development; Environmental laws/regulations.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Ability to recognize the main terminology and concepts of environmental hazards and laws of petroleum and mining industries						✓						
CO2	Ability to identify and understand the environmental impact of petroleum and mining industries.							✓					
CO3	Ability to analyze and evaluate the environmental impact in petroleum and mining industries by using laws and professional understanding							✓					

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Ability to recognize the main terminology and concepts of environmental hazards and laws of petroleum and mining industries	PO6		-	-		CT,MID, FExam
CO2	Ability to identify and understand the environmental impact of petroleum and mining industries.	PO7	C1 C2	-	-	KP 7	CT,MID, FExam
CO3	Ability to analyze and evaluate the environmental impact in petroleum and mining industries by using laws and professional understanding	PO7		-	-		CS,ASG

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture	28
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
2. Self-Directed Learning		

	2.1 Non-face-to-face learning 2.2 Revision 2.3 Preparations: Assignment	28 21 21
3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		103

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1 Lecture-1 Lecture-2	Introduction to Environment, Sustainability and Law;	CT_1
Week-2 Lecture-3 Lecture-4	Environment in Petroleum and Mining Industries	
Week-3 Lecture-5 Lecture-6	Environment in Petroleum and Mining Industries	
Week-4 Lecture-7 Lecture-8	Environment in Petroleum and Mining Industries	
Week-5 Lecture-9 Lecture-10	Environment in Petroleum and Mining Industries	CT_2
Week-6 Lecture-11 Lecture-12	Health Hazards in Petroleum and Mining Industries	
Week-7 Lecture-13 Lecture-14	Health Hazards in Petroleum and Mining Industries	
Week-8 Lecture-15 Lecture-16	Health Hazards in Petroleum and Mining Industries	MID/ASG

Week-9 Lecture-17 Lecture-18	Health Hazards in Petroleum and Mining Industries	
Week-10 Lecture-19 Lecture-20	Health Hazards in Petroleum and Mining Industries	CT_3/ASG
Week-11 Lecture-21 Lecture-22	Safety System in Petroleum and Mining Industries	
Week-12 Lecture-23 Lecture-24	Safety System in Petroleum and Mining Industries	
Week-13 Lecture-25 Lecture-26	Laws for Petroleum and Mining Industries	
Week-14 Lecture-27 Lecture-28	Laws for Petroleum and Mining Industries	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10%	-	C1, C2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2,CO3	
	1.3 Mid term	10%		
2. Final Exam (60%)		60%	CO1, CO2, CO3	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

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.

GERM 352 Fundamentals of Research Methodology

2.00 ContHr; 1.00 Cr Hr

Pre-requisite: None **Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

The Fundamentals of Research Methodology is a hands-on course designed to impart education in the foundational methods and techniques of academic research in Science and Engineering context. UG students would examine and be practically exposed to the main components of a research framework i.e., problem definition, research design, data collection, ethical issues in research, time management, report writing, and presentation. Once equipped with this knowledge, participants would be well-placed to conduct disciplined research under supervision in an area of their choosing. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments.

2. Learning objectives (OB)

1. To evaluate/review related extant literature, form a variety of sources, pertinent to the research objectives/questions.
2. To expose students to various research methodologies (design), relevant to the research problem needing to be addressed.
3. To explain and justify how researchers will collect and analyze research data.
4. To educate students in the common mistakes, research misconduct, and ethical considerations in the field of research methodology.

3. Course Contents

Foundations of Research: Meaning of Research; Definitions of Research; Objectives of Research; Motivation in Research; General Characteristics of Research; Criteria of Good Research; Types of Research; Concept of theory, empiricism, deductive and inductive theory; Characteristics of scientific method. **Problem Identification and Formulation:** Meaning and need of Review of Literature; How to Conduct the Review of literature; Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance. **Research Design:** Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental/Computational Design: Concept of Independent & Dependent variables. **Data Analysis:** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. **Research Misconduct and Ethics:** Understand the research misconduct; type of research misconduct; Ethical issues in conducting research; Ethical issues related to publishing, Plagiarism and Self-Plagiarism. **Use of Tools / Techniques for Research:** Layout of a Research Paper; Methods to search required information effectively; Reference Management Software like Zotero/Mendeley; Software for paper formatting like LaTeX/MS Office; Software for detection of Plagiarism. Time management and developing Gantt Charts.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Understand the research fundamentals and formulate problem statement and research questions/objectives.		✓										
CO2	Formulate and compose a research proposal considering research activities/design, background studies, and following standard guidelines.	✓											✓
CO3	Develop writing and presentation skill, and demonstrate ethical considerations in conducting research								✓		✓		

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	To understand the role of an engineer as a leader in the business environment	PO2	C2	-	-	-	Q, ASG
CO2	To analyze real-life complex decision-making problems and solve those using engineering knowledge and leadership skills	PO1, PO12	C3	-	-	4, 6	Q, ASG, R, Pre
CO3	To familiarize students with the fundamental concepts of human resource management, marketing management, operations management, and financial management	PO8, PO10	C3			4	R, Pre

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	48 24 12
2. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision 2.3 Preparations: Assignment	30 12 18
3. Formal Assessment	3.1 Continuous Assessment 3.2 Presentation (2)	1.5 3
		80
TEACHING METHODOLOGY		

Lecture and Discussion, Mini-Seminars by Experts, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1 Lecture-1 Lecture-2 Lecture-3 Lecture-4	Foundations of Research: Meaning of Research; Definitions of Research; Objectives of Research; Motivation in Research; General Characteristics of Research; Criteria of Good Research; Types of Research; Concept of theoryFoundations of Research: Meaning of Research; Definitions of Research; Objectives of Research; Motivation in Research; General Characteristics of Research; Criteria of Good Research; Types of Research; Concept of theory.	Pre, Q, ASG
Week-2 Lecture-5 Lecture-6 Lecture-7 Lecture-8	Practice session on Foundations of Research	
Week-3 Lecture-9 Lecture-10 Lecture-11 Lecture-12	Problem Identification & Formulation: Meaning & need of Review of Literature; How to Conduct the Review of literature; Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance	
Week-4 Lecture-13 Lecture-14 Lecture-15 Lecture-16	Practice session on Problem Identification & Formulation	
Week-5 Lecture-17 Lecture-18 Lecture-19 Lecture-20	Practice session on Research Design	
Week-6 Lecture-21 Lecture-22 Lecture-23 Lecture-24	Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	ASG, Pre
Week-7 Lecture-25 Lecture-26 Lecture-27 Lecture-28	Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	
Week-8 Lecture-29	Practice session on Data Analysis	

Lecture-30 Lecture-31 Lecture-32		
Week-9 Lecture-33 Lecture-34 Lecture-35 Lecture-36	Research Misconduct and Ethics: Understand the research misconduct; type of research misconduct; Ethical issues in conducting research; Ethical issues related to publishing, Plagiarism and Self-Plagiarism.	
Week-10 Lecture-37 Lecture-38 Lecture-39 Lecture-40	Practice session on Research misconduct and Ethics	ASG, Pre
Week-11 Lecture-41 Lecture-42 Lecture-43 Lecture-44	Use of Tools / Techniques for Research: Layout of a Research Paper; Methods to search required information effectively; Reference Management Software like Zotero/Mendeley; Software for paper formatting like LaTeX/MS Office; Software for detection of Plagiarism. Time management and developing Gantt Charts.Use of Tools / Techniques for Research: Layout of a Research Paper; Methods to search required information effectively; Reference Management Software like Zotero/Mendeley; Software for paper formatting like LaTeX/MS Office; Software for detection of Plagiarism. Time management and developing Gantt Charts.	
Week-12 Lecture-45 Lecture-46 Lecture-47 Lecture-48	Practice session on Use of tools / techniques for Research	
Week-13 Lecture-49 Lecture-50 Lecture-51 Lecture-52	Review Session (Theory) – I /Final Presentation	
Week-14 Lecture-53 Lecture-54 Lecture-55 Lecture-56	Review Session (Practice) – II /Final Presentation	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	30%	CO1, CO2	C2, C3
	1.2 Class Test/ Assignment 1-3			
	1.3 Quiz		CO1, CO3	
2. Final Exam	3.1 Assignment 1	20%	CO1, CO3	

(60%)	3.2 Assignment 2	50%	CO2, CO3
		100%	

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. **Materials Recommended**

1. Engineering Research Methodology: A Practical Insight for Researchers. Springer, by Deb, Dipankar, Dey, Rajeeb, Balas, Valentina E.
2. Research Methods for Engineers, 1st Edition, by David V. Thiel.
3. Handbook of Research Methodology by Talati, J.K.
4. Introducing Research Methodology: A Beginner′s Guide to Doing a Research Project by Uwe Flick.
5. DRM, a Design Research Methodology by Lucienne T.M. Blessing and Amaresh Chakrabarti.
6. Research Methods: Information, Systems, and Contexts by Kirsty Williamson, Graeme Johanson.
7. Zelkowitz, M. V. and Wallace, D. R. (1998), Experimental models for validating technology, Computer, vol. 31, no. 5, pp. 23-31.
8. Internet, mail, and mixed-mode surveys : the tailored design method (3rd ed.) by Dillman, D. A., Smyth, J. D., & Christian, L. M.
9. Improving survey questions: design and evaluation. Sage Publications, by Fowler, F. J.
10. Applied multiple regression/correlation analysis for the behavioral sciences (3rd ed.).
11. Mahwah, NJ: Lawrence Erlbaum Associates, by Cohen, J., Cohen, P., West, S., & Aiken, L.
12. Experimental and Quasi-Experimental Design for Generalized Causal Inference. Boston, Mass: Houghton Mifflin, by Shadish W.R., Cook T.D. & Campbell P.T.
13. Computational handbook of statistics (4th ed.). New York: Longman, by Bruning, J. L. & Kintz, B. L.

