Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

MAKE-UP EXAMINATION-JAN 2023

Date: 25-01-2023
Time: 09:30 AM to 12:30 PM
Max Marks: 100
Weightage: 50%

Course Code: PET 318
Course Name: Unconventional Hydrocarbons
Program : B.Tech.

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) All the questions are compulsory.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries FIVE marks. **(6Qx5M = 30M)**

1: Choose the correct Answer.

(i) _____ is not considered as renewable energy resource.
(A) Wind (B) Solar
(C) Oil (D) Biomass

(ii) _____ type of coal has the most carbon content.
(A) Bituminous (B) Lignite
(C) Peat (D) Anthracite

(iii) _____ theory is related to non-renewable resources.
(A) Game (B) Phlogiston
(C) Big Bang (D) Hotelling’s

(iv) Bill Gates, Chairman of the Board for Terra Power Company, is associated with ______ (non-renewable resources).
(A) earth minerals (B) nuclear energy
(C) fossil fuels (D) metal ores

(v) Rajasthan Renewable Energy Corporation Limited was established in _____.
(A) 1989 (B) 1997
(C) 2002 (D) 2016

[1M + 1M + 1M + 1M + 1M] (C.O.No. 1) [Knowledge]

2: Fill in the blanks with appropriate word.

(i) The law of _____ of energy states that energy can be converted in form, but not created or destroyed.

(ii) The energy whose source can't be replenished is known as _____ energy.

(iii) The most abundantly available fossil fuel in India is _____.

(iv) Common energy source in Indian village is _____ and animal dung.

(v) _____ energy is generated from the heat of the earth.

[1M + 1M + 1M + 1M + 1M] (C.O.No. 1) [Knowledge]

3: Select True or False.

(i) The relative positions of sun and moon and their distances are continuously changing.
(A) True (B) False

(ii) Pyrheliometer is used to measure diffuse radiation.
(A) True (B) False

(iii) Peat is the first stage in the formation of coal from wood.
(A) True (B) False

(iv) The average calorific value of bituminous coal is 1524 kJ/kg.
(A) True (B) False

(v) The major non-renewable energy usage in India is coal.
(A) True (B) False

[1M + 1M + 1M + 1M + 1M] (C.O.No. 1) [Knowledge]

4: Match the information provided in Column A with Column B.

Column A	Column B
(a) Peat	(i) may have thick evaporite deposits that accumulated during arid periods while rainfall was restricted by mountains uplifted at the basin margins
(b) Coal by definition	(ii) is not an unique substance, but rather a group of sedimentary rocks comprised primarily of altered vegetal matter
(c) Pennsylvanian and Permian coalbeds	(iii) provides the percentage of Fixed Carbon (FC), Volatile Matter (VM), Moisture (H2O) Content, and Ash Content of the coal
(d) Rift basins, like the Gulf Coast Basin	(iv) is a dark brown residuum produced by the partial decomposition and disintegration of plants that grow in marshes and swamps
(e) Proximate Analysis	(v) are typically present in a somewhat regular sequence of sedimentary rocks referred to as a cyclothem

[1M + 1M + 1M + 1M + 1M] (C.O.No. 2) [Knowledge]

5: (i) Distinguish at least three significant issues which may influence the significance and future of shale gas.

(ii) Name the basin types allocated to each shale gas play.

[3M + 2M] (C.O.No. 3) [Knowledge]

6: (i) Explain the relation between hydrates and clathrates.

(ii) Identify a compound which is liquid at room conditions but forms hydrate.

[4M + 1M] (C.O.No. 4) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks. (4Qx10M = 40M)

7: (a) To determine the volume of gas-in-place and the potential gas recovery as a function of pressure, the coal matrix properties must be evaluated. Summarize all the coal matrix properties and their most common sources.

(b) To determine the gas and water production rates from coalbed methane wells, the properties of the coal natural fracture system must be evaluated. Identify all the properties of coal natural fracture system and their most common sources.

