PRESIDENCY UNIVERSITY

Private University Estd. in Karnataka State by Act No. 41 of 2013

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PRESIDENCY GROUP OVER 40 YEARS OF ACADEMIC WISDOM

SCHOOL OF ENGINEERING

DEPARTMENT OF PETROLEUM ENGINEERING

List of Courses integrates to Human Values and Professional Ethics, Gender Sensitization, and Environment & Sustainability

Sl. No.	Program	Course Code	Course Name	Total Credit	Course Integrates To
1	B.Tech. (Petroleum Engineering)	PET1002	Introduction to Oil and Gas Industry	3	Human Values and Professional Ethics / Environment and Sustainability
2	B.Tech. (Petroleum Engineering)	PET1005	Geology for Engineers	2	Environment and Sustainability
3	B.Tech. (Petroleum Engineering)	PET1006	Overview of Energy Industry	2	Environment and Sustainability
4	B.Tech. (Petroleum Engineering)	PET1007	Introduction to Energy Trading and Future Options	2	Human Values and Professional Ethics
5	B.Tech. (Petroleum Engineering)	PET1008	Sustainable Energy Management	2	Environment and Sustainability
6	B.Tech. (Petroleum Engineering)	PET1010	Carbon Capture and Utilization for Sustainability	3	Environment and Sustainability
7	B.Tech. (Petroleum Engineering)	PET2015	Coal Bed Methane	3	Human Values and Professional Ethics / Environment and Sustainability
8	B.Tech. (Petroleum Engineering)	PET2016	Shale Gas	3	Human Values and Professional Ethics / Environment and Sustainability
9	B.Tech. (Petroleum Engineering)	PET2017	Natural Gas Hydrates	3	Environment and Sustainability
10	B.Tech. (Petroleum Engineering)	PET2018	Integrated Field Development and Planning	3	Environment and Sustainability
11	B.Tech. (Petroleum Engineering)	PET2025	Petroleum Transportation, Marketing and Management	2	Human Values and Professional Ethics
12	B.Tech. (Petroleum Engineering)	PET2030	Occupational Health and Safety	3	Human Values and Professional Ethics / Environment and Sustainability
13	B.Tech. (Petroleum Engineering)	PET3003	Offshore Drilling and Petroleum Production Practices	3	Environment and Sustainability
14	B.Tech. (Petroleum Engineering)	PET3007	Enhanced Oil and Gas Recovery Techniques	3	Environment and Sustainability

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Course Code: PET1002	**Course Title:** **Introduction to Oil and Gas Industry** **Type of Course:** **1] Program Core** **2] Theory Only**	**L-P-C**	3	0	3
Version No.:	1.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	The aim of the course is to provide a broad overview of the Oil and Gas industry so that advanced courses can be understood within a broader Petroleum engineering context. The concepts such as oil and gas production, reservoir energy and forces, petroleum deposit drainage, development systems, well operation techniques will be covered. The course will develop an understanding of field life cycle and interdisciplinary approach to petroleum field development and operation.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Introduction to Oil and Gas Industry and attain **Skill Development** through **Participative Learning** techniques.				
Course Outcomes:	Upon successful completion of the course the students shall be able to: CO1: Describe the Oil and Gas industry, CO2: Outline the life cycle of a well, CO3: Summarize Oil and Gas processing facilities, CO4: Review the climate change				
Course Content:					
Module 1:	Introduction to the Oil & Gas Industry	Assignment / Quiz	Literature Survey	08 Periods	
Topics: Introduction to the energy business: energy resources; energy demand and supply. Energy security. Scope of the Oil & Gas industry: producer and consumer countries; national/ independent/ international oil companies; services companies; international organizations. Risks related to the Oil & Gas industry					
Module 2:	Life Cycle of a Well	Assignment / Quiz	Programming	09 Periods	
Topics: Drilling: Organization on well site, Various designation at well site, Drilling rigs, Drilling operations chronology, Reservoir-wellbore interface, Offshore wells					
Module 3:	Oil & Gas Processing Facilities	Assignment, Quiz	Project work	08 Periods	
Topics: Produced fluid properties, well head assembly, Gathering system, Crude oil treatment, Storage, metering and shipment transportation.					
Module 4:	Petroleum and the Environment	Quiz / Team Activity	Literature Survey and Report Submission	10 Periods	
Topics: Definition, Scope and Importance of ecosystem. Classification, structure, and function of an ecosystem, Environmental Pollution, Classification of pollution, Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS) Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montreal Protocol.					
Targeted Applications and Tools that can be used: Application: Oil and Gas Industry Tools: MS Office					
Text Book: T1 John R. Fanchi, Richard L. Christiansen, Introduction to Petroleum Engineering, Wiley; 1st edition, November, https://www.wiley.com/en-us/Introduction+to+Petroleum+Engineering-p-9781119193449 T2 Samir Dalvi, Fundamentals of Oil & Gas Industry for Beginners, Notion Press, First edition, 2015, https://books.google.co.in/books?id=gYfZCgAAQBAJ&source=gbs_similarbooks					
Reference Book(s) R1 Mohamed A. Fahim, Taher A. Al-Sahhaf, Amal Elkilani, Fundamentals of Petroleum Refining, Elsevier Science; 1st edition (December 28, 2009), https://www.elsevier.com/books/fundamentals-of-petroleum-refining/fahim/978-0-444-52785-1 R2 F.A. Giuliano, Introduction to Oil and Gas Technology, Springer Netherlands, 1981,					

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https://books.google.co.in/books/about/Introduction_to_Oil_and_Gas_Technology.html?id=efBvtQAACAAJ&redir_esc=y
R3 Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil and Gas Production, Lulu.com, 2013, https://books.google.co.in/books/about/Oil_and_Gas_Production_Handbook_An_Intro.html?id=nJ2XAwAAQBAJ&redir_esc=y

Case Study:

1. A case study of electrostatic accidents in the process of oil-gas storage and transportation, https://iopscience.iop.org/article/10.1088/1742-6596/418/1/012037
2. Prevention of Major Accidents in the Oil & Gas Industry, https://www.grin.com/document/176591

e-Resource:

1. Presidency University e-resource Remote Access (KNIMBUS) portal through the shared link: https://presiuniv.knimbus.com/user#/home
2. Introduction to the Oil and Gas Sector (https://youtu.be/k4cVxGndh9g)
3. Oil and Gas Industry Overview (https://youtu.be/O-qiUD9TEtQ)
4. Conflict in the Middle-East OPEC's 1970's Oil Embargo (https://youtu.be/FiLnj5WD0ao)
5. Birth of an oil field 1949 shell oil industrial film (https://youtu.be/uPUC-GDfYO8)

Topics relevant to "**SKILL DEVELOPMENT**": Energy resources; energy demand and supply for **Skill Development** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by:	Mr. Bhairab Jyoti Gogoi, Dr. Suman Paul, Dr. Deepjyoti Mech, and Dr. Kalpajit Hazarika
Recommended by the Board of Studies on:	12th Meeting of the Board of Studies held on 9th August 2021
Date of Approval by the Academic Council:	16th Meeting of the Academic Council held on 23rd October 2021

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Course Handout: AY 2022-2023

Date of Issue: 07-09-2022

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC-18.5/PET14/2021-25
Semester / Year	:	III / 2nd
Course Code / Title	:	PET1002 / Introduction to Oil and Gas Industry
Course Credit Structure	:	3L-0P-3C
Contact Hours	:	40
Course Instructor In-charge	:	Mr. Bhairab Jyoti Gogoi
Course Instructor	:	Mr. Bhairab Jyoti Gogoi
Course URL	:	N.A.

Program Outcomes (POs) :

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO5: **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.

PO6 **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **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 and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites:

NIL

Course Description:

The aim of the course is to provide a broad overview of the Oil and Gas industry so that advanced courses can be understood within a broader Petroleum engineering context. Participants will learn such concepts as Oil and Gas production, reservoir energy and forces, petroleum deposit drainage, development systems, well operation techniques. Each participant in the course will develop an understanding of field life cycle and interdisciplinary approach to Petroleum field development and operation.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Introduction to Oil and Gas Industry and attain **Skill Development** through **Participative Learning** techniques.

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:

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CO1: Describe the Oil and Gas industry,

CO2: Outline the life cycle of a well,

CO3: Summarize Oil and Gas processing facilities,

CO4: Review the climate change

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	L				M	M	M	M	L	L		M
CO2	H				M	M	M	M	H	L		M
C03	H				M	M	M	M	H	L		M
CO4	H				M	M	M	M	H	L		M
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module I: Introduction to the Oil & Gas Industry [8 hours]
[Knowledge]

Introduction to the energy business: energy resources; energy demand and supply. Energy security. Scope of the Oil & Gas industry: producer and consumer countries; national/ independent/ international oil companies; services companies; international organizations. Risks related to the Oil & Gas industry

Module II: Life Cycle of a Well [9 hours]
[Knowledge]

Drilling: Organization on well site, Various designation at well site, Drilling rigs, Drilling operations chronology, Reservoir-wellbore interface, Offshore wells

Module III: Oil & Gas Processing Facilities [8 hours]
[Comprehension]

Produced fluid properties, well head assembly, Gathering system, Crude oil treatment, Storage, metering and shipment transportation.

Module IV: Petroleum and the Environment [10 hours] Comprehension

Definition, Scope and Importance of ecosystem. Classification, structure, and function of an ecosystem, Environmental Pollution, Classification of pollution, Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS) Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montreal Protocol.

Delivery Procedure (Pedagogy):

This is a theory based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Flip Class Room sessions will be conducted on selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of

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the syllabus. Submission of assignment on time is mandatory for all the students. Assignments, Quiz Competition and Poster Presentation will carry 25% weightage under Continuous Internal Assessment (CIA). Review classes will be conducted to clear doubts and to evaluate the level of understanding of the each student individually.

Following procedures will be adopted in the course for delivering the content:

I. Experiential learning:

1. Article review (Module II) [Foundation/Skill Development/Environment and sustainability]

- "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)
- There is no make up for this component

2. Report writing/Social awareness (Module IV) [Foundation/Skill Development/Environment and sustainability]

- This activity comprise of a social awareness program where students will be given a task of going out in the public and aware them about the deteriorating environment and aware them about its ill effect. After the event a report need to be submitted to the Instructor In-charge along with event photos.
- There is no make up for this component

II. Participative learning:

QUIZ (Module I, II, III, IV & V) [Employability]

- After completion of each module a QUIZ will be conducted. The mode of conduction can be either ONLINE or OFFLINE which will be intimated 2-3 day prior to the date of conduction. After completion of all four quiz, marks of the "best of four" will be considered for evaluation.
- There is no make up for this component.

III. Problem solving:

Root cause analysis (Module I) [Skill/Employability]

- A case study/problem statement will be provided to the students and they have to perform root cause analysis with a collection of principles, techniques and methodologies that can all be leveraged to identify the root cause of the event or trend. A final report should be submitted to the Instructor In-Charge on or before the due date.
- There is no make up for this component

Reference Materials:

(a) Textbook(s)

T1 John R. Fanchi, Richard L. Christiansen, Introduction to Petroleum Engineering, Wiley; 1st edition, November, https://www.wiley.com/en-us/Introduction+to+Petroleum+Engineering-p-9781119193449

T2 Samir Dalvi, Fundamentals of Oil & Gas Industry for Beginners, Notion Press, First edition, 2015, https://books.google.co.in/books?id=gYfZCgAAQBAJ&source=gbs_similarbooks

(b) Reference Book(s)

R1 Mohamed A. Fahim, Taher A. Al-Sahhaf, Amal Elkilani, Fundamentals of Petroleum Refining, Elsevier Science; 1st edition (December 28, 2009), https://www.elsevier.com/books/fundamentals-of-petroleum-refining/fahim/978-0-444-52785-1

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R2 F.A. Giuliano, Introduction to Oil and Gas Technology, Springer Netherlands, 1981, https://books.google.co.in/books/about/Introduction_to_Oil_and_Gas_Technology.html?id=efBvtQAACAAJ&redir_esc=y

R3 Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil and Gas Production, Lulu.com, 2013, https://books.google.co.in/books/about/Oil_and_Gas_Production_Handbook_An_Intro.html?id=nJ2XAwAAQBAJ&redir_esc=y

(c) Case study:

1. A case study of electrostatic accidents in the process of oil-gas storage and transportation, https://iopscience.iop.org/article/10.1088/1742-6596/418/1/012037

2. Prevention of Major Accidents in the Oil & Gas Industry, https://www.grin.com/document/176591

(d) e-Resource:

1. Presidency University e-resource Remote Access (KNIMBUS) portal through the shared link: https://presiuniv.knimbus.com/user#/home

2. Introduction to the Oil and Gas Sector (https://youtu.be/k4cVxGndh9g)

3. Oil and Gas Industry Overview (https://youtu.be/O-qiUD9TEtQ)

4. Conflict in the Middle-East OPEC's 1970's Oil Embargo (https://youtu.be/FiLnj5WD0ao)

5. Birth of an oil field 1949 shell oil industrial film (https://youtu.be/uPUC-GDfYO8)

Guideline to Students:

(a) About the Course:

This is a theory based course which will provide fundamental concepts of oil and gas industry processes. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulations

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website and go through the Section Nos. 1.0 through 25.0 (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf).

Course Schedule:

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Model-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Over View of the course	12-09-2022	12-09-2022	1
02	Module I	14-09-2022	29-09-2022	8
03	Continuous Internal Assessment (CIA)-***Quiz-1***	30-09-2022	30-09-2022	-
04	Continuous Internal Assessment (CIA)-***Root cause analysis***	29-09-2022	15-10-2022	-
05	Module II	10-10-2022	9-11-2022	9
06	Continuous Internal Assessment (CIA)-***Quiz-2***	10-11-2022	10-11-2022	-
07	Continuous Internal Assessment (CIA)-***Article review***	10-11-2022	10-11-2022	
08	Discussion of MID TERM syllabus and pattern	02-09-2022	02-09-2022	-
09	Mid Term examination	3-11-2022	7-11-2022	-
10	Discussion of MID TERM question paper	09-09-2022	09-09-2022	
11	Module III	20-11-2022	27-11-2022	8
12	Continuous Internal Assessment (CIA)-***Quiz-3***	28-11-2022	28-11-2022	-
13	Module IV	30-11-2022	21-12-2022	10
14	Continuous Internal Assessment (CIA)-***Quiz-4***	25-12-2022	25-12-2022	-
15	Continuous Internal Assessment (CIA)-***Report writing/Social awareness***	-	-	-
16	End Term Examinations	06-01-2023	25-01-2023	-

Schedule of Instruction:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No./Date	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
Sl. No.	**Session No./Date**	**Lesson Title**	**Topics**	**Course Outcome Number**	**Delivery Mode**	**Reference**
1	L01/ 12-09-2022	Program Integration	Overview of the course	-	Lecture / Presentation/White board/White board	N.A.
Module I						
2	L02/ 14-09-2022		Introduction to the energy business: energy	CO1	Lecture / Presentation/White	T1 Ch01/Class

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		Introduction to Oil and Gas industry	resources		board/White board	Notes
3	L03/ 15-09-2022		Energy demand and supply	CO1	Lecture / Presentation/White board/White board	T1 Ch01/Class Notes
4	L04/ 19-09-2022		Energy security	CO1	Lecture / Presentation/White board	T1 Ch01/Class Notes
5	L05/21-09-2022		Scope of the Oil & Gas industry	CO1	Lecture / Presentation/White board	T1 Ch01/Class Notes
6	L06/ 22-09-2022		Producer and consumer countries	CO1	Lecture / Presentation/White board	T1 Ch01/Class Notes
7	L07/ 26-09-2022		National/ independent/ international oil companies	CO1	Lecture / Presentation/White board	T1 Ch01/Class Notes
8	L08/ 28-09-2022		Services companies, International organizations	CO1	Lecture / Presentation/White board	T1 Ch01/Class Notes
9	L09/ 29-09-2022		Risks related to the Oil & Gas industry	CO1	Lecture / Presentation/White board	T1 Ch01/Class Notes
-	-		Continuous Internal Assessment (CIA)- ***Quiz-1***	CO1	-	-
-	-		Continuous Internal Assessment (CIA)- ***Root cause analysis***	CO1	-	-
Module II						
10	L10/ 06-10-2022	Life cycle of a well	Organization of well sites	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
11	L11/ 10-10-2022		Organization of well sites	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
12	L12 / 12-10-2022		Various designation at well site	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
13	L13/ 13-10-2022		Drilling rigs	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
14	L14/17-10-2022		Drilling operation technology	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes

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15	L15/ 19-10-2022		Drilling operation chronology	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
16	L16/ 20-10-2022		Reservoir well bore interface	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
17	L17/ 27-10-2022		Reservoir well bore interface	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
18	L18/ 02-11-2022		*Discussion of MID TERM syllabus and pattern*	-	Lecture / Presentation/White board	-
-	-		*MID TERM Examination*	-	-	-
19	L19/ 09-11-2022		*Discussion of MID TERM question paper*	-	Lecture / Presentation/White board	-
20	L20/ 10-11-20222		Offshore wells	CO2	Lecture / Presentation/White board	T1 Ch02/Class notes
-	-		Continuous Internal Assessment (CIA)- ***Quiz-2***	-	-	-
-	-		Continuous Internal Assessment (CIA)- ***Article Review***	-	-	-
Module III						
21	L21/ 14-11-2022		Produce fluid properties			
22	L22/ 16-11-2022	Oil & Gas Processing Facilities	Produce fluid properties	CO3	Lecture / Presentation/White board	T1 Ch03/Class Notes
23	L23/17-11-2022		Well head assembly	CO3	Lecture / Presentation/White board	T1 Ch03/Class Notes
24	L24/21-11-2022		Gathering system	CO3	Lecture / Presentation/White board	T1 Ch03/Class Notes
25	L25/ 23-11-2022		Crude oil treatment	CO3	Lecture / Presentation/White board	T1 Ch03/Class Notes
26	L26/ 24-11-2022		Storage	CO3	Lecture / Presentation/White board	T1 Ch03/Class Notes
27	L27/ 28-11-2022		Metering	CO3	Lecture / Presentation/White	T1 Ch03/Class

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					board	Notes
28	L28/ 28-11-2022		Transportation	CO3	Lecture / Presentation/White board	T1 Ch03/Class Notes
			Continuous Internal Assessment (CIA)- ***Quiz-3***	-	-	-
Module IV						
29	L29/ 30-11-2022		Definition, Scope and Importance of ecosystem			
30	L30/ 01-12-2022	Petroleum and the Environment	Classification, structure, and function of an ecosystem	CO4	Lecture / Presentation/White board	Class notes
31	L31/5-12-2022		Environmental Pollution	CO4	Lecture / Presentation/White board	Class notes
32	L32/ 07-12-2022		Classification of pollution	CO4	Lecture / Presentation/White board	Class notes
33	L33/ 08-12-2022		Climate change and impacts on human environment	CO4	Lecture / Presentation/White board	Class notes
34	L34/ 12-12-2022		Ozone depletion and Ozone depleting substances (ODS) Deforestation and desertification	CO4	Lecture / Presentation/White board	Class notes
35	L35/ 14-12-2022		International conventions / Protocols	CO4	Lecture / Presentation/White board	Class notes
36	L36/ 15-12-2022		Earth summit	CO4	Lecture / Presentation/White board	Class notes
37	L37/ 19-12-2022		Kyoto protocol	CO4	Lecture / Presentation/White board	Class notes
38	L38/ 21-12-2022		Montreal Protocol	CO4	Lecture / Presentation/White board	Class notes
-	-		Continuous Internal Assessment (CIA)- ***Quiz-4***	-	-	-
-	-		Continuous Internal Assessment (CIA)- ***Report***	-	-	-

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		writing/Social awareness			
39	L39/ 22-12-2022	Course Integration	-	-	-
40	L40/ 29-12-2022	Discussion on END Term Question paper and Pattern	-	-	-

Topics relevant to "**SKILL DEVELOPMENT**": Energy resources; energy demand and supply for **Skill Development** through **Participative Learning** techniques. This is attained through the Presentation as mentioned in the assessment Schedule.

Assessment Schedule:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	**Continuous Internal Assessment (CIA)**- *Root cause analysis*	L02-L09	CO1	-	10	5%	-
02	Mid Term	L03 – L17	CO1, CO2	2	50	25%	03-11-2022 to 07-11-2022
03	Assignment: Report – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.	L30 - L38	CO4	-	10	5%	-
04	**Continuous Internal Assessment (CIA)-**	L30-L38	CO4	-	10	10%	-

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	Social awareness/report submission						
05	**Continuous Internal Assessment (CIA)**- *Quiz-1,2,3,4*	L02-L37	CO1, CO2, CO3, CO4	-	10	5%	-
06	End Term Examinations	L03 - L38	CO1, CO2, CO3, CO4	3	100	50%	06-01-2023 to 25-01-2023

****Dates are subjected to change. Course instructor will intimate prior.

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	If you were the Rig Supervisor of the Deep Water Horizon rig, then what difference you would have made to prevent the extent the disaster.	10	CO1	Comprehension
2	"*Timelines and actors in the oil and gas industry lifecycle*", Illustrate the quoted sentence.	10	CO2	Comprehension
3	Throughout the world there has been an increase in the use of renewable energy sources such as solar, wind, geothermal, biomass etc for electrical power generation. These renewable energy sources provide many benefits especially on the environmental aspects. In Malaysia, PV systems are most suitable as the country receives a rather high level of irradiance. However, the use of renewable energy in Malaysia is still low despite the potential. 1. Discuss some of the issues or concerns that contribute to this. Try to consider the issues in terms of cost, environment, safety, policy etc. 2. Propose a suitable PV system if you are to consider installing the system to one of the lecture rooms in the	10	CO3	Comprehension

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	Engineering Faculty. You may use the following plans: 1. Conduct a simple survey of the power consumption based on the available electrical equipment/apparatus/appliances etc and hours of usage			
4	Given that renewable sources provide only a small percentage of our energy and that nuclear power is so expensive, what can we realistically do to get off fossil fuels as soon as possible?	10	C04	Comprehension

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Describe the Oil and Gas industry	55
2	CO2	Outline the life cycle of a well,	55
3	CO3	Summarize Oil and Gas processing facilities,	50
4	CO4	Review the climate change	50

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

Signature of the Chairperson DAC:

Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
01	Continuous Internal Assessment (CIA)-***Root cause analysis***	-		

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02	Mid Term	03-11-2022 to 07-11-2022		
03	Assignment: Report – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)	-		
04	Continuous Internal Assessment (CIA)- ***Quiz-1,2,3,4***	-		
05	Continuous Internal Assessment (CIA)- ***Report writing/Social awareness***			
06	End Term Examinations	05-01-2023 to 25-01-2023		

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	Describe the Oil and Gas industry	55		
2	CO2	Outline the life cycle of a well,	55		
3	CO3	Summarize Oil and Gas processing facilities,	50		
4	CO4	Review the geology of ocean.	60		

Name and Signature of the Course Instructor:

DAC Observation and Approval:

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Course Code: PET1005	**Course Title:** Geology for Engineers **Type of Course:** 1] Open Elective 2] Theory Only	**L-P-C**	2	0	2
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	This conceptual course is designed so that students will be able to grasp the integrated dynamic processes acting on/beneath the Earth's surface, link the deep Earth with its crust, and visualize the associated environments. This knowledge is applied to contemporary geological and socio-environmental problems, including natural and anthropogenic change and the sustainable development of resources. A structured approach would be adopted to engage, relate and contextualize the fundamentals of the Earth System. The level of understanding will be tested through Geology Laboratory / Field visits and assignments.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Geology for Engineers and attain **Skill Development** through **Participative Learning** techniques.				
Course Outcomes:	Upon successful completion of the course the students shall be able to: CO1: describe planet earth and its dynamic processes, CO2: explain various geological resources of the Earth, CO3: relate different geological structures and geomorphological features, and CO4: summarize the implications of climate change.				
Course Content:					
Module 1:	Introduction to Geology and the Planet Earth	e-resource Review / Report Writing	Writing Communication / Analytical Skills Development	05 Periods	
Topics: Introduction to Geology: Definition, Branches of Geology, Scope of Geology for Engineers. Planet Earth: Origin, Shape, Physical Characteristics, Envelopes, Internal Structure, Chemical Composition, Internal Heat Source, and Age of the Earth, Uniformitarianism and Catastrophism, Geologic Time, Dynamic Processes - Introduction, Internal Dynamic Processes - Plate Tectonics, Continental Drift, Earthquake, Volcanism, External Dynamic Processes – Weathering, Erosion, Transportation, Deposition, Burial, Diagenesis.					
Module 2:	Minerals, Rocks, and Geological Resources	Poster Designing and Presentation	Verbal Communication Skill Development	04 Periods	
Topics: Minerals: Definition; Importance of Study of Minerals; Methods of Mineral Identification. Rocks: Definition; Classification of Rocks - Igneous Rocks, Sedimentary Rocks, and Metamorphic Rocks; Rock Cycle; Uses of Rocks; Visit to Geology Laboratory. Geological Resources: Introduction, Metal Deposits, Industrial Materials, Fossil Fuels, Diamonds.					
Module 3:	Geological Structures and Geomorphology	Quiz / Written Tests	Preparedness for Competitive Exams	05 Periods	
Topics: Geological Structures: Introduction, Horizontal and Dipping Strata – Dip, and Strike, Unconformity, Folds, Faults, Joints. Geomorphology: Introduction, Geomorphic Processes and Form, Geomorphic System, Plate Tectonics and associated Structural Landforms, Volcanoes, Impact Craters, Weathering and associated Landforms.					
Module 4:	Geology of the Oceans and Climate Change	Quiz / Team Activity	Literature Survey and Report Submission	05 Periods	
Topics: Geology of the Ocean: Introduction, Topography of the Sea Floor, Geology of the Oceanic Crust, Sea-Floor Sediments, Ocean Water. Climate Change: Introduction, Greenhouse Gas, Natural Climate Forcing, Climate Feedbacks, Anthropogenic Climate Change, Implications of Climate Change.					
Targeted Applications and Tools that can be used: **Application:** Mineral Resource Analyst in Mineral Exploration Company **Tools:** Clinometer Compass / GPS, Geological Hammer, Hand Lens, Magnet, and Mohs Hardness Testing Kit.					
Text Book: T1. Blyth, F.G.H., "A Geology for Engineers", 7th Edition, Elsevier, 2005. T2. Mahapatra, G.B., "Text Book of Physical Geology", CBS Publishers and Distributors Pvt. Ltd., New Delhi, 2019. T3. Graham R. Thompson, Jonathan Turk, "Introduction to Physical Geology", Saunders College, Pub., The University of California, 1998.					

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T4. Richard John Huggett, "Fundamentals of Geomorphology", Routledge (Taylor & Francis Group), 2nd Edition, 2007.

References:

R1. Dasgupta, A., "An Introduction to Earth Science", The World Press Private Limited, Kolkata, 2013.
R2. Sam Boggs, Jr., "Principles of Sedimentology and Stratigraphy" 4th Edition, Pearson Prentice Hall, 2006.
R3. Thomas McGuire, "Earth Science – The Physical Setting", Amsco School Publications, Inc, 2009
R4. Francisco Borrero, Frances Scelsi Hess, Juno Hsu Gerhard Kunze, Stephen A. Leslie, Stephen Letro Michael Manga, Len Sharp, Theodore Snow, Dinah Zike, "Earth Science – Geology, the Environment, and the Universe", McGraw Hill Companies, Inc. 2008.
R5. Edward J. Tarbuck, Frederick K. Lutgens, "Earth Science", Pearson Education, Inc., 14th Edition, 2015.
R6. Diane H. Carlson, Charles C. Plummer, Lisa Hammersley, "Physical Geology: Earth Revealed", McGrill Hill Companies, Inc. 9th Edition, 2011.

e-resources:

1. Link for PU e-resources: https://puniversity.informaticsglobal.com/login
2. Rocks and Minerals: https://www.youtube.com/watch?v=qFEBPD3JEOM
3. Geological Resources: https://www.youtube.com/watch?v=wxQE11QxRrQ
4. Climate Change: https://www.youtube.com/results?search_query=climate+change
5. Geology Writing Guide: https://libraryguides.oswego.edu/c.php?g=587313&p=4069077

Topics relevant to "SKILL DEVELOPMENT": Geomorphology for **Skill Development** through **Participative Learning** techniques**.** This is attained through assessment component mentioned in course handout.

Catalogue prepared by:	Dr. Suman Paul, Dr. Deepjyoti Mech, and Dr. Kalpajit Hazarika
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Handout

Date of Issue: 05-08-2019

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC-18.5/PET14/2019-23
Semester / Year	:	V / 3rd
Course Code / Title	:	PET 1005 / Geology for Engineers
Course Credit Structure	:	2L-0P-2C
Contact Hours	:	43
Course Instructor In-charge	:	Dr. Suman Paul
Course Instructor	:	Dr. Suman Paul
Course URL	:	

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO 01: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 02: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 03: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO 04: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 05: **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 06: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 07: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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PO 09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and 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 knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Course Prerequisites:

NIL

Course Description:

This conceptual course is designed so that students will be able to grasp the integrated dynamic processes acting on/beneath the Earth's surface, link the deep Earth with its crust, and visualize the associated environments. This knowledge is applied to contemporary geological and socio-environmental problems, including natural and anthropogenic change and the sustainable development of resources. A structured approach would be adopted to engage, relate and contextualize the fundamentals of the Earth System. The level of understanding will be tested through Geology Laboratory / Field visits and assignments.

Course Outcome:

The objective of the course is to familiarize the learners with the concepts of Geology for Engineers and attain **Skill Development** through **Participative Learning** techniques.

Course Outcomes (COs):

Upon successful completion of the course the students shall be able to:

CO1: describe planet earth and its dynamic processes,

CO2: explain various geological resources of the Earth,

CO3: relate different geological structures and geomorphological features, and

CO4: summarize the implications of climate change.

Mapping of COs with POs:

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12
CO1	L					L			L	L		M
CO2	M	M			L	L	L	L	M	M		M
CO3	M	M			L	L	L	L	M	M		M
CO4	M	H			M	M	L	L	H	H		H

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CO5	H	H			H	M	M	M	H	H		H
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module1: Introduction to Geology and the Planet Earth [05 Periods] – Knowledge Level

Introduction to Geology: Definition, Branches of Geology, Scope of Geology for Engineers.

Planet Earth: Origin, Shape, Physical Characteristics, Envelopes, Internal Structure, Chemical Composition, Internal Heat Source, and Age of the Earth, Uniformitarianism and Catastrophism, Geologic Time, Dynamic Processes - Introduction, Internal Dynamic Processes - Plate Tectonics, Continental Drift, Earthquake, Volcanism, External Dynamic Processes – Weathering, Erosion, Transportation, Deposition, Burial, Diagenesis.

Module 2: Minerals, Rocks, and Geological Resources [4 Periods] – Application Level

Minerals: Definition; Importance of Study of Minerals; Methods of Mineral Identification.

Rocks: Definition; Classification of Rocks - Igneous Rocks, Sedimentary Rocks, and Metamorphic Rocks; Rock Cycle; Uses of Rocks; Visit to Geology Laboratory.

Geological Resources: Introduction, Metal Deposits, Industrial Materials, Fossil Fuels, Diamonds.

Module 3: Geological Structures and Geomorphology [5 Periods] – Application Level

Geological Structures: Introduction, Horizontal and Dipping Strata – Dip, and Strike, Unconformity, Folds, Faults, Joints.

Geomorphology: Introduction, Geomorphic Processes and Form, Geomorphic System, Plate Tectonics and associated Structural Landforms, Volcanoes, Impact Craters, Weathering and associated Landforms.

Module 4: Geology of the Oceans and Climate Change [5 Periods] – Application Level

Geology of the Ocean: Introduction, Topography of the Sea Floor, Geology of the Oceanic Crust, Sea-Floor Sediments, Ocean Water.

Climate Change: Introduction, Greenhouse Gas, Natural Climate Forcing, Climate Feedbacks, Anthropogenic Climate Change, Implications of Climate Change.

Delivery Procedure (Pedagogy):

This is a theory-based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Exercises will be discussed specific topics and home assignments will be given to judge the understanding level of the students. Assignments / Mini Project will be given to the students after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Report Submission, Quiz Competition, Poster Presentation, and Group Discussion will carry 20% weightage under Continuous Assessment 3 (CA 3). Review classes will be conducted to clear doubts and to evaluate the level of understanding of each student individually.

Following procedures will be adopted in the course for delivering the content:

(a) Self Learning Topics (SLT):

- Volumetric Gas-in-Place Calculations for CBM Reservoir (Unit III)
- Material Balance Calculation for CBM Reservoir (Unit III)
- Petrophysical Evaluation of Gas Shale Reservoirs – Key Properties of Gas Shale Evaluation (Unit IV)
- Geomechanics of Gas Shales – Mechanical Properties of Gas Shales, Wellbore Instability of Gas Shale Reservoirs

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(Unit IV)

(b) Experiential Learning Topics (ELT):
- Identification of Coal Beds and Estimation of Stress Magnitudes using Well Log Data (Unit III)

(c) Participative Learning Topics (PLT):
- Coal Bed Methane (Unit III) – Poster Presentation
- Shale Gas (Unit IV) – Poster Presentation
- Natural Gas Hydrates (Unit V) – Poster Presentation

(d) Technology Enabled Learning Topics (TET):
- Determination of Stress Orientation using Cleat Study Data (Unit III) – Use of 'GeoRose' software

(e) Problem Based Learning Topics (PBLT):
- Natural Gas Hydrate Exploration Strategy Discussion

Reference Materials:

Textbook:

T1. Blyth, F.G.H., "A Geology for Engineers", 7th Edition, Elsevier, 2005.

T2. Mahapatra, G.B., "Text Book of Physical Geology", CBS Publishers and Distributors Pvt. Ltd., New Delhi, 2019.