GEPM 477	Project Management and Finance	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

This course provides knowledge on principles of project management and finance, human resource management, project planning. It is design to develop skills to perform project scheduling, project appraisals, resource allocation by operation research technique which will be useful in their professional life. Evaluations involve assessments of the strengths and weaknesses of projects, programs or policy to improve their effectiveness.

2. Learning objectives (OB)

1. To gain knowledge on principles of project management & organizations, conflict management, human resource management, inventory management, demand forecasting and site management for petroleum and mining industries.
2. To develop skills for evaluating a project based on BCR, NPV, IRR, PBP
3. To execute allocation of resources and plan a project by network techniques and project management skills.
4. To develop the skills of design, operate the projects of petroleum and mining industries
5. To grow the knowledge and understanding of project management in all aspects.

3. Course Contents

Project planning and evaluation; Planning and scheduling; CPM; Resource scheduling; Feasibility reports; Project organization; Technology &management of materials and equipment; Site management; Contracts and specifications; Inspection and quality control; Safety; Psychology in administration; Human factors in management; Human resource management; Procurement; Legal issues in project management; Evaluating a project

Project Management for Oil, Gas, and Mining Industries: Characteristics of Oil and Gas, and Mining Projects; Oil, Gas, and Mining Project Communication; Critical Path Method for Oil, Gas, and Mining Projects; Decision Tools for Project Management in the Oil, Gas and Mining Industry; Managing Construction Projects in Oil, Gas and Mining; Engineering Economics for Oil, Gas and Mining industry; Project Risk Analysis; Application of Evaluation and Management of Petroleum and Mining Projects software.

Financing of Oil, Gas and Mining Industries: Exploration Costs; Drilling and Development Costs; Accounting for Production Activities; Accounting for Production Activities; Accounting for Revenue from Oil and Gas Sales; Basic Oil and Gas Tax Accounting; Accounting for International Petroleum Operations; Analysis of Oil and Gas Companies' Financial Statements.

4. Course Outcomes (CO) and Skill Mapping

Cos	PROGRAM OUTCOMES (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12

CO1	Ability to **explain** principles of projectmanagement &organizations, humanresource management,inventorymanagement , demandforecasting and sitemanagement		✓										
CO2	Ability to **plan** a project schedule by network techniques and project management skill and **execute** allocation of resources			✓									
CO3	Ability to **appraise** a project based on BCR, NPV, IRR, PBP.				✓								
CO4	Ability to work individually and as a team in multidisciplinary settings									✓			
CO5	Ability to show the knowledge and understanding of project management and finance in Petroleum and Mining Industry											✓	

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO 1	Ability to **explain** principles of projectmanagement &organizations, humanresource management,inventorymanagement, demandforecasting and sitemanagement	PO 2		-	-	-	CT,MID, ASG FExam
CO 2	Ability to **plan** a project schedule by network techniques and project management skill and **execute** allocation of resources	PO 3	C1,C2 C3	-	-	-	CT, MID, ASG FExam
CO 3	Ability to **appraise** a project based on BCR, NPV, IRR, PBP.	PO 4		-	-	-	CT,MID
CO 4	Ability to work individually and as a team in multidisciplinary settings	PO 9		-		-	CS,ASG
CO 5	Ability to show the knowledge and understanding of project management and finance in Petroleum and Mining Industry	PO 11		-	-	-	CS,ASG

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
2. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision	84 21
3. Formal Assessment	3.1 Continuous Assessment 3.2 Mid- Term 3.2 Final Examination	2 1 3
		153

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	Project Planning and evaluation	
Lecture-2		
Lecture-3	Planning and Scheduling	
Week-2		
Lecture-4	CPM	
Lecture-5	Resource Scheduling	
Lecture-6		
Week-3		
Lecture-7	Feasibility Reports	
Lecture-8		
Lecture-9	Project Organization	CT_1
Week-4		
Lecture-10	Technology and management of materials and equipments	
Lecture-11		
Lecture-12	Site Management	
Week-5		
Lecture-13	Contracts and specifications	
Lecture-14	Inspection and quality control	
Lecture-15	Safety	CT_2
Week-6		
Lecture-16	Psychology of administration	
Lecture-17	Human factors in management	
Lecture-18	Human resource management	
Week-7		
Lecture-19	Procurement	
Lecture-20		

Lecture-21	Legal issues in project management	
Week-8 Lecture-22 Lecture-23 Lecture-24	Evaluating a project	MID/ASG
Week-9 Lecture-25 Lecture-26 Lecture-27	Project management in Oil, Gas and Mining industries	
Week-10 Lecture-28 Lecture-29 Lecture-30	Project management in Oil, Gas and Mining industries	
Week-11 Lecture-31 Lecture-32 Lecture-33	Project management in Oil, Gas and Mining industries	CT_3/ASG
Week-12 Lecture-34 Lecture-35 Lecture-36	Financing of Oil, Gas and Mining industries	
Week-13 Lecture-37 Lecture-38 Lecture-39	Financing of Oil, Gas and Mining industries	
Week-14 Lecture-40 Lecture-41 Lecture-42	Financing of Oil, Gas and Mining industries	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (40%)	1.1 Class Participation	10%	-	
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2,CO3,CO4,CO5	C1, C2, C3, C5
	1.3 Mid term	10%	CO1,CO3,CO5	C1, C2, C3
4. Final Exam (60%)		60%	CO1, CO3, CO5	C1, C2, C3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Project Management for Oil and Gas Industries by Samuel.

2. Oil and Gas Accounting by Rebecca A Gallun.
3. Project Management Body of Knowledge by Project Management Institute.
4. The art of project management by Scott Berkun.
5. Strategic Project Management Made Simple: Practical Tools for Leaders and Teams by Terry Schmidt.
6. Engineering Economy by illiam G. Sullivan.
7. Engineering Project Management by Nigel J. Smith.
8. Project Management for Engineers by J Michael Bennett.

GEEM 447	**Engineering Ethics and Moral Philosophy**	
		2.00 ContHr; 2.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

Ethics also ensures that engineers are held accountable for their actions, so they recognize and accept the personal commitment towards the client and the job, and maintain discretion over the client information. Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct. Moral philosophy is very important to the success of an individual. Morality is something humans think about and it is not based on physiological factors.

2. Learning objectives (OB)

1.To describe engineering ethics and moral philosophy of petroleum and mining industries.
2. To practice engineering ethics and moral philosophy of petroleum and mining industries.
3. To apply code and standards in engineering ethics and moral philosophy of petroleum and mining industries.
4. To employ in learning of engineering ethics and moral philosophy of petroleum and mining industries in context of technological change.

3. Course Contents

Professionalism and Codes of Ethics; Ethics in the workplace; Understanding Ethical Problems; Ethical Problem Solving Techniques; Risk, Safety, and Accidents; The Rights and Responsibilities of Engineers; Ethical Issues in Engineering Practice; Doing the Right Thing; Scope, dilemma, impacts and related ethical issues in engineering profession; Fairness (personal and social); Code of ethics of IEB & reputed Engineering societies and Case studies.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Recognize the main terminology and concepts of engineering ethics and moral philosophy of petroleum and mining industries						✓						
CO2	Learning the codes and standards in engineering ethics and moral philosophy of petroleum and mining industries.								✓				

CO3	Recognize the need for engineering ethics and moral philosophy in petroleum and mining industries	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Recognize the main terminology and concepts of engineering ethics and moral philosophy of petroleum and mining industries	PO6			-		CT,MID, FExam
CO2	Learning the codes and standards in engineering ethics and moral philosophy of petroleum and mining industries.	PO8	C1,C2	CP5	-	KP7	CT,MID, FExam
CO3	Recognize the need for engineering ethics and moral philosophy in petroleum and mining industries	PO12			-		CS,ASG

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
4. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	28 - -
5. Self-Directed Learning	2.1 Non-face-to-face learning 2.2 Revision 2.3 Preparations: Assignment	28 21 21
6. Formal Assessment	6.1 Continuous Assessment 3.2 Final Examination	2 3
		103

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1 Lecture-1 Lecture-2	Professionalism and Codes of Ethics.	CT_1
Week-2 Lecture-3 Lecture-4	Professionalism and Codes of Ethics.	
Week-3 Lecture-5 Lecture-6	Understanding Ethical Problems.	
Week-4 Lecture-7 Lecture-8	Understanding Ethical Problems.	
Week-5 Lecture-9 Lecture-10	Ethical Problem Solving Techniques	CT_2
Week-6 Lecture-11 Lecture-12	Ethical Problem Solving Techniques.	
Week-7		
Lecture-13 Lecture-14	Risk, Safety, and Accidents.	
Week-8 Lecture-15 Lecture-16	Risk, Safety, and Accidents.	MID/ASG
Week-9 Lecture-17 Lecture-18	The Rights and Responsibilities of Engineers.	
Week-10 Lecture-19 Lecture-20	The Rights and Responsibilities of Engineers.	CT_3/ASG
Week-11 Lecture-21 Lecture-22	Ethical Issues in Engineering Practice.	
Week-12 Lecture-23 Lecture-24	Ethical Issues in Engineering Practice.	
Week-13 Lecture-25 Lecture-26	Doing the Right Thing.	
Week-14 Lecture-27 Lecture-28	Doing the Right Thing.	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
5. Continuous Assessment (40%)	1.1 Class Participation	10%	-	C1, C2
	1.2 Class Test/ Assignment 1-3	20%	CO1, CO2,CO3	
	1.3 Mid term	10%		
6. Final Exam (60%)		60%	CO1, CO2	
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Engineering Ethics by Charles B. Fleddermann.
2. Engineering Ethics: Real World Case Studies by Steve Starrett, Amy Lara, and Carlos Bertha.