[5M + 5M] (C.O.No. 2) [Comprehension]

8: A detailed standardized procedure for describing coal cores should be followed. Various other physical characteristics should be noted and included in a field description of the core before desorption testing and in the lab after desorption testing. Field observations may include photographing the cores and describing cleating, fracturing, crushed or broken zones of the core, partings, mineralization, relative brightness, and any gas bubbling from the core. The detailed lab information should include spacing of cleats, breakage of core, and anything not noted in the field description.

(a) Discuss the influence of coal rank on coalbed reservoirs.

(b) Explain the importance of determining vitrinite reflectance and fixed carbon content.

[5M + 5M] (C.O.No. 2) [Comprehension]

9: Extensive hydraulic fracturing (fracking) is undertaken within the shale gas reservoir to further increase the permeability and hence gas yield. Fracturing is generally undertaken 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 that involve using different volumes and compositions of fluids, depending on the design. Distinguish the sequence of four substages that may be followed during treatment stage.

(C.O.No.3) [Comprehension]

10: Hydrates are classified by the arrangement of the water molecules in the crystal, and hence the crystal structure. There are two types of hydrates commonly encountered in the petroleum business. These are called Type I and Type II, sometimes referred to as Structure I and II. A third type of hydrate that may also be encountered is Type H (Structure H), but it is much less common.

(a) Compare Type I and Type II Hydrates.

(b) Refer the suitable Table given below and answer the following questions:

(i) Will a hydrate form for ethane at a temperature 15°C and 0.77 MPa?

(ii) Will a hydrate form for propane at a temperature 20°C and 10 MPa?

[6M + 4M] (C.O.No. 4) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each question carries FIFTEEN marks. (2Qx15M = 30M)

11: The degree of well interference, and consequently methane recovery rates, are affected by permeability, the degree of well stimulation (hydraulic fracture dimensions), and the well spacing. Illustrate the impact of these parameters on CBM well production with reference diagrams from Warrior Basin simulation model for:

(a) Sensitivity of Gas Production Rate to Well Drainage Area
(b) Sensitivity of Gas Production Rate to Permeability
(c) Sensitivity of Gas Production Rate to Hydraulic Fracture

[5M + 5M + 5M] (C.O.No. 2) [Application]

12: Mud is everywhere, and life is ubiquitous. Therefore, it is not surprising that black shales may be deposited in a wide range of sedimentary environments from the bottom of lakes to the abyssal plains of the ocean. The interpretation of ancient environments of black shale deposition has been influenced by studies of modern environments where organic matter-rich sediments are currently accumulating. However, most ancient black shales appear to have been deposited in shallow marine epicontinental environments for which we have no modern analogs. Demonstrate the contribution of Shallow Marine Depositional Environments for the deposition organic matter-rich shale. (C.O.No. 3) [Application]

Hints for solving problems:

Table 1: Comparison Between Type I and Type II Hydrates.

	Type I	Type II
Water Molecules per Unit Cell	46	136
Cages per Unit Cell		
Small	2	16
Large	6	8
Theoretical Formula†		
All cages filled	$X \times 5\frac{3}{4}\ H_2O$	$X \times 5\frac{2}{3}\ H_2O$
Mole fraction hydrate former	0.1481	0.1500
Only large cages filled	$X \times 7\frac{2}{3}\ H_2O$	$X \times 17\ H_2O$
Mole fraction hydrate former	0.1154	0.0556
Cavity Diameter (Å)		
Small	7.9	7.8
Large	8.6	9.5
Volume of Unit Cell (m^3)	1.728×10^{-27}	5.178×10^{-27}
Typical Formers	CH_4, C_2H_6, H_2S, CO_2	C_3H_8, i-C_4H_{10}, N_2

† = where X is the hydrate former.

Table 2: Hydrate-Forming Conditions for Methane.