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References:

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R4. Francisco Borrero, Frances Scelsi Hess, Juno Hsu Gerhard Kunze, Stephen A. Leslie, Stephen Letro Michael Manga, Len Sharp, Theodore Snow, Dinah Zike, "Earth Science – Geology, the Environment, and the Universe", McGraw Hill Companies, Inc. 2008.

R5. Edward J. Tarbuck, Frederick K. Lutgens, "Earth Science", Pearson Education, Inc., 14th Edition, 2015.

R6. Diane H. Carlson, Charles C. Plummer, Lisa Hammersley, "Physical Geology: Earth Revealed", McGrill Hill Companies, Inc. 9th Edition, 2011.

e-resources:

1. Link for PU e-resources: https://puniversity.informaticsglobal.com/login
2. Rocks and Minerals: https://www.youtube.com/watch?v=qFEBPD3JEOM
3. Geological Resources: https://www.youtube.com/watch?v=wxQE11QxRrQ
4. . Climate Change: https://www.youtube.com/results?search_query=climate+change
5. Geology Writing Guide: https://libraryguides.oswego.edu/c.php?g=587313&p=4069077

Guideline to Students:

(a) About the Course:

Understanding of different unconventional energy resources plays pivotal role in modern Oil and Gas industry

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because it is visible that the industry is shifting from exploration of conventional reservoirs to unconventional reservoirs like coal bed methane, shale gas, gas hydrates, etc. considering the present energy scenario. This course will focus mainly on coal bed methane exploration and production related topics and also provide basic knowledge about the shale gas and gas hydrate. Basic understanding of Petroleum Geology, Well Logging and Formation Evaluation, Drilling Engineering, Reservoir Engineering, and Production Engineering will help understanding this course. Hands-on training (use of basic tool) will be provided for calculation of stresses observed in sedimentary basins.

(b) Notification / Announcement related to the Course:

All the announcements will be made during the regular lecture hours. All the course related notifications will be displayed on the Department Notice Board.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2019, from Presidency University, Bengaluru website and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Unit-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Programme and Course			L01
02	Unit I			L02 – L05
	Continuous Assessment 3: e-resource Review on Unit I			-
03	Unit II			L06 – L15
	Continuous Assessment 3: Report Writing on Unit II			
04	Discussion on Test 1 Question Pattern and Review			L16
05	Discussion on Test 1 Questions and Answers			L17
	Unit III			L18 – L23
	Continuous Assessment 3: Poster Designing and Presentation on Unit III			-
07	Unit IV			L24 – L31
	Continuous Assessment 3: Quiz on Unit IV			-
08	Discussion on Test 2 Question Pattern and Review			L32
09	Discussion on Test 2 Questions and Answers			L33
10	Unit V			L34 – L41
	Continuous Assessment 3: Written Test on Unit V			
11	Course Integration			L42
12	Discussion of End Term Examination Question Pattern			L43

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Schedule of Instruction:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
01	L01	Overview of the Programme and the Course		-	Power Point Presentation	Class Note
Module 1						
02	L02		Introduction to Geology: Definition, Branches of Geology, Scope of Geology for Engineers. Planet Earth: Origin, Shape, Physical Characteristics, Envelopes, Internal Structure, Chemical Composition, Internal Heat Source, and Age of the Earth, Uniformitarianism and Catastrophism, Geologic Time, Dynamic Processes - Introduction, Internal Dynamic Processes - Plate Tectonics, Continental Drift, Earthquake, Volcanism, External Dynamic Processes – Weathering, Erosion, Transportation, Deposition, Burial, Diagenesis.	CO1	Power Point Presentation	Class Note
03	L03			CO1	Audio – Video Session	Class Note
04	L04			CO1	Power Point Presentation	Class Note
05	L05			CO1	Power Point Presentation	Class Note
		Continuous Assessment 3		CO1		
Module 2						
06	L06		Minerals: Definition; Importance of Study of Minerals; Methods of	CO2	Audio – Video Session	Class Note

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			Mineral Identification. Rocks: Definition; Classification of Rocks - Igneous Rocks, Sedimentary Rocks, and Metamorphic Rocks; Rock Cycle; Uses of Rocks; Visit to Geology Laboratory. Geological Resources: Introduction, Metal Deposits, Industrial Materials, Fossil Fuels, Diamonds.			
07	L07			CO2	Power Point Presentation	Class Note
08	L08			CO2	Audio – Video Session	Class Note
09	L09			CO2	Power Point Presentation	Class Note
10	L10			CO2	Power Point Presentation	Class Note
11	L11			CO2	Power Point Presentation	Class Note
12	L12			CO2	Power Point Presentation	Class Note
13	L13			CO2	Power Point Presentation	Class Note
14	L14			CO2	Audio-Video Sessions	Class Note
15	L15			CO2	Power Point Presentation	Class Note
		Continuous Assessment 3	Report Writing on Unit II			
16	L16	TEST 1	Discussion on Question Pattern and Review	CO1 & CO2	White Board	
			TEST 1 Examination	CO1 & CO2		
17	L17		Discussion on Questions and Answers	CO1 & CO2	White Board	
Module 3						
18	L18			CO3	Power Point Presentation	Class Note
19	L19		Geological Structures: Introduction, Horizontal and Dipping Strata – Dip, and Strike, Unconformity, Folds,	CO3	Power Point Presentation	Class Note

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			Faults, Joints. Geomorphology: Introduction, Geomorphic Processes and Form, Geomorphic System, Plate Tectonics and associated Structural Landforms, Volcanoes, Impact Craters, Weathering and associated Landforms.			
20	L20			CO3	Power Point Presentation	Class Note
21	L21			CO3	Power Point Presentation	Class Note
22	L22			CO3	Power Point Presentation	Class Note
23	L23			CO3	Power Point Presentation	Class Note
		Continuous Assessment 3	Poster Designing and Presentation on Unit III	CO3		
Module 4						
24	L24		Geology of the Ocean: Introduction, Topography of the Sea Floor, Geology of the Oceanic Crust, Sea-Floor Sediments, Ocean Water. Climate Change: Introduction, Greenhouse Gas, Natural Climate Forcing, Climate Feedbacks, Anthropogenic Climate Change, Implications of Climate Change.	CO4	Audio – Video Session	Class Note
25	L25			CO4	Power Point Presentation	Class Note
26	L26			CO4	Power Point Presentation	Class Note
27	L27			CO4	Power Point Presentation	Class Note
28	L28			CO4	Power Point Presentation	Class Note
29	L29			CO4	Power Point Presentation	Class Note
30	L30			CO4	Power Point Presentation	Class Note

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31	L31			CO4	Power Point Presentation	Class Note
		Continuous Assessment 3	Quiz on Unit IV	CO4		
32	L32	TEST 2	Discussion on Question Pattern and Review	CO3 & CO4	White Board	
			TEST 2 Examination	CO3 & CO4		
33	L33		Discussion on Questions and Answers	CO3 & CO4	White Board	

Topics relevant to "**SKILL DEVELOPMENT**": Geomorphology for **Skill Development** through **Participative Learning** techniques. This is attained through the Presentation as mentioned in the assessment Schedule.

Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	Continuous Assessment 3: e-resource Review	Unit I	CO1	-	5	2.5%	-
02	Continuous Assessment 3: Report Writing on Unit II	Unit II	CO2	-	5	2.5%	-
03	TEST 1	Unit I and Unit II	CO1 and CO2	1.0	30	15%	-
04	Continuous Assessment 3: Poster Designing and Presentation on Unit III	Unit III	CO3	-	10	5%	-
05	Continuous Assessment 3: Quiz on Unit IV	Unit IV	CO4	-	10	5%	-
06	TEST 2	Unit III and Unit IV	CO3 and CO4	1.0	30	15%	-
07	Continuous Assessment 3: Written Test on Unit V	Unit V	CO5	-	10	5%	
08	END TERM EXAMINATION	Unit I through Unit V and SLT	CO1 through CO5	3.0	100	50%	-

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2019, from Presidency University, Bengaluru website and go through the Section Nos. 1.0 through 24.0.

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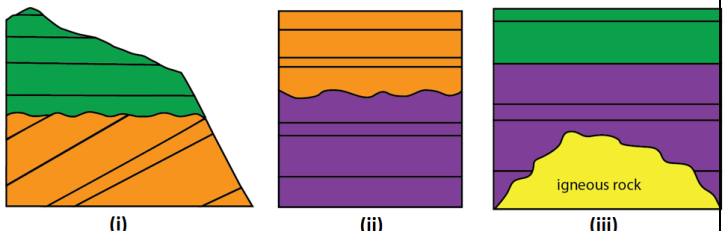
Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	The plate tectonics theory provides a unifying explanation for earthquakes, volcanoes, mountain building, moving continents, and many other manifestations of the Earth's dynamic nature. Like most great, unifying scientific ideas, the plate tectonics theory is simple. Briefly, it describes the Earth's outer layer, called the lithosphere, as a shell of the hard, strong rock. This shell is broken into seven large (and several smaller) segments called tectonic plates. They are also called lithospheric plates, and the two terms are interchangeable. The tectonic plates float on the layer below, called the asthenosphere. The asthenosphere, like the lithosphere, is rock. But the asthenosphere is so hot that 1 to 2 percent of it is melted. As a result, it is plastic, and weak. The lithospheric plates glide slowly over the asthenosphere like sheets of ice drifting across a pond. Continents and ocean basins make up the upper parts of the plates. As a tectonic plate glides over the asthenosphere, the continents and oceans move with it. Most of the Earth's major geological activity occurs at plate boundaries, the zones where tectonic plates meet and interact. Illustrate any two of the consequences of plate tectonics processes.	10	CO1	Comprehension
2	Geologists have identified thousands of minerals. In fact, new minerals are discovered and named all the time. The wide variety of minerals makes it difficult to define exactly what a mineral is. Most of the newly discovered minerals are rare and have no practical use. Chemical composition and crystal structure determine a mineral's properties, including density, shape, hardness, and color. Because each mineral forms under specific conditions, examining minerals helps scientists understand the history of the earth and the other planets within our solar system. However, geologists do study certain characteristics that identify minerals. Is the study of minerals playing any role in day-to-day human life? Explain your answer logically.	10	CO2	Comprehension
3	An unconformity is a buried erosional or non-depositional surface separating two rock masses or strata of different ages, indicating that sediment deposition was not continuous. Schematic diagrams of different types of unconformities are displayed below.  (i) (ii) (iii) (a) Identify the types of unconformities displayed above. (b) Explain the formation of any two unconformities identified	10	CO3	Comprehension

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	above with diagrams.			
4	Except for steep areas of the continental slope and areas near the crest of the mid-ocean ridge, the ocean floor is covered with sediment. Part of this material has been deposited by turbidity currents, and the rest has slowly settled to the seafloor from above. The thickness of this carpet of debris varies greatly. In some trenches, which act as traps for sediments originating on the continental margin, accumulations may approach 10 kilometers (6 miles). In general, however, sediment accumulations are considerably less. (a) Classify the seafloor sediments as per their origin. (b) Compare the seafloor sediments classified above based on their origin.	10	CO4	Comprehension

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	To describe planet earth and its dynamic processes	40
2	CO2	To explain various geological resources of the Earth	40
3	C03	To relate different geological structures and geomorphological features	40
4	CO4	To summarize the implications of climate change.	40

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

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Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	To describe planet earth and its dynamic processes	40		
2	CO2	To explain various geological resources of the Earth	40		

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3	C03	To relate different geological structures and geomorphological features	40		
4	CO4	To summarize the implications of climate change	40		

Name and Signature of the Course Instructor:

D.A.C. Observation and Approval:

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Course Code: PET1006	**Course Title:** Overview of Energy Industry **Type of Course:** 1] Open Elective 2] Theory Only	**L-P-C**	2	0	2
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	This conceptual course is designed in such a way that students will be able to grasp clearly the critical activities at upstream, midstream and downstream of energy industry. This course will also discuss the contemporary methods used in energy industry. A structured approach would be taken whereby students will get the opportunity to engage, relate and contextualize the fundamentals of the energy industry. The course is designed to provide an awareness of how the oil and gas business works.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Overview of Energy Industry and attain **Employability** through **Participative Learning** techniques.				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: Define basic terminologies related to energy resources, CO2: Discuss the nature, practicalities, realities and complexities of the nonrenewable energy industry, CO3: Classify the different renewable energy resources, CO4: Relate environment and sustainability energy development.				
Course Content:					
Module 1:	Introduction to Energy	Assignment / Quiz	Data Collection and Report Submission	04 Periods	
Topics: Energy: Definition, Forms of Energy, Types of Energy Resources, Conservation of Energy, Sources of Energy – Renewable and Non Renewable, Energy Use and Users, Energy Use and Prices, Projected World Energy Consumption by 2050.					
Module 2:	Non Renewable Energy Resources	Assignment / Quiz	Poster Designing and Presentation	08 Periods	
Topics: Fossil Fuels: Definition, Origin – Coal, Oil & Natural Gas, Distribution, Supply and Demand, Classification of Reserves. Energy Industry: Introduction, Type of Industry – Upstream, Midstream, and Downstream, Oil and Gas Lifecycle: Oil and Natural Gas Reservoir, Lifecycle of a Well - Exploration, Appraisal, Development, Production, Decommission, Nuclear energy.					
Module 3:	Renewable Energy Resources	Assignment / Quiz	Learning through Audio-Visual Aid / Movies	07 Periods	
Topics: Solar energy, wind energy, Geothermal energy, Tidal energy, Hydro power.					
Module 4:	Environment and Sustainable Energy Development	Assignment / Quiz	Blog Writing on Current Affairs	04 Periods	
Topics: Environment: Definition, Functions of Environment, Global Environment Issues, Major Challenges of India's Environment. Sustainable Energy: Definition, Need for Sustainable Energy, Types of Sustainable Energy, Sustainable Development – Definition and Strategies.					
Targeted Application and Tools that can be used: Application: Energy Analyst / Market Analyst in Oil and Gas Industry Tools: MS Excel					
Text Book: T1. Joseph F. Hilyard, "The Oil & Gas Industry: A Nontechnical Guide", PennWell Corporation, 2012. T2. Martin S. Raymond and William L. Leffler, "Oil & Gas Production in Nontechnical Language, PennWell Corporation, 2006.					
References: R1. Ustina Markus, "Oil & Gas: The Business & Politics of Energy", Palgrave Macmillan, 2014. **e-resources:** 1. https://puniversity.informaticsglobal.com/login 2. https://mnre.gov.in/ 3. https://www.ibef.org/industry/renewable-energy.aspx 4. https://www.eia.gov/energyexplained/renewable-sources/					

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5. https://en.wikipedia.org/wiki/Sustainable_energy	
Topics relevant to "EMPLOYABILITY SKILLS": Non Renewable Energy Resources for developing **Employability Skills** through **Participative Learning techniques.** This is attained through the **Presentation** as mentioned in the assessment component.	
Catalogue prepared by:	Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Kalpajit Hazarika, Mr. Bhairab Jyoti Gogoii
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Handout AY 2021-22

Date of Issue: 11 March 2022

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	
Semester / Year	:	II / 2021-22
Course Code / Title	:	PET 1006 / Overview of Energy Industry
Course Credit Structure	:	2L 0T 0P 2C
Contact Hours	:	28
Course Instructor In-charge	:	Dr. Kalpajit Hazarika
Course Instructor	:	Dr. Kalpajit Hazarika
Course URL of Edhitch	:	https://www.edhitch.com/gotodashboard

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO5: **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.

PO6: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites: Nil.

Course Description as approved in P.R.C.:

This conceptual course is designed in such a way that students will be able to grasp clearly the critical activities at upstream, midstream and downstream of energy industry. This course will also discuss the contemporary methods used in energy industry. A structured approach would be taken whereby students will get the opportunity to engage, relate and contextualize the fundamentals of the energy industry. The course is designed to provide an awareness of

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how the oil and gas business works.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Overview of Energy Industry and attain **Employability** through **Participative Learning** techniques.

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:

CO1: Define basic terminologies related to energy resources,

CO2: Discuss the nature, practicalities, realities and complexities of the energy industry,

CO3: Classify the different renewable energy resources, and

CO4: Relate environment and sustainability energy development.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	H	M		M		H			H	H		H
CO2	H	L		L		H			H	H		H
C03	H	M		M		H			H	H		H
CO4	H	L		L		H			H	H		H
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module-I: Introduction to Energy [4 Classes] – Knowledge Level

Energy: Definition, Forms of Energy, Types of Energy Resources, Conservation of Energy, Sources of Energy – Renewable and Non Renewable, Energy Use and Users, Energy Use and Prices, Projected World Energy Consumption by 2050.

Module II: Non renewable Energy resources [8 Classes] – Comprehension Level

Fossil Fuels: Definition, Origin – Coal, Oil & Natural Gas, Distribution, Supply and Demand, Classification of Reserves. Energy Industry: Introduction, Type of Industry – Upstream, Midstream, and Downstream, Oil and Gas Lifecycle: Oil and Natural Gas Reservoir, Lifecycle of a Well - Exploration, Appraisal, Development, Production, Decommission, Nuclear energy.

Module -III: Renewable energy resources [7 Classes] – Comprehension Level

Solar energy, wind energy, Geothermal energy, Tidal energy, Hydro power.

Module -IV: Environment and Sustainable Energy Development [4 Classes] – Knowledge Level

Environment: Definition, Functions of Environment, Global Environment Issues, Major Challenges of India's Environment. Sustainable Energy: Definition, Need for Sustainable Energy, Types of Sustainable Energy, Sustainable Development – Definition and Strategies.

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Delivery Procedure (Pedagogy):

This is a theory based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Flip Class Room sessions will be conducted on selective topics. One day visit to course related industry / field will be arranged for providing practical exposure. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Report Submission, Quiz Competition, Poster Presentation, and Group Discussion, etc. will carry **20%** weightage under Continuous Assessment 3 (CA 3). Review classes will be conducted to clear doubts and to evaluate the level of understanding of the each student individually.

Following procedures will be adopted in the course for delivering the content:

(a) Experiential Learning Topics:

· Poster Presentation (Module 1, 2, 3 and 4) (Skill development):

Topics

- Renewable Energy
- Non Renewable Energy
  - Projected World Energy Consumption by 2050
  - Fossil Fuels
  - Need for Sustainable Energy

(b) Participative Learning Topics:

· Quiz (Module-1) (Employability): Introduction to energy

· Quiz (Module -2) (Employability): Fossil Fuels and Energy Industry

· Quiz (Module -4) (Foundation skill): Environment and Sustainable Energy Development

· Peer learning

(C) Problem solving:

· Case study (Module 2, 3 & 4) (Employability): Sustainable Energy, Sustainable Development

· Subject related exercise (Unit 1, 2, 3, 4)

Reference Materials:

Textbook(s)

T1: Joseph F. Hilyard, "The Oil & Gas Industry: A Nontechnical Guide", PennWell Corporation, 2012.

T2: Martin S. Raymond and William L. Leffler, "Oil & Gas Production in Nontechnical Language, PennWell Corporation, 2006.

Reference Book(s)

R1: Ustina Markus, "Oil & Gas: The Business & Politics of Energy", Palgrave Macmillan, 2014.

e-resources:

1. https://mnre.gov.in/

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2. https://www.ibef.org/industry/renewable-energy.aspx

3. https://www.eia.gov/energyexplained/renewable-sources/

4. https://en.wikipedia.org/wiki/Sustainable_energy

5. https://unece.org/DAM/energy/se/pdfs/CSE/Publications/Final_Report_PathwaysToSE.pdf

Guideline to Students:

(a) About the Course:

Knowledge of the course helps the students to learn the various types of energy resources. Basic awareness about this course may help how to extract the energy from different sources. Students are requested to collect the books related to this course from the library and start reading the chapters mention in the handout. It is a request to all the students not to rely entirely on class notes and presentation. To clear concepts they need to go through the books which is recommended here. Students are requested to be serious about their Assignments, Quiz, Seminar and Poster presentation. These all are part of continuous evaluation and no make up for any of these components. All assignments should be submitted on or before the given day. No assignments will be accepted one the submission date is passed.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulations

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0.

Course Schedule:

Unit-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Programme and Course			01
02	Unit-I			04
03	Unit-II			08
04	Continuous Assessment 3: Component 1 - Quiz Competition			-
05	Discussion of Midterm Question Pattern			01
06	Midterm			-
07	Discussion of Midterm Questions and Answers			01

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08	Unit-III			07
09	Unit-IV			04
10	Continuous Assessment 3: Component 2 - Poster presentation			-
11	Continuous Assessment 3: Component 3 - Case study			
12	Course Integration			01
13	Discussion of End Term Examination Question Pattern			01
14	END TERM EXAMINATION			-

Schedule of Instruction:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
01	L01	Overview of the Programme and Course	Overview of Energy industry	-	Power Point Presentation	Class Note
Module I: Introduction to Energy						
02	L02	Introduction to Energy	Energy: Definition, Forms of Energy	CO1	Power Point Presentation	T1, Class Note
03	L03		Types of Energy Resources, Conservation of Energy	CO1	Power Point Presentation	T1, Class Note
04	L04		Sources of Energy – Renewable and Non Renewable, Energy Use and Users	CO1	Power Point Presentation	T1, Class Note
05	L05		Energy Use and Prices, Projected World Energy Consumption by 2050.	CO1	Power Point Presentation	T1, Class Note
Module II: Fossil Fuels and Energy Industry						
06	L06	Fossil Fuels	Definition, Origin – Coal, Oil & Natural Gas,	CO2	Power Point Presentation	T1, Class Note
07	L07		Distribution, Supply	CO2	Power Point	T1, Class

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			and Demand, Classification of Reserves.		Presentation and White Board	Note
08	L08	Energy Industry	Introduction, Type of Industry – Upstream, Midstream, and Downstream,	CO2	Power Point Presentation and White Board	T1, Class Note
09	L09		Oil and Gas Lifecycle: Oil and Natural Gas Reservoir,	CO2	Power Point Presentation and White Board	T1, Class Note
10	L10		Lifecycle of a Well - Exploration, Appraisal,	CO2	Power Point Presentation and White Board	T1, Class Note
11	L11	Energy management	Development, Production,	CO2	Power Point Presentation and White Board	T1, Class Note
12	L12		Decommission,	CO2	Power Point Presentation and White Board	T1, Class Note
13	L13		Nuclear energy.	CO2	Power Point Presentation and White Board	T1, Class Note
Module III: Renewable energy resources						
14	L14	**Renewable energy resources**	Solar energy,	CO3	Power Point Presentation and White Board	Class Note
	L15		Solar energy,	CO3	Power Point Presentation and White Board	Class Note
15	L16		wind energy,	CO3	Power Point Presentation and White Board	Class Note
16	L17		Geothermal energy, Tidal energy,	CO3	Power Point Presentation and White Board	Class Note
	L18		Tidal energy,	CO3	Power Point Presentation and White Board	Class Note

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17	L19		Hydro power.	CO3	Power Point Presentation and White Board	T1, Class Note
	L20		Hydro power.	CO3	Power Point Presentation and White Board	T1, Class Note
Module IV: Environment and Sustainable Energy Development						
21	L21	Basic Concepts	Environment: Definition, Functions of Environment	CO4	Power Point Presentation	T1, Class Note
22	L22		Global Environment Issues, Major Challenges of India's Environment	CO4	Power Point Presentation	T1, Class Note
23	L23	Sustainable Energy	Sustainable Energy: Definition, Need for Sustainable Energy	CO4	Power Point Presentation and White Board	T1, Class Note
24	L24		Types of Sustainable Energy, Sustainable Development – Definition and Strategies	CO4	Power Point Presentation	T1, Class Note
25	L25	Course Integration	Course Summary and Relation with other Courses of the Programme	-	Power Point Presentation	T1, Class Note

Topics relevant to "EMPLOYABILITY SKILLS": Non Renewable Energy Resources for developing **Employability Skills** through **Participative Learning techniques.** This is attained through the **Presentation** as mentioned in the assessment component.

Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	Mid term	Module I, II	CO1, CO2	2.0	50	25%	-
02	End Term Examination	Module I to Module IV, Self-Learning Topics	CO1 - CO4	3.0	100	50%	-
03	Continuous Assessment 3: Quiz	Module I, II	CO1, CO2	-	20	10%	-
04	Continuous Assessment 3: Poster	Module III, IV	CO3, CO4	-	20	10%	-

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	Presentation						
05	Continuous Assessment 3: Case study	Module I to Module IV	CO1 - CO4	-	20	5%	-

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Classify different forms of energy with example.	5	CO1	Knowledge
2	Differentiate between renewable and nonrenewable energy resources with example.	10	CO1	Comprehension
3	Classify the oil reservoirs with neat diagram	10	C02	Comprehension
4	Classify the gas reservoir with neat diagram	10	CO2	Comprehension
5	Discuss about the Industry Supply Chain: Upstream, Midstream, and Downstream Phases.	10	C03	Comprehension
6	What do you mean by sustainable energy resources? Is hydrocarbon energy sustainable? Justify your answer.	10	CO4	Comprehension

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Define basic terminologies related to energy resource	30%
2	CO2	Discuss the nature, practicalities, realities and complexities of the energy industry	30%
3	C03	Classify the different renewable energy resources,	30%

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4	CO4	Relate environment and sustainability energy development.	35%

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	Define basic terminologies related to energy resource	30%		
2	CO2	Discuss the nature, practicalities, realities and complexities of the energy industry	30%		
3	C03	Classify the different renewable energy resources,	30%		
4	CO4	Relate environment and sustainability energy development.	35%		

Name and Signature of the Course Instructor:

D.A.C. Observation and Approval:

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose,	rearranging component ideas

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	construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

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Course Code: PET1007	**Course Title:** Introduction to Energy Trading and Future Options **Type of Course:** 1] Open Elective 2] Theory Only	**L- P- C**	2	0	2
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	This course intends to give overview of the Energy Trading and the Future Options feature of stock exchange. The students will develop a strong foundation about stock markets, Future Options, Energy trading, etc. The course is theoretical in nature with special emphasis on the knowledge of trading on stock exchange. Students should have strong background in economics, and mathematics in order to excel in this course.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Introduction to Energy Trading and Future Options and attain **Entrepreneurship** through **Participative Learning** techniques.				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: Explain the basic Future and Options Contracts and Markets CO2: Explain the behavior of Commodity Futures Prices CO3: Apply Strategies for Energy trading				
Course Content:					
Module 1:	Introduction to Futures and Options Contracts and Markets	Term paper	Data Collection and Review Paper	08 Periods	
Topics: Introduction, Commodity futures and options Contracts and markets, Commodity Futures Exchanges, Future Contracts: Pricing relationships and hedging relationships; Electronic Trading, Regulations, Basics of Trading, Brokerage Firms and Commissions					
Module 2:	Behavior of Commodity Futures Prices	Assignment	Quiz	10 Periods	
Topics: Principles of Futures Prices, Structure of Futures Prices, Forward and Futures Markets; Forward and Futures Pricing: Valuing forward contract, valuing future contract, the relationship between forward and future prices; Commodity Price dynamics, Stochastic Volatility, Seasonal Commodities, Non-Storable Commodities, Speculation and Position Trading, Spreads, Hedging					
Module 3:	Introduction to Options on Futures	Assignment	Article Review	06 Periods	
Topics: Options Terminology, Option Payoffs, Option Valuation; Option Pricing; Energy Options Strategies					
Targeted Application and Tools that can be used: Applications: Business Analyst in the Stock Market / Market Outlook Tool: MS Excel					
Text Book: T1: Errerra and S. L. Brown, Fundamentals of Trading Energy Futures and Options, 2nd Edition, PennWell. T2: Stefano Fiorenzani, The Handbook of Energy Trading, 1st Edition, 2012, Wiley.					
References: R1: Parag Diwan , Energy Trading,1st Edition, 2008, Pentagon Press. **e-resources:** 1.Presidency University e-access portal:https://presiuniv.knimbus.com/user#/home 2. Fundamentals of Energy Trading Market (Youtube Channel) :https://www.youtube.com/watch?v=8lC8e2YjGNM 3.Energy :(YoutubeChannel):https://www.youtube.com/watch?v=SiMLey6XLTI&list=PLWVdW85uAEcqZVfjn8sRB7NKIDu0KE_LM 4. Energy Options Strategies (Youtube Channel):https://www.youtube.com/watch?v=8lC8e2YjGNM 5. Energy Speculation and Position Trading (Youtube Channel): https://www.youtube.com/watch?v=jlR9JJWYxB8 6. Basics of Trading(Youtube Channel) :https://www.youtube.com/watch?v=CJEm99cp0Os					
Topics relevant to "ENTREPRENEURIAL SKILLS": Behavior of Commodity Futures Prices for developing **Entrepreneurial Skills** through **Participative Learning** techniques. This is attained through the **Assignment** as mentioned in the course handout.					

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Catalogue prepared by:	Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Kalpajit Hazarika, Mr. Ankur Neog
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Handout

Date of Issue: Not Offered Yet
Revised on:

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B. Tech.in Petroleum Engineering
P.R.C. Approval Ref.	:	
Semester / Year	:	III/ 2nd
Course Code / Title	:	PET1007 / Introduction to Energy Trading and Future Options
Course Credit Structure	:	2L– 0P – 2C
Contact Hours	:	29
Course Instructor In-charge	:	
Course Instructor	:	

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **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.

PO6: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own

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work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites:
NIL

Course Description:

This course intends to give overview of the Energy Trading and the Future Options feature of stock exchange. It will develop a strong foundation about stock markets, Future Options, Energy trading, etc. The course is theoretical in nature with special emphasis on the knowledge of trading on stock exchange. Students should have strong background in economics, and mathematics in order to excel in this course.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Introduction to Energy Trading and Future Options and attain **Entrepreneurship** through **Participative Learning** techniques.

Course Outcomes (COs):

On successful completion of the course the students shall be able to:
CO1: Explain the basic Future and Options Contracts and Markets,
CO2: Explain the behavior of Commodity Futures Prices,
CO3: Apply Strategies for Energy trading.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	H	M	M	L	L		L	L	L	H	L	L
CO2	H	H	M	L	L		L	L	L	H	L	L
CO3	H	H	L	M	M		M	M	M	H	M	M
CO4	H	H	L	M	M		H	M	M	H	M	L
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module I: Introduction to Futures and Options Contracts and Markets [8 Classes] – Comprehension Level
Introduction, Commodity futures and options Contracts and markets, Commodity Futures Exchanges, Future Contracts: Pricing relationships and hedging relationships; Electronic Trading, Regulations, Basics of Trading, Brokerage Firms and Commissions

Module II: Behavior of Commodity Futures Prices [10 Classes] – Comprehension Level
Principles of Futures Prices, Structure of Futures Prices, Forward and Futures Markets; Forward and Futures Pricing: Valuing forward contract, valuing future contract, the relationship between forward and future prices; Commodity Price dynamics, Stochastic Volatility, Seasonal Commodities, Non-Storable Commodities, Speculation and Position Trading, Spreads, Hedging

Module III: Introduction to Options on Futures [6 Classes] – Application Level
Options Terminology, Option Payoffs, Option Pricing; Energy Options Strategies

Delivery Procedure (Pedagogy):

This is a theory based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Flip Class Room sessions will be conducted on selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Assignments, Quiz Competition and Poster Presentation will carry 25% weightage under Continuous Internal Assessment (CIA). Review classes will be conducted to clear doubts and to evaluate the level of understanding of the each student individually. If required some classes may be engaged in virtual mode under unavoidable circumstances.

Following procedures will be adopted in the course for delivering the content:

(a) Experiential Learning Topics (ELT):

-Article Review [Module III] [Foundation/Skill Development]

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(1) Energy Options Strategies (Team Activity)

(b) Participative Learning Topics (PLT):
- Quiz [Module I, II][Skill Development]
- The average of all the quizzes will be considered for evaluation.

Reference Materials:

Text Book:
T1: Errerra and S. L. Brown, Fundamentals of Trading Energy Futures and Options, 2nd Edition, PennWell.
T2: Stefano Fiorenzani, The Handbook of Energy Trading, 1st Edition, 2012, Wiley

References:
R1: Parag Diwan, Energy Trading,1st Edition, 2008, Pentagon Press.

E-resources:
1.Presidency University e-access portal:https://presiuniv.knimbus.com/user#/home
2. Fundamentals of Energy Trading Market (Youtube Channel) :https://www.youtube.com/watch?v=8lC8e2YjGNM
3.Energy :(YoutubeChannel):https://www.youtube.com/watch?v=SiMLey6XLTI&list=PLWVdW85uAEcqZVfjn8sRB7NKIDu0KE_LM
4. Energy Options Strategies (Youtube Channel):https://www.youtube.com/watch?v=8lC8e2YjGNM
5. Energy Speculation and Position Trading (Youtube Channel): https://www.youtube.com/watch?v=jlR9JJWYxB8
6. Basics of Trading (Youtube Channel) :https://www.youtube.com/watch?v=CJEm99cp0Os

Guideline to Students:

(a) About the Course:
This course intends to give overview of the Energy Trading and the Future Options feature of stock exchange. It will develop a strong foundation about stock markets, Future Options, Energy trading, etc. The course is theoretical in nature with special emphasis on the knowledge of trading on stock exchange. Students should have strong background in economics, and mathematics in order to excel in this course.

(b) Notification / Announcement related to the Course:
All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulation
The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0.