PHY 141	Waves and Oscillations, Optics, and Structure of Matter
	3.00 ContHr; 3.00 Cr Hr
Pre-requisite: None	**Curriculum structure:** Outcome Based Education (OBE)

1. **Rationale**

   This course covers the basics of physics in the fields of waves and oscillations, optics, and structure of matter. The course will emphasize the basic concepts, theories, and solving quantitative problems that can be applicable in a wide spectrum of engineering disciplines

2. **Learning objectives (OB)**
   1. To define the different parameters, concepts, logical and critical thinking with scientific knowledge of waves and oscillations, optics, and structure of matter.
   2. To explain the basic theories and laws of waves and oscillations, optics, and structure of matter.
   3. To solve numerical and analytical problems regarding waves and oscillations, optics, and structure of matter.

3. **Course Contents**

Waves and Oscillations: Simple Harmonic Motion (SHM) and its properties, differential equation of a SHM and its solution, total energy and average energy of a body executing SHM, simple pendulum, torsional pendulum, spring-mass system, LC oscillatory circuit, two body oscillation and reduced mass, Composition of SHM,Damped oscillations, and its different condition, forced oscillations and its different condition, resonance, Wave motion : expressionfor a plane progressive wave,differential equation of wave motion, energy density of wave motion, average kinetic and potential energy of wave motion, Stationary wave.
Optics: Combination of lens, equivalent lens and power, Defects of images and different aberrations, Interference of light, Young's double slit experiment, interference in thin films, Newton's ring, Diffraction of light, Fraunhofer and Fresnel diffraction, diffraction by single slit and double slit, diffraction grating, Fraunhofer diffraction at a circular aperture, resolving power of optical instrument, Polarization of light, Brewster's law, Malus law, polarization by double refraction,Nicole prism, optical activity and polarimeters, Laser: spontaneous and stimulated emission.
Structure of matter : Crystalline and non-crystalline solids, single crystal and poly-crystal solids, unit cell, crystal systems, co-ordinations number, crystal planes and directions, NaCl and CsCl structure, packing factor, Miller indices, relation between inter-planar spacing and Miller indices, Bragg's law, methods of determination of inter-planar spacing from diffraction patterns; defects in solids: point defects, line defects, surface defects, bonds in solids, band theory of solids: distinction between metal, semiconductor and insulator, inter-atomic distances, calculation of cohesive and bonding energy.

4. Course Outcomes (CO) and Skill Mapping

Cos		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to Define different basic parameters in the field of waves and oscillations, optics, and structure of matter such as periodic motion, simple harmonic			✓									

	motion, undamped oscillations, interference, diffraction, polarization, crystal structure, crystal defects etc.	
CO2	Be capable to Explain different basic theories in the field of waves and oscillations, optics, and structure of matter such as the wave motion for different systems along with energy, different formula for interference, diffraction, polarization, the packing factor, Bragg's law, etc.	✓
CO3	Be skilled to Solve quantitative problems in the field of waves and oscillations, optics, and structure of matter such as energy of wave motion, wavelength, interference, diffraction, polarization, packing factor, Miller indices, etc.	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	**Define** different basic lawsand parametersin the field of waves and oscillations, optics, and structure of matter such as simple harmonic motion, damped oscillations,interference, diffraction, polarization,crystal structure, crystal defects, etc.	PO3	C1	-	-	1	CT, MID, FExam
CO2	**Explain** different basic theories in the field of waves and oscillations, optics, and structure of mattersuch as the SHM, damped motion, wave motion, interference, diffraction, polarization, Bragg's law, bonding energy, etc.	PO1	C2	-	-	1	MID, FExam
CO3	**Solve** quantitative problems in the field of waves and oscillations, optics, and structure of matter such as	PO1	C3	-	-	2	CT, MID, FExam, ASG

SHM, damped motion, wave motion, interference, diffraction, polarization,packing factor, Miller indices, etc.	

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **Ass**ignment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
4. Face-to-Face Learning	Lecture	42
	Practical / Tutorial	-
	Student-Centered Learning	-
5. Self-Directed Learning	Non-face-to-face learning	42
	Revision	21
	Preparation for test and examination	21
6. Formal Assessment	Test/Mid- Term	3
	Final Examination	3
		132

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1		
Lecture-1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, assessment of the course.	
Lecture-2	Periodic motion, oscillatory motion, simple harmonic motion (SHM), properties of SHM, differential equations, general solution of SHM, graphical representation of SHM	
Lecture-3	Velocity, acceleration, phase and epoch, time period, frequency and angular frequency of SHM	
Week-2		
Lecture-4	Total energy and average energy of SHM, problems	
Lecture-5	Simple pendulum, torsional pendulum, spring-mass system	
Lecture-6	LC oscillatory circuit, two body oscillations, reduced mass	
Week-3		
Lecture-7	Composition of SHM	
Lecture-8	Composition of SHM, problems	CT_1

Lecture-9	Damped oscillations and its differential equation	
Week-4		
Lecture-10	Displacement equation of damped oscillations and its different conditions, electric damped oscillatory circuit	
Lecture-11	Forced oscillations and its differential equation, displacement equation of forced oscillations, resonance	
Lecture-12	Wave motion : expression for a plane progressive wave, differential equation of wave motion, particle velocity, wave velocity	
Week-5		CT_2
Lecture-13	Energy density of a plane progressive wave, average energy in a plane progressive wave, problems	
Lecture-14	Stationary wave : node, anti-node, problems	
Lecture-15	Lens and combination of lenses, equivalent lens, power of lens, cardinal points	
Week-6		
Lecture-16	Defects of images and different aberrations	
Lecture-17	Defects of images and different aberrations	
Lecture-18	Interference of light, young's double slit experiment	
Week-7		
Lecture-19	Analytical treatment of interference, energy distribution	
Lecture-20	Interference fringes, interference in thin films	
Lecture-21	Newton's ring, Interferometer	
Week-8		
Lecture-22	Diffraction : Fresnel & Fraunhofer diffraction, diffraction by single slit	
Lecture-23	Diffraction by double slit, diffraction gratings	
Lecture-24	Fraunhofer diffraction at a circular aperture, resolving power of optical instrument	
Week-9		
Lecture-25	Polarization of light, Brewster's law, Malus' law Optical activity and polarimeter.	
Lecture-26	Polarization by double refraction, Nicol prism: Polarizer and analyzer	
Lecture-27	Optical activity: specific rotation, polarimeters	MID
Week-10		
Lecture-28	Laser: spontaneous and stimulated emission, applications of laser	
Lecture-29	Classification of solids, types of crystalline solids, crystal, lattice, basis, crystal structure, plane lattice, space lattice, Bravais and non-Bravais lattices	
Lecture-30	Unit cell, lattice parameters, primitive and non-primitive cells and their distinctions, lattice symbols, crystal structure of NaCl and CsCl	
Week-11		
Lecture-31	Unit face, axial units: linear and numerical parameters and, Miller indices	
Lecture-32	Atomic radius, packing factor and coordination number for different structures	

Lecture-33	Relation between lattice constant and density of solids and related numerical problems	CT_3
Week-12		
Lecture-34	Inter-planer spacing, relation between inter-planar spacing and Miller indices, problems	
Lecture-35	X-ray diffraction, Bragg's law, methods of determination of inter-planar spacing from diffraction patterns, problems	
Lecture-36	Defects in solids: point defects, line defects, surface defects	
Week-13		
Lecture-37	Defects in solids: point defects, line defects, surface defects	
Lecture-38	Atomic arrangement in solid: different types of bonds in solids	
Lecture-39	Band theory of solids : valence band, conduction band, energy gap, distinction between metal, semiconductor and insulator	
Week-14		
Lecture-40	Potential, cohesive energy, binding energy, Madelung constant, inter-atomic distance, calculation of total potential energy of a pair of atoms	
Lecture-41	Calculation of total potential energy at the equilibrium separation of an ionic crystal, problems	
Lecture-42	Review of the syllabus	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
6. Continuous Assessment (40%)	1.1 Class Participation	5%	CO1, CO2,CO3	C1, C2,C3
	1.2 Class Test/	20%		
	Class performance	5%		
	1.3 Mid term	10%		
7. Final Exam (60%)		60%	CO1, CO2, CO3	
		100%		

C: Cognitive domain; A: Affective domain; P: Phychomotor domain

9. Materials Recommended

1. 1. Physics for Engineers : Part-I and Part-II : Dr Giasuddin Ahmad
2. Physics, Volume I and Volume II**:** Resnick and Halliday
3. Fundamentals of Physics : Halliday, Resnick and Walker
4. Physics for Scientists and Engineers: Serway and Jewett
5. Waves and Oscillations : Brij Lal and Subramannyam
6. Fundamental of Optics: Francis A. Jenkins and Harvey E.White
7. Introduction to Modern Optics: Grant R. Fowles
8. Fundamental Optical Design: Michael J. Kidger

9. A Text Book of Optics **:** Brijlal and N. Subrahmanyam
10. Introduction to Solid State Physics: Charles Kittle
11. Solid State Physics: S. O. Pillai
12. Solid State Physics: Ali Omar
13. Fundamentals of Solid State Physics**:** B.S. Saxena, R.C. Gupta, P.N. Saxena
14. B.Sc Physics : C. L. Arora.