Temp. (°C)	Press. (MPa)	Phases	Composition (mol %)		
			Aqueous	Vapor	Hydrate
0.0	2.60	L_A-H-V	0.10	0.027	14.1
2.5	3.31	L_A-H-V	0.12	0.026	14.2
5.0	4.26	L_A-H-V	0.14	0.026	14.3
7.5	5.53	L_A-H-V	0.16	0.025	14.4
10.0	7.25	L_A-H-V	0.18	0.024	14.4
12.5	9.59	L_A-H-V	0.21	0.024	14.5
15.0	12.79	L_A-H-V	0.24	0.025	14.5
17.5	17.22	L_A-H-V	0.27	0.025	14.5
20.0	23.4	L_A-H-V	0.30	0.027	14.6
22.5	32.0	L_A-H-V	0.34	0.028	14.6
25.0	44.1	L_A-H-V	0.37	0.029	14.7
27.5	61.3	L_A-H-V	0.41	0.029	14.7
30.0	85.9	L_A-H-V	0.45	0.029	14.7

Notes: Composition for the aqueous phase and for the hydrate is the mole percent of the hydrate former (CH_4). For the vapor the composition is the mole percent water.

Table 3: Hydrate-Forming Conditions for Ethane.

Temp. (°C)	Press. (MPa)	Phases	Composition (mol %)		
			Aqueous	Non-Aqu.	Hydrate
0.0	0.53	L_A-H-V	0.037	0.126	11.5
2.0	0.61	L_A-H-V	0.041	0.117	11.5
4.0	0.77	L_A-H-V	0.047	0.107	11.5
6.0	0.99	L_A-H-V	0.054	0.096	11.5
8.0	1.28	L_A-H-V	0.062	0.086	11.5
10.0	1.68	L_A-H-V	0.072	0.075	11.5
12.0	2.23	L_A-H-V	0.083	0.065	11.5
14.0	3.10	L_A-H-V	0.096	0.052	11.5
14.6	3.39	L_A-L_H-V-H	0.098	0.049 – V	11.5
				0.025 – L_H	
15.0	4.35	L_A-L_H-H	0.098	0.025	11.5
16.0	10.7	L_A-L_H-H	0.103	0.023	11.5
16.7	15.0	L_A-L_H-H	0.105	0.022	11.5
17.5	20.0	L_A-L_H-H	0.106	0.022	11.5

Notes: Composition for the aqueous phase and for the hydrate is the mole percent of the hydrate former (C_2H_6). For the nonaqueous phase (either the vapor or a second liquid) the composition is the mole percent water. The phase designated L_H is a C_2H_6-rich liquid.

Table 4: Hydrate-Forming Conditions for Propane.

Temp. (°C)	Press. (MPa)	Phases	Composition (mol %)		
			Aqueous	Non-Aqu.	Hydrate
0.0	0.17	L_A-H-V	0.012	0.36	5.55
1.0	0.21	L_A-H-V	0.014	0.31	5.55
2.0	0.26	L_A-H-V	0.017	0.27	5.55
3.0	0.32	L_A-H-V	0.019	0.23	5.55
4.0	0.41	L_A-H-V	0.023	0.19	5.55
5.0	0.51	L_A-H-V	0.027	0.17	5.55
5.6	0.55	L_A-L_H-V-H	0.028	0.158 – V	5.55
				0.0094 – L_H	
5.6	1.0	L_A-L_H-H	0.028	0.0093	5.55
5.6	5.0	L_A-L_H-H	0.028	0.0088	5.55
5.7	10.0	L_A-L_H-H	0.028	0.0083	5.55
5.7	15.0	L_A-L_H-H	0.028	0.0079	5.55
5.7	20.0	L_A-L_H-H	0.028	0.0074	5.55

Notes: Composition for the aqueous phase and for the hydrate is the mole percent of the hydrate former (C_3H_8). For the nonaqueous phase (either the vapor or a second liquid) the composition is the mole percent water. The phase designated L_H is a C_3H_8-rich liquid.