Course Schedule:

Module-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Program and Course			L1
02	Module I			L2-L9
03	Continuous Internal Assessment 1: Quiz			-
04	Module II			L10-L19
05	Continuous Internal Assessment 2: Quiz			-
06	Discussion of Mid Term Exam Question Pattern			L20
07	Mid Term Exam			-
08	Discussion of Mid Term Exam Questions and Answers			L21
09	Module III			L22-L27
10	Continuous Internal Assessment 3: Article Review			-

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11	Course Integration			L28
12	Discussion of End Term Exam Question Pattern			L29
13	End Term Exam			-
14	Discussion of End Term Exam Questions and Answers			-

Schedule of Instruction:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No. / Date	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L01 /	Overview of the Program and Course	Overview of the Program and Course	-	PowerPoint Presentation	N/A
Module I						
2	L02 /	Introduction to Futures and Options Contracts and Markets	Introduction	CO1	Lecture and PowerPoint Presentation	T1 CH3 / CN
3	L03 /		Commodity futures and options Contracts and markets	CO1	PowerPoint Presentation / Videos	T1 CH3 / CN
4	L04 /		Commodity Futures Exchanges	CO1	PowerPoint Presentation / Videos	T1 CH3 / CN
5	L05 /		Electronic Trading	CO1	PowerPoint Presentation / Videos	T1 CH3 / CN
6	L06 /		Pricing relationships and hedging relationships, Regulations	CO1	PowerPoint Presentation / Videos	T1 CH3 / CN
7	L07/		Pricing relationships and hedging relationships, Basics of Trading	CO1	Lecture & presentation	T1 CH4 / CN
8	L08/		Basics of Trading,Brokerage Firms and Commissions	CO1	Lecture & Presentation	T1 CH4 / CN
9	L09/		Brokerage Firms and Commissions	CO1	Lecture & Presentation	T1 CH4 / CN
	-		Continuous Internal Assessment 1- Quiz	-	-	-
Module II						
10	L10 /	Behavior of Commodity Futures Prices	Principles of Futures Prices	CO2	PowerPoint Presentation / Videos	T1 / CN
11	L11 /		Principles of Futures Prices	CO2		T1 / CN
12	L12 /		Structure of Futures Prices	CO2		T1 / CN
13	L13 /		Structure of Futures Prices	CO2	Lecture, Presentation & Video	T1 / CN
14	L14/		Forward and Futures Markets; Speculation and Position Trading	CO2	Lecture & Presentation	T1 / CN
15	L15/		Speculation and Position Trading; Forward and Futures Pricing	CO2	Lecture & Presentation	T1 / CN
16	L16/		Valuing forward contract, valuing future contract	CO2	Lecture & Presentation	T1 / CN
17	L17/		Spreads	CO2	Lecture & Presentation	T1 / CN

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-	-		Continuous Internal Assessment 2- Quiz	CO2	-	-
18	L18 /		Discussion of Mid Term Exam Question Pattern	CO1 and CO2	PowerPoint Presentation	N/A
			Mid Term Exam	CO1 and CO2	N/A	N/A
19	L19 /		Discussion of Mid Term Exam Questions and Answers	CO1 and CO2	PowerPoint Presentation	N/A
20	L20 /		Spreads	CO2	Lecture & Presentation	CN
21	L21/		Hedging	CO2		
Module III						
22	L22 /	Introduction to Options on Futures	Options Terminology	CO3	Lecture & Presentation	T1 / CN
23	L23 /		Option Payoffs	CO3	Lecture & Presentation	T1 / CN
24	L24 /		Option Payoffs	CO3	Lecture & Presentation	T1 / CN
25	L25 /		Option Pricing	CO3	Lecture & Presentation	T1 / CN
26	L26 /		Option Pricing	CO3	Lecture & Presentation	T1 / CN
27	L27/		Energy Options Strategies	CO3	Lecture & Presentation	CN
	-		Continuous Internal Assessment 3: Article Review	-	-	-
28	L28 /	Course Integration	Course Integration	CO1 through CO4	PowerPoint Presentation	N/A
29	L 29 /		Discussion of End Term Exam Questions and Answers	CO3 and CO4	PowerPoint Presentation	N/A
			End Term Exam	CO1 through CO4	N/A	N/A

Topics relevant to "ENTREPRENEURIAL SKILLS": Behavior of Commodity Futures Prices for developing **Entrepreneurial Skills** through **Participative Learning** techniques. This is attained through the **Presentation** as mentioned in the assessment schedule.

Assessment Schedule:

Module-wise Micro Level planning for course assessment schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time (Date may Change)
01	Continuous Internal Assessment 1: Quiz	L02 – L9	CO1, CO2	-	20	10%	
02	Continuous Internal Assessment 2: Quiz	L10 – L21	CO1, CO2	-	20	10%	
04	Mid Term Examination	L02 – L21	CO1, CO2	2	50	25%	
06	Assignment: Article writing – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-	L21 - L28	CO3	-	10	5%	

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	resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)						
07	End Term Examinations	L03 - L28	CO1, CO2, CO3	3	100	50%	

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Carbon trade is the buying and selling of credits that permit a company or other entity to emit a certain amount of carbon dioxide. The value of the carbon is based on the ability of the country to store it or to prevent it from being released into the atmosphere. Debate over carbon trade is inevitable since it involves finding a compromise between profit, equality, and ecological concerns.Explain the idea behind carbon trading with respect to trade of securities or commodities in a marketplace.	6	CO1	Comprehension
2	As the world became more dependent on oil, oil prices became a matter of political and global economic importance. Major oil companies set crude oil prices, until control shifted in the 1960s to oil exporting countries. Price forecasting became important in the early 1960s after a series of oil price hikes turned into oil crises.Price benchmarks are used in the oil and gas industry to give buyers a way to value the commodity based on quality and locations.Describe the price benchmarks which are vital for deciding future crude oil pricing options.	6	CO2	Comprehension
3	An option is contract which provides the buyer of the contract the right, but not the obligation, to purchase or sell a particular amount of a specific commodity on or before a specific date or period of time. There are two primary types of options, call options (also known as a caps) and put options (also knows as floors). A call option provides the buyer of a call option with protection against rising prices. Conversely, a put option provides the buyer of the put option with protection against declining prices. Compare call options with reference to put options in trading industry.	6	CO3	Comprehension

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Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Explain the basic Future and Options Contracts and Markets	40
2	CO2	Explain the behavior of Commodity Futures Prices	40
3	CO3	Apply Strategies for Energy trading	40

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1	Continuous Internal Assessment 1: Quiz			
2	Continuous Internal Assessment 2: Quiz			
3	Mid Term Examination			
4	Assignment: Article writing – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing			

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	digital resources, otherwise, it will not be evaluated.)			
5	End Term Examinations			

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	Explain the basic Future and Options Contracts and Markets	40		
2	CO2	Explain the behavior of Commodity Futures Prices	40		
3	C03	Apply Strategies for Energy trading	40		

Name and Signature of the Course Instructor:

D.A.C. Observation and Approval:

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Course Code: PET1008	**Course Title:** **Sustainable Energy Management** **Type of Course:** **1] Discipline Elective** **2] Theory Only**	**L- P- C**	2	0	2
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	The purpose of this course is to enable to understand the status of energy sector with respect to sustainability. The overall theme of the course is to emphasize the process of thinking: qualitatively and quantitatively; strategically, using concrete; real-life practical examples. The course is theoretical in nature. The course develops the critical thinking and analytical skills.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Sustainable Energy Management and attain **Entrepreneurship** through **Participative Learning** techniques.				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: differentiate between various forms of energy, CO2: discuss factors affecting planning and implementation of energy management, CO3: describe priorities of sustainable energy development.				
Course Content:					
Module 1:	Energy and Sustainable Development	Assignment	Data Collection	10 Periods	
Topics: Introduction to Energy: Definition, Need for energy, Forms / Type of Energy, Renewable versus Non-renewable Energy. Sustainable development, Sustainable development Principles, Energy sustainability, Problems of Future Energy Development, Need for long term development.					
Module 2:	Energy Management Planning and Implementation	Assignment	Data Collection	12 Periods	
Topics: Concepts of energy management, Sustainability approach to energy management, Strategic analysis of energy sector, Implementation of energy management plan: Basic approach, Traditional approach, System approach, Eco-management approach, life cycle analysis.					
Module 3:	Priorities of Sustainable Energy Development	Quiz	Data Collection	12 Periods	
Topics: Renewable Energy: Solar energy, Biomass energy, Wind energy, Geothermal energy, Hydropower Energy, Management of Renewable Energy Sources; Energy efficiency: Introduction, Energy audit, Energy Transition.					
Targeted Application and Tools that can be used: Application area is as a Sustainability Analyst as it helps in the decision making of the projects and also assessing the risk associated with new projects. Application tools include Excel, Power BI.					
Text Book: T1: Sustainable Energy Management. Mirjana Radovanovic (Golusin), Stevan Popov, Sinisa Dodic, 1st Edition, 2012					
References: R1: Renewable Energy Sources and Emerging Technologies. Kothari, 2nd Edition, 2011 **E-resource:** 1. Presidency University e-resource library: https://puniversity.informaticsglobal.com/login 2. Presidency University e-access portal: https://presiuniv.knimbus.com/user#/home					
Topics relevant to "ENTREPRENEURIAL SKILLS": Energy Management Planning and Implementation for developing **Entrepreneurial Skills** through **Participative Learning techniques.** This is attained through the **Assignment** as mentioned in the course handout.					
Catalogue prepared by:	Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Kalpajit Hazarika				
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022				
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022				

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Course Hand Out

Date of Issue: 07-09-2020

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	
Semester / Year	:	V / 3rd
Course Code / Title	:	PET1008/ Sustainable Energy Management
Course Credit Structure	:	2L-0P-2C
Contact Hours	:	40L
Course Instructor In-charge	:	Mr. Sugat Srivastava
Course Instructor	:	Mr. Sugat Srivastava
Course URL	:	
Program Outcomes (POs)	:	

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **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.

PO6: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites:

Nil

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Course Description:

The purpose of this course is to understand the status of energy sector with respect to sustainability. The overall theme of the course is to emphasize the process of thinking: qualitatively and quantitatively; strategically, using concrete; real-life practical examples. The course is theoretical in nature. The course develops the critical thinking and analytical skills.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Sustainable Energy Management and attain **Entrepreneurship** through **Participative Learning** techniques.

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:

CO1: Differentiate between various forms of energy,

CO2: Discuss factors affecting planning and implementation of energy management,

CO3: Describe priorities of sustainable energy development.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	M	H	M	L	M	M	M	H		H	L	L
CO2	H	M	M	H	M	M	H	L		M	M	L
C03	H	L	H	M	L	H	L	M		M	L	L
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module I: Energy and Sustainable Development [10 Classes] [Application]

Introduction to Energy: Definition, Need for energy, Forms / Type of Energy, Renewable versus Non-renewable Energy. Sustainable development, Sustainable development Principles, Energy sustainability, Problems of Future Energy Development, Need for long term development.

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Module II: Energy Management Planning and Implementation [12 Classes] [Application]

Concepts of energy management, Sustainability approach to energy management, Strategic analysis of energy sector, Implementation of energy management plan: Basic approach, Traditional approach, System approach, Eco-management approach, life cycle analysis.

Module III: Priorities of Sustainable Energy Development [12 Classes] [Application]

Renewable Energy: Solar energy, Biomass energy, Wind energy, Geothermal energy, Hydropower Energy, Management of Renewable Energy Sources; Energy efficiency: Introduction, Energy audit, Energy Transition.

Skill Sets to be Developed:

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. **Ability to interpret events and results.**
4. **Ability to work as a leader and as a member of a team.**
5. **Assess errors in systems/processes/programs/computations and eliminate them.**
6. Observe and measure physical phenomena.
7. **Write reports.**
8. **Select suitable equipment, instrument, materials & software**
9. Locate faults in system/Processes/software.
10. **Manipulative skills for setting and handling systems/Process/ Issues**
11. **The ability to follow standard /Legal procedures.**
12. **An awareness of the Professional Ethics.**
13. **Need to observe safety/General precautions**.
14. To judge magnitudes/Results/issues without actual measurement/actual contacts

Delivery Procedure (Pedagogy):

Most of the lectures will be taken with the help of Microsoft teams. Videos will be shown for the better understanding of selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Most of the lectures will be delivered online (Virtual Classroom Mode) using Microsoft Team platform.

Following procedures will be adopted in the course for delivering the content:

Experiential learning (Module I) (Foundation Skill)

- **Literature review (Module I) (Employability/Skill development/ Environment and sustainability):**

Literature Review of Digital/e-resources from Presidency University link shared below. It is mandatory to submit a screenshot accessing digital resources, otherwise, it will not be evaluated. Link to Presidency University e-resources:

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https://puniversity.informaticsglobal.com/login.

Participative learning (Module II) (Skill Development/ Human Values and Professional Ethics):

Poster Presentation on the topic: Module II

Problem solving (Module III) (Employability):

Assignment on Module III

Reference Materials:

(a) Text Book:

1. Sustainable Energy Management. Mirjana Radovanovic (Golusin), Stevan Popov, Sinisa Dodic, 1st Edition, 2012

(b) Reference Book(s):

1) Renewable Energy Sources and Emerging Technologies. Kothari, 2nd Edition, 2011

(c) Case study:

1. Efficient Wastewater Plant Applying E-Plate Heat Exchanger: https://www.das-ee.com/en-us/wastewater-treatment/case-studies/case-study-paper-industry/

(d) e- References:

1.Presidency University e-resource library: https://puniversity.informaticsglobal.com/login

2.Presidency University e-access portal: https://presiuniv.knimbus.com/user#/home

Guideline to Students:

(a) About the Course:

This is a theory based course which will provide fundamental concepts of oil and gas industry processes. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from

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Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0.

COURSE SCHEDULE FOR THEORY COMPONENT

Module-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
1	Over View of the course			1
2	Module I:			10
3	Literature Review on Module I			
4	Module II:			12
6	Poster Presentation on Module II			
7	Mid Term Syllabus and question pattern discussion			1
8	Mid term			
9	Mid Term Question Paper discussion			1
10	Module III:			12
10	Assignment on Module III			
11	Course Integration			1
12	End Term Syllabus and Question Paper Pattern Discussion			1
13	End Term Final Examination			

Dates as per the academic calendar

Schedule of Instruction:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L1 / 12/09/22	**Programme Integration**	Overview of the course		PPT/White board	
Module I						
2	L2 / 15/09/22	Energy and Sustainable Development	Introduction to Energy: Definition, Need for energy	CO1	PPT/White board	T1 Ch01
3	L3 / 19/09/22		Introduction to Energy: Definition, Need for energy	CO1	PPT/White board	T1 Ch01

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4	L4 / 22/09/22		Forms / Type of Energy, Renewable versus Non-renewable Energy	CO1	PPT/White board	T1 Ch02
5	L5 / 26/09/22		Forms / Type of Energy, Renewable versus Non-renewable Energy	CO1	PPT/White board	T1 Ch02
6	L6 / 29/09/22		Sustainable development	CO1	PPT/White board	T1 Ch02
7	L7 / 06/10/22		Sustainable development Principles	CO1	PPT/White board	T1 Ch02
8	L8 / 10/10/22		Energy sustainability, Energy Development	CO1	PPT/White board	T1 Ch07
9	L9 / 13/10/22		Energy sustainability, Energy Development	CO1	PPT/White board	T1 Ch07
10.	L/10		Need for long term development			
11.	L/11		Need for long term development			
Literature Survey on Module I				CO1		
Module II						
12.	L12	Energy Management Planning and Implementation	Concepts of energy management,	CO2	PPT/White board	T1 Ch09
13.	L13		Sustainability approach to energy management	CO2	PPT/White board	T1 Ch09
14.	L14	Mid Term Syllabus and question pattern discussion		C01, CO2		
15.	L15	Mid Term question paper discussion		C01, CO2		
16.	L16	Energy Management Planning and Implementation	Sustainability approach to energy management	CO2	PPT/White board	T1 Ch09
17.	L17		Strategic analysis of energy sector	CO2	PPT/White board	T1 Ch09
18.	L18		Traditional approach	CO2	PPT/White board	T1,CN
19.	L19		Traditional approach	CO2	PPT/White board	T1,CN
20.	L20		System approach	CO2	PPT/White board	T1,CN
21.	L21		System approach	CO2	PPT/White board	T1,CN
22.	L22		Eco-management approach	CO2	PPT/White board	T1,CN
23.	L23		Eco-management approach	CO2	PPT/White board	T1,CN
24.	L24		life cycle analysis			

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25.	L25		life cycle analysis			
Poster Presentation on Module II				CO2		
Module III						
26.	L26	Priorities of Sustainable Energy Development Renewable Energy: Solar energy, Biomass energy, Wind energy, Geothermal energy, Hydropower Energy, Management of Renewable Energy Sources; Energy efficiency: Introduction, Energy audit, Energy Transition.	Renewable Energy: Solar energy	CO3	PPT/White board	T1,CN
27.	L27		Solar energy	CO3	PPT/White board	T1,CN
28.	L29		Biomass energy	CO3	PPT/White board	T1,CN
30.	L30		Wind energy	CO3	PPT/White board	T1,CN
31.	L31		Wind energy	CO3	PPT/White board	T1,CN
32.	L32		Geothermal energy	CO3	PPT/White board	T1,CN
33.	L33		Geothermal energy	CO3	PPT/White board	T1,CN
34.	L35		Hydropower Energy			
35.	L35		Management of Renewable Energy Sources;			
36.	L36		Energy efficiency: Introduction			
37.	L37		Energy audit			
38.	L38		Energy Transition			
39.	L39	Course Integration	Course Summary and Relation with other Courses of the Program	-	PPT/White boar	-
Quiz on Module on III				CO3		
40	L40	End Term Question paper discussion		CO1-CO4		

Topics relevant to "ENTREPRENEURIAL SKILLS": Energy Management Planning and Implementation for developing **Entrepreneurial Skills** through **Participative Learning techniques.** This is attained through the **Presentation** as mentioned in the assessment Schedule.

ASSESSMENT SCHEDULE FOR THEORY COMPONENT:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome	Duration in Hours	Marks	Weightage	Venue, Date, and Time

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			Number				
1	Assignment: Report – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://puniversity.informaticsglobal.com/login). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)	L02-L09	CO1	-	10	5	
2	Poster Module II	L10-L18	CO2	-	20	10	
3	Mid term	L02-L11	CO1, CO2	1.5	60	30	
4	Quiz on Module III	L20-L28	CO3	-	10	5	
5	End term final examination	L02-L27	CO1 - CO4	3	100	50	

Assessment Matrix for Daily Task Evaluation for Laboratory component:

Sl. No.	Task No.	Marks for activity 01 [Mention the activity]	Marks for activity 02 [Mention the activity]	Marks for activity 03 [Mention the activity]	Total Marks		
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Course Clearance Criteria :

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

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Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Renewable energy is energy that is collected from renewable resources that are naturally replenished on a human timescale. Justify the statement with suitable examples.	10	C01	Comprehension
2	Energy entrepreneurs support energy consumption reduction efforts with their in-depth knowledge of energy costs. Explain the statement	10	C02	Comprehension
3	Geothermal energy source is the almost unlimited amount of heat generated by the Earth's core. Justify the statement and explain its future prospects	10	C03	Comprehension

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Differentiate between various forms of energy	20
2	CO2	Discuss factors affecting planning and implementation of energy management	25
3	C03	Describe priorities of sustainable energy development.	20

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

Signature of the Chairperson DAC:

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Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Name and Signature of the Course Instructor:

DAC Observation and Approval:

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Course Code: PET 1010	Course Title: Carbon Capture and Utilization for Sustainability Type of Course: 1] Discipline Elective 2] Theory only	L- T- P- C	3	0	0	3
Version No.:	1.0					
Course Pre-requisites:	NIL					
Anti-requisites:	NIL					
Course Description:	The purpose of this course is to introduce climate change and how to assess and explore CO2 capture and utilization technologies, and assess geologic utilization and sub-surface storage options.					
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Carbon Capture and Utilization for Sustainability and attain **Employability** through **Participative Learning** techniques.					
Course Outcomes:	On successful completion of the course, the student shall be able to: CO1: Develop carbon capture, utilization, and storage strategies CO2: Define the role of carbon capture, utilization, and storage in reducing emissions. CO3: Classify different principles of CO2 capture CO4: Develop new technologies for low carbon energy supply with CO2 capture and storage (CCUS)					
Course Content:						

Unit I:	Introduction	Quiz/Assignment	Data Collection and Review Paper	07 Periods
Topics: Introduction to carbon capture, utilization, and storage; legal and regulatory issues for implementing CO_2 storage; role of carbon capture and utilization in sustainability				
Unit II:	CCS technology	Assignment/Poster Presentation	Poster Designing and Presentation	07 Periods
Topics: Applications for CCUS, characteristics of CCS, current status of CCS technology, costs for CCS and technical and economic potential				
Unit III:	CO2 transport and emission	Assignment	Numerical Solving	09 Periods
Topics: Sources of CO2, capture of CO2, transport of CO2, Low emission solutions when using CO2 in petroleum production				
Unit IV:	CO2 storage	Case Study	Group discussion	09 Periods
Topics: Carbon storage: geological storage, ocean storage, geographical relationship between the sources and storage opportunities for CO2, health, safety and environment risks of CCS				

Targeted Application and Tools that can be used:

Application area: Project Planning and Management Analyst, Management trainee
Professionally Used Software: Kato, MS-Excel

(a) Text Books:

T1. Metz, B., Davidson, O., Coninck, H.d., Loos, M., Meyer, L. 2005. Carbon dioxide capture and storage . Intergovernmental Panel on Climate Change, Cambridge University Press.
T2. Feng, D., Sun, J., Zhou, Z., 2023. Carbon Dioxide Capture, Utilization and Storage (CCUS) . MDPI .

(b) Reference Book(s)

R1. Goel, M., 2008. Carbon capture and storage: R&D technologies for sustainable energy future. Alpha Science.
R2. Shah, Y.T., 2021 CO2 Capture, Utilization, and Sequestration Strategies , CRC Press.

(c) e-resources:

1. Link for Knimbus remote login: https://presiuniv.knimbus.com
2. SWAYAM Course - Introduction to Climate Change, By Dr V. Venkat Ramanan , https://www.classcentral.com/course/swayam-introduction-to-climate-change-58478

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Topics relevant to "**SKILL DEVELOPMENT**": CCS technology for developing **Employability** through **Participative Learning** techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by:	Dr. Barasha Deka, Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Abhinav Kumar, Mr. Gaurav Kundu
Recommended by the Board of Studies on:	16th Meeting of the Board of Studies held on 8th July, 2023
Date of Approval by the Academic Council:	

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Course Handout (AY 2022-2023)

Date of Issue:

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	
Semester / Year	:	
Course Code / Title	:	PET1010 / Carbon Capture and Utilization for Sustainability
Course Credit Structure	:	3L 0P 3C
Contact Hours	:	37L
Course Instructor In-charge	:	
Course Instructor	:	

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences**.**

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **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.

PO6: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites:
NIL

Course Description:

The purpose of this course is to introduce climate change and how to assess and explore CO2 capture and utilization technologies, and assess geologic utilization and sub-surface storage options.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Carbon Capture and Utilization for Sustainability and attain **Employability** through **Participative Learning** techniques.

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:
CO1: Develop carbon capture, utilization, and storage strategies
CO2: Define the role of carbon capture, utilization, and storage in reducing emissions.
CO3: Classify different principles of CO2 capture
CO4: Develop new technologies for low carbon energy supply with CO2 capture, utilization and storage (CCUS)

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	H	M	M	L	L	L	L	L	L	H	L	L
CO2	H	H	M	L	L	L	L	L	L	H	L	L
CO3	H	H	L	M	M	L	M	M	M	H	M	M
CO4	H	H	L	M	M	L	H	M	M	H	M	L
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module I: CCUS and sustainability [7L - Application Level]

Introduction to carbon capture, utilization, and storage; legal and regulatory issues for implementing CO2 storage; role of carbon capture and utilization in sustainability

Module II: CCS technology [7L - Application Level]

Applications for CCUS, characteristics of CCS, current status of CCS technology, costs for CCS and technical and economic potential

Module III: Reservoir Characterization and Simulation [9L - Application Level]

Sources of CO2, capture of CO2, transport of CO2, Low emission solutions when using CO2 in petroleum production

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Module IV: Drilling and Completion Optimization [9L - Comprehension Level]

Carbon storage: geological storage, ocean storage, geographical relationship between the sources and storage opportunities for CO2, health, safety and environment risks of CCS

Delivery Procedure (Pedagogy):

This is a theory based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Assignments, Quiz Competition and Poster Presentation will carry 20% weightage under Continuous Internal Assessment (CIA). Review classes will be conducted to clear doubts and to evaluate the level of understanding of the each student individually. If required some classes may be engaged in virtual mode under unavoidable circumstances.

(a) Self Learning Topics:

Sources of CO2
Capture of CO2,
Transport of CO2

(b) Experiential Learning Topics (ELT):

Article Review [Module-IV] [Foundation/Skill Development]

Carbon storage: geological storage and ocean storage

-"Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link https://presiuniv.knimbus.com/user#/home. It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)

(c) Participative Learning Topics (PLT):

Quiz on legal and regulatory issues for implementing CO2 storage [Module-I][Skill Development]

Quiz on characteristics of CCS [Module-II][Skill Development]

Quiz on Sources of CO2 [Module-III][Skill Development]
The average of all the quizzes will be considered for evaluation.

(d) Problem Based Learning Topics (PBLT):

Case Study on health, safety and environment risks of CCS

Student needs to submit the problem assignments before the due date.

Reference Materials:

Text Book(s)

T1: T1. Metz, B., Davidson, O., Coninck, H.d., Loos, M., Meyer, L. 2005. Carbon dioxide capture and storage . Intergovernmental Panel on Climate Change, Cambridge University Press.
T2: T2. Feng, D., Sun, J., Zhou, Z., 2023. Carbon Dioxide Capture, Utilization and Storage (CCUS) . MDPI .

References:

R1: Goel, M., 2008. Carbon capture and storage: R&D technologies for sustainable energy future. Alpha Science
R2: R2. Shah, Y.T., 2021 CO2 Capture, Utilization, and Sequestration Strategies , CRC Press.

E-resources:

3. Link for Knimbus remote login: https://presiuniv.knimbus.com
4. SWAYAM Course - Introduction to Climate Change, By Dr V. Venkat Ramanan , https://www.classcentral.com/course/swayam-introduction-to-climate-change-58478

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Guideline to Students:

(a) About the Course:

The purpose of this course is to introduce climate change and how to assess and explore CO2 capture and utilization technologies, and assess geologic utilization and sub-surface storage options. The course is conceptual in nature, and is intended to develop understanding of the CCUS concepts, problems, and implementation. The course develops the critical and analytical thinking skills through various case studies. The course also enhances the understanding about sustainability through assignments.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2020', Regulation No. PU/AC-13/16/11_2020, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2017/08/Academic-Regulations-2020.pdf) and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Module-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Program and Course			L01
02	Module I			L02 – L8
03	Continuous Internal Assessment 1: Quiz			-
04	Module II			L9 – L15
05	Continuous Internal Assessment 2a: Quiz			-
06	Continuous Internal Assessment 2b: Course based problems			-
07	Discussion of Mid Term Exam Question Pattern			L16
08	Mid Term Exam			-
09	Discussion of Mid Term Exam Questions and Answers			L17
10	Module III			L18 – L26
11	Continuous Internal Assessment 3: Quiz			-
12	Module IV			L27 – L35
13	Continuous Internal Assessment 4: Article Review			-
14	Course Integration			L36
15	Discussion of End Term Exam Question Pattern			L37
16	End Term Exam			-
17	Discussion of End Term Exam Questions and Answers			-

Schedule of Instruction:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No. / Date	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L01 /	Overview of the Program and	Overview of the Program and Course	-	PowerPoint Presentation	N/A

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		Course				
Module I						
2	L02 /	CCUS and sustainability	Introduction to carbon capture	CO1	Lecture, Video	R1 CH1/CN
3	L03 /		Introduction to carbon utilization	CO1	Lecture and PPT	R1 CH1/CN
4	L04 /		Introduction to carbon storage	CO1	Lecture and PPT	R1 CH1/CN
5	L05 /		Legal issues for implementing CO2 storage	CO1	Lecture and PPT	R1 CH1/CN
6	L06 /		Regulatory issues for implementing CO2 storage	CO1	Lecture and PPT	R1 CH1/CN
7	L07 /		Introduction to sustainability	CO1	Lecture and PPT	R1 CH1/CN
8	L08 /		Role of carbon capture and utilization in sustainability	CO1	Lecture and PPT	R1 CH1/CN
	-		Continuous Internal Assessment 1 : Quiz	-	-	-
Module II						
10	L10 /	CCS technology	Applications of CCUS	CO2	Lecture and PPT	R1 CH2/CN
11	L11 /		Importance of CCUS	CO2	Lecture and PPT	R1 CH2/CN
12	L12 /		Characteristics of CCS	CO2	Lecture and PPT	R1 CH2/CN
13	L13 /		Current status of CCS technology	CO2	Lecture and PPT	R1 CH2/CN
14	L14 /		Costs of CCS implementation	CO2	Lecture and PPT	R1 CH2/CN
15	L15 /		technical potential of CCS implementation	CO2	Lecture and PPT	R1 CH2/CN
16	L16 /		Economic potential of CCS implementation	CO2	Lecture and PPT	R1 CH2/CN
-	-		Continuous Internal Assessment 2a : Quiz	CO2	-	-
-	-		Continuous Internal Assessment 2b : Course based problems	CO2	-	-
20	L17 /		Discussion of Mid Term Exam Question Pattern	CO1 and CO2	PowerPoint Presentation	N/A
			Mid Term Exam	CO1 and CO2	N/A	N/A
21	L18 /		Discussion of Mid Term Exam Questions and Answers	CO1 and CO2	PowerPoint Presentation	N/A
Module III						
22	L219/	CO2 transport and emission	Sources of CO2	CO3	Lecture and PPT	R2 CH04/CN
23	L20/		Sources of CO2	CO3	Lecture and PPT	R2 CH03/CN
24	L21/		capture of CO2	CO3	Lecture and PPT	R2 CH05/CN
25	L22/		capture of CO2	CO3	Lecture and PPT	R2 CH05/CN
26	L23/		transport of CO2	CO3	Lecture and PPT	R2 CH05/CN

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27	L24 /		transport of CO2	CO3	Lecture and PPT	R2 CH05/CN
28	L25 /		Low emission solutions when using CO2 in petroleum production	CO3	Lecture and PPT	R2 CH05/CN
29	L26 /		Low emission solutions when using CO2 in petroleum production	CO3	Lecture and PPT	R2 CH05/CN
30	L27 /		Low emission solutions when using CO2 in petroleum production	CO3	Lecture and PPT	R2 CH05/CN
-	-		Continuous Internal Assessment 3 : Quiz	-	-	-
Module IV						
31	L28 /	CO2 storage	Carbon storage	CO4	Lecture and PPT	R2 CH09/CN
32	L29 /		geological storage	CO4	Lecture and PPT	R2 CH09/CN
33	L30 /		ocean storage	CO4	Lecture and PPT	R2 CH09/CN
34	L31 /		geographical relationship between the sources and storage opportunities for CO2	CO4	Lecture and PPT	R2 CH09/CN
35	L32 /		geographical relationship between the sources and storage opportunities for CO2	CO4	Lecture and PPT	R2 CH09/CN
36	L33/		health, safety and environment risks of CCS	CO4	Lecture and PPT	R2 CH08/CN
37	L34/		health, safety and environment risks of CCS	CO4	Lecture and PPT	R2 CH08/CN
38	L35/		health, safety and environment risks of CCS	CO4	Lecture and PPT	R2 CH08/CN
	-	-	Continuous Internal Assessment 4: Article Review	-	-	-
39	L36 /	Course Integration	Course Integration	CO1 through CO4	PowerPoint Presentation	N/A
40	L37 /		Discussion of End Term Exam Questions and Answers	CO3 and CO4	PowerPoint Presentation	N/A
			End Term Exam	CO1 through CO4	N/A	N/A

Topics relevant to **"EMPLOYABILITY SKILLS":** Data Management for developing **Employability Skills** through **Participative Learning** techniques.. This is attained through quiz as mentioned in the assessment component.