PHY 142	**Physics Sessional**	
		3.00ContHr; 1.50Cr Hr
Pre-requisite:	None	**Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

This is a laboratory course in basic physics in the fields of waves and oscillations, optics, mechanics, electricity, modern physics, and thermal physics. The course will emphasize the fundamental experiments in different fields of physics that can be applicable to a wide spectrum of engineering disciplines. This laboratory course will enable students to understand basic physics practically as well as work with a team or individual.

2. Learning objectives (OB)

1. To develop basic physics knowledge practically
2. To practice use of basic scientific instrument.

3. Course Contents

Quantitative measurement of different parameters in the field of waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics such as Specific resistance of materials, high resistance, resistance of a galvanometer, Electrochemical equivalent (ECE) of copper, comparison of the E.M.F's of two cells, radius of curvature, wavelength of light, focal length of lens, specific rotation of sugar, refractive index of a liquid, thermal conductivity of a bad conductor, temperature co-efficient of resistance, pressure co-efficient of a gas, specific heat of a liquid, acceleration due to gravity, spring constant, rigidity modulus, young's modulus, moment of inertia, conservation of linear momentum, frequency of a tuning fork, surface tension, Planck's constant.

1. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to Define the different parameters regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physicsetc.	✓											
CO2	Be capable to Describe the different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	✓											
CO3	Be skilled to Construct Experiments by an individual or by a group to determine different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal	✓											

	physics etc.	
CO4	Be able to Prepare a report for an experimental work.	✓

2. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Be able to Define the different parameters regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physicsetc.	PO1	C1	-	-	1	CT, MID, FExam ,Q,R
CO2	Be capable to Describe the different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO1	C1	-	-	1	CT, MID, FExam ,Q,R
CO3	Be skilled to Construct Experiments by an individual or by a group to determine different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO1	C2	-	-	2	CT, MID, FExam ,Q,R
CO4	Be able to Prepare a report for an experimental work.	PO1	C2			2	R

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

3. Teaching- Learning Strategy

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7

Experiment	35
Self-Directed Learning	
Preparation of Lab Reports	21
Preparation for the Lab Test	13
Preparation of Quiz	9
Preparation of viva	9
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Final viva	1
Final lab exam	3
Total	**112**

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE

Weeks	**Topics**	Remarks
Week-1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, evaluation system of the course, grouping, visit different section of the laboratory, introduction to different basic equipment	
Week-2	Determination of the specific resistance of a wire using meter bridge / Determination of focal length of a concave lens by auxiliary lens method	Perform any one
Week-3	Determination of high resistance by the method of deflection / Determination of resistance of a galvanometer by half deflection method / Determination of specific heat of a liquid by the method of cooling	Perform any one
Week-4	Determination of ECE of copper by using copper voltameter / Determination of the Young's modulus of bar by bending method / Determination of the Young's modulus for the material of a wire by Searle's apparatus	Perform any one
Week-5	Determination of the wavelength of sodium light by a spectrometer using a plane diffraction grating / Determination of the moment of inertia of a Fly-wheel about its axis of rotation	Perform any one
Week-6	Determination of the radius of curvature of a plano-convex lens by Newton's ring method/ Determination of the temperature co-efficient of resistance of the material of a wire using a meter-bridge	Perform any one
Week-7	Determination of the specific rotation of sugar by polarimeter / Determination of the refractive index of a liquid by plane mirror and pin method using a convex lens	Perform any one

Week-8	Determination of the thermal conductivity of a bad conductor by Lee's method / Verification of the law of conservation of linear momentum / Determination of the surface tension of water by capillary tube method and hence to verify Jurin's law	Perform any one
Week-9	Determination of the value of g acceleration due to gravity by means of a compound pendulum / Comparison of the E.M.F's of two cells by a potentiometer	Perform any one
Week-10	Determination of the spring constant, effective mass and the rigidity modulus of the spring / Determination of the pressure co-efficient of a gas at constant volume by constant volume air thermometer	Perform any one
Week-11	Determination of the Planck's constant using photoelectric effect / Determination of the frequency of a tuning fork by Melde's experiment	Perform any one
Week-12	Viva & lab final experimental exam	
Week-13	Viva & lab final experimental exam	
Week-14	Quiz exam	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class performance/ Assignment	10%		
	Report Writing/ Assignment	30%	CO1, CO4	C1, C2
Final Exam (60%)	Lab test	30%	CO1, CO2, CO3	C1, C2
	Viva	10%		
	Quiz	20%		
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, A = Affective Domain, P = Psychomotor Domain)

REFERENCE BOOKS

1. Practical physics for degree students: Dr Giasuddin Ahmad and Md. Sahabuddin
2. Practical Physics: G. L. Squires
3. B.Sc. Practical Physics: C. L Arora
4. Practical Physics: S.L. Gupta and V. Kumar

CHEM 101	**Fundamentals of Chemistry**	
		3.00 ContHr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale

This course is to learn the basic concepts of inorganic, organic and physical chemistry.

2. Learning objectives (OB)

1. To define the different parameter and concepts of inorganic chemistry.
2. To apply different chemical theory to evaluate structure of molecules.
3. To describe basic reaction mechanism of selective organic reactions.
4. To explain the basic concepts of physical chemistry.

3. Course Contents

Atomic Structure: Concepts of atomic structure, Different atom models, Quantum theory and electronic configurations, Heisenberg's uncertainty principle. **Periodic Table:** Periodic classification of elements, Periodic properties of elements, Properties and uses of noble gases. **Chemical Bonding:** Types and properties, Lewis theory, VBT, MOT, Hybridization and shapes of molecules. **Basic Concepts of Organic Chemistry**: History, Physical and chemical properties, Classification. **Hydrocarbon:** Chemistry of hydrocarbon, Nomenclature, Properties. **Selective Organic Reactions:** Oxidation-reduction, Substitution, Addition, Polymerization, Alkylation reactions. **Acids-Bases/Buffer Solution:** Different concepts of acids-bases, Buffer solution, Mechanism of buffer solution, Henderson-Hasselbalch equation, Water chemistry and pH of water. **Solutions:** Solutions and their classification, Unit expressing concentration, Colligative properties and dilute solutions, Raoult's law, Van't Hoff's law of osmotic pressure. **Thermochemistry:** Laws of thermochemistry, Enthalpy, Heat of reaction, Heat of formation, Heat of neutralization, Kirchoff's equations, Hess's law. **Electrochemistry:** Conductors and nonconductors, Difference between electrolytic and metallic conduction, Electrolytic conductance, Factors influencing the conductivity of electrolytes, Kohlrausch Law and conductometric titrations. **Chemical Equilibria:** Equilibrium law/constant, K_p and K_c, Homogeneous and heterogeneous equilibrium, Van't Hoff's reaction isotherm, Le Chatelier's principle. **Phase Rule:** Basic terms and phase rule derivation, Phase diagram of water and carbon dioxide. **Chemical Kinetics:** Order and rate of reaction, Pseudo and zero order reaction, Half-life, Determination and factors affecting the rate of a reaction, First order reaction, Second order reaction, Collision theory, Transition state theory

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to define the different parameter and concepts regarding atomic structure, periodic table, chemical bonding, acids and bases.	✓											
CO2	Be able to apply different theory on chemical bonding and hybridization to evaluate structure of molecules.	✓											
CO3	Be able to classify hydrocarbon and explain the mechanism of selective organic	✓											

	reactions.	
CO4	Explain chemical equilibrium, thermo-chemistry, chemical and ionic equilibria, electro-chemical cells.	✓

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Be able to define the different parameter and concepts regarding atomic structure, periodic table, chemical bonding, acids and bases.	PO1	C1	-	-	1	CT, FExam
CO2	Be able to apply different theory on chemical bonding and hybridization to evaluate structure of molecules.	PO1	C3, C5	-	-	1, 2	CT, FExam, ASG
CO3	Be able to classify hydrocarbon and explain the mechanism of selective organic reactions.	PO1	C2	-	-	1, 2	CT, FExam, ASG
CO4	Explain chemical equilibrium, thermo-chemistry, chemical and ionic equilibria, electro-chemical cells.	PO1	C2	-	-	1, 2	MID, FExam, ASG

***CP*- *C*omplex *P*roblem/ *WP*- *W*ashington Accord Complex *P*roblem Solving; *CA*- *C*omplex *A*ctivities/ *EA*- *E*ngineering *A*ctivities; *KP*- *K*nowledge *P*rofile/ *WK*- *W*ashington Accord *K*nowledge Profile.**

CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
1. Face-to-Face Learning	1.1 Lecture 1.2 Practical / Tutorial 1.3 Student-Centered Learning	42 - -
2. Self-Directed Learning	2.1 Assignments 2.2 Revision of lectures 2.2 Preparation: Exam	42 21 21
3. Formal Assessment	3.1 Continuous Assessment 3.2 Final Examination	2 3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Atomic Structure**	
Lecture-1	Concepts of atomic structure, Different atom models.	CT_1
Lecture-2	Quantum numbers, Electronic configuration.	
Lecture-3	Hydrogen spectral lines, Heisenberg's uncertainty principle.	
Week-2	**Periodic Table/Chemical Bonding**	
Lecture-4	Classification of elements according to electronic configurations, Periodic classification of elements.	
Lecture-5	Periodic properties of elements, Properties and uses of noble gases, Alkali metals: Chemical properties and uses.	
Lecture-6	Chemical bonding (types, properties, Lewis theory, VBT).	
Week-3	**Periodic Table/Chemical Bonding**	
Lecture-7	Chemical bonding (types, properties, Lewis theory, VBT).	
Lecture-8	Molecular orbital theory (MOT).	
Lecture-9	Molecular orbital theory (MOT).	
Week-4	**Chemical Bonding**	CT_2
Lecture-10	Hybridization and shapes of molecules.	
Lecture-11	Hybridization and shapes of molecules.	
Lecture-12	Hybridization and shapes of molecules.	
Week-5	**Organic Chemistry**	
Lecture-13	Basic concepts of organic chemistry: History, Physical and chemical properties, Classification.	
Lecture-14	Chemistry of hydrocarbon, Nomenclature, Properties	
Lecture-15	Selective organic reactions: Oxidation-reduction, Substitution.	
Week-6	**Organic Chemistry/Acids-Bases**	
Lecture-16	Selective organic reactions: Addition, Polymerization, Alkylation.	
Lecture-17	Selective organic reactions: Addition, Polymerization, Alkylation.	
Lecture-18	Different concepts of acids-bases.	
Week-7	**Acids-Bases**	
Lecture-19	Buffer solution, Mechanism of buffer solution.	
Lecture-20	Henderson-Hasselbalch equation.	
Lecture-21	Water chemistry and pH of water.	
Week-8	**Solutions/Thermochemistry**	CT_3/ MID
Lecture-22	Solutions and their classification, Unit expressing concentration,Effect of temperature and pressure on solubility, Validity and limitations of Henry’s law.	
Lecture-23		
Lecture-24	Colligative properties and dilute solutions,Raoult’s law, deviation from Raoult’s law.	
Week-9	**Solutions/Thermochemistry**	
Lecture-25	Elevation of boiling point, Freezing point depression, Van’t Hoff’s law of osmotic pressure.	
Lecture-26	Laws of thermochemistry, Enthalpy.	
Lecture-27	Heat of reaction, Heat of formation, Heat of neutralization.	
Week-10	**Thermochemistry/Electrochemistry**	

Lecture-28	Hess's law, Kirchoff's equations.	
Lecture-29	Electrolytic conduction and its mechanism.	
Lecture-30	Faraday's law, Kohlrausch Law, Debye-Huckel-Onsagar theory.	
Week-11	**Electrochemistry/ Chemical Equilibrium**	
Lecture-31	Conductometric titrations.	
Lecture-32	Different types of cells.	
Lecture-33	Reversible reactions, Characteristics of chemical equilibrium	
Week-12	**Chemical Equilibrium**	
Lecture-34	Law of mass action, Equilibrium constant, Units of equilibrium constant.	
Lecture-35	Relation between K_p and K_c,Van't Hoff's reaction isotherm	
Lecture-36	Free energy and its significance Heterogeneous equilibrium, Le Chatelier's principle.	CT_4
Week-13	**Phase Rule/Chemical Kinetics**	
Lecture-37	Phase Rule: Basic terms and phase rule derivation.	
Lecture-38	Phase Diagram of water and carbon dioxide.	
Lecture-39	Pseudo and zero order reaction, Half-life.	
Week-14	**Chemical Kinetics**	
Lecture-40	Determination and factors affecting the rate of a reaction.	
Lecture-41	First order reaction, Second order reaction.	
Lecture-42	Collision theory, Transition state theory.	

8. Assessment Strategy

<table>
<tr><th colspan="2">Components</th><th>Grading</th><th>Course Outcome (CO)</th><th>Blooms Taxonomy</th></tr>
<tr><td rowspan="3">8. Continuous Assessment (40%)</td><td>1.1 Class Participation</td><td>5%</td><td rowspan="3">CO1, CO2, CO3, CO4</td><td rowspan="4">C1, C2, C3, C5</td></tr>
<tr><td>1.2 Class Test/ Assignment 1-3</td><td>20%</td></tr>
<tr><td>1.3 Mid term</td><td>15%</td></tr>
<tr><td colspan="2">9. Final Exam (60%)</td><td>60%</td><td>CO1, CO2, CO3, CO4</td></tr>
<tr><td colspan="2"></td><td>100%</td><td></td><td></td></tr>
</table>

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. Modern Inorganic Chemistry – S. Z. Haider.
2. Concise Inorganic Chemistry – J. D. Lee.
3. A Textbook of Organic Chemistry – Arun Bahl and B. S. Bahl.
4. Organic Chemistry – Morrison and Boyd.
5. Principles of Physical Chemistry – Haque and Nawab.
6. Essentials of Physical Chemistry – Bahl and Tuli.
7. Physical Chemistry – Atkins.

.

CHEM 102 **Chemistry Sessional**

3.00ContHr; 1.50Cr Hr

Pre-requisite: None **Curriculum structure:**Outcome Based Education (OBE)

1. Rationale

This course is to learn the basic concepts of inorganic and physical chemistry in a laboratory environment.

2. Learning objectives (OB)

a) To learn inorganic and physical chemistry quantitative analysis techniques.

3. Course Contents

Quantitative chemical analysis in the field of inorganic and physical chemistry such as: Acid-base titration, Redox titration, Iodometric and Iodimetric titration, Complexometric titration.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Define the different parameters regarding acid and base neutralization, titration and quantitative analysis of metals etc. and others key words like primary standard substances, secondary standard substances, molarity, normality, indicator, equivalent weights and so on	✓											
CO2	Explain the different phenomena regarding iodimetric and iodometric method, complexometric titration etc	✓											
CO3	Estimate ferrous, copper and zinc content samples by using various titrimetric methods	✓											
CO4	Summarize a report of any project work and apply in real life.										✓		

5. Mapping of Course Outcomes (CO) and General Skills

Course Outcomes(CO)	POs	Blooms	CP	CA	KP	Assessment

			Taxonomy	(WP)	(EA)	(WK)	Methods
CO1	Define the different parameters regarding acid and base neutralization, titration and quantitative analysis of metals etc. and others key words like primary standard substances, secondary standard substances, molarity, normality, indicator, equivalent weights and so on	PO1	C1	-	-	1	CT, FExam
CO2	Explain the different phenomena regarding iodimetric and iodometric method, complexometric titration etc	PO1	C3, C5	-	-	1, 2	CT, FExam, ASG
CO3	Estimate zinc, ferrous content in water sample by using various titrimetric methods	PO1	C2	-	-	1, 2	CT, FExam, ASG
CO4	Summarize a report of any project work and apply in real life.	PO10	C2	-	-	1, 2	MID, FExam, ASG

***CP**- **C**omplex **P**roblem/ **WP**- **W**ashington Accord Complex **P**roblem Solving; **CA**- **C**omplex **A**ctivities/ **EA**- **E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam

6. Teaching- Learning Strategy

Activities		Engagement (hours)
7. Face-to-Face Learning	1.1 Lecture 1.2 Experiment/ Modeling 1.3 Student-Centered Learning	10 18 -
8. Self-Directed Learning	2.1 Preparation: Lab reports 9.2 Preparation: Lab test 9.3 Preparation: quiz 9.4 Preparation: viva	18 25 9 9
10. Formal Assessment		

	3.1 Continuous Assessment	2
	3.2 Quiz	1
	3.2 Final Lab Exam	3
		95

TEACHING METHODOLOGY
Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Design Based Method

7. Teaching Schedule

Lecture	Experiments
Week-1	Introduction
Week-2	Standardization of Sodium Hydroxide (NaOH) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.
Week-3	Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Hydroxide (NaOH) Solution.
Week-4	Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Carbonate (Na_2CO_3) Solution.
Week-5	Determination of Calcium (Ca) Content in a Calcium Chloride dihydrate ($CaCl_2.2H_2O$) Solution with Standard Di-Sodium Ethylenediamminetetraacetic Acid (Na_2-EDTA) Solution.
Week-6	Standardization of Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution with Standard Potassium Dichromate ($K_2Cr_2O_7$) Solution.
Week-7	Estimation of Copper (Cu) Content in a Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$) (Blue Vitriol) Solutions by Iodometric Method with Standard Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution.
Week-8	Standardization of Potassium Permanganate ($KMnO_4$) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.
Week-9	Determination of Ferrous (Fe) Content in a Ammonium Ferrous Sulphate (Mohr`s Salt) [$FeSO_4.(NH_4)_2SO_4.6H_2O$] Solution with Standard Potassium Permanganate ($KMnO_4$) Solution.
Week-10	Determination of Zinc (Zn) Content in a Zinc Sulphate Heptahydrate ($ZnSO_4.7H_2O$) Solution with Standard Di-Sodium Ethylenediaminetetraacetic Acid (Na_2-EDTA) Solution by using Eriochrome Black T Indicator.
Week-11	Practice Lab
Week-12	Lab Test
Week-13	Quiz Test
Week-14	Viva

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (75%)	1.1 Lab Participation and performance	10%	CO1	C1
	1.2 Report	30%	CO1, CO4	C1, C2

	1.3 Assignment			
2. Lab exam (60%)	2.1 Lab test 2.2 Viva 2.3 Quiz	30% 10% 20%	CO1, CO2, CO3	C1, C2
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

1. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Scientific & Technical, 1989
2. G. D. Christian., Analytical Chemistry, 6th Edition, Wiley India Pvt. Limited, 2007
3. A. Jabbar Mian and M. Mahbubul Haque-Practical Chemistry

MATH 101	Differential and Integral Calculus	
		3.00 Cont Hr;3.00 Cr Hr
PRE-REQUISITE	**None**	**Curriculum Structure:** Outcome Based Education (OBE)

1. Rationale

Purpose of this course is to introduce knowledge of Calculus and use it to engineering study.

