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**PRESIDENCY UNIVERSITY**

**Bengaluru**

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| **End - Term Examinations – JANUARY 2025** |
| **Date:** 16 – 01- 2025 **Time:** 09:30 am – 12:30 pm |

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| **School:** SOE | **Program:** B. Tech in Petroleum Engineering | |
| **Course Code :** PET2017 | **Course Name :** Natural Gas Hydrates | |
| **Semester**: V | **Max Marks**: 100 | **Weightage**: 50% |

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| **Marks** | **20** | **20** | **30** | **30** | **-** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Do not write anything on the question paper other than roll number.*

**Part A**

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| **Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M** | | | | |
| **1** | State and write the Hammerschmidt Equation. | **2 Marks** | **L1** | **CO3** |
| **2** | State two differences between the Labile Cluster Nucleation Hypothesis and the Nucleation at the Interface Hypothesis. | **2 Marks** | **L1** | **CO3** |
| **3** | List two key safety aspects related to gas hydrates in industrial settings. | **2 Marks** | **L1** | **CO3** |
| **4** | Recall the “memory effect” phenomenon. | **2 Marks** | **L1** | **CO3** |
| **5** | Recall the difference between hydrate growth and dissociation in kinetic studies. | **2 Marks** | **L1** | **CO3** |
| **6** | List the criteria for phase equilibrium involving hydrates as established by Gibbs. | **2 Marks** | **L1** | **CO4** |
| **7** | List the reasons gas hydrates are considered a promising medium for the long-term storage of CO2. | **2 Marks** | **L1** | **CO4** |
| **8** | Define the concept of the hydrate stability zone in subsea sediments | **2 Marks** | **L1** | **CO4** |
| **9** | Mention two benefits of using gas hydrates in gas transport and storage. | **2 Marks** | **L1** | **CO4** |
| **10** | State the factors that make desalination using gas hydrates a sustainable solution for water scarcity. | **2 Marks** | **L1** | **CO4** |

**Part B**

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| **Answer the Questions Total 80 Marks.** | | | | | |
| **11.** | Discuss the potential of gas hydrates as an alternative energy resource, discussing their advantages and the challenges of sustainable extraction. Examine the environmental implications of gas hydrates, focusing on their ecological impacts, associated risks, and their role in mitigating climate change. | | **20 Marks** | **L2** | **CO1** |
| **or** | | | | | |
| **12.** | Discuss the knowledge base for hydrate nucleation by addressing the following aspects: the behavior of supercooled water, the solubility of natural gases in water, the basic nucleation theory of ice, and the significance of the sites of hydrate nucleation in understanding hydrate formation mechanisms. | | **20 Marks** | **L2** | **CO1** |
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| **13.** | Discuss the steps involved in an experiment for hydrate formation and dissociation, focusing on the relationship between gas consumption and time during the hydrate formation process. Provide a plot illustrating gas consumption versus time during hydrate formation.  Also, define hydrate dissociation and discuss its various mechanisms in detail. | | **20 Marks** | **L2** | **CO2** |
| **or** | | | | | |
| **14.** | Discuss how the pressure and temperature conditions depicted in the phase diagram affect the formation and stability of gas hydrates in the presence of different hydrocarbons, such as methane, ethane, and propane. Compare and contrast the behavior of these hydrocarbons under varying conditions, and evaluate their impact on hydrate stability.  Examine how the quadruple points in the phase diagram represent the coexistence of different phases and assess their significance in understanding gas hydrate systems for various hydrocarbons. | | **20 Marks** | **L2** | **CO2** |

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| **15.** | Discuss the Statistical Thermodynamic Approach to Hydrate Phase Equilibria, focusing on the Langmuir Adsorption Analogy and its application in modeling hydrate formation. Discuss how hydrate fugacity is defined and the importance of reference parameters in phase equilibrium calculations. Explore the Gibbs Free Energy Method and its role in determining hydrate stability. Examine the use of Ab Initio methods and the van der Waals and Platteeuw methods in modeling gas hydrate systems. Finally, evaluate the accuracy and practical reliability of CSMGem in comparison to other commercial hydrate programs, highlighting their strengths and limitations in predicting hydrate behavior and phase equilibria. | **20 Marks** | **L2** | **CO3** |
| **Or** | | | | |
| **16.** | Discuss the various measurement methods for hydrate phase equilibria and kinetics, covering the following aspects:   * 1. Principles of equilibrium apparatus development.   2. Apparatuses designed for use above and below the ice point.   3. Apparatuses for two-phase equilibria.   4. Flow loops used for studying hydrate formation kinetics.   Provide detailed explanations and examples for each of these measurement techniques. | **20 Marks** | **L2** | **CO3** |

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| **17.** | An oil and gas company has identified a significant natural gas reserve in an Arctic offshore region, where the extreme low temperatures and high pressures pose challenges related to gas hydrate formation. Develop a detailed case study evaluating:   * 1. The risks associated with hydrate formation during drilling and production operations.   2. Effective strategies to mitigate pipeline blockages caused by hydrates.   3. The feasibility of utilizing gas hydrates as a temporary storage medium for natural gas during transport. | **20 Marks** | **L3** | **CO4** |
| **Or** | | | | |
| **18.** | An energy company is exploring innovative solutions for sustainable energy practices and environmental challenges. They aim to integrate gas hydrate technology into two important applications CO₂ Sequestration and Desalination.  Develop a detailed analysis addressing the following (include appropriate diagrams, examples, and data to support your evaluation):   1. The thermodynamic and kinetic factors influencing the formation and stability of CO₂ hydrates in natural reservoirs. 2. The environmental implications and long-term viability of CO₂ sequestration using gas hydrates. 3. The technical and economic feasibility of gas hydrate-based desalination as a sustainable solution for freshwater production.   The challenges and potential synergies in combining CO₂ sequestration and desalination within a single gas hydrate framework. | **20 Marks** | **L3** | **CO4** |

**\*\*\*\*\* BEST WISHES \*\*\*\*\***