Assessment Schedule:

Module-wise Micro Level planning for course assessment schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time (Date may Change)
01	Continuous Internal Assessment 1: Quiz	L02 – L08	CO1	-	10	5%	

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02	Continuous Internal Assessment 2a: Quiz	L10 - L18	CO2	-	10	5%	
03	Continuous Internal Assessment 2b: Course based problems	L10 - L18	CO2	-	10	5%	
04	Mid Term Examination	L02 – L18	CO1, CO2	2	60	30%	
06	Assignment: Article writing – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)	L28 - L35	CO4	-	10	5%	
07	End Term Examinations	L02 - L35	CO1, CO2, CO3, CO4	3	100	50%	

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2020', Regulation No. PU/AC-13/16/11_2020, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2017/08/Academic-Regulations-2020.pdf) and go through the Section Nos. 1.0 through 24.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	How should the benefits and risks of carbon capture, storage, and utilization (CCSU) be balanced, considering potential environmental and social impacts? Are there potential unintended consequences that need to be thoroughly evaluated before widespread implementation?	6	CO1	Comprehension
2	What economic incentives and policy mechanisms are required to drive the adoption of carbon capture, storage, and utilization technologies at a scale that can make a meaningful impact on reducing carbon emissions? How can governments, industries, and financial institutions collaborate to create a sustainable business model for CCSU projects?	6	CO2	Comprehension
3	What breakthroughs in materials science, engineering, and chemistry are needed to improve the efficiency and effectiveness of carbon capture, storage, and utilization processes? How can we encourage ongoing research and development to continuously enhance these technologies and address their current limitations?	6	CO3	Comprehension

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4	How can carbon capture, storage, and utilization be integrated into existing energy and industrial systems, as well as into future clean energy infrastructure? What challenges might arise during this transition, and what strategies can be employed to ensure a smooth integration while minimizing disruption to existing energy sectors and supply chains?	6	CO4	Comprehension

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Develop carbon capture, utilization, and storage strategies	50
2	CO2	Define the role of carbon capture, utilization, and storage in reducing emissions.	45
3	CO3	Classify different principles of CO2 capture	45
4	CO4	Develop new technologies for low carbon energy supply with CO2 capture and storage (CCUS)	45

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks

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1	Continuous Internal Assessment 1: Quiz			
2	Continuous Internal Assessment 2a: Quiz			
3	Continuous Internal Assessment 2b: Course based problems			
4	Mid Term Examination			
5	Continuous Internal Assessment 3: Quiz			
6	Assignment: Article writing – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)			
7	End Term Examinations			
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	Develop carbon capture, utilization, and storage strategies	50		
2	CO2	Define the role of carbon capture, utilization, and storage in reducing emissions.	45		
3	CO3	Classify different principles of CO2 capture	45		
4	CO4	Develop new technologies for low carbon energy supply with CO2 capture and storage (CCUS)	45		

Name and Signature of the Course Instructor:

D.A.C. Observation and Approval:

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Course Code: PET2015	**Course Title:** Coal Bed Methane **Type of Course:** 1] Discipline Elective 2] Theory only	**L-P-C**	3	0	3
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	This conceptual course is designed so that students will be able to understand the requirement for exploring unconventional energy resources that are trapped beneath the Earth's surface. A few practical approaches to solving a variety of problems common to coalbed methane reservoir analysis and development will be discussed through case studies. The processes involved in optimizing the methane recovery and economics of existing coalbed methane operations and more effectively evaluate the potential of coalbed methane prospects will be discussed. A structured approach would be taken to engage, relate and contextualize the fundamentals of Coal Bed Methane projects. The understanding level will be enhanced through the assignments.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Coal Bed Methane and attain **Employability Skills** through **Problem Solving** methodologies.				
Course Outcomes:	Upon successful completion of the course the students shall be able to: CO1: explain the origin of coal bed methane, CO2: illustrate the process of evaluating coal bed methane using wireline logs, CO3: demonstrate the critical factors that influence the production of coal bed methane, and CO4: analyze the basic data for coal bed methane projects.				
Course Content:					
Module 1:	Coal as a Reservoir and Coal Bed Methane	Quiz / Team Exercise	Data Collection and Presentation	09 Periods	
Topics: Coal as a Reservoir: Introduction, Origin and Formation of Coal, Physical and Chemical Properties of Coal, Coal Rank, Porosity in Coal, Coal Cleat and Permeability, Influence of Coal Rank on Coal Cleat, Gas in Coal. Coal Bed Methane: Introduction, Methods for Characterizing the Origin – Biogenic Gases and Thermogenic Gases – Controls on Distribution and Producibility, Catalytic Hypothesis of Gas Generation. Coal Bed Methane Reservoir Properties: Structure of Coal, Storage Mechanisms – Gas Storage in the Coal Matrix (Langmuir Isotherm), and Gas Diffusion through the Coal Matrix, Transport Mechanisms – Gas Flow through the Natural Fracture System, Factors controlling Well Productivity, Preparing Basic Reservoir Data.					
Module 2:	Evaluation of Coal Bed Methane Reservoirs	Quiz / Team Activity	Digital Poster Presentation	09 Periods	
Topics: Evaluation of CBM Reservoirs: Introduction, Prospect Evaluation, Production Forecasting, Enhanced CBM Recovery, Wireline Logs for CBM Evaluation – Basic Coalbed Log Evaluation, Advanced Coal Analysis, Imaging and Mechanical Properties					
Module 3:	Coal Bed Methane Wells and Emerging Practices	Quiz / Team Exercise	Data and Map Analysis	09 Periods	
Topics: Coal Bed Methane Wells: Vertical Well Construction and Hydraulic Fracturing – Introduction, Well Construction, Completion Processes, Hydraulic Fracturing, Horizontal Well Construction – Introduction, Critical Factors Influencing Surface CBM Wells, Directional Drilling Technology Development. Emerging Practices: Introduction, CBM Produced Water Management and Treatment.					
Module 4:	Economic Analysis of Coal Bed Methane Projects and Present Status	Quiz / Team Activity	Literature Survey and Report Submission	09 Periods	
Topics: Economic Analysis of Coal Bed Methane Projects: Introduction, Reserve Categories, Project Area Map, Geologic Assessment, Forecasting Future Production, Economic Evaluation Model, Economic Output, Project Risk. Present Status of Coal Bed Methane: Introduction, CMM and CBM in selected Countries; Coal Bed Methane in India: Geological Feasibility, Government Policy towards CBM, CBM Potential Assessment for Gondwana Coalfields, Economic and Environmental Aspects.					
Targeted Applications and Tools that can be used: **Application:** CBM Exploration, Development, and Production Engineer in CBM Company **Tools:** Data Analysis using MS Excel					
Text Book: T1: Jerrald L. Saulsberry, Paul S. Schafer, and Ricjard A. Schraufnagel, 1996. "A Guide To Coalbed Methane Reservoir Engineering", Gas Research Institute, Chicago. [GRI Reference No.: GRI-94/0397]					

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T2: Pramod Thakur, Steve Schatzel, and Kashy Aminian, 2015. "Coal Bed Methane – From Prospect To Pipeline", 2nd Edition, Elsevier.
T3: Ajay Kumar Singh, and Partha Narayan Hajra, 2018. "Coalbed Methane in India - Opportunities, Issues and Challenges for Recovery and Utilization", 1st Edition, Springer.

References:

R1: Vicki A. Hollub and Paul S. Schafer, 1992. "A Guide to Coalbed Methane Operations", Gas Research Institute, Chicago.
R2: R. E. Rogers, 1994. "Coal Bed Methane: Principles and Practice", 3rd Edition, Prentice Hall.
R3: Promod Thakur, 2016. "Advanced Reservoir and Production Engineering for Coal Bed Methane", 1st Edition, Elsevier.

e-resources:

1. Link for PU e-resources: https://puniversity.informaticsglobal.com/login
2. What If Earth Released All Its Methane (YouTube Video): https://www.youtube.com/watch?v=FmMmgW3R3UI
3. Coal Bed Methane Engineering: https://www.youtube.com/watch?v=jHnIRw-iETg
4. What is Coal Bed Methane (YouTube Video): https://www.youtube.com/watch?v=TgeZ4WC0HEE
5. Coal Bed Methane (YouTube Video): https://www.youtube.com/watch?v=xcKDI0IZiBc&t=128s
6. What is Coal Seam Gas? (YouTube Video): https://www.youtube.com/watch?v=kNa5pvh_4tQ
7. The Journey of Natural Gas (YouTube Video): https://www.youtube.com/watch?v=V8EHHW-3N5Y&t=326s
8. Coal Gas Seam Drilling (YouTube Video): https://www.youtube.com/watch?v=o0J_Xzfo3rI&t=219s
9. Coal Bed Methane Drilling Technology (YouTube Video): https://www.youtube.com/watch?v=xTUe7JgzJak

Skill Sets:

Topics relevant to **"EMPLOYABILITY SKILLS":** Evaluation of Coal Bed Methane Reservoirs for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout.

Catalogue prepared by:	Dr. Suman Paul, Dr. Deepjyoti Mech, and Dr. Kalpajit Hazarika
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Handout 2022-23

Date of Issue: 05-08-2019

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC-18.5/PET14/2020-24
Semester / Year	:	V / 2022-23
Course Code / Title	:	PET 2015 / Coal Bed Methane
Course Credit Structure	:	3L-0T-0P-3C
Contact Hours	:	43
Course Instructor In-charge	:	Dr. Suman Paul
Course Instructor	:	Dr. Suman Paul
Course URL	:	NA

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO 01: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 02: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 03: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO 04: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 05: **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 06: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 07: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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PO 09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and 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 knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Course Prerequisites:

NIL

Course Description:

This conceptual course is designed so that students will be able to understand the requirement for exploring unconventional energy resources that are trapped beneath the Earth's surface. A few practical approaches to solving a variety of problems common to coalbed methane reservoir analysis and development will be discussed through case studies. The processes involved in optimizing the methane recovery and economics of existing coalbed methane operations and more effectively evaluate the potential of coalbed methane prospects will be discussed. A structured approach would be taken to engage, relate and contextualize the fundamentals of Coal Bed Methane projects. The understanding level will be enhanced through the assignments.

Course Objectives:

The objective of the course is to familiarize the learners with the concepts of Coal Bed Methane and attain **Employability Skills** through **Problem Solving** methodologies**.**

Course Outcomes (COs):

Upon successful completion of the course the students shall be able to:

CO1: explain the origin of coal bed methane,

CO2: illustrate the process of evaluating coal bed methane using wireline logs,

CO3: demonstrate the critical factors that influence the production of coal bed methane, and

CO4: analyze the basic data for coal bed methane projects.

Mapping of COs with POs:

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	P0 10	PO 11	PO 12
CO1	L					L			L	L		M
CO2	M	M			L	L	L	L	M	M		M
C03	M	M			L	L	L	L	M	M		M

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CO4	M	H			M	M	L	L	H	H		H
CO5	H	H			H	M	M	M	H	H		H
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module1: Coal as a Reservoir and Coal Bed Methane [9 Periods] – Knowledge Level

Coal as a Reservoir: Introduction, Origin and Formation of Coal, Physical and Chemical Properties of Coal, Coal Rank, Porosity in Coal, Coal Cleat and Permeability, Influence of Coal Rank on Coal Cleat, Gas in Coal.

Coal Bed Methane: Introduction, Methods for Characterizing the Origin – Biogenic Gases and Thermogenic Gases – Controls on Distribution and Producibility, Catalytic Hypothesis of Gas Generation.

Coal Bed Methane Reservoir Properties: Structure of Coal, Storage Mechanisms – Gas Storage in the Coal Matrix (Langmuir Isotherm), and Gas Diffusion through the Coal Matrix, Transport Mechanisms – Gas Flow through the Natural Fracture System, Factors controlling Well Productivity, Preparing Basic Reservoir Data.

Module 2: Evaluation of Coal Bed Methane Reservoirs [9 Periods] – Application Level

Evaluation of CBM Reservoirs: Introduction, Prospect Evaluation, Production Forecasting, Enhanced CBM Recovery, Wireline Logs for CBM Evaluation – Basic Coalbed Log Evaluation, Advanced Coal Analysis, Imaging and Mechanical Properties

Module 3: Coal Bed Methane Wells and Emerging Practices [9 Periods] – Application Level

Coal Bed Methane Wells: Vertical Well Construction and Hydraulic Fracturing – Introduction, Well Construction, Completion Processes, Hydraulic Fracturing, Horizontal Well Construction – Introduction, Critical Factors Influencing Surface CBM Wells, Directional Drilling Technology Development.

Emerging Practices: Introduction, CBM Produced Water Management and Treatment.

Module 4: Economic Analysis of Coal Bed Methane Projects and Present Status [9 Periods] – Application Level

Economic Analysis of Coal Bed Methane Projects: Introduction, Reserve Categories, Project Area Map, Geologic Assessment, Forecasting Future Production, Economic Evaluation Model, Economic Output, Project Risk.

Present Status of Coal Bed Methane: Introduction, CMM and CBM in selected Countries; Coal Bed Methane in India: Geological Feasibility, Government Policy towards CBM, CBM Potential Assessment for Gondwana Coalfields, Economic and Environmental Aspects.

Delivery Procedure (Pedagogy):

This is a theory-based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Exercises will be discussed specific topics and home assignments will be given to judge the understanding level of the students. Assignments / Mini Project will be given to the students after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Report Submission, Quiz Competition, Poster Presentation, and Group Discussion will carry 20% weightage under Continuous Assessment 3 (CA 3). Review classes will be conducted to clear doubts and to evaluate the level of understanding of each student individually.

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Following procedures will be adopted in the course for delivering the content:

(a) Self Learning Topics (SLT):
- Volumetric Gas-in-Place Calculations for CBM Reservoir (Unit III)
- Material Balance Calculation for CBM Reservoir (Unit III)
- Petrophysical Evaluation of Gas Shale Reservoirs – Key Properties of Gas Shale Evaluation (Unit IV)
- Geomechanics of Gas Shales – Mechanical Properties of Gas Shales, Wellbore Instability of Gas Shale Reservoirs (Unit IV)

(b) Experiential Learning Topics (ELT):
- Identification of Coal Beds and Estimation of Stress Magnitudes using Well Log Data (Unit III)

(c) Participative Learning Topics (PLT):
- Coal Bed Methane (Unit III) – Poster Presentation
- Shale Gas (Unit IV) – Poster Presentation
- Natural Gas Hydrates (Unit V) – Poster Presentation

(d) Technology Enabled Learning Topics (TET):
- Determination of Stress Orientation using Cleat Study Data (Unit III) – Use of 'GeoRose' software

(e) Problem Based Learning Topics (PBLT):
- Natural Gas Hydrate Exploration Strategy Discussion

Reference Materials:

Textbook:

T1: Jerrald L. Saulsberry, Paul S. Schafer, and Ricjard A. Schraufnagel, 1996. "A Guide To Coalbed Methane Reservoir Engineering", Gas Research Institute, Chicago. [GRI Reference No.: GRI-94/0397]

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T3: Ajay Kumar Singh, and Partha Narayan Hajra, 2018. "Coalbed Methane in India - Opportunities, Issues and Challenges for Recovery and Utilization", 1st Edition, Springer.

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3. Coal Bed Methane Engineering: https://www.youtube.com/watch?v=jHnIRw-iETg
4. What is Coal Bed Methane (YouTube Video): https://www.youtube.com/watch?v=TgeZ4WC0HEE
5. Coal Bed Methane (YouTube Video): https://www.youtube.com/watch?v=xcKDI0IZiBc&t=128s
6. What is Coal Seam Gas? (YouTube Video): https://www.youtube.com/watch?v=kNa5pvh_4tQ
7. The Journey of Natural Gas (YouTube Video): https://www.youtube.com/watch?v=V8EHHW-3N5Y&t=326s
8. Coal Gas Seam Drilling (YouTube Video): https://www.youtube.com/watch?v=o0J_Xzfo3rI&t=219s
9. Coal Bed Methane Drilling Technology (YouTube Video): https://www.youtube.com/watch?v=xTUe7JgzJak

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Guideline to Students:

(a) About the Course:

Understanding of different unconventional energy resources plays pivotal role in modern Oil and Gas industry because it is visible that the industry is shifting from exploration of conventional reservoirs to unconventional reservoirs like coal bed methane, shale gas, gas hydrates, etc. considering the present energy scenario. This course will focus mainly on coal bed methane exploration and production related topics and also provide basic knowledge about the shale gas and gas hydrate. Basic understanding of Petroleum Geology, Well Logging and Formation Evaluation, Drilling Engineering, Reservoir Engineering, and Production Engineering will help understanding this course. Hands-on training (use of basic tool) will be provided for calculation of stresses observed in sedimentary basins.

(b) Notification / Announcement related to the Course:

All the announcements will be made during the regular lecture hours. All the course related notifications will be displayed on the Department Notice Board.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2019, from Presidency University, Bengaluru website and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Unit-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Programme and Course			L01
02	Unit I			L02 – L05
	Continuous Assessment 3: e-resource Review on Unit I			-
03	Unit II			L06 – L15
	Continuous Assessment 3: Report Writing on Unit II			
04	Discussion on Test 1 Question Pattern and Review			L16
05	Discussion on Test 1 Questions and Answers			L17
	Unit III			L18 – L23
	Continuous Assessment 3: Poster Designing and Presentation on Unit III			-
07	Unit IV			L24 – L31
	Continuous Assessment 3: Quiz on Unit IV			-
08	Discussion on Test 2 Question Pattern and Review			L32
09	Discussion on Test 2 Questions and Answers			L33
10	Unit V			L34 – L41
	Continuous Assessment 3: Written Test on Unit V			

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11	Course Integration			L42
12	Discussion of End Term Examination Question Pattern			L43

Schedule of Instruction:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
01	L01	Overview of the Programme and the Course		-	Power Point Presentation	Class Note
Module 1						
02	L02		Coal as a Reservoir: Introduction, Origin and Formation of Coal, Physical and Chemical Properties of Coal, Coal Rank, Porosity in Coal, Coal Cleat and Permeability, Influence of Coal Rank on Coal Cleat, Gas in Coal. Coal Bed Methane: Introduction, Methods for Characterizing the Origin – Biogenic Gases and Thermogenic Gases – Controls on Distribution and Producibility, Catalytic Hypothesis of Gas Generation. Coal Bed Methane Reservoir Properties: Structure of Coal, Storage Mechanisms – Gas Storage in the Coal Matrix (Langmuir Isotherm), and Gas Diffusion through the Coal Matrix, Transport Mechanisms – Gas Flow through the Natural Fracture System, Factors controlling Well Productivity, Preparing Basic Reservoir Data.	CO1	Power Point Presentation	Class Note

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03	L03			CO1	Audio – Video Session	Class Note
04	L04			CO1	Power Point Presentation	Class Note
05	L05			CO1	Power Point Presentation	Class Note
		Continuous Assessment 3		CO1		
Module 2						
06	L06		Evaluation of CBM Reservoirs: Introduction, Prospect Evaluation, Production Forecasting, Enhanced CBM Recovery, Wireline Logs for CBM Evaluation – Basic Coalbed Log Evaluation, Advanced Coal Analysis, Imaging and Mechanical Properties	CO2	Audio – Video Session	Class Note
07	L07			CO2	Power Point Presentation	Class Note
08	L08			CO2	Audio – Video Session	Class Note
09	L09			CO2	Power Point Presentation	Class Note
10	L10			CO2	Power Point Presentation	Class Note
11	L11			CO2	Power Point Presentation	Class Note
12	L12			CO2	Power Point Presentation	Class Note
13	L13			CO2	Power Point Presentation	Class Note
14	L14			CO2	Audio-Video Sessions	Class Note
15	L15			CO2	Power Point Presentation	Class Note
		Continuous Assessment 3	Report Writing on Unit II			
16	L16	TEST 1	Discussion on Question Pattern and Review	CO1 & CO2	White Board	
			TEST 1 Examination	CO1 & CO2		
17	L17		Discussion on Questions and Answers	CO1 & CO2	White Board	

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Module 3						
18	L18			CO3	Power Point Presentation	Class Note
19	L19		Coal Bed Methane Wells: Vertical Well Construction and Hydraulic Fracturing – Introduction, Well Construction, Completion Processes, Hydraulic Fracturing, Horizontal Well Construction – Introduction, Critical Factors Influencing Surface CBM Wells, Directional Drilling Technology Development. Emerging Practices: Introduction, CBM Produced Water Management and Treatment.	CO3	Power Point Presentation	Class Note
20	L20			CO3	Power Point Presentation	Class Note
21	L21			CO3	Power Point Presentation	Class Note
22	L22			CO3	Power Point Presentation	Class Note
23	L23			CO3	Power Point Presentation	Class Note
		Continuous Assessment 3	Poster Designing and Presentation on Unit III	CO3		
Module 4						
24	L24		Economic Analysis of Coal Bed Methane Projects: Introduction, Reserve Categories, Project Area Map, Geologic Assessment, Forecasting Future Production, Economic Evaluation Model, Economic Output, Project Risk. Present Status of Coal Bed Methane: Introduction, CMM and CBM in selected Countries; Coal Bed Methane in India: Geological Feasibility, Government Policy towards CBM, CBM Potential Assessment for Gondwana Coalfields, Economic and	CO4	Audio – Video Session	Class Note

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			Environmental Aspects.			
25	L25			CO4	Power Point Presentation	Class Note
26	L26			CO4	Power Point Presentation	Class Note
27	L27			CO4	Power Point Presentation	Class Note
28	L28			CO4	Power Point Presentation	Class Note
29	L29			CO4	Power Point Presentation	Class Note
30	L30			CO4	Power Point Presentation	Class Note
31	L31			CO4	Power Point Presentation	Class Note
		Continuous Assessment 3	Quiz on Unit IV	CO4		
32	L32	TEST 2	Discussion on Question Pattern and Review	CO3 & CO4	White Board	
			TEST 2 Examination	CO3 & CO4		
33	L33		Discussion on Questions and Answers	CO3 & CO4	White Board	

Topics relevant to **"EMPLOYABILITY SKILLS":** Evaluation of CBM Reservoirs for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through the Assignment as mentioned in the assessment component.

Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	Continuous Assessment 3: e-resource Review	Unit I	CO1	-	5	2.5%	-
02	Continuous Assessment 3: Assgnment on Unit II	Unit II	CO2	-	5	2.5%	-
03	TEST 1	Unit I and Unit II	CO1 and CO2	1.0	30	15%	-
04	Continuous Assessment 3: Poster Designing and Presentation on Unit III	Unit III	CO3	-	10	05%	-
05	Continuous Assessment 3: Quiz on Unit IV	Unit IV	CO4	-	10	05%	-

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06	TEST 2	Unit III and Unit IV	CO3 and CO4	1.0	30	15%	-
07	Continuous Assessment 3: Written Test on Unit V	Unit V	CO5	-	10	05%	
08	END TERM EXAMINATION	Unit I through Unit V and SLT	CO1 through CO5	3.0	100	50%	-

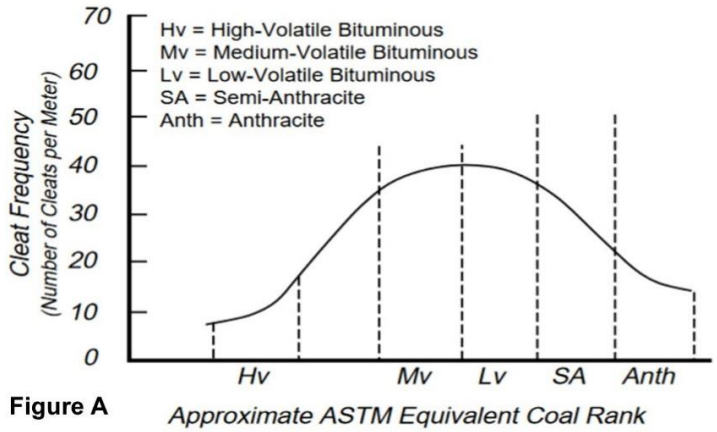
Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2019, from Presidency University, Bengaluru website and go through the Section Nos. 1.0 through 24.0.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	A cross-plot between coal rank and cleat frequency is shown in Figure A below. Describe the importance of Figure A.  **Figure A**	10	CO1	Comprehension
2	The two-phase flow in the cleat system can be adequately represented by Darcy's law. Cleat system porosity, permeability, and relative permeability control the fluid flow within the cleat system. As the desorption process continues, gas saturation within the cleat system increases, and the flow of methane becomes increasingly more dominant. Thus, the water production declines rapidly until the gas rate reaches the peak value and water saturation	10	CO2	Comprehension

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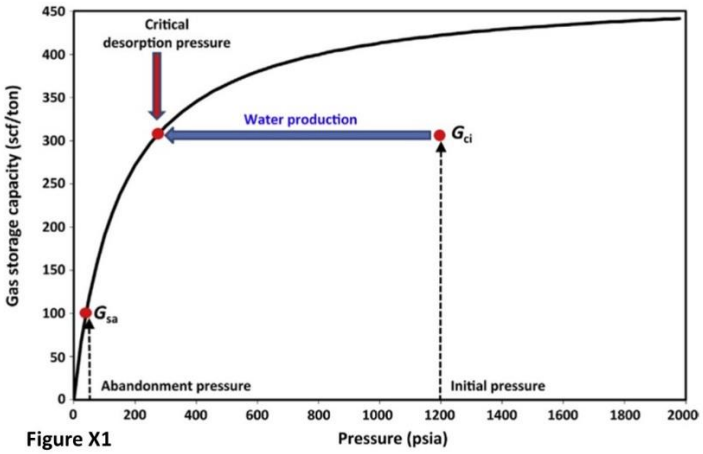
	approaches the irreducible water saturation. Keeping the above observation in mind, draw and illustrate a typical production history curve of a coal bed methane reservoir.			
3	The vast majority of the gas in coals is stored by adsorption in the coal matrix. As a result, pressure–volume relationship is defined by the sorption isotherm. A sorption isotherm relates the gas storage capacity of coal to pressure and depends on the rank, temperature, and moisture content of the coal. The sorption isotherm can be used to predict the volume of gas that will be released from the coal as the reservoir pressure is lowered. Explain the typical sorption isotherm presented in Figure X1.  Figure X1	10	CO3	Comprehension
4	Kalidaspur, which is situated on the southern bank of Damodar River in the Raniganj coalfield, is a Degree III gassy mine where extraction of coal from R-IX (Ghusick) and R-IXA (Ghusick A) seams has been in progress by conventional Bord and Pillar method. The average thickness of R-IX seam is 3.2 m and that of the R-IXA seam is 2.75 m. These seams are separated by 18–20 m of parting. The leasehold area of Kalidaspur project is 9.34 km^2. Presently R-IX seam is fully developed whereas R-IXA seam is being developed. Mining methods involve drill and blast and load out techniques. The mine is serviced via a drift and was opened in 1984. The colliery currently produces thermal coal. The current production target rate is 450 tonnes per day, 350 tonnes is more than usual. The area appears to be minimally affected by faulting and has not experienced outbursts. R-I is the lowermost coal seam whereas R-IX is the top most coal seam. Table A displays in-situ gas content, sorption time, and proximate analysis of coal core samples retrieved from the borehole drilled near Kalidaspur Colliery. (a) Interpret the data given in Table A and list down the observations. (b) Plot Seam Name versus Gas Content and explain the	10	CO4	Comprehension

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variation in gas content with depth. Assume the depth gap (parting) between each seam is 100 m.

Table A:

Seam name	Thickness (m)	Gas content (m^3/t)	Sorption time (t_0) (days)	Moisture (%)	Ash (%)	VM (%)	FC (%)
R-IX	2.76	0.70	4.16	6.67	14.45	32.13	46.75
R-IXA	2.90	1.00	3.48	4.31	14.27	33.90	47.52
R-VIII	1.09	1.2	3.53	3.65	18.96	33.22	44.16
R-VII	4.95	1.87	4.67	3.20	51.35	20.44	25.00
L-2	1.55	3.09	3.91	3.12	31.76	26.70	38.42
R-VI	1.67	3.43	3.49	2.58	22.15	30.99	44.28
R-VA	0.50	4.77	4.90	3.14	35.37	25.88	35.61
R-VB	0.50	4.89	4.17	2.26	25.26	28.95	43.53
R-VC	0.50	5.17	4.31	1.90	46.46	23.42	28.21
R-IV	2.20	5.10	3.87	1.93	22.60	31.35	44.12
R-III	1.00	5.36	4.25	1.87	30.19	27.99	39.95
R-II	1.19	5.64	4.73	2.12	48.13	20.66	29.10
R-I	0.53	5.55	5.81	2.05	35.34	26.02	36.60

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	To explain the origin of coal bed methane	40
2	CO2	To illustrate the process of evaluating coal bed methane using wireline logs	40
3	C03	To demonstrate the critical factors that influence the production of coal bed methane	40
4	CO4	To analyze the basic data for coal bed methane projects	40

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

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Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	To explain the origin of coal bed methane	40		

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2	CO2	To illustrate the process of evaluating coal bed methane using wireline logs	40		
3	C03	To demonstrate the critical factors that influence the production of coal bed methane	40		
4	CO4	To analyze the basic data for coal bed methane projects	40		

Name and Signature of the Course Instructor:

D.A.C. Observation and Approval:

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Course Code: PET2016	**Course Title:** Shale Gas **Type of Course:** 1] Discipline Elective 2] Theory only	**L-P-C**	3	0	3
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	This conceptual course is designed so that students will be able to understand the requirement for exploring unconventional energy resources that are trapped beneath the Earth's surface. A few practical approaches for solving a variety of problems common to shale gas reservoir analysis and development will be discussed through case studies. Shale gas is seen as a major game changer for the global petroleum industry. The processes involved in optimizing the shale gas recovery and economics of existing shale gas operations and more effectively evaluating the potential of shale gas prospects will be discussed. A structured approach would be taken to engage, relate and contextualize the fundamentals of shale gas projects. The understanding level will be enhanced through the assignments.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Shale Gas and attain **Employability Skills** through **Participative Learning** techniques.				
Course Outcomes:	Upon successful completion of the course the students shall be able to: CO1: discuss the properties of shale and the environments of shale deposition, CO2: explain the importance of studying the geomechanical properties of shale gas reservoirs, CO3: demonstrate the critical factors that influence the shale gas exploration technique, and CO4: illustrate the environmental concerns of shale gas production.				
Course Content:					
Module 1:	Shale as a Reservoir and Shale Gas	Quiz / Team Exercise	Data Collection and Presentation	08 Periods	
Topics: **Topics:** Shale as a Reservoir: Introduction, Shale Composition, Environments of Shale Deposition, Physical Properties of Shale, Deposition and Diagenesis. Shale Gas: Introduction, Geochemistry of Shale Gas, Organic Matter in Gas Shales, Basin Structure, Tectonics, and Stratigraphy.					
Module 2:	Geomechanics of Gas Shales	Quiz / Team Activity	Digital Poster Presentation	08 Periods	
Topics: Geomechanics of Gas Shales: Introduction, Mechanical Properties of Gas Shale Reservoirs, Anisotropy, Wellbore Instability in Gas Shale Reservoirs.					
Module 3:	Shale Gas Exploration Technique and Hydraulic Fracturing	Quiz / Team Exercise	Data Analysis	09 Periods	
Topics: Shale Gas Exploration Technique: Introduction, Shallow Seismic, Geochemical Exploration, Petrophysics. Hydraulic Fracturing: Introduction, Hydraulic Fracturing, Hazards, Fracturing Fluids, Water Management, Transportation, Fluid Disposal, Risks in Hydraulic Fracturing, Induced Earthquakes, Hazard Management, Waste Water Disposal.					
Module 4:	Environmental Concerns of Shale Gas Production	Quiz / Team Activity	Literature Survey and Report Submission	11 Periods	
Topics: Environmental Concerns of Shale Gas Production: Introduction, Induced Seismicity, Groundwater Contamination, Atmospheric Emissions, Shale Gas Exploitation and Health Hazard, Impact on Water and Environment, Noise Pollution, Environmental Impact of Blowout, Guidelines for Shale Gas Development, Site Disposal after the Completion of Shale Gas Exploitation, Regulations for Shale Gas Exploration and Exploitation.					
Targeted Applications and Tools that can be used: **Application:** Shale Gas Exploration, Development, and Production Engineer in Oil and Gas Company **Tools:** Data Analysis using MS Excel					
Text Book: T1: Reza Rezaee, 2015. "Fundamentals of Shale Gas Reservoirs", John Wiley & Sons, Inc., Hoboken, New Jersey. T2: Dayal, A.M., Kalpana, M.S., Mani, D., Patil, D.J., Vadapalli, U., Varma, A.K., and Vedanti, N., 2017. "Shale Gas Exploration and Environmental and Economic Impacts", Elsevier. T3: Jebraeel Gholinezhad, John Senam Fianu, Mohamed Galal Hassan, 2018. "Challenges in Modelling and Simulation of Shale Gas Reservoirs", Springer.					

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References:

R1: James G. Speight, 2017. "Deep Shale Oil and Gas", Gulf Professional Publishing, Elsevier.
R2: Sohrab Zendehboud, and Alireza Bahadori, 2017. "Shale Oil and Gas Handbook - Theory, Technologies, and Challenges", Gulf Professional Publishing, Elsevier.
R3: José A. Torres, and Hector Klie, 2020. "Shale Oil and Shale Gas Resources" Multidisciplinary Digital Publishing Institute.

e-resources:

1. Link for PU Knimbus e-resources: https://presiuniv.knimbus.com/user#/home
2. What is Shale Gas? (YouTube Video): https://www.youtube.com/watch?v=1lHC74fCyeI
3. Shale Gas Risk or Opportunity? (YouTube Video): https://www.youtube.com/watch?v=Ag9GUogWEa0
4. Shale Gas – Hydraulic Fracturing (YouTube Video): https://www.youtube.com/watch?v=CM8Lh7SAm6A
5. Impact of Shale Gas and Shale Oil Extraction on the Environment and on Human Health (Workshop): https://www.europarl.europa.eu/document/activities/cont/201312/20131205ATT75545/20131205ATT75545EN.pdf
6. Shale Energy Engineering 2014: Technical Challenges, Environmental Issues, and Public Policy (Proceedings): https://ascelibrary.org/doi/book/10.1061/9780784413654

Skill Sets:

Topics relevant to **"EMPLOYABILITY SKILLS":** Shale Gas Exploration Technique and Hydraulic Fracturing for developing **Employability Skills** through **Participative Learning** techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by:	Dr. Suman Paul, Dr. Deepjyoti Mech, and Dr. Kalpajit Hazarika
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Handout

Date of Issue: 05-08-2019

Revised On:

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC-11/10/06_2019
Semester / Year	:	V / 3rd
Course Code / Title	:	PET 2016 / Shale Gas
Course Credit Structure	:	3L-0T-0P-3C
Contact Hours	:	43
Course Instructor In-charge	:	Dr. Suman Paul
Course Instructor	:	Dr. Suman Paul
Course URL	:	

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO 01: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 02: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 03: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO 04: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 05: **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 06: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 07: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the

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engineering practice.

PO 09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and 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 knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Course Prerequisites:

NIL

Course Description:

This conceptual course is designed so that students will be able to understand the requirement for exploring unconventional energy resources that are trapped beneath the Earth's surface. A few practical approaches for solving a variety of problems common to shale gas reservoir analysis and development will be discussed through case studies. Shale gas is seen as a major game changer for the global petroleum industry. The processes involved in optimizing the shale gas recovery and economics of existing shale gas operations and more effectively evaluating the potential of shale gas prospects will be discussed. A structured approach would be taken to engage, relate and contextualize the fundamentals of shale gas projects. The understanding level will be enhanced through the assignments.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Shale Gas and attain **Employability Skills** through **Participative Learning** techniques**.**

Course Outcomes (COs):

Upon successful completion of the course the students shall be able to:

CO1: discuss the properties of shale and the environments of shale deposition,

CO2: explain the importance of studying the geomechanical properties of shale gas reservoirs,

CO3: demonstrate the critical factors that influence the shale gas exploration technique, and

CO4: illustrate the environmental concerns of shale gas production.

Mapping of COs with POs:

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12
CO1	L					L			L	L		M
CO2	M	M			L	L	L	L	M	M		M
CO3	M	M			L	L	L	L	M	M		M

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CO4	M	H			M	M	L	L	H	H		H
CO5	H	H			H	M	M	M	H	H		H
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module1: Shale as a Reservoir and Shale Gas [8 Periods] – Knowledge Level

Shale as a Reservoir: Introduction, Shale Composition, Environments of Shale Deposition, Physical Properties of Shale, Deposition and Diagenesis.