2. Learning Objectives (OB)

1. Be able to acquire knowledge on differential and integral calculus to solve engineering problems and other applied problems.
2. Be able to understand the important aspects of rate of change, tangent, normal, area and volume.
3. Be expert in applying knowledge of functional analysis such as increasing, decreasing, maximum and minimum values of a function.

3. Course Contents

Differential Calculus: Introduction, differential calculus for engineering, function, graphs of standard functions, limit, continuity and differentiability of functions, successive differentiation, Leibnitz's theorem, Rolle's theorem, Mean-value theorem, expansion of functions, Lagrange's form of remainder, Cauchy's form of remainder, indeterminate form, partial differentiation, Euler's theorem, tangent and normal, maxima and minima, curvature, asymptotes.

Integral Calculus: Definition of integration, Various techniques of integration , integration by substitution, standard integrals, integration by parts, integration by successive reduction, definite integrals, Walli's formula, integration as a limit of sum, improper integrals, Beta and Gamma functions, multiple integral, standard graphs of Cartesian, polar & parametric equations, lengths of curves, area of the region enclosed by two curves, volume of solid of revolution.

4. Course Outcome(CO) and Skill Mapping

COs		PROGRAM OUTCOMES (POs)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	**Define** limit, continuity and differentiability of functions, the rate of change of a function with respect to independent variables, the extreme value of functions.			✓									
CO2	**Apply** the concepts and techniques of differentiation and integration to solve the problems related to engineering study.			✓									
CO3	**Calculate** length, area, volume and average value related to engineering measurement.			✓									

5. Mapping of Course Outcomes(COs) and General Skills

Course Outcomes(COs)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	**Define** limit, continuity and differentiability of functions, the rate of change of a function with respect to independent variables, the extreme value of functions.	PO3	C1	1	**-**	3	CT,MID, ASG
CO2	**Apply** the concepts and techniques of differentiation and integration to solve the problems related to engineering study.	PO3	C3	1	**-**	3	CT,MID, ASG FExam
CO3	**Calculate** length, area, volume and average value related to engineering measurement.	PO3	C3	-	**-**	3	CT,MID, ASG FExam

***CP-C**omplex**P**roblem/**WP-W**ashingtonAccordComplex**P**roblemSolving;**CA-C**omplex**A**ctivities/**EA-E**ngineering **A**ctivities; **KP- K**nowledge **P**rofile/ **WK- W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam, **CS**- Case Study.

6. Teaching Learning Strategy

Activities		**Engagement (Hours)**
1. Face to Face Learning	1.1 Lecture	42
	1.2 Practical/Tutorial	-
	1.3 Student Centered Learning	-
2. Self-Directed Learning	2.1 Non Face-to-Face Learning	25
	2.2 Revision	21
	2.3 Preparations: Assignment	21
3. Formal Assessment	3.1 Continuous Assessment	8
	3.2 Final Examination	3
		120

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method,
Problem Based Learning.

7. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week1		
Class1	Introduction to differential calculus for engineering study, limit of a function and its properties.	CT1
Class2	Basic limit theorems with proofs, limit at infinity and infinite limit, Sandwich (Squeezing) theorem with problems.	
Class3	Concept of differentiation, definition, classification of discontinuity and solution of problems	
Week2		
Class4	Basic concept of differentiability, definition, derivative of a function, differentiable function.	
Class5	Differentiability, solution of problems	
Class6	Successive differentiation-concept and solution of problems	
Week3		
Class7	Leibnitz's theorem and its applications	
Class8	Determination of $(y_n)_0$	
Class9	Mean-Value theorem, Taylor theorem	
Week4		CT2
Class10	Expansionoffiniteandinfiniteforms,Lagrange'sandCauchy's form of remainder	
Class11	Indeterminate forms-concept and solution of problems	
Class12	L' Hospital's rules with application	
Week5		
Class13	Partial differentiation-partial derivatives of a function of two variables and problems	
Class14	Partial differentiation-partial derivatives of a homogeneous function of two variables ,Euler's theorem for two variables and problems	
Class15	Partial differentiation-partial derivatives of a homogeneous function of several variables, Euler's theorem for several variable sand problem solving	
Week6		
Class16	Tangents and Normal :Tangents and Normal in Cartesian, equation of tangent at the origin, equation of normal of functions of explicit and implicit forms, angle between two intersection of two curves, solution of problems	
Class17	Tangents and normal- tangents and normal in polar, angle between two intersection of two curves, solution of problems	

Class18	Tangents and normal-sub tangent and subnormal's in Cartesian and polar coordinate, solution of problems	
Week7		Mid Term
Class19	Maxima and minima of functions of single variables: concept, increasing and decreasing function, concave up and concave down functions	
Class20	Curvature	
Class21	Asymptotes	
Week8		
Class22	Introduction to integral calculus	
Class23	Standard integrals: concept of definite and indefinite integrals, applications.	
Class24	Indefinite integrals: Method of substitution, various techniques of integration	
Week9		
Class25	Indefinite integrals: Integration by parts, special types of integration, integration by partial fraction	
Class26	Integration by the method of successive reduction	
Class27	Definite integrals : definite integrals with properties and problems	
Week10		
Class28	Definite integrals: Reduction formula, Walli's formula	
Class29	Definite integrals : Definite integral as the limit of sum	
Class30	Beta function :Concept and solution of problems	
Week11		CT 3
Class31	Gamma function : Concept and problem solving	
Class32	Relation between Beta and Gamma functions, Legendre duplication formula, problems and applications	
Class33	Multiple integrals: Double integrals	
Week12		
Class34	Multiple integrals: Triple integrals	
Class35	Multiple integrals : Successive integration for two and three variables	
Class36	Lengths of curves in Cartesian coordinate	
Week13		
Class37	Arc lengths of curves in polar coordinates	
Class38	Area in Cartesian co-ordinate	
Class39	Area bounded by parametric equation	
Week14	Area in polar co-ordinate	
Class40	Area of a region enclosed by two curves in Cartesian and polar coordinates	
Class41	Volume of solid of revolution	
Class42	Volume of solid of revolution	

8. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
1. Continuous Assessment (40%)	1.1 Class Participation	10%	-	
	1.2 Class Test/ASG 1-3	20%	CO1,CO2,CO3,	C1,C3
	1.3 Mid Term/ASG	10%		
2. Final Exam (60%)		60%	CO1,CO2,CO3,	C1,C3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Psychomotor domain*

9. Materials Recommended

1. Calculus by Howard Anton, IrlC. Bivens, Stephen Davis
2. Differential Calculus(Part I-II) by Dr Md Abdul Matin and Bidhu Bhushan Chakra borty
3. Integral Calculus and Differential Equation by Md Abdul Matin and Bidhu Bhushan Chakraborty
4. Calculus: An Intuitive and Physical Approach by Morris Kline
5. Differential Calculus by B.C. Das and B.N. Mukherjee
6. Integral Calculus by B.C. Das and B.N. Mukherjee

MATH 103	**Differential Equations and Matrix**	***3.00 Cont Hr;3.00 Cr Hr***
PRE-REQUISITE	MATH 101	**Curriculum Structure:** Outcome Based Education(OBE)

10. Rationale

Purpose of this course is to introduce knowledge to solve differential equations and apply them to solve engineering problems. Also to acquire knowledge on matrix, formulate the engineering problems in matrix form and solve them.

11. Learning Objectives (OB)

1. Be able to acquire knowledge on ordinary and partial differential equations.
2. Be able to understand important aspects of ordinary & partial differential equations and be able to solve them.
3. Be able to apply differential equations and matrices in solving engineering problems

12. Course Contents

Differential Equations: Introduction & formulation of differential equations, solution of first order ordinary differential equations by various methods, solution of general ordinary differential equations of higher order, solution of Euler's homogeneous linear ordinary differential equations, Frobenious methods, Bessel's functions, Legendre's polynomial, linear first order partial differential equations, nonlinear first order partial differential equations, standard form differential equations of higher order and wave equation, particular solutions with boundary and initial condition, linear partial differential equations with constant coefficients, non-linear partial differential equations of order one, Charpit's method, Applications of partial differential equations.

Matrix: Different types of matrices, transpose and adjoint of a matrix and inverse matrix, rank of matrix and elementary transformation, matrix algebra, solution of system of linearequations,matrixpolynomials,eigen-valueandeigen-vector,CayleyHamiltontheorem.

13. **Course Outcome(CO) and Skill Mapping**

COs		PROGRAM OUTCOMES (POs)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	**Define** various types of differential equations and matrices.			✓									
CO2	**Apply** the knowledge of differential equations and matrices to solve the engineering problems			✓									
CO3	**Apply** the various operations of matrices to formulate engineering problems and solve them			✓									

14. Mapping of Course Outcomes(COs) and General Skills

Course Outcomes(COs)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	**Define** various types of differential equations and matrices.	PO3	C1	1	-	3	CT,MID, ASG
CO2	**Apply** the knowledge of differential equations and matrices to solve the engineering problems	PO3	C3	1	-	3	CT,MID, ASG FExam
CO3	**Apply** the various operations of matrices to formulate engineering problems and solve them	PO3	C3	1	-	3	CT,MID, ASG FExam

***CP-C**omplex**P**roblem/**WP-W**ashingtonAccordComplex**P**roblemSolving;**CA-C**omplex**A**ctivities/**EA-E**ngineering **A**ctivities; **KP- K**nowledge **P**rofile/ **WK- W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid** term exam, **CS**- Case Study.

15. Teaching Learning Strategy

Activities		**Engagement (Hours)**
4. Face to Face Learning	1.1 Lecture	42
	1.2 Practical/Tutorial	-
	1.3 Student Centered Learning	-
5. Self-Directed Learning	2.1 Non Face-to-Face Learning	25
	2.2 Revision	21
	2.3 Preparations: Assignment	21
6. Formal Assessment	6.1 Continuous Assessment	8
	6.2 Final Examination	3
		120

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Learning.

16. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week 1		
Lecture 1	Introduction & formulation of differential equations,	
Lecture 2	degree and order of differential equations	
Lecture 3		

Week 2		CT 1
Lecture 4 Lecture 5 Lecture 6	Solution of first order differential equations by various methods	
Week 3		
Lecture 7 Lecture 8 Lecture 9	Application of first order ordinary differential equations in Malthusian population model	
Week 4		
Lecture 10	Application of first order ordinary differential equations in trajectory.	
Lecture 11	Solution of higher order differential equations	
Lecture 12		CT 2
Week 5		
Lecture 13	Solution of higher order differential equations	
Lecture 14		
Lecture 15	Solution of higher order differential equations by method of variation of parameter	
Week 6		
Lecture 16	Formation of partial differential equation	
Lecture 17	Linear first order PDE, Non linear first order PDE	
Lecture 18	Particular solutions with boundary and initial condition, Non- Linear PDE of order one: Charpit's method	
Week 7		
Lecture 19 Lecture 20 Lecture 21	Linear PDE with constant coefficients, Applications of DE	MID/ASG
Week 8		
Lecture 22	Wave equations	
Lecture 23 Lecture 24	Particular solutions with boundary and initial conditions	
Week 9		
Lecture 25 Lecture 26 Lecture 27	Second order PDE and classifications to canonical(standard)-parabolic, elliptic, hyperbolic solution by separation of variables	
Week 10		
Lecture 28	Application of OD and PDE in Engineering study	
Lecture 29	Definition of matrix, different types of matrices, algebra of matrices	
Lecture 30	Transpose and adjoint of a matrix and inverse matrix	
Week 11		
Lecture 31 Lecture 32 Lecture 33	Solution of system of linear equations	
Week 12		

Lecture 34 Lecture 35 Lecture 36	Solution of linear equations by using inverse matrix Rank, nullity and elementary transformations	CT 3/ASG
Week 13 Lecture 37 Lecture 38 Lecture 39	 Dependent and independent of vectors Matrix polynomials: determination characteristic roots and vectors	
Week 14 Lecture 40 Lecture 41 Lecture 42	 Characteristic sub space of matrix and eigen values and eigen vectors	

17. Assessment Strategy

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
3. Continuous Assessment (40%)	1.1 Class Participation	10%	-	
	1.2 Class Test/ASG 1-3	20%	CO1,CO2,CO3,	C1,C3
	1.3 Mid Term/ASG	10%		
4. Final Exam (60%)		60%	CO1,CO2,CO3,	C1,C3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Psychomotor domain*

18. Materials Recommended

1. Ordinary and Partial Differential Equations- Dr. M.D. Raisinghania
2. College Linear Algebra- Md. Abdur Rahman
3. Differential Equations- Shepley L. Ross
4. Elementary Linear Algebra- Howard Anton, Chris Rorres

MATH 201	**Vector Analysis, Laplace Transformation and Coordinate Geometry**	***3.00 Cont Hr;3.00 Cr Hr***
PRE-REQUISITE	**None**	**Curriculum Structure:** Outcome Based Education(OBE)

19. Rationale

Purpose of this course is to introduce basic knowledge to identify and solve vector mathematical problems, to demonstrate practical applications of Laplace Transform and analyze co-ordinate geometry.

20. Learning Objectives (OB)

1. Be able to acquire knowledge on vector analysis, Laplace transform and geometry.
2. Achieve ability to solve problems with straight lines, pair of straight lines, circles, conics in 2D and 3D co-ordinate systems.
3. Be able to find the length, volume and area of objects related to engineering study by using vector, Laplace transform to ordinary differential equation sandal so be able to solve the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc

21. Course Contents

Vector Analysis: Definition of Vector and scalars & vector algebra, scalar and vector products of two vectors and their geometrical interpretation, triple products and multiple products, linear dependence and independence of vectors, differentiation of vectors, Gradient of scalar functions, divergence and curl of vector functions, physical significance of gradient, divergence and curl, definition of line, surface and volume integral, integration of vectors, Green's theorem and its application, Stoke's theorem and its application, Gauss theorem and its application in Engineering.

Laplace Transform: Definition of Laplace transform and application of Laplace transform for Engineering, Laplace transform of some standard functions and properties of Laplace transform, sufficient condition for existence of Laplace transform, inverse Laplace transform, some special theorems on Laplace transform, solution of differential equations by Laplace transform, Heaviside expansion formula, Convolution theorem, evaluation of improper integral, application of Laplace transform.

Co-ordinateGeometry: Introduction to geometry forEngineering andRectangularco-ordinates, transformation of co-ordinates, changes of axes, pair of straight lines, generalequationofseconddegreeandreductiontoitsstandardformsandproperties,circles(tangents, normal, chord of contact, pole),Equation of conics,homogeneousequationsofsecond degree, angle between straightlines, pairoflines joining the origin tothe point of intersection of two given curves, equations of parabola, ellipse in Cartesian andpolar coordinates, system of circles (radical axes, coaxial circles, limiting points), threedimensional co-ordinate system, direction cosines, projections, the plane (angle between twoplanes, parallel & perpendicular plane, distance of a point from a plane) and the straight line(coplanar lines, shortest distance between two given straight lines), standard equation ofsphere,ellipsoid.

22. **Course Outcome(CO) and Skill Mapping**

COs		PROGRAM OUTCOMES (POs)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	**Define** vector terms, Laplace transform and geometrical terms			✓									

CO2	**Identify** different properties ofstraightlines,pairofstraight lines, circles, radical axis and centerin2Dand3Dco-ordinatesystems.	✓		
CO3	**Apply** Laplace transform and geometry in engineering study. **Solve** the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.	✓		

23. Mapping of Course Outcomes(COs) and General Skills

Course Outcomes(COs)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	**Define** vector terms, Laplace transform and geometrical terms	PO3	C1	1	**-**	3	CT,MID, ASG
CO2	**Identify** different properties ofstraightlines,pairofstraight lines, circles, radical axis and centerin2Dand3Dco-ordinatesystems.	PO3	C2	1	**-**	3	CT,MID, ASG FExam
CO3	**Apply** Laplace transform and geometry in engineering study. **Solve** the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.	PO3	C3	1	**-**	3	CT,MID, ASG FExam

***CP**-**C**omplex**P**roblem/**WP**-**W**ashingtonAccordComplex**P**roblemSolving;**CA**-**C**omplex**A**ctivities/**EA**-**E**ngineering **A**ctivities; **KP**- **K**nowledge **P**rofile/ **WK**- **W**ashington Accord **K**nowledge Profile.*
CT- **C**lass **T**est; **Proj**- **Pr**oject; **Q**- **Q**uiz; **ASG**- **As**si**g**nment; **Pre**- **Pr**esentation; **R**- **R**eport; **FExam**- **F**inal **ex**am, **MID**- **Mid**term exam, **CS**- Case Study.

24. Teaching Learning Strategy

Activities		**Engagement (Hours)**
7. Face to Face Learning	1.1 Lecture	42
	1.2 Practical/Tutorial	-
	1.3 Student Centered Learning	-
8. Self-Directed Learning	2.1 Non Face-to-Face Learning	25
	2.2 Revision	21
	2.3 Preparations: Assignment	21
9. Formal Assessment	9.1 Continuous Assessment	8
	9.2 Final Examination	3
		120
TEACHING METHODOLOGY		

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Learning.

25. Teaching Schedule

Lecture	Lecture Topic	Assessments
Week 1		CT 1
Lecture 1 Lecture 2 Lecture 3	Definition of vector and scalar & vector algebra, scalar and vector products of two vectors and their Geometrical interpretation	
Week 2		
Lecture 4 Lecture 5 Lecture 6	Triple products and multiple products, linear dependence and independence of vectors, Differentiation of vectors Gradient of scalar functions, divergence and curl of point functions Physical significance of gradient, divergence and curl	
Week 3		
Lecture 7 Lecture 8 Lecture 9	Definition of line, surface and volume integral, integration of vectors, Green's theorem and application Green’s theorem and its application	
Week 4		CT 2
Lecture 10 Lecture 11 Lecture 12	Gauss theorem and its application in Engineering Stoke's theorem and its application. Introduction to geometry for engineering and rectangular co-ordinates, transformation of co-ordinates	
Week 5		
Lecture 13 Lecture 14 Lecture 15	Changes of axes, pair of straight lines, general equation of second degree and reduction to its standard form sand properties	
Week 6		
Lecture 16 Lecture 17 Lecture 18	Circles (tangents, normal, chord of contact, pole and polar),equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves	
Week 7		MID/ASG
Lecture 19 Lecture 20 Lecture 21	Circles (tangents, normal, chord of contact, pole and polar),equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points)	