Shale Gas: Introduction, Geochemistry of Shale Gas, Organic Matter in Gas Shales. Basin Structure, Tectonics, and Stratigraphy.

Module 2: Geomechanics of Gas Shales [8 Periods] – Application Level

Geomechanics of Gas Shales: Introduction, Mechanical Properties of Gas Shale Reservoirs, Anisotropy, Wellbore Instability in Gas Shale Reservoirs.

Module 3: Shale Gas Exploration Technique and Hydraulic Fracturing [9 Periods] – Application Level

Shale Gas Exploration Technique: Introduction, Shallow Seismic, Geochemical Exploration, Petrophysics.

Hydraulic Fracturing: Introduction, Hydraulic Fracturing, Hazards, Fracturing Fluids, Water Management, Transportation, Fluid Disposal, Risks in Hydraulic Fracturing, Induced Earthquakes. Hazard Management, Waste Water Disposal.

Module 4: Environmental Concerns of Shale Gas Production [11 Periods] – Application Level

Environmental Concerns of Shale Gas Production: Introduction, Induced Seismicity, Groundwater Contamination, Atmospheric Emissions, Shale Gas Exploitation and Health Hazard, Impact on Water and Environment, Noise Pollution, Environmental Impact of Blowout, Guidelines for Shale Gas Development, Site Disposal after the Completion of Shale Gas Exploitation, Regulations for Shale Gas Exploration and Exploitation.

Delivery Procedure (Pedagogy):

This is a theory-based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Exercises will be discussed specific topics and home assignments will be given to judge the understanding level of the students. Assignments / Mini Project will be given to the students after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Report Submission, Quiz Competition, Poster Presentation, and Group Discussion will carry 20% weightage under Continuous Assessment 3 (CA 3). Review classes will be conducted to clear doubts and to evaluate the level of understanding of each student individually.

Following procedures will be adopted in the course for delivering the content:

(a) Self Learning Topics (SLT):

- Volumetric Gas-in-Place Calculations for CBM Reservoir (Unit III)
- Material Balance Calculation for CBM Reservoir (Unit III)
- Petrophysical Evaluation of Gas Shale Reservoirs – Key Properties of Gas Shale Evaluation (Unit IV)
- Geomechanics of Gas Shales – Mechanical Properties of Gas Shales, Wellbore Instability of Gas Shale Reservoirs (Unit IV)

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(b) Experiential Learning Topics (ELT):
- Identification of Coal Beds and Estimation of Stress Magnitudes using Well Log Data (Unit III)

(c) Participative Learning Topics (PLT):
- Coal Bed Methane (Unit III) – Poster Presentation
- Shale Gas (Unit IV) – Poster Presentation
- Natural Gas Hydrates (Unit V) – Poster Presentation

(d) Technology Enabled Learning Topics (TET):
- Determination of Stress Orientation using Cleat Study Data (Unit III) – Use of 'GeoRose' software

(e) Problem Based Learning Topics (PBLT):
- Natural Gas Hydrate Exploration Strategy Discussion

Reference Materials:

Textbook:

T1: Reza Rezaee, 2015. "Fundamentals of Shale Gas Reservoirs", John Wiley & Sons, Inc., Hoboken, New Jersey.

T2: Dayal, A.M., Kalpana, M.S., Mani, D., Patil, D.J., Vadapalli, U., Varma, A.K., and Vedanti, N., 2017. "Shale Gas Exploration and Environmental and Economic Impacts", Elsevier.

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4. Shale Gas – Hydraulic Fracturing (YouTube Video): https://www.youtube.com/watch?v=CM8Lh7SAm6A
5. Impact of Shale Gas and Shale Oil Extraction on the Environment and on Human Health (Workshop): https://www.europarl.europa.eu/document/activities/cont/201312/20131205ATT75545/20131205ATT75545EN.pdf
6. Shale Energy Engineering 2014: Technical Challenges, Environmental Issues, and Public Policy (Proceedings): https://ascelibrary.org/doi/book/10.1061/9780784413654

Guideline to Students:

(a) About the Course:

Understanding of different unconventional energy resources plays pivotal role in modern Oil and Gas industry because it is visible that the industry is shifting from exploration of conventional reservoirs to unconventional reservoirs like coal bed methane, shale gas, gas hydrates, etc. considering the present energy scenario. This course will focus mainly on coal bed methane exploration and production related topics and also provide basic knowledge about the shale gas and gas hydrate. Basic understanding of Petroleum Geology, Well Logging and Formation

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Evaluation, Drilling Engineering, Reservoir Engineering, and Production Engineering will help understanding this course. Hands-on training (use of basic tool) will be provided for calculation of stresses observed in sedimentary basins.

(b) Notification / Announcement related to the Course:

All the announcements will be made during the regular lecture hours. All the course related notifications will be displayed on the Department Notice Board.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2019, from Presidency University, Bengaluru website and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Unit-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Programme and Course			L01
02	Unit I			L02 – L05
	Continuous Assessment 3: e-resource Review on Unit I			-
03	Unit II			L06 – L15
	Continuous Assessment 3: Report Writing on Unit II			
04	Discussion on Test 1 Question Pattern and Review			L16
05	Discussion on Test 1 Questions and Answers			L17
	Unit III			L18 – L23
	Continuous Assessment 3: Poster Designing and Presentation on Unit III			-
07	Unit IV			L24 – L31
	Continuous Assessment 3: Quiz on Unit IV			-
08	Discussion on Test 2 Question Pattern and Review			L32
09	Discussion on Test 2 Questions and Answers			L33
10	Unit V			L34 – L41
	Continuous Assessment 3: Written Test on Unit V			
11	Course Integration			L42
12	Discussion of End Term Examination Question Pattern			L43

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Schedule of Instruction:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
01	L01	Overview of the Programme and the Course		-	Power Point Presentation	Class Note
Module 1						
02	L02		Shale as a Reservoir: Introduction, Shale Composition, Environments of Shale Deposition, Physical Properties of Shale, Deposition and Diagenesis. Shale Gas: Introduction, Geochemistry of Shale Gas, Organic Matter in Gas Shales. Basin Structure, Tectonics, and Stratigraphy.	CO1	Power Point Presentation	Class Note
03	L03			CO1	Audio – Video Session	Class Note
04	L04			CO1	Power Point Presentation	Class Note
05	L05			CO1	Power Point Presentation	Class Note
		Continuous Assessment 3		CO1		
Module 2						
06	L06		Geomechanics of Gas Shales: Introduction, Mechanical Properties of Gas Shale Reservoirs, Anisotropy,Wellbore Instability in Gas Shale Reservoirs.	CO2	Audio – Video Session	Class Note
07	L07			CO2	Power Point Presentation	Class Note
08	L08			CO2	Audio – Video Session	Class Note

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09	L09			CO2	Power Point Presentation	Class Note
10	L10			CO2	Power Point Presentation	Class Note
11	L11			CO2	Power Point Presentation	Class Note
12	L12			CO2	Power Point Presentation	Class Note
13	L13			CO2	Power Point Presentation	Class Note
14	L14			CO2	Audio-Video Sessions	Class Note
15	L15			CO2	Power Point Presentation	Class Note
		Continuous Assessment 3	Report Writing on Unit II			
16	L16	TEST 1	Discussion on Question Pattern and Review	CO1 & CO2	White Board	
			TEST 1 Examination	CO1 & CO2		
17	L17		Discussion on Questions and Answers	CO1 & CO2	White Board	
Module 3						
18	L18			CO3	Power Point Presentation	Class Note
19	L19		Shale Gas Exploration Technique: Introduction, Shallow Seismic, Geochemical Exploration, Petrophysics. Hydraulic Fracturing: Introduction, Hydraulic Fracturing, Hazards, Fracturing Fluids, Water Management, Transportation, Fluid Disposal, Risks in Hydraulic Fracturing, Induced Earthquakes, Hazard Management, Waste Water Disposal.	CO3	Power Point Presentation	Class Note
20	L20			CO3	Power Point Presentation	Class Note
21	L21			CO3	Power Point Presentation	Class Note
22	L22			CO3	Power Point Presentation	Class Note
23	L23			CO3	Power Point Presentation	Class Note

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		Continuous Assessment 3	Poster Designing and Presentation on Unit III	CO3		
Module 4						
24	L24		Environmental Concerns of Shale Gas Production: Introduction, Induced Seismicity, Groundwater Contamination, Atmospheric Emissions, Shale Gas Exploitation and Health Hazard, Impact on Water and Environment, Noise Pollution, Environmental Impact of Blowout, Guidelines for Shale Gas Development, Site Disposal after the Completion of Shale Gas Exploitation, Regulations for Shale Gas Exploration and Exploitation.	CO4	Audio – Video Session	Class Note
25	L25			CO4	Power Point Presentation	Class Note
26	L26			CO4	Power Point Presentation	Class Note
27	L27			CO4	Power Point Presentation	Class Note
28	L28			CO4	Power Point Presentation	Class Note
29	L29			CO4	Power Point Presentation	Class Note
30	L30			CO4	Power Point Presentation	Class Note
31	L31			CO4	Power Point Presentation	Class Note
		Continuous Assessment 3	Quiz on Unit IV	CO4		
32	L32	TEST 2	Discussion on Question Pattern and Review	CO3 & CO4	White Board	
			TEST 2 Examination	CO3 & CO4		
33	L33		Discussion on Questions and Answers	CO3 & CO4	White Board	

Topics relevant to **"EMPLOYABILITY SKILLS":** Shale Gas Exploration Technique for developing **Employability Skills** through **Participative Learning** techniques. This is attained through the Presentation as mentioned in the assessment component

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Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	Continuous Assessment 3: e-resource Review	Unit I	CO1	-	5	2.5%	-
02	Continuous Assessment 3: Report Writing on Unit II	Unit II	CO2	-	5	2.5%	-
03	TEST 1	Unit I and Unit II	CO1 and CO2	1.0	30	15%	-
04	Continuous Assessment 3: Poster Designing and Presentation on Unit III	Unit III	CO3	-	10	05%	-
05	Continuous Assessment 3: Quiz on Unit IV	Unit IV	CO4	-	10	05%	-
06	TEST 2	Unit III and Unit IV	CO3 and CO4	1.0	30	15%	-
07	Continuous Assessment 3: Written Test on Unit V	Unit V	CO5	-	10	05%	
08	END TERM EXAMINATION	Unit I through Unit V and SLT	CO1 through CO5	3.0	100	50%	-

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2019, from Presidency University, Bengaluru website and go through the Section Nos. 1.0 through 24.0.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	The depositional setting directly controls key factors in shales, such as organic geochemistry, organic richness, and rock composition. The organic matter preserved in shales depends on the dissolved oxygen level in the water. Shale gas organic	10	CO1	Comprehension

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	geochemistry is a function of the depositional environment and is similar to conventional source rock geochemistry. Explain how the depositional environment can be used for identification of kerogen type.			
2	The assessment of the global shale gas data includes the identification of the shale depositional environment and basin type. Based on the global statistical dataset available, answer the followings: (a) Establish the relation between TOC and Shale Gas Depositional Environment. (b) Illustrate the association between TOC and Shale Gas Basin Type.	10	CO2	Comprehension
3	Extensive hydraulic fracturing (fracking) is undertaken within the shale gas reservoir to further increase the perme ability and hence gas yield. Fracturing is generally under taken in multiple stages, with the fracturing treatment of each individual section being undertaken separately, so as to maximize the control and effectiveness of the process. It is also not usually possible to maintain a downhole pressure sufficient to stimulate the entire length of a well's reservoir intersection in a single stimulation / treatment event, and it would also probably result in the concentration of fractures in the most susceptible zones. Each treatment stage involves a series of substages which involve using different volumes and compositions of fluids, depending on the design. Distinguish the sequence of substages may be followed during treatment stage.	10	CO3	Comprehension

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	To discuss the properties of shale and the environments of shale deposition	40
2	CO2	To explain the importance of studying the geomechanical properties of shale gas reservoirs	40
3	C03	To demonstrate the critical factors that influence the shale gas exploration technique	40
4	CO4	To illustrate the environmental concerns of shale gas production.	40

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

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Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	To discuss the properties of shale and the environments of shale deposition	40		
2	CO2	To explain the importance of studying the geomechanical properties of shale gas reservoirs	40		
3	C03	To demonstrate the critical factors that influence the shale gas exploration technique	40		
4	CO4	To illustrate the environmental concerns of shale gas production.	40		

Name and Signature of the Course Instructor:

D.A.C. Observation and Approval:

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Course Code: PET2017	**Course Title:** Natural Gas Hydrates **Type of Course:** 1] Discipline Elective 2] Theory only	**L- P- C**	3	0	3
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	The purpose of the course is to understand about the importance of one of the upcoming natural energy resources, i.e., gas hydrates. This gas hydrate is widely spread throughout the world. It is estimated that the methane gas from the hydrate reservoirs can efficiently fulfil the world's energy demand for more than 200 years. The course is to enable the students to appreciate the need for understanding the extraction of natural gas hydrates reservoirs and utilization of this method for other applications. The course is conceptual and analytical in nature and needs fair knowledge of basic engineering science and computing. The course develops the critical and analytical thinking skills. The course also enhances the programming abilities through assessments.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Natural Gas Hydrates and attain **Employability** through **Problem Solving** methodologies				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: state the importance and scope of gas hydrates CO2: discuss the significance of thermodynamic studies for gas hydrates CO3: describe the significance of kinetic studies for gas hydrates CO4: explain the utility of gas hydrates for different applications				
Course Content:					
Module 1:	Overview and Prospect of Gas Hydrates	Assessment 1: Assignment / Quiz	Data Collection		06 Periods
Topics: Properties of Natural Gases, Hydrates as a Laboratory Curiosity, Hydrates in the Natural Gas Industry, Hydrates as an Energy Resource, Environmental Aspects of Hydrates, Safety Aspects of Hydrates.					
Module 2:	Thermodynamics of Gas Hydrates	Assessment 2: Assignment / Quiz	Slide Designing and Presentation		07 Periods
Topics: Hydrate Nucleation, Growth and Dissociation, Estimation Techniques for Phase Equilibria of Natural Gas Hydrates, Statistical Thermodynamic Approach to Hydrate Phase Equilibria, Measurement Methods.					
Module 3:	Kinetics of Gas Hydrates	Assessment 3: Assignment / Quiz	Poster designing		08 Periods
Topics: Hydrate Nucleation, Growth and Dissociation, Estimation Techniques for Kinetics of Natural Gas Hydrates, Measurement Methods, Gas equations for Kinetic studies.					
Module 4:	Gas Hydrates for Flow assurance and other Applications	Assessment 4: Term Paper	Coding		11 Periods
Topics: Hydrates as a threat in flowline and storage vessels, Prevention of hydrates, Removal of Hydrate Plugs, Applications towards Gas Transport and Storage, CO_2 sequestration and Desalination.					
Targeted Application and Tools that can be used: Application: Targeted for Oil and Gas / Energy Industry, Waste Water Treatment Plants, Desalination Plant as a Project Engineer and / or Research Officer. Tools: MS Office, CSMGem (Industry used software).					
Text Book: T1: E.D. Sloan and C.A Koh, Clathrate Hydrates of Natural Gases, 3rd Edition, CRC Press, Taylor and Francis Group, 2008. T2: Makogon, Y.F., Hydrates of Natural Gas, Moscow, Nedra, Izadatelstro, 208 (1974 in Russian). Translated by W.J. Cieslesicz, PennWell Books, Tulsa, Oklahoma, 237 (1981 in English).					
References: R1: Y Yuguang and L Changling, Natural gas hydrates: Experimental Techniques and their Applications, Springer, 2013. R2: E.D. Sloan et al., Natural Gas Hydrates in Flow Assurance, Elsevier, 2010.					

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Class Note (CN) /Materials/Other materials.

E-resources:
Presidency University e-resource Remote Access (KNIMBUS) portal through the shared link:
https://presiuniv.knimbus.com/user#/home

1. https://www.usgs.gov/faqs/what-are-gas-hydrates
2. https://pemedianetwork.com/petroleum-economist/articles/upstream/2005/gas-hydrates-a-nice-idea
3. https://youtu.be/QEJmhokSmZM
4. https://youtu.be/dVM_-2hzFrk
5. https://puniversity.informaticsglobal.com/login

Topics relevant to **"EMPLOYABILITY SKILLS":** Kinetics of Gas Hydrates for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout

Catalogue prepared by:	Dr. Deepjyoti Mech, Dr. Suman Paul, Dr. Kalpajit Hazarika, Mr. Ankur Neog
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Hand Out: AY 2022-2023

Date of Issue: 07-sept-2022

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC 18.5/PET14/2020-24
Semester / Year	:	V Sem / 3rd Year
Course Code / Title	:	PET2017 / Natural Gas Hydrates
Course Credit Structure	:	3L - 0P - 3C
Contact Hours	:	39 (L)
Course Instructor In-charge	:	Dr. Deepjyoti Mech
Course Instructor	:	Dr. Deepjyoti Mech

Program Outcomes (POs) :

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **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.

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PO6 **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Description:

The purpose of the course is to understand about the importance of one of the upcoming natural energy resources, i.e., gas hydrates. This gas hydrate is widely spread throughout the world. It is estimated that the methane gas from the hydrate reservoirs can efficiently fulfil the world's energy demand for more than 200 years. The course is to appreciate the need for understanding the extraction of natural gas hydrates reservoirs and utilization of this method for other applications. The course is conceptual and analytical in nature and needs fair knowledge of basic engineering science and computing. The course develops the critical and analytical thinking skills. The course also enhances the programming abilities through assessments.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Natural Gas Hydrates and attain **Employability** through **Problem Solving** methodologies

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:

CO1: state the importance and scope of gas hydrates

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CO2: discuss the significance of thermodynamic studies for gas hydrates

CO3: describe the significance of kinetic studies for gas hydrates

CO4: explain the utility of gas hydrates for different applications

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H					H	H	L	H	L		L
CO2	H	H	H	L	L	H	H	L	H	L		L
CO3	H	H	H	L	L	H	H	L	H	M		L
CO4	H	H	H	L	L	H	H	L	H	M		L
H= High, M= Medium, L= Low												

Course Content (Syllabus):

Module 1: Overview and Prospect of Gas Hydrates [6 Classes] – Knowledge Level

Properties of Natural Gases, Hydrates as a Laboratory Curiosity, Hydrates in the Natural Gas Industry, Hydrates as an Energy Resource, Environmental Aspects of Hydrates, Safety Aspects of Hydrates.

Module 2: Thermodynamics of Gas Hydrates [7 Classes] – Comprehension Level

Hydrate Nucleation, Growth and Dissociation, Estimation Techniques for Phase Equilibria of Natural Gas Hydrates, Statistical Thermodynamic Approach to Hydrate Phase Equilibria, Measurement Methods.

Module 3: Kinetics of Gas Hydrates [8 Classes] – Application Level

Hydrate Nucleation, Growth and Dissociation, Estimation Techniques for Kinetics of Natural Gas Hydrates, Measurement Methods, Gas equations for Kinetic studies.

Module 4: Gas Hydrates for Flow assurance and other Applications [11 Classes] – Application Level

Hydrates as a threat in flowline and storage vessels, Prevention of hydrates, Removal of Hydrate Plugs, Applications towards Gas Transport and Storage, CO2 sequestration and Desalination.

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Delivery Procedure (Pedagogy):

This is a mix theory and numerical-based course. Most of the lectures will be taken with the help of PowerPoint Presentations and the White Board. Videos will be shown for a better understanding of selective topics. Exercises will be discussed on specific topics and home assignments will be given to judge the understanding level of the students. Assignments / Mini Project will be given to the students after completion of a considerable portion of the syllabus. Submission of assignments on time is mandatory for all the students. Report Submission, Quiz Competition, Poster Presentation, and Group Discussion will carry 20% weightage under Continuous Internal Assessment (CIA). Review classes will be conducted to clear doubts and to evaluate the level of understanding of each student individually.

Following procedures will be adopted in the course for delivering the content:

(a) Self Learning Topics (SLT):

- Properties of Natural Gases, - Historical evolution of gas hydrates measurements,

(b) Experiential Learning Topics (ELT): Collect the data of possible methods for gas hydrate dissociation and analyse their safety and cost effective plan using E-Resources of Presidency University.

(c) Participative Learning Topics (PLT): Any one of the following activities will be conducted:

- Make a PPT to analyse the phase stability of CO2 gas hydrates with and without promoters
- Design a Poster to show the kinetics of methane hydrates in the presence of inhibitors for the production of methane from the hydrate reservoirs

(d) Problem Based Learning Topics (PBLT):

- Data Analysis using tools like MS Excel / Python

Continuous Assessment Plan:

Module I: Quiz Competition

Quiz will be conducted on related topics.

Module II: PPT Presentation

A Team Activity will be conducted for the students. Students will have the flexibility to select their team members. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the activity.

Activity 2.2(a): Students will learn how-to collect required data from available e-resources and how to work in a team. Students will develop oral communication skills through this activity. The students are expected to gather information and design a PPT to analyse the phase stability of CO2 gas hydrates with and without promoters. The objective of this activity is to let the students develop presentation skills and learn about the importance of phase stability studies.

Module III: Digital Poster Presentation

3.2 A Team Exercise will be conducted for the students. Students will have the flexibility to select their team

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members. Students will learn to Design a Poster to show the kinetics of methane hydrates in the presence of inhibitors for the production of methane from the hydrate reservoirs. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the presentation.

Exercise 3.2(a): The objective of this exercise is to make the students learn how to determine the number of moles of gas consumption inside the hydrate structure.

Exercise 3.2(b): The objective of this exercise is to make the students learn the importance of kinetic studies.

Module IV: Literature Survey and Report Submission

A Team Exercise will be conducted for the students. Students will have the flexibility to select their team members. Students will learn to carry out a literature survey on specified topics. Students will develop writing communication skills through this activity. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the activity. Link to Presidency University e-resources: https://puniversity.informaticsglobal.com/login

Exercise 4.2(a): The objective of this exercise is to make the students understand about the different applications of gas hydrates.

Textbook(s)

T1: E.D. Sloan and C.A Koh, Clathrate Hydrates of Natural Gases, 3rd Edition, CRC Press, Taylor and Francis Group, 2008.

T2: Makogon, Y.F., Hydrates of Natural Gas, Moscow, Nedra, Izadatelstro, 208 (1974 in Russian). Translated by W.J. Cieslesicz, PennWell Books, Tulsa, Oklahoma, 237 (1981 in English).

Reference Book(s)

R1: Y Yuguang and L Changling, Natural gas hydrates: Experimental Techniques and their Applications, Springer, 2013.

R2: E.D. Sloan et al., Natural Gas Hydrates in Flow Assurance, Elsevier, 2010.

E-resources:

Presidency University e-resource Remote Access (KNIMBUS) portal through the shared link:

https://presiuniv.knimbus.com/user#/home

6. Introduction to Gas Hydrates. https://www.usgs.gov/faqs/what-are-gas-hydrates
7. Concepts of Gas Hydrates. https://pemedianetwork.com/petroleum-economist/articles/upstream/2005/gas-hydrates-a-nice-idea
8. Gas hydrates formation and Dissociation. https://youtu.be/QEJmhokSmZM
9. Applications of Gas Hydrates. https://youtu.be/dVM_-2hzFrk

Any other Reference:

Class Note (CN)

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Guideline to Students:

(a) About the Course:

Knowledge of this course will be applied for solving phase behaviors and kinetics of natural gas hydrate system. A structured approach would be taken whereby students will get the opportunity to engage, relate and contextualize the fundamentals of the Hydrate System.

(b) Notification / Announcement related to the Course:

All the course-related notifications will be shared in the Department Notice Board / Email/ Whatsapp. All the announcements will be made during the regular lecture hours.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2020', Regulation No. PU/AC-13/16/11_2020, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2017/08/Academic-Regulations-2020.pdf) and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Unit-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Course	12-09-2022	13-09-2022	2
02	Module I	16-09-2022	27-09-2022	6
03	CIA: Quiz	-	-	-
04	Module II	30-09-2022	21-10-2022	7
05	CIA: PPT Presentation	-	-	-
06	Discussion on Mid Term Exam Syllabus and Question Pattern	28-10-2022	28-10-2022	-
07	Mid Term Examination	03-11-2022	07-11-2022	-
08	Discussion on Mid Term Exam Question Paper	08-11-2022	08-11-2022	-
09	Module III	11-11-2022	29-11-2022	8
10	CIA: Digital Poster Presentation	-	-	-

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11	Module IV	02-12-2022	27-12-2022	11
12	CIA: Literature Survey and Report Submission	-	-	-
13	Course Integration	-	-	-
14	Discussion on End Term Exam Syllabus and Question Pattern	30-12-22	30-12-22	-
15	End Term Examination	05-01-23	25-01-23	-

Schedule of Instruction:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L1 / 12-09-2022	Program Integration	Program Integration		Lecture	T1, CN
2	L2 / 13-09-2022		Program Integration		Lecture	T1, CN
3	L3 / 16-09-2022	Overview and Prospect of Gas Hydrates	Introduction	CO1	W.B/PPT	T1, CN
4	L4 / 19-09-2022		Laboratory Curiosity	CO1	W.B/PPT	T1, CN
5	L5 / 20-09-2022		Hydrates in the Natural Gas Industry	CO1	W.B/PPT	T1, CN
6	L6 / 23-09-2022		Hydrates as an Energy Resource	CO1	W.B/PPT	T1, CN
7	L7 / 26-09-2022		Environmental Aspects of Hydrates	CO1	W.B/PPT	T1, CN
8	L8 / 27-09-2022		Safety Aspects of Hydrates	CO1	W.B/PPT	T1, CN
CIA from Module I						
Module I Completed						
9	L9 / 30-09-2022	Course Integration		CO2		

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10	L10 / 07-10-2022	Thermodynamics of Gas Hydrates	Hydrate Nucleation	CO2	W.B/PPT	T1, CN
11	L11 / 10-10-2022		Growth- Part 1	CO2	W.B/PPT	T1, CN
12	L12 / 11-10-2022		Part 2	CO2	W.B/PPT	T1, CN
13	L13 / 14-10-2022		Dissociation- Part 1	CO2	W.B/PPT	T1, CN
14	L14 / 17-10-2022		Estimation Techniques for Phase Equilibria of Natural Gas Hydrates	CO2	W.B/PPT	T1, CN
15	L15 / 18-10-2022		Measurement Methods	CO2	W.B/PPT	T1, CN
16	L16 / 21-10-2022		Statistical Thermodynamic Approach to Hydrate Phase Equilibria	CO2	W.B/PPT	T1, CN
CIA from Module II						
Module II Completed						
17	L17 / 11-11-2022	Course Integration		CO3		
18	L18 / 14-11-2022	Kinetics of Gas Hydrates	Hydrate Nucleation	CO3	W.B/PPT	T1, CN
19	L19 / 15-11-2022		Growth- Part 1	CO3	W.B/PPT	T1, CN
20	L20 / 18-11-2022		Part 2	CO3	W.B/PPT	T1, CN
21	L21 / 21-11-2022		Dissociation- Part 1	CO3	W.B/PPT	T1, CN

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22	L22 / 22-11-2022		Estimation Techniques for Phase Equilibria of Natural Gas Hydrates	CO3	W.B/PPT	T1, CN
23	L23 / 25-11-2022		Measurement Methods	CO3	W.B/PPT	T1, CN
24	L24 / 28-11-2022		Apparatus	CO3	W.B/PPT	T1, CN
25	L25 / 29-11-2022		Numerical	CO3	W.B/PPT	T1, CN
CIA from Module III						
Module III Completed						
26	L26 / 02-12-2022	Course Integration		CO4	Lecture	
27	L27 / 05-12-2022	Gas Hydrates for Flow assurance and other Applications	Hydrates as a threat in flowline and storage vessels	CO4	W.B/PPT	T1, CN
28	L28 / 06-12-2022		Case Study 1	CO4	W.B/PPT	T1, CN
29	L29 / 09-12-2022		Case Study 2	CO4	W.B/PPT	T1, CN
30	L30 / 12-12-2022		Prevention of hydrates	CO4	W.B/PPT	T1, CN
31	L31 / 13-12-2022		Removal of Hydrate Plugs	CO4	W.B/PPT	T1, CN
32	L32 / 16-12-2022		Case study	CO4	W.B/PPT	T1, CN
33	L33 / 19-12-2022		Kinetic Hydrate Preventions	CO4	W.B/PPT	T1, CN
34	L34 / 20-12-2022		Hydrate Plug Dissociation	CO4	W.B/PPT	T1, CN
35	L35 / 23-12-2022		Applications towards Gas Transport and Storage	CO4	W.B/PPT	CN

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36	L36 / 26-12-2022		CO_2 sequestration	CO4	W.B/PPT	CN
37	L37 / 27-12-2022		Desalination	CO4	W.B/PPT	CN
CIA from Module IV						
Module IV Completed						
38	L38 / 30-12-2022		Course Integration	CO1-CO4		
39	L39 / 31-12-2020		Discussion on End Term Exam Syllabus and Question Pattern	CO1-CO4		

Topics relevant to **"EMPLOYABILITY SKILLS":** Kinetics of Gas Hydrates for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through the Assignment as mentioned in the assessment component.

Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl.no	Assessment type	contents	Course outcome Number	Duration In Hours	Marks	Weightage	Venue, DATE &TIME
1	Mid Term	Module I and II	C.O 1 &2	2	60	30 %	-
2	End Term	Module I, II, III, IV	CO 1,2,3,4	3	100	50 %	-
3	CIA: Quiz	Module I	CO1	-	10	5 %	-
4	CIA: Assignment	Module II	CO2	-	10	5 %	-
5	CIA: Digital Poster Presentation	Module III	CO3	-	10	5 %	-
6	CIA: Literature Survey and Report Submission. Link to Presidency University e-resources: https://presiuniv.k	Module IV	CO4	-	10	5 %	-

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	nimbus.com/user#/home						

Course Clearance Criteria :

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1	Hydrates are solid crystalline structures which is same as like Ice. How can you differentiate both? List out the various properties for both the structures.	10	CO1	Comprehension
2	Phase behaviour study is an important aspect to find the potentiality of gas hydrate. Is the statement correct? Justify your answer with suitable examples.	10	CO2	Comprehension
3	Hydrate Nucleation, Growth and Dissociation are important stages during hydrate phenomenon. Why Kinetics study is relevant to the hydrate? Explain the kinetics of a gas hydrate with a suitable diagram.	10	CO3	Comprehension
4	Hydrate method is now using for various applications. What feature is attracting to use for different applications? Explain those features with respect to different applications. You can use diagrams to support your answer.	10	CO4	Comprehension

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Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	state the importance and scope of gas hydrates	40
2	CO2	discuss the significance of thermodynamic studies for gas hydrates	30
3	C03	describe the significance of kinetic studies for gas hydrates	30
4	CO4	explain the utility of gas hydrates for different applications	35

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

Signature of the Chairperson DAC:

Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				

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3				
4				
5				
6				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	state the importance and scope of gas hydrates	40		
2	CO2	discuss the significance of thermodynamic studies for gas hydrates	30		
3	C03	describe the significance of kinetic studies for gas hydrates	30		
4	CO4	explain the utility of gas hydrates for different applications	35		

Name and Signature of the Course Instructor:

DAC Observation and Approval:

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Course Code: PET2018	**Course Title: Integrated Field Development and Planning** **Type of Course: 1] Discipline Elective 2] Theory only**	**L- P- C**	3	0	3
Version No.:	1.0				
Course Pre-requisites:					
Anti-requisites:	NIL				
Course Description:	This course is designed with the aim of developing a decision-making ability as a Reservoir Engineer. The course gives a comprehensive account of the methodology, processes and techniques utilized in developing an oil or gas field. A comprehensive hand on case study provides practical exposure to the issues discussed and group study sessions helps to develop the planning and organization skills.				
Course Objectives:	The objective of the course is to familiarize the learners with the concepts of Integrated Field Development and Planning and attain **Employability** through **Problem Solving** methodologies.				
Course Content:					

Module 1:	Introduction to field development	Assignment	Decision tree analysis	10 Periods

Topics:
The field cycle: Exploration Phase, Appraisal Phase, Development Planning, Production Phase, Decommissioning, Hydrocarbon Accumulations, Exploration Methods and Techniques, and PVT analysis, Pressure - depth relationships, Data Gathering, Classification of methods, Coring and core analysis, Wire line logging, Petroleum Agreements and Bidding

Module 2:	Field appraisal and study of Well dynamic behavior	Quiz and Assignment	Simulation	09 Periods

Topics:
The role of appraisal in the field life cycle, objective of performing appraisal activities, Identifying and quantifying sources of uncertainty, Appraisal tools, Cost-benefit calculations for appraisal Practical aspects of appraisal, Reservoir dynamic behavior and Well dynamic behavior. The driving force for production, Reservoir drive mechanisms, Gas reservoirs, Major differences between oil and gas field development, Estimating the number of development wells, Fluid flow near the wellbore, Horizontal wells, Production testing and bottom hole pressure testing, Tubing performance, Well completions.

Module 3:	Production operations and management of producing field	Assignment	Programming	08 Periods

Topics:

Operating and Maintenance Objectives, Production Operations input to the FDP, Maintenance engineering input to the FDP, Managing the producing field: Managing the reservoir: Managing the Surface Facilities: Decommissioning: Legislation, Economic lifetime, decommissioning funding, Decommissioning methods, Phasing and organization, planning and control, Safety and Environment: Safety management system, current environmental concern.

Module 4:	Introduction to Reservoir management, Process and Economics	Case Study	Data collection	06 Periods

Topics:
Definition, Scope, History, Integration Geoscience and Engineering, Integration of Exploration and Development, Goal setting, Developing plan, Economics, Surveillance and Monitoring, Evaluation, Data acquisition, Analysis and management, Economic criteria, Scenario, Data, Economic evaluation, Risk management and Uncertainties. Case studies on reservoir management. Reservoir management plans: Newly operated Field, secondary and EOR operated field.