Week 8 Lecture 22 Lecture 23 Lecture 24	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points)	
Week 9 Lecture 25 Lecture 26 Lecture 27	Circles (tangents, normal, chord of contact, pole and polar),equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves	
Week 10 Lecture 28 Lecture 29 Lecture 30	Circles (tangents, normal, chord of contact, pole and polar),equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves Definition of Laplace transform and Application of Laplace transform for Engineering, Laplace transform of some elementary functions and properties of Laplace transform	
Week 11 Lecture 31 Lecture 32 Lecture 33	Sufficient condition for existence of Laplace transform Laplace transform of derivatives and its application Laplace transform of Integration with application, Laplace transform of sine and cosine integral	CT 3/ASG
Week 12 Lecture 34 Lecture 35 Lecture 36	Unit step function and its application Periodic function with examples, Laplace transform of some special function. Definition of inverse Laplace Transform and its properties	
Week 13 Lecture 37 Lecture 38 Lecture 39	Partial fraction and its application in inverse Laplace Transform Heaviside formula and its application Convolution theorem, Evaluation of improper integral, Application of Laplace transform	
Week 14 Lecture 40 Lecture 41 Lecture 42	Solve ordinary differential equations by Laplace transform Application of Laplace transform in Engineering study	

26. Assessment Strategy

Components	Grading	Course Outcome (CO)	Blooms Taxonomy

5.	Continuous Assessment (40%)	1.1 Class Participation	10%	-	
		1.2 Class Test/ASG 1-3	20%	CO1,CO2,CO3,	C1,C2,C3
		1.3 Mid Term/ASG	10%		
6.	Final Exam (60%)		60%	CO1,CO2,CO3,	C1,C2,C3
			100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Psychomotor domain*

27. Materials Recommended

1. Vector Analysis-Murray R.Spiegel, Seymour Lipschutz, Dennis Spellman
2. Laplace Transforms-MurrayR. Spiegel
3. A Text Bookon Co-ordinate Geometry with Vector Analysis-Rahman & Bhattacharjee.
4. Vector Analysis- K.A. Strout, Dexter Booth
5. A Student's Guide to Laplace's Transforms by Deniel

CHAPTER 7

DEPARTMENTAL COURSES FOR OTHERS

7.1PME Courses for others

Sr No	Course Code	Course Name	Level Term	Cr Hr	ContHr	Total	Page No
1	PME 201 / 203	Geology for Petroleum and Mining Engineers	L2 T1	3	3	Cr Hr **3.0 and** ContHr **3.0**	353 - 356

PME201/ 203	Engineering Geology and Geomorphology	
		3.00 Co Hr; 3.00 Cr Hr
Pre-requisite:	None	**Curriculum structure:** Outcome Based Education (OBE)

1. Rationale:

This course provides engineers the background knowledge of geologic characterization and the evaluation of the earth's surface for engineering-issues. It also aims to shed light on landforms, land forming processes, and landscape evolution. However, the intent is to develop a fundamental understanding of geologic-issues from an engineering point of view.

2. Learning objectives (OB):

a) To have through understanding of rocks as an engineering material.
b) To have profound knowledge on the fluvial processes and landforms.
c) To comprehend the technical issues related to geological structures and tectonics.

3. Course Contents:

Petrology: Igneous rock, metamorphic rock, sedimentary rock. **Mineralogy:** Rock and soil minerals. **Surface Processes:** Aeolian, fluvial, coastal and glacial. **Fluvial processes and landforms:** Erosion, transportation and deposition, river dynamics, channel patterns and the basin. **Earth dynamics:** Dynamics of basin, Tectonophysics.**Structural geology:** Folds, faults, joints, doms and basin. **Maps and sections:**Geological and topographical maps, engineering geological maps, sections from maps. **Geology of Bangladesh:** Geology and geomorphological aspect, Earthquake and seismotectonic aspect.

4. Course Outcomes (CO) and Skill Mapping

COs		PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Identify the rocks as an engineering material.	✓											
CO2	Evaluate the landforms and the dynamics of it.		✓										
CO3	Consider the geologic-issues for design fundamentals considering morphologic-issues.		✓										

l) **Mapping of Course Outcomes (CO) and General Skills**

Course Outcomes (CO)		POs	Blooms Taxonomy	CP (WP)	CA (EA)	KP (WK)	Assessment Methods
CO1	Identify the rocks as an engineering material.	PO1	C1, C2	-	-	1	CT, MID, FExam
CO2	Evaluate the landforms and the dynamics of it.	PO2	C2	-	-	1, 2, 3	CT, MID, FExam
CO3	Consider the geologic-issues for design fundamentals considering morphologic-issues.	PO2	C3	1	-	1,2,4	ASG/ Pro

CP- Complex Problem; CA- Complex Activities; KP- Knowledge Profile; CT- Class Test; Pro- Project; Q- Quiz; ASG- Assignment; Pre- Presentation; R- Report; FExam- Final exam, MID- Mid term exam

m) Teaching- Learning Strategy

Activities		Engagement (hours)
22. Face-to-Face Learning		
	1.1 Lecture	42
	1.2 Practical / Tutorial	-
	1.3 Student-Centered Learning	-
23. Self-Directed Learning		
	2.1 Non-face-to-face learning	42
	2.2 Revision of lecture at home	21
	2.3 Preparation for final examination	21
24. Formal Assessment		
	3.1 Continuous Assessment	2
	3.2 Final Examination	3
		131

TEACHING METHODOLOGY
Lecture and Discussion, Problem Based Method

n) Lecture Schedule

Lecture	Lecture Topic	Assessments
Week-1	**Introduction to Geology and Mineralogy**	
Lecture-1	Importance of geology and fundamental laws	
Lecture-2	Rock and soil minerals	
Lecture-3	Physical properties of minerals	
Week-2	**Mineralogy**	
Lecture-4	Major rock forming minerals; composition	
Lecture-5	Major rock forming minerals; properties	
Lecture-6	Basics of optical microscopy, XRD and SEM	
Week-3	**Petrology**	
Lecture-7	Igneous rock; Classification, formation, structure and texture	
Lecture-8	Rock and soil minerals	
Lecture-9	Metamorphic rock; Classification, formation, structure and texture	
Week-4	**Petrology**	
Lecture-10	Sedimentation environments	
Lecture-11	Clastic rock; classification, structure and texture	
Lecture-12	Non- clastic rock; classification, structure and texture	
Week-5	**Mineralogy and Surface Processes**	
Lecture-13	Susceptibility of rocks and minerals to alteration	
Lecture-14	Weathering processes	
Lecture-15	Transportation and sedimentation processes	
Week-6	**Fluvial Processes and Landform**	
Lecture-16	Deposits and landforms	CT-1

Lecture-17	Quantification of erosion, saltation, suspension, corrosion	
Lecture-18	Stream channel types	
Week-7	**Fluvial Processes and Landform**	
Lecture-19	Stream channel features	
Lecture-20	Floodplain	
Lecture-21	Alluvial fans and deltas	
Week-8	**Fluvial Processes and Landform**	
Lecture-22	Flow dynamics in rivers	
Lecture-23	Sediment transport dynamics	
Lecture-24	Dynamics of floodplains	
Week-9	**Fluvial Processes and Landform**	
Lecture-25	Channel patterns and the basin	
Lecture-26	River dynamics and management	
Lecture-27	Channel patterns and the basin	
Week-10	**Structural Geology**	
Lecture-28	Description and classificationof folds	
Lecture-29	Mechanism and causes of folds	
Lecture-30	Field study of folds	
Week-11	**Structural Geology**	
Lecture-31	Description and classification of faults	
Lecture-32	Description and classificationof joints	
Lecture-33	Mechanism and causes of faults and joints	
Week-12	**Structural Geology and plate tectonics**	
Lecture-34	Field study of faults and joints	
Lecture-35	Domes and basin	
Lecture-36	Plate tectonics	
Week-13	**Techtonophysicsand Maps**	CT-2; MID
Lecture-37	Earthquakes: Mechanism	
Lecture-38	Earthquakes: GPS and SAR data interpretation	
Lecture-39	Geological and Engineering Geological Map making	ASG/ Pro
Week-14	**Sections, and Geomorphological and Tectonic aspect of Bangladesh**	
Lecture-40	Preparation of sections from map	
Lecture-41	Geological and geomorphological aspects of Bangladesh	
Lecture-42	Earthquakes, seismotectonics of the Bangladesh	

o) Assessment Method

Components		Grading	Course Outcome (CO)	Blooms Taxonomy
9. Continuous Assessment (40%)	1.1 Class Participation	5%	-	A1, A2
	1.2 Class Test/ Assignment/ Project(1-3)	20%	CO1, CO3	C1, C2, C3
	1.3 Mid term	15%	CO1, CO2	C1, C2
10. Final Exam (60%)		60%	CO1, CO2	C1, C2, C3
		100%		

***C**: Cognitive domain; **A**: Affective domain; **P**: Phychomotor domain*

9. Materials Recommended

8. Fundamentals of Physical Geology; S Jain. 2014, 488 pp.
9. Physical Geology: The Science of Earth; C Fletcher. 2017, 600 pp.
10. Geology for Civil Engineers; AC McLean, CD Gribble. 1985, 332 pp.
11. Foundations of Engineering Geology; T Waltham. 2009, 98 pp.
12. Fundamentals of Geomorphology; RJ Huggett. 2016, 578 pp.
13. Fluvial Processes in Geomorphology; LB Leopold, MG Wolman, JP Miller. 2012, 544 pp.
14. Principles of Seismology; AUdias. 2000, 492 pp.
15. Geological Maps and Sections for Civil Engineers; PR Thomas. 1998, 106 pp.
16. Supplied materials.