Targeted Application and Tools that can be used:
The students will be introduced to all of these concepts as they are applied to the process of coming up with a development plan in relation to the reservoir life cycle. This course will acquaint engineers, geoscientists, and operating personnel with the basic techniques used by asset management teams.

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Text Book: T1. Abdus Satter and Ganesh C. Thakur, "Integrated Reservoir management", PennwellBooks T2. Frank Jahn, Mark Cook and Mark Graham," Hydrocarbon exploration and Production" T3. "Introduction to fundamentals of reservoir engineering" L.P. Dake
References: R1 Tarek Ahmed and D. Nathan Meehan, "Advanced Reservoir Management and Engineering", Baker Hughes R2 Pathak, A. (2021). Petroleum Reservoir Management (1st ed.). CRC Press. Retrieved from https://www.perlego.com/book/2555058/petroleum-reservoir-management-considerations-and-practices-pdf **e-resources:** 1. E- remote access portal: https://presiuniv.knimbus.com/user#/home 2. Integrated Reservoir management: https://www.youtube.com/watch?v=e3b0ttaEzZI 3. Webinar: Reservoir Management Part 1: https://www.youtube.com/watch?v=yiSSHmIg8l4 4. Webinar: Reservoir Management Part 2: https://www.youtube.com/watch?v=9yiNIJkr-WA
Topics relevant to **"EMPLOYABILITY SKILLS":** Apply the main concepts of Reservoir Management, process and economics for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout.

Catalogue prepared by:	Mr. Bhairab Jyoti Gogoi, Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Kalpajit Hazarika
Recommended by the Board of Studies on:	11th Meeting of the Board of Studies held on 5th September 2020
Date of Approval by the Academic Council:	13th Meeting of the Academic Council held on 6th November 2020

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Course Handout (AY: 2022-2023)

Date of Issue: 23-Jan-2022

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B. Tech in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC-18.5/PET14/2020-24
Semester / Year	:	**6/ 2022-23**
Course Code / Title	:	PET2018 / Integrated Field Development and Planning
Course Credit Structure	:	3L–0T- 0P–3C
Contact Hours	:	40 (40L +0 T+0P)
Course Instructor In-charge	:	**Dr. Abhinav Kumar**
Course Instructor	:	**Dr. Abhinav Kumar**
Course URL	:	

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **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.

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PO6: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering commModuley and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites:

NIL

Course Description:

This course is designed with the aim of developing a decision-making ability as a Reservoir Engineer. The course gives a comprehensive account of the methodology, processes and techniques utilized in developing an oil or gas field. A comprehensive hand on case study provides practical exposure to the issues discussed and group study sessions helps to develop the planning and organization skills.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Integrated Field Development and Planning and attain **Employability** through **Problem Solving** methodologies.

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:
CO1: Discuss decision making process of field development projects and related economic criteria,
CO2: Describe main reservoirs monitoring techniques allowing to apply IOR/EOR methods and increase recovery,
CO3: Dramatize the main concepts of risks and uncertainties and their integration into reserves evaluation,
CO4: Apply the main concepts of Reservoir Management, process and economics.

Mapping of COs with POs:

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	M	L			L	M	M	L		M		L
CO2	M	L			M	L	M	L		M		L
C03	H	M			L	L	M	M		H		M
CO4	H	M			L	M	H	M		H		H
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module I: Introduction to field development [10 Classes] Knowledge Level

The field cycle: Exploration Phase, Appraisal Phase, Development Planning, Production Phase, Decommissioning, Hydrocarbon Accumulations, Exploration Methods and Techniques, and PVT analysis, Pressure - depth relationships, Data Gathering, Classification of methods, Coring and core analysis, Wire line logging, Petroleum Agreements and Bidding

Module II: Field appraisal and study of Well dynamic behavior [9 Classes] Comprehension Level

The role of appraisal in the field life cycle, objective of performing appraisal activities, Identifying and quantifying sources of uncertainty, Appraisal tools, Cost-benefit calculations for appraisal Practical aspects of appraisal, Reservoir dynamic behavior and Well dynamic behavior: The driving force for production, Reservoir drive mechanisms, Gas reservoirs, Major differences between oil and gas field development, Estimating the number of development wells, Fluid flow near the wellbore, Horizontal wells, Production testing and bottom hole pressure testing, Tubing performance, Well completions.

Module III: Production operations and management of producing field [8 Classes] Application Level

Topics:

Operating and Maintenance Objectives, Production Operations input to the FDP, Maintenance engineering input to the FDP, Managing the producing field: Managing the reservoir: Managing the Surface Facilities: Decommissioning: Legislation, Economic lifetime, decommissioning funding, Decommissioning methods, Phasing and organization, planning and control, Safety and Environment: Safety management system, current environmental concern.

Module IV: Introduction to Reservoir management, Process and Economics [6 Classes] Application Level

Definition, Scope, History, Integration Geoscience and Engineering, Integration of Exploration and Development, Goal setting, Developing plan, Economics, Surveillance and Monitoring, Evaluation, Data acquisition, Analysis and management, Economic criteria, Scenario, Data, Economic evaluation, Risk management and Uncertainties. Case studies on reservoir management. Reservoir management plans: Newly operated Field, secondary and EOR operated field.

Delivery Procedure (Pedagogy):

This is a theory-based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Flip Class Room sessions will be conducted on selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Assignments, Quiz Competition and Poster Presentation will carry 20% weightage under Continuous Internal Assessment (CIA). Review classes will be conducted to clear doubts and to evaluate the level of understanding of each student individually. If required, some classes may be conducted in virtual mode under unavoidable circumstances

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Following procedures will be adopted in the course for delivering the content:

(a) Self Learning Topics (SLT):

- Well Planning, Rig Types and Rig Selection, Drilling systems and equipment
- Expressing reduction of uncertainty
- Reservoir Description

(b) Experiential Learning Topics (ELT): Any one of the following activities will be conducted:

- Article Review (Module IV) [Foundation/Skill Development/Environment and Sustainability]

(1) Life Cycle of an Oil Field (Team Activity)

(2) Real-time Well & Reservoir Management by Intelligent Well Technology (Team Activity)

(3) Development of mature Oil Field (Team Activity)

(4) Waterflood surveillance techniques-A reservoir management approach (Team Activity)

Students are required to access the e-resource portal for reviewing of Article. They are required to make a report and submit the same before due date

(c) Participative Learning Topics (PLT): Any one of the following activities will be conducted:

- Quiz (Module I and Module II) [Skill Development]

The average of all the quizzes will be considered for evaluation

- Poster Presentation on "The Play of Reservoir Characterization in the Field Development Plan" (Module III)
- Poster Presentation on "Reservoir Management key Performance Indicators" (Module III)

Students are required to submit the poster before the due date

(d) Problem Based Learning Topics (PBLT):

Subject related Case Study on

- Reservoir Management for Waterfloods
- Reservoir management case study on McAllen Ranch field
- Field Development of Brassey oil field
- Field example of Economic optimization

Students need to submit the problem solving assignments before the due date

Reference Materials:

Text Book:

T1. Abdus Satter and Ganesh C. Thakur, "Integrated Reservoir management", PennwellBooks, https://www.pennwellbooks.com/integrated-petroleum-reservoir-management-a-team-approach-book-satter-thakur-

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9781593702618/

T2. Frank Jahn, Mark Cook and Mark Graham," Hydrocarbon exploration and Production" https://www.elsevier.com/books/hydrocarbon-exploration-and-production/jahn/978-0-444-53236-7

T3. "Introduction to fundamentals of reservoir engineering" L.P. Dake,

https://www.academia.edu/28070833/FUNDAMENTALS_OF_RESERVOIR_ENGINEERING_LP_Dake_pdf

References:

R1: Tarek Ahmed and D. Nathan Meehan, "Advanced Reservoir Management and Engineering", Baker Hughes

R2: Pathak, A. (2021). Petroleum Reservoir Management (1st ed.). CRC Press. Retrieved from https://www.perlego.com/book/2555058/petroleum-reservoir-management-considerations-and-practices-pdf

e-resources:

1. E- remote access portal: https://presiuniv.knimbus.com/user#/home
2. Integrated Reservoir management: https://www.youtube.com/watch?v=e3b0ttaEzZI
3. Webinar: Reservoir Management Part 1: https://www.youtube.com/watch?v=yiSSHmIg8l4
4. Webinar: Reservoir Management Part 2: https://www.youtube.com/watch?v=9yiNIJkr-WA

Guideline to Students:

(a) About the Course:

The course gives a comprehensive account of the methodology, processes and techniques utilized in developing an oil or gas field, and also to understand main reservoirs monitoring techniques allowing to apply IOR/EOR methods and increase recovery. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/08/Academic-Regulations-2019-2020.pdf) and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Module-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Overview of the Program and Course			L01
02	Module I			L02-L11
03	Continuous Internal Assessment: Quiz 1 on Module I			

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04	Module II			L12-L21
05	Continuous Internal Assessment: Quiz 2 on Module II			
06	Discussion of Mid Term Exam Question Pattern			L17
07	Mid Term Exam			
08	Discussion of Mid Term Exam Questions and Answers			L18
09	Module III			L23-27, L28-L30
10	Continuous Internal Assessment: Poster Presentation on Module III			
11	Module IV			L31-L38
12	Continuous Internal Assessment: Article Review Writing on Module IV			
13	Course Integration			L39
14	Discussion of End Term Exam Question Pattern			L40
15	End Term Exam			-
16	Discussion of End Term Exam Questions and Answers	___	____	-

Schedule of Instruction:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No. / Date	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L01 / 27-09-2022	Program Integration	Overview of the Course	-	PowerPoint Presentation	N/A
Module I						
2	L02 / 27-09-2022	Introduction to field development	The field cycle: Exploration Phase, Appraisal Phase	CO1	PowerPoint Presentation	T2CH1
3	L03 / 29-09-2022		The field cycle: Production Phase, Decommissioning	CO1	PowerPoint Presentation	T2CH1
4	L04 / 30-09-2022		Hydrocarbon Accumulations	CO1	PowerPoint Presentation	T2CH1
5	L05 / 06-10-2022		Exploration Methods and Techniques	CO1	PowerPoint Presentation	T2CH1

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6	L06 / 07-10-2022		PVT analysis	CO1	PowerPoint Presentation	T2CH1
7	L07/ 11-10-2022		Pressure - depth relationships, Data Gathering	CO1	PowerPoint Presentation	T2CH1
8	L08/ 11-10-2022		Classification of methods	CO1	PowerPoint Presentation	T2CH1
9	L09/ 13-10-2022		Coring and core analysis	CO1	PowerPoint Presentation	T2CH1
10	L10/ 14-10-2022		Petroleum Agreements	CO1	PowerPoint Presentation	T2CH1
11	L11/ 18-10-2022		Bidding	CO1	PowerPoint Presentation	T2CH1
———	———		Continuous Assessment: Quiz on Module 1			
Module II						
12	L12 / 20-10-2022	Field appraisal and study of Well dynamic behavior	The role of appraisal in the field life cycle	CO2	PowerPoint Presentation	T2CH4
13	L13 / 21-10-2022		objective of performing appraisal activities	CO2	PowerPoint Presentation	T2CH4
14	L14 / 27-10-2022		Identifying and quantifying sources of uncertainty, Appraisal tools	CO2	PowerPoint Presentation	T2CH4
15	L15/ 28-10-2022		Cost-benefit calculations for appraisal Practical aspects of appraisal	CO2	PowerPoint Presentation	T2CH4
16	L16/ 01-11-2022		Reservoir dynamic behavior and Well dynamic behavior	CO2	PowerPoint Presentation	T2CH4
17	L17/ 01-11-2022		Discussion of Mid Term Exam Question Pattern	CO1 & CO2		NA
18	L18/ 08-11-2022		Discussion of Mid Term Exam Question Paper and Answers	CO2	N/A	T2CH4

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19	L19/ 08-11-2022		Fluid flow near the wellbore	CO2	PowerPoint Presentation	T2CH4
20	L20/ 10-11-2022		Horizontal wells	CO2	N/A	T2CH4
21	L22/ 11-11-2022		Production testing and bottom hole pressure testing	CO2	PowerPoint Presentation	T2CH4
22	L22/ 15-11-2022		Tubing performance	CO2	PowerPoint Presentation	T2CH4
	L23/ 15-11-2022		Well completions			
			Continuous Assessment: Quiz on Module 2	CO1 & CO2		NA
Module III						
24	L24 / 17-11-2022	Production operations and management of producing field	Operating and Maintenance Objectives	CO3	PowerPoint Presentation	T2CH5
25	L25 / 18-11-2022		Production Operations input to the FDP	CO3	PowerPoint Presentation	T2CH5
26	L26 / 22-11-2022		Maintenance engineering input to the FDP	CO3	PowerPoint Presentation	T2CH5
27	L27/ 22-11-2022		Managing the producing field: Managing the reservoir: Managing the Surface Facilities:	CO3	PowerPoint Presentation	T2CH5
28	L28/ 24-11-2022		Decommissioning: Legislation, Economic lifetime, decommissioning funding, Decommissioning methods, Phasing and organization	CO3	PowerPoint Presentation	T2CH5
			Continuous Assessment: Assignment 2 on Module 3	CO3	PowerPoint Presentation	
29	L29/ 25-11-2022		Decommissioning methods: planning and control	CO3	PowerPoint Presentation	T2CH5
30	L30/ 29-11-2022		Safety and Environment: Safety management system	CO3	PowerPoint Presentation	T2CH6

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31	L31/ 01-12-2022		current environmental concern	CO3	PowerPoint Presentation	T2CH6
Module IV						
32	L32/ 02-12-2022	Introduction to Reservoir management, Process and Economics	Definition, Scope, History, Integration Geoscience and Engineering	CO4	PowerPoint Presentation	T1CH1
33	L32/ 06-12-2022		Integration of Exploration and Development	CO4	PowerPoint Presentation	T1CH2
34	L33/ 06-12-2022		Goal setting, Developing plan, Economics	CO4	PowerPoint Presentation / Videos	T1CH3
35	L34/ 08-12-2022		Basic principles of development economics	CO4	PowerPoint Presentation	T1CH4
36	L35/ 09-12-2022		Economic evaluation	CO4	PowerPoint Presentation	T1CH5
37	L36/ 13-12-2022		Risk management and Uncertainties	CO4	PowerPoint Presentation	T1CH6
38	L38/ 15-12-2022		Case study: Reservoir management plans: Newly operated Field, secondary and EOR operated field.	CO4	PowerPoint Presentation	T1CH1, T1CH2, T1CH3, T1CH4, T1CH5, T1CH6
			Continuous Assessment: Assignment 3 on Module 4	CO4	N/A	NA
39	L39/ 16-12-2022		Course Integration	CO1 through CO4	PowerPoint Presentation	NA
40	L40/ 20-12-2022		Discussion of End Term Exam Question Pattern	CO1 through CO4	PowerPoint Presentation	NA

Topics relevant to **"EMPLOYABILITY SKILLS":** Field Development and study of Well dynamic behavior for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through the Assignment as mentioned in the assessment component.

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Assessment Schedule:

Module-wise Micro Level planning for course assessment schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time (Date may Change)
01	CIA: Quiz: "Introduction to Field Development"	L02-L11	CO1	-	10	5%	
02	CIA: Assignment: "Field Development and study of Well dynamic behavior"	L12-L21	CO2	-	10	5%	
03	Mid Term Exam	Module I and Module II	CO1 and CO2		60	30%	
04	CIA: Poster Presentation	L23-27, L28-L30	CO3	-	10	5%	
05	CA: Assignment 1: Literature Review – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (:https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)	L31-L38	CO3 & CO4	-	10	5%	
06	End Term Exam	Module I through Module IV	CO1 through CO4		100	50%	-

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2019', Regulation No. PU/AC-11/20/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/08/Academic-Regulations-2019-2020.pdf) and go through the Section Nos. 1.0 through 24.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

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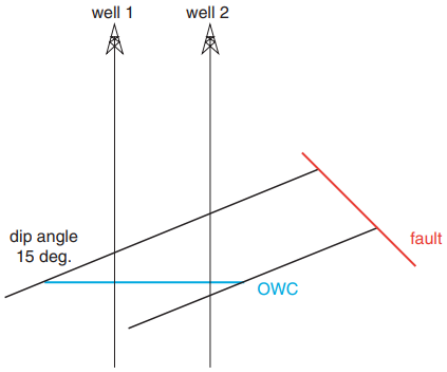
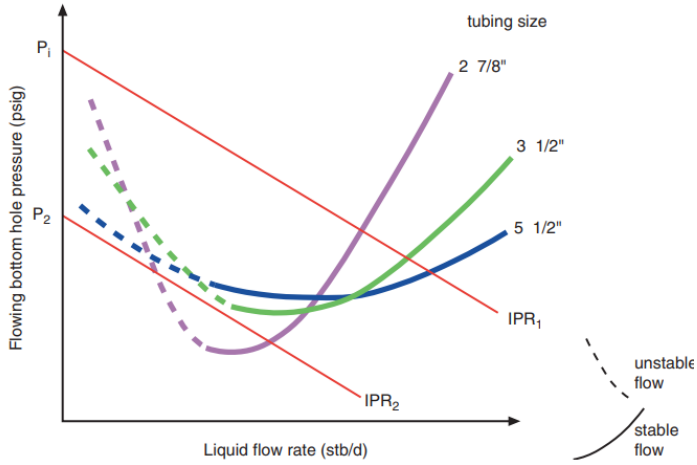
Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Once an exploration well has encountered hydrocarbons, considerable effort will still be required to accurately assess the potential of the find. The amount of data acquired so far does not yet provide a precise picture of the size, shape and producibility of the accumulation. According to your opinion, Identify the various possible options have to be considered at this point.	8	CO1	Comprehension
2	From the partially appraised structure, identify various factors that can influence the uncertainty in GRV. 	6	CO2	Comprehension
4	 Interpret the figure given above, and Identify whether workover is required or not? If yes, What can be done economically	6	CO3	Application

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6	Once a team is formed and begins to function, another item of significance is how to sustain team effort. It is easy to get excited when the teams are set up, at times of major expenditures, development effort, 3D seismic program, and so forth. However, to get the ongoing attention by a multidisciplinary team for all major reservoirs requires great commitment by operating company. Therefore, prepare a model of team approach for reservoir management.	15	CO4	Application

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Discuss decision making process of field development projects and related economic criteria	40
2	CO2	Describe main reservoirs monitoring techniques allowing to apply IOR/EOR methods and increase recovery	40
3	CO3	Dramatize main concepts of risks and uncertainties and their integration into reserves evaluation	40
4	CO4	Apply the main concepts of Reservoir Management, process and economics	40

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

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Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1	CIA: Quiz: "Introduction to Field Development"			
2	CIA: Quiz: "Field Development and study of Well dynamic behavior"			
3	Mid Term Exam			
4	CIA: Poster Presentation			
5	CIA: Assignment 1: Literature Review – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/user#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)			
6	End Term Exam			

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to

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					Enhance the Attainment
1	CO1	Discuss decision making process of field development projects and related economic criteria	40		
2	CO2	Describe main reservoirs monitoring techniques allowing to apply IOR/EOR methods and increase recovery	40		
3	CO3	Dramatize main concepts of risks and uncertainties and their integration into reserves evaluation	40		
4	CO4	Apply the main concepts of Reservoir Management, process and economics	40		

Name and Signature of the Course Instructor:

D.A.C. Observation and Approval:

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Course Code: PET 2025	**Course Title:** Petroleum Transportation, Marketing and Management **Type of Course:** 1] Discipline Elective 2] Theory only	**L- P- C**	2	0	2
Version No.:	1.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	The purpose of this course is to enable the student to understand the fundamentals and application of transportation of petroleum and petroleum products. Along with these principles, students will learn about crude oil marketing and trading as well as the oil pricing mechanisms. This course will also help the students to understand different resource management techniques. The course develops the critical thinking and analytical skills.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Petroleum Transportation, Marketing and Management and attain **Employability** through **Problem Solving** methodologies.				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: Compare different modes of transportation for petroleum products, CO2: Explain international crude oil market and oil pricing mechanisms, CO3: Describe the different resource management and production sharing contracts.				
Course Content:					

Module 1:	Transportation of Hydrocarbons	Team Exercise	Presentation	07 Periods

Topics:
The structure and development of the Oil and Gas Industry. Outline of the gas and oil industry with main sub divisions. Transportation of petroleum & petroleum products. Transportation modes. Basics of pipeline construction, operation and protection. Pump and compressor stations. Instrumentation and control. Metering and measurements of oil and gas

Module 2:	Crude Oil Marketing and Trading	Team Activity	Poster Designing and Presentation	08 Periods

Topics:
Oil and Gas Prices: International Market and Geo politics, Crude oil characteristics, Marketing and trading of crude oil, Crude oil pricing, Mechanism and oil price elasticity. Issues in domestic petroleum pricing. Administered and Market determined pricing mechanism in India. Conservation of petroleum & its products, Spot and other market control mechanism. Indian and Global supply scenario of petroleum and petroleum products.

Module 3:	Hydrocarbon Resource Management	Exercise	Data Collection and Report submission	09 Periods

Topics:
Petroleum Resource classification, Analysis of resource management. International & National Institutions of Oil and Gas: API, OPEC, OECD, OIDB, DGH, PNGRB, CHT, PII, PPAC, PCRA. Petroleum Contracts: NELP - Role & Background, Types of Contracts and fiscal components, Production sharing contracts in India. Strategic Reserves concepts.

Targeted Application and Tools that can be used:
Application: CGD Engineer / Oil and Gas Marketing Professional in Energy Industry
Tools: OLGA, OFM, PIPESIM (Professionally used Software)

Text Book:
1. Oil & Natural Gas Transportation & Storage Infrastructure: Status, Trends, & Economic Benefits, report for American Petroleum Institute, IHS Global Inc, First Edition, 2013.
2. Harold Sill Bell, Petroleum Transportation Handbook, McGraw-Hill, First Edition, 1963.
3. William Henry Day, Petroleum marketing practices and problems**,** Commercial Publishers, First Edition, 1966.

References:
1. Morris Albert Adelman, The World Petroleum Market, The Johns Hopkins university press, First Edition, 1973.
2. Petroleum Marketing and Transportation**,** Dallas (Tex.) International Oil and Gas Educational Center, Gulf Publishing Company, First Edition, 1964.

e- References:
1. E- remote acess portal: https://presiuniv.knimbus.com/user#/home
2. Oil and Gas Industry downstream: https://guides.loc.gov/oil-and-gas-industry/downstream
3. Oil Transportation- https://energyeducation.ca/encyclopedia/Transportation_of oil

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Skill Sets: Topics relevant to **"EMPLOYABILITY SKILLS":** International & National Institutions of Oil and Gas: API, OPEC, OECD, OIDB, DGH, PNGRB, CHT, PII, PPAC, PCRA for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by:	Mr. Bhairab Jyoti Gogoi, Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Kalpajit Hazarika
Recommended by the Board of Studies on:	11th Meeting of the Board of Studies held on 5th September 2020
Date of Approval by the Academic Council:	13th Meeting of the Academic Council held on 6th November 2020

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Course Hand Out

Date of Issue: 11-03-2022

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC18.5/PET14/PET/2020-24
Semester / Year	:	
Course Code / Title	:	PET 2025 / Petroleum Transportation, Marketing and Management
Course Credit Structure	:	2L 0P 2C
Contact Hours	:	29L+0T+0P = 29
Course Instructor In-charge	:	
Course Instructor	:	

Program Outcomes (POs) :

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and

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synthesis of the information to provide valid conclusions.

PO5: **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.

PO6 **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites:

Nil

Course Description:

The purpose of this course is to understand the fundamentals and application of transportation of petroleum and petroleum products. Along with these principles, it enables to learn about crude oil marketing and trading as well as the oil pricing mechanisms. It will also help to understand different resource management techniques. The course develops the critical thinking and analytical skills.

Course Objective: The objective of the course is to familiarize the learners with the concepts of Petroleum

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Transportation, Marketing and Management and attain **Employability** through **Problem Solving** methodologies.

Course Outcomes (COs):

On successful completion of the course the students shall be able to:

CO1: Compare different modes of transportation for petroleum products,

CO2: Explain international crude oil market and oil pricing mechanisms,

CO3: Describe the different resource management and production sharing contracts.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	M	L	L				M	M	H	H	H	L
CO2	M	M	M				L	H	L	H	H	L
C03	M	M	L				L	H	L	H	H	L
CO4	M	M	L				M	H	M	H	H	L
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module I: Transportation of Hydrocarbons [7 Classes]
[Knowledge]

The structure and development of the Oil and Gas Industry. Outline of the gas and oil industry with main sub divisions. Transportation of petroleum & petroleum products. Transportation modes. Basics of pipeline construction, operation and protection. Pump and compressor stations. Instrumentation and control. Metering and measurements of oil and gas

Module II: Crude oil Marketing and Trading [8 Classes]
[Knowledge]

Oil and Gas Prices: International Market and Geo politics, Crude oil characteristics, Marketing and trading of crude oil, Crude oil pricing, Mechanism and oil price elasticity. Issues in domestic petroleum pricing. Administered and Market determined pricing mechanism in India. Conservation of petroleum & its products, Spot and other market control mechanism. Indian and Global supply scenario of petroleum and petroleum products.

Module III: Hydrocarbon Resource Management [9 Classes]
[Knowledge]

Petroleum Resource classification, Analysis of resource management. International & National Institutions of Oil and Gas: API, OPEC, OECD, OIDB, DGH, PNGRB, CHT, PII, PPAC, PCRA. Petroleum Contracts: NELP - Role & Background, Types of Contracts and fiscal components, Production sharing

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contracts in India. Strategic Reserves concepts.

Delivery Procedure (Pedagogy):

This is a theory-based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Flip Class Room sessions will be conducted on selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Assignments, Quiz Competition and Poster Presentation will carry 20% weightage under Continuous Internal Assessment (CIA). Review classes will be conducted to clear doubts and to evaluate the level of understanding of each student individually. Most of the lectures will be delivered offline

Following procedures will be adopted in the course for delivering the content:

Self - Learning Topics:

- Pump and Compressor stations (Module I)
- Crude oil pricing (Module II)
- Fiscal Components (Module III)

Experiential Learning:

Article Writing [Foundation/Skill Development/Environment and sustainability]

- **Topic:** Types of Petroleum Contract

Participative Learning:

(Unit I, II) [Skill Development]

- QUIZ on UNIT 1
- Peer to Peer Learning
- Presentation on Topic: Modes of Transportation of Petroleum Products

Problem Solving: Subject Related Topic [Environment and sustainability/Human Values and Professional Ethics]

- Poster Presentation on topic Petroleum Pricing and Geopolitics

Reference Materials:

Text Book(s):

T1: Oil & Natural Gas Transportation & Storage Infrastructure: Status, Trends, & Economic Benefits, report for American Petroleum Institute, IHS Global Inc, First Edition, 2013.

T2: Harold Sill Bell, Petroleum Transportation Handbook, McGraw-Hill, First Edition, 1963.

T3: William Henry Day, Petroleum marketing practices and problems**,** Commercial Publishers, First Edition, 1966.

Reference Book(s):

R1: Morris Albert Adelman, The World Petroleum Market, The Johns Hopkins university press, First Edition, 1973.

R2: Petroleum Marketing and Transportation**,** Dallas (Tex.) International Oil and Gas Educational Center, Gulf Publishing Company, First Edition, 1964.

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E-resources:

2. E- remote acess portal: https://presiuniv.knimbus.com/user#/home
3. Oil and Gas Industry downstream - https://guides.loc.gov/oil-and-gas-industry/downstream
4. Oil Transportation- https://energyeducation.ca/encyclopedia/Transportation_of oil

Any other Reference:

Class Note (CN)

Guideline to Students:

(a) About the Course:

This is a theory-based course which will provide fundamental concepts of oil and gas industry processes. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board only. All the announcements will be made during the regular lecture hours.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2020', Regulation No. PU/AC-13/16/11_2020, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2017/08/Academic-Regulations-2020.pdf) and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Unit-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Over View of the course			1
02	Module I			7
03	Module II			8
04	Discussion on Mid Term Question Pattern			01
05	Mid Term Exam			-
06	Discussion on Mid Term Questions and Answers			01
07	Continuous Internal Assessment 3:			-

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08	Module III			9
09	Discussion on End Term Question Pattern			01
10	Course Integration			-
14	End Term			01

Schedule of Instruction:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1.	L01	Overview of the programme and Course		C01, CO2, CO3, CO4	Lecture / Presentation	CN
2.	L02	Transportation of hydrocarbons	The structure and development of oil and gas industry	CO1	Lecture / Presentation	CN
3.	L03		Outline of gas and oil industry with main subdivisions	CO1	Lecture	CN
4.	L04		Transportation of petroleum and petroleum products	CO1	Lecture / Presentation	CN
5.	L05		Transportation modes	CO1	Lecture / Presentation	CN
6.	L06		Basics of pipeline construction	CO1	Lecture / Presentation	CN
7.	L07		Operation and protection	CO1	Lecture / Presentation	CN
8.	L08		Instrumentation and control	CO1	Lecture / Presentation	CN
Module I Completed						
9.	L09	Crude oil Marketing and	Oil and gas prices	CO2	Lecture / Video	CN

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		Trading			Presentation	
10.	L10		Crude oil characteristics	CO2	Lecture / Video Presentation	CN
11.	L11		Administrative marketing and trading	CO2	Lecture / Video Presentation	CN
12.	L12		Mechanism of oil price elasticity	CO2	Lecture / Video Presentation	CN
13.	L13		Conservation of petroleum and its products	CO2	Lecture / Presentation	CN
14.	L14		Market control system	CO2	Lecture / Presentation	CN
15.	L15		Market determined pricing system	CO2	Lecture / Presentation	CN
16.	L16		Indian and Global supply scenario			
	Module II Completed					
17.	L17	Hydrocarbon Resource Management	Petroleum Resource classification	CO3	Lecture / Presentation	CN
18.	L18		Analysis of resource amangement	CO3	Lecture / Presentation	CN
19.	L19		International and National Instituitions of Oil & Gas	CO3	Lecture / Presentation	CN
20.	L20		Petroleum Contracts	CO3	Lecture / Presentation	CN
21.	L21		NELP	CO3	Lecture / Presentation	CN
22.	L22		Role and background of licensing policies	CO3	Lecture / Presentation	CN
23.	L23		Types of contracts	CO3	Lecture / Presentation	CN

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24.	L24		Production sharing contracts	CO3	Lecture / Presentation	CN
25.	L25		strategic reserve concepts	CO3	Lecture / Presentation	CN
26.	L26		Course Integration			
	Module III Completed					

Topics relevant to **"EMPLOYABILITY SKILLS":** International and National Instituitions of Oil & Gas for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through the Assignment as mentioned in the assessment component.

Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	CIA: Quiz: "Transportation of Hydrocarbons"	Module I	CO1	-	10	5%	
02	CIA: Quiz: "marketing & Trading"	Module II	CO2	_	10	5%	
03	Mid Term Exam	Module I and Module II	CO1 and CO2		60	30%	
04	CIA: Assignment 2: Poster Presentation	Module III	CO3	-	10	5%	
05	CIA: Assignment 1: Literature Review – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://presiuniv.knimbus.com/use	Module 4	CO4	-	10	5%	

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	r#/home). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)						
06	End Term Exam	Module 1 through Module 4	CO1 through CO4		100	50%	

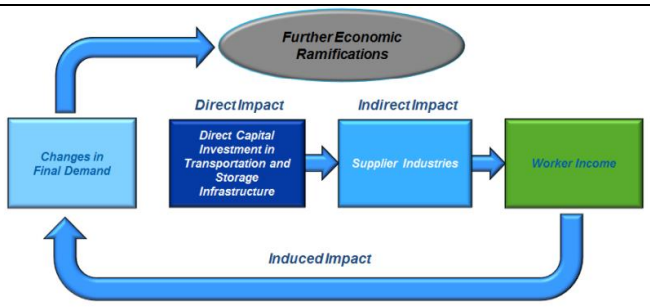
Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2020', Regulation No. PU/AC-13/16/11_2020, from Presidency University, Bengaluru website(https://presidencyuniversity.in/wpcontent/uploads/2017/08/Academic-Regulations-2020.pdf) and go through the Section Nos. 1.0 through 24.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	 Based on the figure provided, summarize the steps used to derive the economic contribution of any industry in your opinion.	5	CO1	Comprehension
2	When choosing heating fuels or heating systems, consumers may want to compare the cost of different heating fuels or energy sources. Because heating fuels are measured and sold in different units, such as gallons of oil and propane, cubic feet or therms of	5	CO2	Application

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	natural gas, and kilowatthours (kWh) of electricity. Therefore, describe how do you compare the price of heating fuels?			
3	The country currently faces a situation where oil and gas constitute a major and increasing share of total imports. Thus, the new policy regime marks a generational shift and modernization of the oil and gas exploration policy. If this is the scenario, summarize how NELP and HELP is going to stimulate the domestic production in own words.	5	CO3	Comprehension

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Compare different modes of transportation for petroleum products,	35%
2	CO2	Explain international crude oil market and oil pricing mechanisms,	35%
3	CO3	Describe the different resource management and production sharing contracts.	35%

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

Signature of the Chairperson DAC:

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Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	Compare different modes of transportation for petroleum products,	35%		
2	CO2	Explain international crude oil market and oil pricing mechanisms,	35%		
3	CO3	Describe the different resource management and production sharing contracts.	35%		

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Name and Signature of the Course Instructor:

DAC Observation and Approval:

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Course Code: PET 2030	**Course Title:** Occupational Health and Safety **Type of Course:** 1] Open Elective 2] Theory only	**L-P-C**	3	0	3
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	The purpose of this course is to understand the safety rules, regulations, guidelines, and accident investigations, reliability characteristics in oil and gas industry. The course is conceptual and analytical in nature, aims to provide detailed coverage of environmental laws and regulation, guidelines for safety and health programs as well as accident reporting and accident investigations**.** The course develops the critical and analytical thinking skills. The course also enhances the programming abilities through assignments.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Occupational Health and Safety and attain **Employability** through **Problem Solving** methodologies.				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: Recognize importance of reliability and safety at workplace, CO2: Apply the risk assessment techniques, CO3: Describe the safety practices applicable in drill site, CO4: Classify methods to control oil spill and treat waste water.				
Course Content:					
Module 1:	Introduction	Assignment / Quiz	Literature Survey	08 Periods	
Topics: Introduction to Safety, Health, and Environment Management, History, Terms and definitions, Environment concepts, Impact on Eco system, Air, Water and Soil, Toxicity.					
Module 2:	Accident modeling, risk assessment & management	Assignment / Quiz	Data Collection	09 Periods	
Topics: Dose assessment, safety regulations-Toxic releases-models and methods-Chemical risk analysis-Chemical exposure index (CEI)-Case studies in oil industries-Quantitative risk assessment-Fire and explosion models-Flammability diagrams-Exposure models-Fire and explosion: prevention methods-Event tree and fault tree analyses					
Module 3:	Safety Practices at Work site	Assignment / Quiz	Programming	10 Periods	
Topics: Impact of Drilling on environment, Safety practices in Drilling sites: Preparation of Drill sites, Storage and Material Handling, Precautions for Drilling in landfills, Electrical safety, General equipment safety, PPE, Caselet issues related to any Industry.					
Module 4:	Oil Spill Remediation	Case Study	Data Collection	08 Periods	
Topics: Offshore environmental studies, Fate and behavior of Oil spill, Response strategies and techniques, Mechanical and chemical treatments, Soil remediation. What is waste water, Waste water treatment, Case studies.					
Targeted Application and Tools that can be used: Application: HSE Engineer / Officer in Oil and Gas / Process / Steel / Manufacturing Industry, Thermal / Power Plants. Tools: MS Excel					
Text Book: 1. B.S. Dhillon, "Safety and Reliability in the Oil and Gas Industry: A Practical Approach", 1st edition, CRC Press, 2019. 2. S. Chandrasekaran, "Health, Safety, and Environmental Management in Offshore and Petroleum Engineering", 1st edition, Wiley, 2016.					
References: 1. Charles D. Reese, "Occupational Health and Safety Management:" A Practical Approach", 3rd edition, CRC Press, 2016. 2. Morten Holmager, Søren Dybdahl, "Offshore Book Oil and Gas", 3rd edition, Offshoreenergy.dk, 2014. **E-resources:** 1 https://puniversity.informaticsglobal.com/login 2. https://youtu.be/7cqGjBj77Zs?list=PLbMVogVj5nJTKcMfWNwQfPkT014KEJAzE 3. https://youtu.be/7CwPDiqlmv0					

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4. https://youtu.be/IJqKyBHHdI8 5. https://youtu.be/0dcQcNARKOI	
Topics relevant to **"EMPLOYABILITY SKILLS":** Oil Spill Control for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by:	Mr. Bhairab Jyoti Gogoi, Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Kalpajit Hazarika, Mr. Ankur Neog, Mr. Anmol Bhargava, Mr. Sugat Srivastava
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Handout: AY 2022-2023

Date of Issue: 07-09-2022

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC 18.5/PET14/PET/2021-25
Semester / Year	:	IV / 2022-23
Course Code / Title	:	PET 2030 / Occupational Health and Safety
Course Credit Structure	:	3L 0T 0P 3C
Contact Hours	:	39
Course Instructor In-charge	:	Mr. Ankur Neog
Course Instructor	:	Dr. Sidharth Gautam
Course URL	:	N/A

Program Outcomes (POs)

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO5: **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.

PO6: **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering comm Moduley and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites: None

Course Description:

The purpose of this course is to understand the safety rules, regulations, guidelines, and accident investigations, reliability characteristics in oil and gas industry. The course is conceptual and analytical in nature, aims to provide detailed coverage of environmental laws and regulation, guidelines for safety and health programs as well as accident reporting and accident investigations. The course develops the critical and analytical thinking skills. The course also enhances the programming abilities through assignments.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Occupational Health and Safety and

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attain **Employability** through **Problem Solving** methodologies.

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:

CO1: Recognize importance of reliability and safety at workplace,

CO2: Apply the risk assessment techniques,

CO3: Demonstrate the safety practices applicable in drill site,

CO4: Illustrate the methods to control oil spill and treat waste water.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	L	L	M		L	H	M	H	L	L	L	M
CO2	L	L	H		M	H	H	H	L	L	L	M
C03	M	M	L		M	H	M	L	H	M	M	M
CO4	L	M	L		H	H	H	M	H	M	H	L

H = High, M = Moderate, L = Low

Course Content (Syllabus):

Module I: Introduction **[7 Classes, Knowledge Level]**

Introduction to Safety, Health, and Environment Management, History, Terms and definitions, Environment concepts, Impact on Eco system, Air, Water and Soil, Toxicity.

Module II: **Accident modeling, risk assessment & management** **[7 Classes, Application Level]**

Dose assessment, Safety regulations-Toxic releases-models and methods-Chemical risk analysis-Chemical exposure index (CEI)-Case studies in oil industries-Quantitative risk assessment-Fire and explosion models-Flammability diagrams-Exposure models-Fire and explosion: prevention methods-Event tree and fault tree analyses

Module III: **Safety practices at Work site** **[10 Classes, Application level]**

Impact of Drilling on environment, Safety practices in Drilling sites: Preparation of Drill sites, Storage and Material Handling, Precautions for Drilling in landfills, Electrical safety, General equipment safety, PPE, Case issues related to any Industry.

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Module IV : **Oil spill Remediation** **[10 Classes, Application Level]**

Offshore environmental studies, Fate and behavior of Oil spill, Response strategies and techniques, Mechanical and chemical treatments, Soil remediation. What is waste water, Waste water treatment, Case studies.

Delivery Procedure (Pedagogy):

This is a theory based course and lectures will be delivered in the form of whiteboard lectures/classroom presentations. Case study will be employed to ensure clear understanding of certain topics. Experiential learning in the form of group discussions or seminar presentations will be included. These may or may not be included in the evaluation scheme. Most of the lectures will be delivered online (Virtual Classroom Mode) using Microsoft Team platform.

Following procedures will be adopted in the course for delivering the content:

Experiential learning (Module I & II) (Skill development/Employability)

Article writing on the following topic,

- Hazard Identification and mitigation by taking an example of an Industrial accident

Participative learning (Module II & III) (Employability):

- Quiz on Module II and III
- Peer learning

Problem solving: Subject related exercise (Module III & IV) (Entrepreneurship/Environment/ Sustainability):

- Case on Risk Assessment or Hazard Surveys.
- Case Study on HSE Practices or HAZOP in Oil Industry

CIA Plan:

Module I: Literature Review

1.1 Quiz will be conducted on related topics. OR

1.2 A Team Exercise will be conducted for the students. Students will have the flexibility to select their team members. Students will learn how-to collect required data from available physical/e-resources and how to work in a team. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the presentation.
Exercise 1.2(a): Literature Review of Digital/e-resources from Presidency University link shared below. It is mandatory to submit a screenshot accessing digital resources, otherwise, it will not be evaluated.

Link to Presidency University e-resources: https://presiuniv.knimbus.com

Exercise 1.2(b): The objective of this exercise is to Hazard Identification and mitigation by taking an example of an Industrial accident.

Module II: Quiz (OR) Case Study

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2.1 Quiz will be conducted on related topics. OR

2.2 A Team Activity will be conducted for the students. Students will have the flexibility to select their team members. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the activity.

Activity 2.2: Students will learn how-to collect required data from available e-resources and how to work in a team. Students will develop oral communication skills through this activity. The students are expected to gather information on various safety regulations, environmental assessment techniques and environmental protection laws.

Module III: Quiz (OR) Poster Presentation

3.1 Quiz will be conducted on related topics. OR

3.2 A Team Exercise will be conducted for the students. Students will have the flexibility to select their team members. Students will learn to design a Poster to show the effect of drilling on environment, effect of offshore drilling on benthic environment. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the presentation.

Module IV: Quiz (OR) Literature Survey and Report Submission

4.1 Quiz will be conducted on related topics. OR

4.2 A Team Exercise will be conducted for the students. Students will have the flexibility to select their team members. Students will learn to carry out a literature survey on specified topics. Students will develop writing communication skills through this activity. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the activity.

Exercise 4.2: The objective of this exercise is to make the students understand different remediation techniques for oil spill.

Reference Materials:

(a) Textbook(s)

T1 S. Chandrasekaran, "Health, Safety, and Environmental Management in Offshore and Petroleum Engineering", 1st edition, Wiley, 2016.

T2 B.S. Dhillon, "Safety and Reliability in the Oil and Gas Industry: A Practical Approach", 1st edition, CRC Press, 2019.

(b) Reference Book(s)

R1 Charles D. Reese, "Occupational Health and Safety Management:" A Practical Approach", 3rd edition, CRC Press, 2016.

R2 Morten Holmager, Søren Dybdahl, "Offshore Book Oil and Gas", 3rd edition, Offshoreenergy.dk, 2014.

(c) Case study:

1.Fire incident in Crude Distillation Module due to SR line leak: https://www.oisd.gov.in/oisd-case-studies

2.Blast and Subsequent Fire in Storage Tank: https://www.oisd.gov.in/oisd-case-studies

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(d) E-resources:

1. **Presidency University e-Resource**: https://presiuniv.knimbus.com
2. **Video on Health, Safety**: https://youtu.be/7cqGjBj77Zs?list=PLbMVogVj5nJTKcMfWNwQfPkT014KEJAzE
3. **Video on effects of oil drilling and fracking on the environment**: https://youtu.be/IJqKyBHHdI8
4. **Video on Oil Spills**: https://youtu.be/0dcQcNARKOI
5. **E-Book** : https://hsseworld.com/e-bookssuccessful-health-and-safety-management/

Guideline to Students:

(a) About the Course:

Health, Safety and Environment deals with safety procedures and regulations applicable in the industry. The subject enables the student to understand and employ mandatory safety protocol to avoid any accidents or to take necessary actions when an unwanted incident actually occurs.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board only. All the announcements will be made during the regular lecture hours.

(c) Academic Regulation

The students are advised to download the 'Academic Regulations, 2020', Regulation No. PU/AC-13/16/11_2020, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2017/08/Academic-Regulations-2020.pdf) and go through the Section Nos. 1.0 through 24.0.

Course Schedule:

Module-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
1.	Overview of the Programme and Course			01
2.	Module-1			07
3.	CIA I: Assignment			-
4.	Module-2			07
5.	CIA II: Quiz			-
6.	Discussion of Mid Term Question Pattern			01

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	7.	Mid Term			-
	8.	Discussion of Mid Term Questions and Answers			01
	9.	Module-3			10
	10.	CIA III: Case Study			-
	11.	Module-4			10
	12.	CIA III: Poster			-
	13.	Course Integration			01
	14.	Discussion of End Term Examination Question Pattern			01
	15.	END TERM EXAMINATION			-

Schedule of Instruction:

Module-wise Micro Level planning for course delivery schedule is provided below:

	Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
	1	L1	**Program Integration**	Overview of Course	-	White Board/ PPT/Video Lecture	T1, CN
	Module-I (Introduction)						
	2	L2	**Introduction**	Introduction to the Safety	CO 1	White Board/ PPT/Video Lecture	T1, CN
	3	L3		Health, and Environment Management	CO 1	White Board/ PPT/Video Lecture	T1, CN
	4	L4		History, Terms and definitions	CO 1	White Board/ PPT/Video Lecture	CN
	5	L5		History, Terms and definitions	CO 1	White Board/ PPT/Video Lecture	CN
	6	L6		Concept of Environment	CO 1	White Board/ PPT/Video Lecture	CN
	7	L7		Impact on ecosystem	CO 1	White Board/ PPT/Video Lecture	T1, CN
	8	L8		Air, Water and	CO 1	White Board/	T1, CN

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				Soil, Toxicity.		PPT/Video Lecture	
		CIA I			CO 1		
Module – II (Accident modeling, risk assessment & management)							
	9	L9	**Accident modeling, risk assessment & management**	Dose assessment, safety regulations-	CO 2	White Board/ PPT/Video Lecture	T1, CN
	10	L10		Toxic releases- models and methods- Chemical risk analysis-Chemical exposure index (CEI)-	CO 2	White Board/ PPT/Video Lecture	T1, CN
	11	L11		Case studies in oil industries- tree analyses	CO 2	White Board/ PPT/Video Lecture	CN
	12	L12		Quantitative risk assessment-	CO 2	White Board/ PPT/Video Lecture	CN
	13	L13		Fire and explosion models-	CO 2	White Board/ PPT/Video Lecture	CN
	14	L14		Flammability diagrams-	CO 2	White Board/ PPT/Video Lecture	CN
	15	L15		Exposure models- Fire and explosion: prevention methods-Event tree and fault	CO 2	White Board/ PPT/Video Lecture	CN
			CIA II		CO 2	-	-
	16	L16	Discussion of Mid Term Question Pattern		CO 1 & 2	White Board/ PPT/Video Lecture	-
	17	L17	Discussion of Mid Term Questions and Answers		CO 1 & 2	White Board/ PPT/Video Lecture	-
Module – III (Safety practices at Work site)							
	18	L18	**Safety practices at Work site**	Impact of Drilling on environment	CO 3	White Board/ PPT/Video Lecture	T1, CN
	19	L19		Safety practices in Drilling sites	CO 3	White Board/ PPT/Video Lecture	CN

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	20	L20		Safety practices in Drilling sites	CO 3	White Board/ PPT/Video Lecture	CN
	21	L21		Preparation of Drill sites	CO 3	White Board/ PPT/Video Lecture	CN
	22	L22		Storage and Material Handling	CO 3	White Board/ PPT/Video Lecture	T1, CN
	23	L23		Precautions for Drilling in landfills	CO 3	White Board/ PPT/Video Lecture	T1, CN
	24	L24		Electrical safety	CO 3	White Board/ PPT/Video Lecture	T1, CN
	25	L25		General equipment safety	CO 3	White Board/ PPT/Video Lecture	T1, CN
	26	L26		PPE, Caselet issues related to any Industry.	CO 3	White Board/ PPT/Video Lecture	T1, CN
	27	L27		Caselet issues related to any Industry.	CO 3	White Board/ PPT/Video Lecture	T1, CN
			CIA III		CO 3	-	-
Module – IV (Oil spill Remediation)							
	28	L28	**Oil spill Remediation**	Introduction	CO4	White Board/ PPT/Video Lecture	CN
	29	L29		Offshore environmental studies	CO 4	White Board/ PPT/Video Lecture	CN
	30	L30		Fate and behavior of Oil spill	CO 4	White Board/ PPT/Video Lecture	CN
	31	L31		Response strategies and techniques	CO 4	White Board/ PPT/Video Lecture	CN
	32	L32		Mechanical and chemical treatments (Part-I)	CO 4	White Board/ PPT/Video Lecture	CN
	33	L33		Mechanical and chemical treatments (Part-II)			
	34	L34		Soil remediation			
	35	L35		Waste water treatment			
	36	L36		Waste water	CO 4	White Board/	CN

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				treatment		PPT/Video Lecture	
	37	L37		Waste water treatment	CO 4	White Board/ PPT/Video Lecture	CN
			CIA IV		CO 4		
	38	L38	**Course Integration**	Course Summary and Relation with other Courses of the Programme	CO 1, 2, 3 & 4	White Board/ PPT	T1, Class Note
	39	L39		Discussion of End Term Question Pattern	CO 1, 2, 3 & 4	White Board/ PPT	

Topics relevant to **"EMPLOYABILITY SKILLS":** Oil Spill Control for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through the Assignment as mentioned in the assessment component.

Assessment Schedule:

Module-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	CIA I: Assignment	Module 1	CO1	-	10	5%	
02	CIA II: Article Writing – Based on e-resources	Module 2	CO2	-	10	5%	
03	Mid Term	Module-1, 2	CO1, CO2	1.5	60	30%	-
04	CIA III: Case Study	Module 3	CO3	-	10	5%	-
05	CIA IV: Assignment – numerical solving on oil spill control	Module 4	CO4	-	10	5%	-
06	End Term Examination	Module 1 to Module 4, Self-Learning Topics	CO1 – CO4	3.0	100	50%	-

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Course Clearance Criteria :

The students are advised to download the 'Academic Regulations, 2020', Regulation No. PU/AC-13/16/11_2020, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2017/08/Academic-Regulations-2020.pdf) and go through the Section Nos. 1.0 through 24.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Let's assume you have joined some XYZ oil company as an HSE Engineer and in your job description it was mention as "Prepares and ensures effective implementation in respect of adherence and HSE and safety policy and procedural requirements. Identification and Classification of potential hazards. Ensures Bio-Hazard analysis with the help of FAULT TREE ANALYSIS at the rig site". As your first assignment you were sent to a Drill site located at some ABC location. Mention the work plan of yours as a Drill site HSE engineer which will meet all the expectation from the company as well as the roles mention in the job description.	10	CO 1	Knowledge
2	Risk ranking of the departments is done based on the composite risk as this will help the risk managers to decide the requirement of fund for each department either to mitigate risk or at least to control risk. Departments should be ranked from highest composite score to the lowest. Amount of money allotted for safety is distributed among the department according to the risk ranking. Risk assessment for an XYZ oil company is given and Data for each department of the process plant is tabulated below. Consider yourself as a "Risk manager" and compute the composite risk for each department using any standard risk analysis method	10	CO 1	Knowledge

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	then rank each department based on the department with the higher composite risk.			
3	"Effect of life cycle stage on Hydrocarbon toxicity" - Discuss the quoted sentences with suitable examples and diagrams.	10	CO 2	Knowledge
4	Being a Risk and Safety engineer adopt any standard method of "Risk analysis" and show a execute risk analysis for a firm having 5 departments; Dept-A, Dept-B, Dept-C, Dept-D and Dept-E respectively. Select any random values with the following guidelines, (a) Hazards scores for each departments should range between 350 to 680 (b) Control sore for each department should range between 550 to 1000 (c) Take exposure values in such a way that composite exposure values doesn't exceed 13000×1013 $ and also it should not be less the 7500×1013 $. Show each and every step in detail and also rank all five departments.	10	CO 2	Comprehension
5	Give your comments on "Pacific herring test" to check the effect of oil spill.	10	CO 3	Comprehension
6	Write your strategy to remove Lead, Antimony from Produce water, small size cuttings from oil based Drilling fluid, Volatile organic carbon compounds, Calcium and Magnesium ions, Salts from waste water.	10	CO 3	Comprehension
7	Using the concept of "WASTE HIERARCHY" write a note on Produce water form production.	10	CO 4	Knowledge
8	The 2021 Mediterranean oil spill was an ecological disaster which occurred in February 2021 along the Mediterranean coast of Israel and Lebanon. Starting on 16 February 2021, dozens to hundreds of tons of tar washed up on the beaches along a 160-kilometre (99 mi) stretch of Israel's coast from Rosh Hanikra to Ashkelon, following a heavy storm and unusually high waves. Tar deposits also heavily impacted the beaches in south Lebanon. European Sentinel satellite photos showed 12 apparent oil slicks at various distances from the shore between 11-13 February 2021 according to Greenpeace. More than 4,000 volunteers from the Israeli nonprofit group EcoOcean have helped remove tar from beaches so far, according to the ministry. The Israel Nature and Parks Authority warned that the "consequences will be seen for years to come." Israeli environmental minister Gila Gamliel said	10	CO 4	Application

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	Saturday that there are no more oil slicks visible off Israel's coast, "which is an encouraging condition." However the ministry warned that large waves are forecast this week. The waves could carry chunks of sticky tar from beach to beach, complicating cleanup efforts. Based on the information make report on the fate and behaviour of this event with necessary diagram. Also add some suggestion for response strategies which will help in oil spill cleanup.			

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Recognize importance of reliability and safety.	55
2	CO2	Apply the risk assessment techniques	50
3	C03	Describe the safety practices applicable in work site.	50
4	CO4	Generalize methods to control oil spill and treat waste water.	45

Signature of the Course Instructor In-charge: Mr. Ankur Neog

Signature of the Course Instructor: Mr. Ankur Neog

Signature of the Chairperson DAC:

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Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	Recognize importance of reliability and safety at workplace.	55		
2	CO2	Apply the risk assessment techniques	50		

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3	C03	Describe the safety practices applicable in drill site.	50		
4	CO4	Generalize methods to control oil spill and treat waste water	50		

Name and Signature of the Course Instructor:

DAC Observation and Approval:

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Course Code: PET3003	**Course Title:** Offshore Drilling and Petroleum Production Practices **Type of Course:** 1] Program Core 2] Theory only	**L- P- C**	3	0	3
Version No.:	2.0				
Course Pre-requisites:	NIL				
Anti-requisites:	NIL				
Course Description:	This course is theory course. The main objective of this course is to focus on the sea behavior and the platforms used for drilling & production operation. It also helps to understand drilling and production practices used in offshore environment and problems associated with offshore operation. This course is both conceptual and analytical in nature. With the knowledge of basic sciences are preferable to register in this course.				
Course Objective:	The objective of the course is to familiarize the learners with the concepts of Offshore Drilling and Petroleum Production Practices and attain **Skill Development** through **Problem Solving** techniques.				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: Discuss the offshore sea environment and station keeping mechanism of offshore structures, CO2: Explain various fixed offshore drilling and production structures, CO3: Summarize various floating offshore platforms, CO4: Distinguish between the offshore production facilities.				
Course Content:					
Module 1:	Introduction to Offshore and Sea Environment	Assignment	Literature Survey and Group Discussion	04 Periods	
Topics: Introduction, Historical development of offshore Structures, Deep water challenges and offshore disasters, Functions of offshore structures, Water Depth classification, Offshore India. Classification Societies and Industry Standard Groups Buoyancy and Gravity Principals, Metacenter, Station keeping, Motions of floating vessel.					
Module 2:	Fixed Offshore Drilling and Production Platform	Quiz	Model Making	07 Periods	
Topics: Bottom Supported structures- Minimal platforms, Jacket structures, Gravity based structures, Jack ups, Subsea templates and pipelines; Complaint structures- Articulated Platforms, Complaint tower, Guyed tower.					
Module 3:	Floating Offshore Drilling and Production Platforms	Quiz	Data Collection and Programming	15 Periods	
Topics: Floating offshore drilling units- introduction to Mobile offshore drilling units, semisubmersible, Drill ships; Floating offshore production units: Floating production systems (FPS) structures- Semisubmersibles, SPARS, Conventional TLP, Mini TLP; Floating storage and offloading (FSO) systems- Ship shaped vessels; Floating production systems (FPS)- Ship/barge;, Mooring systems, Dynamic positioning system.					
Module 4:	Offshore Production Facilities	Assignment	Literature Survey and Group Discussion	09 Periods	
Topics: Oil and Gas Separation, Treatment of Oil, Treatment of Gas, Treatment of Produced Water, Storage of Oil and, Gas, Transportation of Oil and Gas .					
Targeted Application and Tools that can be used: Application: Offshore Drilling / Production / Structural / Pipeline Engineer in Oil and Gas Industry Tools: Marine Riser, Riser Tensioner, Engineer's Desktop (Landmark Halliburton software), Petrel					
Text Book: T1. S. Chakrabarti, "Handbook of Offshore Engineering", Volume 1 and 2, Elsevier (2005) . T2. S. Laik "Offshore Petroleum Drilling and Production" CRC Press, Taylor and Francis, 2018					
References: R1. The Technology of Offshore Drilling: Completion and Production ETA Offshore Seminars, Inc R2. Dr. Ignatius Louis Prashanth , Onshore Gas Drilling Hardcover – 1 January 2022 **E-resources:** 1. Presidency University e-Resource: https://puniversity.informaticsglobal.com/login 2. Basics of Soil Mechanics I https://nptel.ac.in/courses/114/106/114106015/ 3. Offshore Structures Under Special Loads Including Fire Resistance https://nptel.ac.in/courses/114/106/114106043/					

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Topics relevant to "**SKILL DEVELOPMENT**": Bottom Supported structures- Minimal platforms and Jacket structures for **Skill Development** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by:	Dr. Suman Paul, Dr. Deepjyoti Mech, Dr. Kalpajit Hazarika, Mr. Bhairab Jyoti Gogoi, Mr. Anmol Bhargava, Mr. Sugat Srivastava
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022

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Course Hand Out

Date of Issue:

Revised On: N.A.

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	PU/AC-18.5/PET14/
Semester / Year	:	VII / 4th
Course Code / Title	:	PET3003 / Offshore Drilling and Petroleum Production Practices
Course Credit Structure	:	3L-0T-0P 3C
Contact Hours	:	38
Course Instructor In-charge	:	Mr. Bhairab Jyoti Gogoi
Course Instructor	:	Mr. Bhairab Jyoti Gogoi

Program Outcomes (POs) :

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO5: **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.

PO6 The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites:

NIL

Course Description:

The main aim of this course is to understand the drilling and production practices used in offshore environment. It will also help the students to understand unique challenges faced during offshore operations. This course will focus on the sea behavior and the platforms used for drilling & production operation.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Offshore Drilling and Petroleum Production Practices and attain **Skill Development** through **Problem Solving** techniques.

Course Outcomes (COs):

On successful completion of the course, the student shall be able to:

CO1: Discuss the offshore sea environment

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CO2: Analyze station keeping mechanism of offshore structures,

CO3: Categorize various fix and floating offshore platforms,

CO4: Distinguish between the offshore production facilities.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	L	L	L	L	M		M		L	L		M
CO2	H	M	M	M	M		M		H	L		M
C03	H	M	M	M	M		M		H	L		M
CO4	H	M	M	L	M		M		H	L		M
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Unit I: Introduction to Offshore and sea environment [8 hours]
[Comprehension]

Introduction, Historical development of offshore Structures, Deep water challenges and offshore disasters, Water Depth classification, Offshore India. Classification Societies and Industry Standard Groups

Unit II: Movement of Offshore structure [7 hours]
[Analysis]

Meteorology, Oceanography, Buoyancy and Gravity Principals, Metacenter, Motions of floating vessel, Station keeping, Mooring Components, Principle of a Mooring System, Mooring pattern, Dynamic Positioning System.

Unit III: Offshore fix and floating environment [15 hours]
[Analysis]
Bottom Supported structures- Minimal platforms, Jacket structures, Gravity based structures, Jack ups, Subsea templates and pipelines; Complaint structures- Articulated Platforms, Complaint tower, Guyed tower, Floating offshore drilling units- introduction to Mobile offshore drilling units, semisubmersible, Drill ships; Floating offshore production units: Floating production systems (FPS) structures- Semisubmersibles, SPARS, Conventional TLP, Mini TLP; Floating storage and offloading (FSO) systems- Ship shaped vessels; Floating production systems (FPS)- Ship/barge;, Mooring systems, Dynamic positioning system.

Unit IV: Offshore production facilities [5 hours]
[Comprehension]

Oil and Gas Separation, Treatment of Oil, Treatment of Gas, Treatment of Produced, Water, Storage of Oil and, Gas, Transportation of Oil and Gas

Delivery Procedure (Pedagogy):

This is a theory based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Flip Class Room sessions will be conducted on selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Assignments, Quiz Competition and Poster Presentation will carry 20% weightage under Continuous Assessment (CA). Review classes will be conducted to

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clear doubts and to evaluate the level of understanding of the each student individually. If required some classes may be engaged in virtual mode under unavoidable circumstances.

Following procedures will be adopted in the course for delivering the content:

I. Experiential learning:

Article review (Unit III) [Foundation/Skill Development/Environment and sustainability]

- Response control of fixed offshore structure with wind turbine using MR damper

II. Participative learning:

QUIZ (Unit I, II, III & IV) [Employability]

- Quiz-1 on Unit I: Date: 13/10/2022
- Quiz-2 on Unit II: Date: 13/11/2022
- Quiz-3 on Unit III: Date: 07/12/2022
- Quiz-4 on Unit IV: Date: 20/12/2022

One minute presentation

- Offshore India (Unit I)
- Classification societies and industry standard groups (Unit I)
- Historical development of offshore structures (Unit I)

III. Problem solving: Subject related exercise(Unit II) [Skill/Employability]

- Numerical on Buoyancy and Stability

Reference Materials:

(a) Textbook(s)

T1 S. Chakrabarti, "Handbook of Offshore Engineering", Volume 1 and 2, Elsevier (2005) https://www.sciencedirect.com/book/9780080443812/handbook-of-offshore-engineering#book-description

T2 S. Laik "Offshore Petroleum Drilling and Production" CRC Press, Taylor and Francis, 2018, https://www.taylorfrancis.com/books/mono/10.1201/9781315157177/offshore-petroleum-drilling-production-sukumar-laik

(b) Reference Book(s)

R1 The Technology of Offshore Drilling: Completion and Production ETA Offshore Seminars, Inc. https://www.abebooks.com/9780878140664/Technology-Offshore-Drilling-Completion-Production-0878140662/plp

R2 Dr. Ignatius Louis Prashanth , Onshore Gas Drilling Hardcover – 1 January 2022, https://www.amazon.in/Onshore-Drilling-Ignatius-Louis-Prashanth/dp/B09RK2FH57/ref=asc_df_B09RK2FH57/?tag=googleshopdes-21&linkCode=df0&hvadid=544900977831&hvpos=&hvnetw=g&hvrand=10965203824159332545&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9301811&hvtargid=pla-1627329831532&psc=1

(c) Case study:

1. Management Case Study – Southeast Asia Offshore Oil Drilling Problem,

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https://www.aiche.org/chenected/2013/01/management-case-study-southeast-asia-offshore-oil-drilling-problem

2. Offshore Oil & Gas Case Study, https://www.brownmac.com/en/latest/case-studies/offshore-oil-gas-case-study

3. The offshore oil drilling Harvard Case Solution & Analysis, https://www.thecasesolutions.com/the-offshore-oil-drilling-145436

(d) e-Resource:

1. Presidency University e-Resource: https://puniversity.informaticsglobal.com/login
2. NPTEL video on Loads On Offshore Structures, https://nptel.ac.in/courses/114106011
3. NPTEL video on Concepts of Fixed Offshore Platform Deck and Jacket,
4. NPTEL video on Jackup RIGS-Analysis and Design, https://nptel.ac.in/courses/114106011
5. Presidency University e-resource Remote Access (KNIMBUS) portal through the shared link: https://presiuniv.knimbus.com/user#/home

Guideline to Students:

(a) About the Course:

The goal of the course will be to enable the students to understand the fundamentals of offshore and subsea engineering and develop knowledge and skills in the dynamics of offshore structures for drilling and production, their installations, designs, mooring lines, and station keeping mechanism which are critical in the industry.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulations

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0.

Course Schedule:

Unit-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Over View of the course	26-09-2022	26-09-2022	1
02	Unit I	27-09-2022	11-10-2022	8
03	Continuous Assessment-***Quiz-1***	-	-	-

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04	Continuous Assessment-***One minute presentation***	-	-	-
05	Unit II	13-10-2022	11-11-2022	7
06	Discussion on Mid Term syllabus and pattern	28-10-2022	28-10-2022	1
07	Mid Term	3-11-2022	7-11-2022	-
08	Discussion on Mid Term paper	08-11-2022	08-11-2022	-
09	Continuous Assessment-***Quiz-2***	26-09-2022	15-12-2022	-
10	Continuous Assessment-***Course based problems***	-	-	-
11	Unit III	14-11-2022	05-12-2022	15
12	Continuous Assessment-***Quiz-3***	26-09-2022	15-12-2022	-
13	Continuous Assessment-***Article review***	-	-	-
14	Unit IV	06-12-2022	13-12-2022	5
15	Continuous Assessment-***Quiz-4***	-	-	-
16	Discussion on End Term syllabus and pattern	-	-	1
17	End Term Examinations	05-1-2022	25-1-2022	-

Schedule of Instruction:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No./Date	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L01/ 26-09-2022	Program Integration	Overview of the course	-	Lecture / Presentation/ White board	N/A
Unit I						
2	L02/ 27-09-2022	Introduction to Offshore and sea environment	Historical development of offshore Structures	CO1	Lecture / Presentation/ White board	T2 Ch01
3	L03/ 30-09-2022		Deep water challenges	CO1	Lecture / Presentation/ White board	T2 Ch01
4	L04/ 06-10-2022		Offshore disasters	CO1	Lecture / Presentation/ White board	T2 Ch01
5	L05/ 07-10-2022		Water Depth classification	CO1	Lecture / Presentation/ White board	T2 Ch01

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6	L06/ 10-10-2022		Offshore India. Classification Societies	CO1	Lecture / Presentation/ White board	T2 Ch01
7	L07/ 11-10-2022		Industry Standard Groups	CO1	Lecture / Presentation/ White board	T2 Ch01
	-		Continuous Assessment- ***Quiz-1***	-	-	-
	-		Continuous Assessment- ***One minute presentation***	-	-	-
Unit II						
8	L08/ 13-10-2022	Movement of Offshore structure	Meteorology	CO2	Lecture / Presentation/ White board	T2 Ch02
9	L09/ 14-10-2022		Oceanography	CO2	Lecture / Presentation/ White board	T2 Ch02
10	L10/ 17-10-2022		Buoyancy and Gravity Principals	CO2	Lecture / Presentation/ White board	T2 Ch02
11	L11/ 18-10-2022		Metacenter	CO2	Lecture / Presentation/ White board	T2 Ch02
12	L12/ 20-10-2022		Motions of floating vessel, Station keeping	CO2	Lecture / Presentation/ White board	T2 Ch02
13	L13/ 21-10-2022		Mooring Components,	CO2	Lecture / Presentation/ White board	T2 Ch02
14	L14/ 27-10-2022		Principle of a Mooring System	CO2	Lecture / Presentation/ White board	T2 Ch02
15	L15/ 28-10-2022		Mid-term syllabus discussion	-	Lecture / Presentation/ White board	-
16	L16/ 08-11-2022		Mid-term syllabus discussion	-	Lecture / Presentation/ White board	-
17	L17/ 10-11-2022		Mooring pattern	CO2	Lecture / Presentation/ White board	T2 Ch02
18	L18/ 11-11-2022		Dynamic Positioning System	CO2	Lecture / Presentation/ White board	T2 Ch02
-	-	-	Continuous Assessment-	CO2	-	-

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			Quiz-2			
-	-		Continuous Assessment- ***Course based problems***	CO2	-	-
Unit III						
19	L19/ 14-11-2022	Offshore fix and floating environment	Minimal platforms	CO3	Lecture / Presentation/ White board	T2 Ch03
20	L20/ 15-11-2022		Jacket structures	CO3	Lecture / Presentation/ White board	T2 Ch03
21	L21/ 17-11-2022		Gravity based structures	CO3	Lecture / Presentation/ White board	T2 Ch03
22	L22/ 18-11-2022		Jack ups	CO3	Lecture / Presentation/ White board	T2 Ch03
23	L23/ 21-11-2022		Subsea templates and pipelines	CO3	Lecture / Presentation/ White board	T2 Ch03
24	L24/ 22-11-2022		Complaint structures- Articulated Platforms	CO3	Lecture / Presentation/ White board	T2 Ch03
25	L25/ 24-11-2022		Complaint tower, Guyed tower	CO3	Lecture / Presentation/ White board	T2 Ch03
26	L26/ 25-11-2022		Introduction to Mobile offshore drilling units	CO3	Lecture / Presentation/ White board	T2 Ch03
27	L27/ 28-11-2022		Semisubmersibles	CO3	Lecture / Presentation/ White board	T2 Ch03
28	L28/ 29-11-2022		SPARS	CO3	Lecture / Presentation/ White board	T2 Ch03
29	L29/ 01-12-2022		Drill ships	CO3	Lecture / Presentation/ White board	T2 Ch03
30	L30/ 02-12-2022		Conventional TLP, Mini TLP	CO3	Lecture / Presentation/ White board	T2 Ch03
31	L31/ 05-12-2022		Ship shaped vessels, Barge	CO3	Lecture / Presentation/ White board	T2 Ch03
-	-		Continuous Assessment- ***Quiz-3***	-	-	-

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-	-		Continuous Assessment- ***Article review***	-	-	-
Unit IV						
32	L32/ 06-12-2022	Offshore production facilities	Oil and Gas Separation,	CO4	Lecture / Presentation/ White board	T2 Ch06
33	L33/ 08-12-2022		Treatment of Oil	CO4	Lecture / Presentation/ White board	T2 Ch06
34	L34/ 09-12-2022		Treatment of Gas	CO4	Lecture / Presentation/ White board	T2 Ch06
35	L35/ 12-12-2022		Treatment of Produced water	CO4	Lecture / Presentation/ White board	T2 Ch06
36	L36/ 13-12-2022		Storage and transportation of Oil and Gas	CO4	Lecture / Presentation/ White board	T2 Ch06
-	-		Continuous Assessment- ***Quiz-4***	-	-	-
37	L37/ 15-12-2022		Discussion on End Term syllabus and pattern	-	Lecture / Presentation/ White board	N/A
38	L38/ 16-12-2022	Course Integration			Lecture / Presentation/ White board	N/A

Topics relevant to "**SKILL DEVELOPMENT**": Bottom Supported structures- Minimal platforms and Jacket structures for **Skill Development** through **Problem Solving methodologies**. This is attained through the Assignment as mentioned in the assessment Schedule.

Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	Continuous Assessment-***Quiz-1, 2, 3, 4***	L03 – L36	CO1, CO2, CO3, CO4	-	10	5	-
02	Continuous Assessment-***One minute presentation***	L02-L07	CO1	-	10	5	-
03	Mid Term	L03 – L29	CO1, CO2	2	60	30%	03-11-2022

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	Examination						to 07-11-2022
04	Continuous Assessment-***Course based problems***	L08 – L18	CO2	15 min	10	5%	
05	Assignment: Article writing – "Submission of e-resource Review Report along with a Screenshot of the Student visiting the e-resource" (Review of Digital/e-resources from Presidency University link (https://puniversity.informaticsglobal.com/login). It is mandatory to submit a screenshot of accessing digital resources, otherwise, it will not be evaluated.)	L19 - L31	CO1	-	20	5%	-
06	End Term Examinations	L03 - L36	CO1, CO2, CO3, CO4	3	100	50%	05-01-2023 to 25-01-2022

Course Clearance Criteria:

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0. The students may consult with the Course Instructor, Instructor In-Charge, Class Coordinator, Head of the Department, and Dean (School of Engineering) for further assistance.

Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	You are hired as a petroleum engineer and are posted near Aberdeen. You are asked to give suggestions for the planning of offshore operations in the North Sea. From the initial surveys, it was found that the water depth at the site is around 300 m and the conditions are marred with constant	10	CO1	Comprehension

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	winds, cold current, and rains. The distance of the site from the sea shore is 50 km with the slope of the sea bottom is 1.5 - 2 degrees. Explain your response to the situation with proper reasoning and diagrams. Also explain the construction of the platform with diagrams and steps.			
2	A spar is a marine structure, used for floating oil/gas platforms. Named after navigation channel Spar buoys, spar platforms were developed as an extreme Deepwater alternative to conventional platforms. The deep draft design of spars makes them less affected by wind, wave, and currents and allows for both dry tree and subsea production. A spar platform consists of a large-diameter, vertical buoyant cylinder(s) supporting a deck. Spars are permanently anchored to the seabed by way of a spread mooring system composed of either a chain-wire-chain or chain-polyester-chain configuration. Explain why it is positively buoyant if it is anchored to the sea bed. Use the concept of stability and equilibrium to support your answer.	10	C02	Comprehension
3	Operating at the Indian Ocean is a challenging task owing to its characteristic of being one of the most deadly ocean waters in the world. The Indian Ocean bears close to 1/4th of the water found on the surface of the planet and its warm temperature makes it susceptible to climatic changes like monsoon, tsunami, cyclone and often, strong winds. The ocean's currents are mainly controlled by the monsoon. Two large gyres, one in the northern hemisphere flowing clockwise and one south of the equator moving anticlockwise (including the Agulhas Current and Agulhas Return Current), constitute the dominant flow pattern. During the winter monsoon (November–February), however, circulation is reversed north of 30°S and winds are weakened during winter and the transitional periods between the monsoons. There are only two trenches in the Indian Ocean: the 6,000 km (3,700 mi)-long Java Trench between Java and the Sunda Trench and the 900 km (560 mi)-long Makran Trench south of Iran and Pakistan. A series of ridges and seamount chains produced by hotspots pass over the Indian Ocean. These hotspot tracks have been broken by the still active spreading ridges mentioned above. There are fewer seamounts in the Indian Ocean than in the Atlantic and Pacific. These are typically deeper than 3,000 m (9,800 ft) and located north of 55°S and west of 80°E. Most originated at spreading ridges but some are now located in basins far away from these ridges. The ridges of the Indian Ocean form ranges of seamounts, sometimes very long, including the Carlsberg Ridge, Madagascar Ridge, Central Indian Ridge, Southwest Indian Ridge, Chagos-Laccadive Ridge, 85°E Ridge, 90°E Ridge, Southeast Indian Ridge, Broken Ridge, and East Indiaman Ridge. Based on the information given, select the most appropriate offshore platform, its mooring system and installation method for smooth conduction of E&P activity. Do add supporting statements in your answer.	20	CO3	Comprehension
4	XYZ International reports that one of the Company's Jackup drilling rigs, XYZ-64, was directly in the path of Hurricane Ivan and has sustained damage. The rig is now afloat in the U.S. Gulf of Mexico approximately 80 miles southeast of Venice,	20	C04	Comprehension

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	Louisiana. The rig was operating in ABC location for Dominion Exploration and Production Incorporated, and all personnel had been safely evacuated ahead of the storm. Appropriate regulatory agencies have been notified. The Ocean Tower, which was directly in the path of the storm, operates in water up to 350 feet deep and can drill to a depth of 25,000 feet. As the reservoir has very significant amount of reserves so the owner of the well want to re-start the E&P activity immediately. Prepare a plan to remove the floating Jack-up rig and select another platform with which you can continue the E&P activities at the same well site. Do give justification for your selection			

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage
1	CO1	Discuss the offshore sea environment	55
2	CO2	Analyze station keeping mechanism of offshore structures	55
3	CO3	Categorize various fix and floating offshore platforms,	50
4	CO4	Discuss offshore production facilities	60

Signature of the Course Instructor In-charge:

Signature of the Course Instructor:

Signature of the Chairperson DAC:

Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				

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7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

Course Outcome Attainment:

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Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	Discuss the offshore sea environment	55		
2	CO2	Analyze station keeping mechanism of offshore structures	55		
3	CO3	Categorize various fix and floating offshore platforms,	50		
4	CO4	Discuss offshore production facilities	60		

Name and Signature of the Course Instructor:

DAC Observation and Approval:

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Course Code: PET3007	**Course Title: Enhanced Oil and Gas Recovery Techniques** **Type of Course: 1] Discipline Elective 2] Theory only**	**L- P- C**	3	0	3
Version No.:	2.0				
Course Pre-requisites:	Fundamentals of Reservoir Engineering (RE Lab): Reservoir rock and fluid properties Reservoir Simulation and Modelling (CMG - Software-based Lab) Fluid Flow through Porous Media (Practice based)				
Anti-requisites:	Nil				
Course Description:	The purpose of this course is to enable to understand the oil recovery concepts using different methods, and performance analysis and to develop the basic abilities of modelling and analyzing the reservoir simulation software. The course is both conceptual and analytical in nature and needs fair knowledge of Mathematical and computing. The course develops the critical thinking and analytical skills. The course also enhances the programming abilities through assignments.				
Course objective	The objective of the course is to familiarize the learners with the concepts of Enhanced Oil and Gas Recovery Techniques and attain **Employability** through **Problem Solving** methodologies.				
Course Outcomes:	On successful completion of the course the students shall be able to: CO1: characterize the rock and fluid properties for different chemical EOR processes CO2: choose the reservoir for thermal recovery process CO3: categorize the reservoir for gas injection process CO4: understand the recent trends in enhanced oil recovery				
Course Content:					

Module 1:	Chemical flooding	Term paper	Programming / Simulation	11 Periods

Topics:
Introduction: Oil recovery processes, Geological factors in EOR, EOR Methods
Polymer flooding: Introduction- Planning polymer flood projects - Application of PAM/AA in enhanced oil recovery- Factors affecting flow in porous media- Field considerations- Site factors- Field operation
Alkaline Flooding - Types of alkali used - Entrapment of residue oil - Displacement mechanisms in alkaline flooding - Reservoir selection.
Use of surfactants in oil recovery: Introduction- Classification of EOR surfactants- Mechanism of oil displacement by surfactant flooding- Ultra low interfacial tension in relation to oil displacement by surfactant flooding- Factors influencing oil recovery - Mechanism of surfactant loss in porous media

Module 2:	Thermal flooding for enhanced oil recovery	Assignment	Data Collection	09 Periods

Topics:
Introduction- Theory- Screening criteria for steam flood prospects- Reservoir rock and fluid properties- heat losses and formation heating- oil recovery calculations- An overview of steam flood modeling, parametric studies in steam flooding- Economics of the steam flooding process - Water treatment for steam generation- Steam generators- Determination of steam quality.
In-situ combustion technology: Introduction-Reservoir characteristics- Ignition- Ignition methods, Process In-situ Combustion- Use of In-situ Combustion- conclusions

Module 3:	Gas Injection	Assignment	Seminar	10 Periods

Topics:
Predictive techniques, Reservoir performance, Gas injection in carbonate reservoirs, Inert gas injection, Candidates for gas injection, Immiscible gas injection
Miscible flooding: Introduction- Difference between miscible and immiscible flooding, Sweep efficiency- High pressure gas injection- Enriched gas drive- LPG slug drive- Predictive technique- Field applications.
Carbon dioxide flooding: Process description- Field projects- CO_2 sources- problem areas- designing a CO_2 flood- Guidelines for selection of miscible CO_2 projects- Immiscible CO_2 flooding Conclusions

Module 4:	MEOR and Nano particles in enhanced oil recovery	Assignment	Data Collection	06 Periods

Topics:
MEOR, Types of NP used in EOR, Effects of Nanoparticles on Oil Recovery, Effects of Nanoparticles on IFT Stability of nano particles, Surfactant-NPs Combined Flooding, Field Applications, Challenges, and Perspective.

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Targeted Application and Tools that can be used: Application Area are upstream oil and gas companies like OIL, ONGC Professionally Used Software: CMG, Eclipse
Text Book: **Textbook(s)** E. C. Donaldson, G. V. Chilingarian, T. F. Yew, "Enhanced Oil Recovery: Processes and Operations", Elsevier.
References: **Reference Book(s)** R1: Larry W. Lake, "Enhanced Oil Recovery", Prentice Hall. R2:H. R. Van Pollew and Associates, "Fundamentals of Enhanced Oil Recovery", PennWell. R3: Gogoi S.B., "Advances in Petroleum Technology" Pan Stanford Publishing. 1st edition **e-resources:** 1. https://puniversity.informaticsglobal.com/login 2. https://www.youtube.com/watch?v=azLVjYij5U4 3.https://www.youtube.com/playlist?list=PLXpyHm2f8CTdq4GYer8Wh9RtPnVFq7_Mj (Video Tutorials on Reservoir Engineering) 4. https://www.youtube.com/watch?v=RtPdFsyqbrw 5. https://www.youtube.com/watch?v=BBk2pN4L2Kg
Topics relevant to **"EMPLOYABILITY SKILLS":** Oil Recovery calculations for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout.

Catalogue prepared by:	Dr. Kalpajit Hazarika, Mr. Bhairab Jyoti Gogoi, Mr. Indraneel Agasty, Mr. Anmol Bhargava, Mr. Sugar Srivastava
Recommended by the Board of Studies on:	14th Meeting of the Board of Studies held on 27th July 2022
Date of Approval by the Academic Council:	18th Meeting of the Academic Council held on 3rd August 2022.

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Course Handout AY 2022-23

Date of Issue:

School	:	School of Engineering
Department	:	Department of Petroleum Engineering
Name of the Program	:	B.Tech. in Petroleum Engineering
P.R.C. Approval Ref.	:	
Semester / Year	:	Not Offered
Course Code / Title	:	PET3007 / Enhanced Oil Recovery
Course Credit Structure	:	3L – 0P – 3C
Contact Hours	:	41
Course Instructor In-charge	:	Dr. Kalpajit Hazarika
Course Instructor	:	Dr. Kalpajit Hazarika
Course URL of Edhitch	:	

Program Outcomes (POs):

B. Tech. Program in Petroleum Engineering is designed to prepare graduates to attain following Program Outcomes:

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **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 the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **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.

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PO6 **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO09: **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Course Prerequisites: Nil

Course Description:

The purpose of this course is to enable to understand the oil recovery concepts using different methods, and performance analysis and to develop the basic abilities of modelling and analyzing the reservoir simulation software. The course is both conceptual and analytical in nature and needs fair knowledge of Mathematical and computing. The course develops the critical thinking and analytical skills. The course also enhances the programming abilities through assignments.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Enhanced Oil and Gas Recovery Techniques and attain **Employability** through **Problem Solving** methodologies

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Course Outcomes (COs):

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Upon successful completion of the course the students shall be able to:

CO1: characterize the rock and fluid properties for different chemical EOR processes

CO2: choose the reservoir for thermal recovery process

CO3: categorize the reservoir for gas injection process

CO4: understand the recent trends in enhanced oil recovery

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12
CO1	H	M			L		L			L		
CO2	H	M			L		M			L		
C03	M	H			M		L			L		
CO4	M	H			L		M			L		
CO5	M	H			L		L			L		
H = High, M = Moderate, L = Low												

Course Content (Syllabus):

Module-I: Chemical flooding **[11 Hours]-Application Level**

Introduction: Oil recovery processes, Geological factors in EOR, EOR Methods

Polymer flooding: Introduction- Planning polymer flood projects - Application of PAM/AA in enhanced oil recovery- Factors affecting flow in porous media- Field considerations- Site factors- Field operation

Alkaline Flooding - Types of alkali used - Entrapment of residue oil - Displacement mechanisms in alkaline flooding - Reservoir selection.

Use of surfactants in oil recovery: Introduction- Classification of EOR surfactants- Mechanism of oil displacement by surfactant flooding- Ultra low interfacial tension in relation to oil displacement by surfactant flooding- Factors influencing oil recovery - Mechanism of surfactant loss in porous media

Module-II: Thermal flooding for enhanced oil recovery **[9 hours]-Application Level**

Introduction- Theory- Screening criteria for steam flood prospects- Reservoir rock and fluid properties- heat losses and formation heating- oil recovery calculations- An overview of steam flood modeling, parametric studies in steam flooding- Economics of the steam flooding process - Water treatment for steam generation- Steam generators- Determination of steam quality.

In-situ combustion technology: Introduction-Reservoir characteristics- Ignition- Ignition methods, Process In-situ Combustion- Use of In-situ Combustion- conclusions

Module-III: Gas Injection **[10 hours]- Application Level**

Predictive techniques, Reservoir performance, Gas injection in carbonate reservoirs, Inert gas injection, Candidates for gas injection, Immiscible gas injection

Miscible flooding: Introduction, Difference between miscible and immiscible flooding - Sweep efficiency- High pressure gas injection- Enriched gas drive- LPG slug drive- Predictive technique- Field applications.

Carbon dioxide flooding: Process description- Field projects- CO_2 sources- problem areas- designing a CO_2 flood- Guidelines

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for selection of miscible CO_2 projects- Immiscible CO_2 flooding Conclusions

Module-IV: MEOR and Nano particles in enhanced oil recovery: [6 Hours]- Application Level

MEOR, Types of NP used in EOR, Effects of Nanoparticles on Oil Recovery, Effects of Nanoparticles on IFT Stability of nano particles, Surfactant-NPs Combined Flooding, Field Applications, Challenges, and Perspective.

Delivery Procedure (Pedagogy):

This is a theory based course. Most of the lectures will be taken with the help of Power Point Presentations and White Board. Videos will be shown for the better understanding of selective topics. Flip Class Room sessions will be conducted on selective topics. Assignments will be given to each student time-to-time after completion of considerable portion of the syllabus. Submission of assignment on time is mandatory for all the students. Assignments, Quiz Competition and Poster Presentation will carry 20% weightage under Continuous Assessment 3 (CA 3). Review classes will be conducted to clear doubts and to evaluate the level of understanding of the each student individually.

Following procedures will be adopted in the course for delivering the content:

(a) Self Learning Topics:

- Present status of the use of surfactants in oil recovery (Module-II)
- Current status of In-situ Combustion (Module -III)
- CO_2 sources(Module -IV)
- Field application of microbial enhancement of oil recovery(Module -IV)

(b) Participative Learning Topics: Poster Presentation-

-Recent Progress of High Pressure Air Injection Process (HPAI) in Light Oil Reservoir

-Forecasting Ultimate Oil Recovery
-Enhanced Oil Recovery Using Nanoparticles
-Enhanced-Oil-Recovery Injection Waters
-Enhanced Oil Recovery Water Requirements
-Oil Recovery by Gravity Drainage
-Principles of Heavy Oil Recovery
-Nanofluids Application for Heavy Oil Recovery
-Sustainable Surfactants in Enhanced Oil Recovery
-Chemical Methods for Heavy Oil Recovery
-Environmental Aspects of Enhanced Oil Recovery
-Enhancing Oil Recovery WithNanoemulsion Flooding
-Economic Evaluation of Enhanced Oil Recovery

(c) Technology Enabled Learning Topics (TET):

- Application of different EOR methods through Audio - Video Session

(d) Problem Based Learning Topics (PBLT):

- Data Analysis using tools like CMG software / Grapher

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Continuous Assessment Plan:

Module **I: Quiz**

1.1 Quiz will be conducted on related topics.

Module II: Literature Review

2.1**:** Literature Review of Digital/e-resources from Presidency University link shared below. It is mandatory to submit a screenshot accessing digital resources, otherwise, it will not be evaluated. Link to Presidency University e-resources: https://puniversity.informaticsglobal.com/login.

Module III: Poster Presentation

3.1 A Team Exercise will be conducted for the students. Students will have the flexibility to select their team members. For assessment, maximum weightage will be given on how professionally the teams are interacting with each other during the presentation.

Module IV: Quiz (OR) Literature Survey and Report Submission

4.1 Quiz will be conducted on related topics.

Reference Materials:

Textbook(s)

E. C. Donaldson, G. V. Chilingarian, T. F. Yew, "Enhanced Oil Recovery: Processes and Operations", Elsevier.

Reference Book(s)

R1: Larry W. Lake, "Enhanced Oil Recovery", Prentice Hall.

R2:H. R. Van Pollew and Associates, "Fundamentals of Enhanced Oil Recovery", PennWell

e-resources:

1. Link for PU e-resources: https://puniversity.informaticsglobal.com/login

2.EOR methods:
https://fenix.tecnico.ulisboa.pt/downloadFile/1689244997256108/Master%20thesis%20for%20submmit%20.pdf

3. Introduction to Enhanced Oil Recovery Techniques:
http://large.stanford.edu/courses/2015/ph240/zerkalov2/docs/sino.pdf

4.Polymer flooding: https://www.youtube.com/watch?v=7kF2LWpuhFc&t=1154s

Guideline to Students:

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(a) About the Course:

The goal of the course will be to enable the students to obtain sufficient knowledge of challenging forces and processes within the reservoir. This knowledge will form the building blocks to be able to understand synthesize and evaluate different approaches of how to get more hydrocarbons out of a specific reservoir type.

(b) Notification / Announcement related to the Course:

All the course related notifications will be displayed on the Department Notice Board or the same will be shared through email/ Whatsapp. All the announcements will be made during the regular lecture hours as well.

(c) Academic Regulations

The students are advised to download the 'Academic Regulations, 2021', Regulation No. PU/AC-15/10/06_2021, from Presidency University, Bengaluru website (https://presidencyuniversity.in/wp-content/uploads/2022/09/Academic-Regulations-2021.pdf) and go through the Section Nos. 1.0 through 25.0.

Course Schedule:

Module-wise Macro Level planning for course delivery schedule is provided below:

Module-wise Macro Level planning for course delivery schedule is provided below:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Over View of the course			1
02	Module-I			11
03	Quiz on Module I			-
04	Module -II			09
05	Literature Review on Module II			-
06	Mid Term Syllabus and question pattern discussion			1
07	Mid Term question paper discussion			1
08	Mid Term Exam			-
09	Module -III			10
10	Quiz (OR) Digital Poster Presentation on Module III			-
11	Module -IV			06
12	Quiz on Unit IV			-
13	Course integration			1
14	End Term Examination			1

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Schedule of Instruction:

Module -wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Session No.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
01	L01	Program Integration	Overview of the course			
Unit-I: Chemical flooding						
02	L02	Introduction:	Oil recovery processes,	CO1	Lecture / Presentation	T1 Ch08
03	L03		Geological factors in EOR, EOR Methods	CO1	Lecture / Presentation	T1 Ch08
04	L04	Polymer flooding:	Introduction- Planning polymer flood projects - Application of PAM/AA in enhanced oil recovery-	CO1	Lecture / Presentation	T1 Ch08
05	L05		Factors affecting flow in porous media-	CO1	Lecture / Presentation	T1 Ch08
06	L06		Field considerations- Site factors- Field operation	CO1	Lecture / Presentation	T1 Ch08
07	L07	Alkaline Flooding	- Types of alkali used - Entrapment of residue oil -	CO1	Lecture / Presentation	T1 Ch08
08	L08		Displacement mechanisms in alkaline flooding - Reservoir selection.	CO1	Lecture / Presentation	T1 Ch08
09	L09	Use of surfactants in oil recovery:	Introduction- Classification of EOR surfactants- Mechanism of oil displacement by surfactant flooding-	CO1	Lecture / Presentation	T1 Ch08
10	L10		Ultra low interfacial tension in relation to oil displacement by surfactant flooding-	CO1	Lecture / Presentation	T1 Ch08
11	L11		Factors influencing oil		Lecture /	T1 Ch08

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			recovery -		Presentation	
12	L12		Mechanism of surfactant loss in porous media		Lecture / Presentation	T1 Ch08
Quiz on Unit I				CO1		
Unit II Thermal flooding for enhanced oil recovery						
12	L13	Thermal flooding	Introduction- Theory- Screening criteria for steam flood prospects-	CO2	Lecture / Presentation	T1 Ch09
13	L14		Reservoir rock and fluid properties-	CO2	Lecture / Presentation	T1 Ch09
14	L15		heat losses and formation heating-	CO2	Lecture / Presentation	T1 Ch09
15	L16		oil recovery calculations- An overview of steam flood modeling,	CO2	Lecture / Presentation	T1 Ch10
16	L17		parametric studies in steam flooding- Economics of the steam flooding process -	CO2	Lecture / Presentation	T1 Ch10
17	L18		Water treatment for steam generation- Steam generators-	CO2	Lecture / Presentation	T1 Ch10
18	L19		Determination of steam quality.	CO2	Lecture / Presentation	T1 Ch10
19	L20	In-situ combustion technology:	Introduction-Reservoir characteristics- Ignition- Ignition methods,	CO2	Lecture / Presentation	T1 Ch10
20	L21		Process In-situ Combustion- Use of In-situ Combustion- conclusions	CO2	Lecture / Presentation	T1 Ch10
22	L22	Mid Term Syllabus and question pattern discussion		CO1, CO2		
23	L23	Mid Term question paper discussion		CO1, CO2		
Literature Review on Unit II				C02	-	-
Unit-III: Gas Injection						
24	L24	Gas injection	Predictive techniques, Reservoir performance,	CO3	Lecture / Presentation	T1 Ch11

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25	L25		Gas injection in carbonate reservoirs,	CO3	Lecture / Presentation	T1 Ch11
26	L26		Inert gas injection,	CO3	Lecture / Presentation	T1 Ch11
27	L27		Candidates for gas injection, Immiscible gas injection	CO3	Lecture / Presentation	T1 Ch12
28	L28	Miscible flooding:	Introduction- Sweep efficiency, Difference between miscible and immiscible flooding	CO3	Lecture / Presentation	T1 Ch12
29	L29		High pressure gas injection- Enriched gas drive-	CO3	Lecture / Presentation	T1 Ch12
30	L30		LPG slug drive- Predictive technique- Field applications.	CO3	Lecture / Presentation	T1 Ch12
31	L31	Carbon dioxide flooding:	Process description- Field projects-	CO3	Lecture / Presentation	T1 Ch12
32	L32		CO_2 sources- problem areas- designing a CO_2 flood-	CO3	Lecture / Presentation	T1 Ch12
33	L33		Guidelines for selection of miscible CO_2 projects- Immiscible CO_2 flooding Conclusions	CO3	Lecture / Presentation	T1 Ch12
Quiz (OR) Digital Poster Presentation on Unit III				CO3		
Unit-IV: MEOR and Nano particles in enhanced oil recovery:						
34	L34	**MEOR and Nano particles in enhanced oil recovery:**	MEOR,	CO4	Lecture / Presentation	T1 Ch04
35	L35		Types of NP used in EOR,	CO4	Lecture / Presentation	T1 Ch04
36	L36		Effects of Nanoparticles on Oil Recovery,	CO4	Lecture / Presentation	T1 Ch04
37	L37		Effects of Nanoparticles on IFT Stability of nano particles,	CO4	Lecture / Presentation	T1 Ch04
38	L38		Surfactant-NPs Combined Flooding, Field Applications,	CO4	Lecture / Presentation	T1 Ch04

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39	L39		Challenges, and Perspective.	CO4	Lecture / Presentation	T1 Ch04
	Quiz on Unit IV			CO4	-	-
40	L40	Course Integration		-	-	-
41	L41	End Term Syllabus and question paper pattern discussion		C01 - CO4	-	-

Topics relevant to **"EMPLOYABILITY SKILLS":** Oil Recovery calculations for developing **Employability Skills** through **Problem Solving** methodologies. This is attained through the Assignment as mentioned in the assessment component.

Assessment Schedule:

Unit-wise Micro Level planning for course delivery schedule is provided below:

Sl. No.	Assessment Type	Contents	Course Outcome Number	Duration in Hours	Marks	Weightage	Venue, Date, and Time
01	CA: Quiz on Unit I	L02-L10	CO1	-	10	5	
02	Mid Term	L02-L16	C01- CO2	2	60	30	
03	CA: Literature Review of Digital/e-resources from Presidency University link shared below. It is mandatory to submit a screenshot accessing digital resources, otherwise, it will not be evaluated. Link to Presidency University e-resources: https://puniversity.informaticsglobal.com/login	L09-L16	CO2	-	10	5	
04	CA: Quiz (OR) Digital Poster Presentation on Unit III	L19-L27	C03	-	10	5	
05	CA: Quiz on Unit IV	L28 - L34	CO4	-	10	5	

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06	End Term	L02-L49	CO1-CO4	3	100	50	

Course Clearance Criteria:

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Contact Timings in the Chamber for any Discussion:

Students may meet the Course Instructor either during the Chamber Consultation Hour (CCH) as mentioned in their respective Section Time Table or take a prior appointment for the consultation. Students may clear their doubts from the Course Instructor during CCH.

Sample Thought Provoking Questions:

Sl. No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Steam at T∞,1 = 320 °C flows in a cast iron pipe [k = 80 W/ m.°C] whose inner and outer diameter are D1 = 5 cm and D2 = 5.5 cm, respectively. The pipe is covered with a 3-cm-thick glass wool insulation [k = 0.05 W/ m.°C]. Heat is lost to the surroundings at T∞,2 = 5°C by natural convection and radiation, with a combined heat transfer coefficient of h2 = 18 W/m2. °C. Taking the heat transfer coefficient inside the pipe to be h1 = 60 W/m2K, determine the rate of heat loss from the steam per unit length of the pipe. Also determine the temperature drop across the pipe shell and the insulation.	10	CO3	Application
2	Mobility ratio and volumetric sweep efficiency plays important role in polymer flooding process, justify this statement. The viscosity and relative permeability of polymer slug is 9 cp and 0.25 respectively. The viscosity and relative permeability of reservoir fluid is 7 cp and 0.3 respectively. Find the mobility ratio and Inverse mobility ratio for the polymer slug.	10	CO2	Comprehension
3	Gas is injected to increse the hydrocarbon production in oil and gas industry in different process. Mention all the process and differentiate between them with respect to their objective, mechanism and propetry change during the process.	5	CO4	Comprehension
4	Enhanced oil recovery process is mainly applied after secondary recovery technique to enhance the oil production. Infill drilling is an another technique to enhance the oil production. According to you which is preferable technique in between EOR and infill drilling? Give justification to support your opinion. Mention the diffrences between secondary recovery technique, EOR, Infill	8	CO1	Application

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	drilling process.			
5	The profitabilioty of any EOR process depends on efficiency of the process. What are the two main efficiency in EOR process and how they will play role on surfactant, alkali and polymer flooding process? Define areal, vertical and volumetric sweep efficiency.	10	CO1	Comprehension
6	Screening criteria plays an important role on Selection of EOR process. All EOR process are not suitable for all types of reservoir. Write the screening criteria for polymer flooding flooding process. Explain how do charecterization factor and correlation index plays an important role in alkali flooding process.	8	CO2	Comprehension
7	Microbial Enhance oil recovery is one of the most important EOR technique. Mention the screening criteria and basic mechanism for MEOR. Apart from MEOR, microbes has been extensively used in oil and gas industries. Write the different application of microbes in oil and gas industry with example. Some literature has mentioned about the reduction of oil price due to the presence of microbes in hydrocarbon, give justification in support of this finding.	8	CO5	Comprehension
8	Immiscible gas injection technique comes under enhance oil recovery process. This process can be classified based on the the reservoir fluid characterstic, type of injected gas used and minimum missibility pressure. Mention the different classifications and differentiate between them with appropriate diagram. A reservoir is having hydrocarbon comprised of 70 % C7+, 20 % C2-C6 and remaining 10 % C1. Misscible gas injection process has been selected based on different reservoir parameters. According to you which misscible flooding process is suitable for this case? Explain with proper diagram and justification.	8	CO4	Application
9	What are the reasons in selecting a shallow depth for Steam Flooding injection process?	8	CO3	Comprehension
10	Differentiate between forward combustion and reversion combustion?	8	CO3	Comprehension
11	A hydrocarbon reservoir is having 35 degree API and boilling point 180 degree Celcious. During distillation process 26 ml of distillate was collected at 180 degree Celcius temperature. Find the relevent parameters to characterize the crude.	8	C05	Application

Target Set for Course Outcome attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage

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1	CO1	characterize the rock and fluid properties for different chemical EOR processes	**60**
2	CO2	choose the reservoir for thermal recovery process	**50**
3	CO3	categorize the reservoir for gas injection process	**50**
4	CO4	understand the recent trends in enhanced oil recovery	**40**

Signature of the Course Instructor In-charge: Dr. Kalpajit Hazarika

Signature of the Course Instructor: Dr. Kalpajit Hazarika

This course has been duly verified and approved by the D.A.C.

Signature of the Chairperson D.A.C.:

Course Completion Remarks and Self-Assessment:

Sl. No.	Activity as listed in the Course Schedule	Scheduled Completion date	Actual Completion Date	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Any Specific Suggestion / Observation on Content / Coverage / Pedagogical Methods:

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Course Outcome Attainment:

Sl. No.	CO No.	Course Outcome	Target Set for Attainment in Percentage	Actual CO Attainment in Percentage	Remarks on Attainment and Measures to Enhance the Attainment
1	CO1	characterize the rock and fluid properties for different chemical EOR processes	40		
2	CO2	choose the reservoir for thermal recovery process	40		
3	C03	categorize the reservoir for gas injection process	40		
4	CO4	understand the recent trends in enhanced oil recovery	40		

Name and Signature of the Course Instructor: Dr. Suman Paul

D.A.C. Observation and Approval:

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