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PRESIDENCY UNIVERSITY BENGALURU

SCHOOL OF ENGINEERING

MAKEUP EXAMINATION - July 2024

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| **Semester : III& VI** | **Date :09-07-02024** |
| **Course Code:** PET 2009 | **Time: 9:30AM -12:30PM** |
| **Course Name:** Thermodynamics of Reservoir Fluids | **Max Marks:** 100 |
| **Program:** B.Tech. (Petroleum Engineering) | **Weightage:** 50% |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Question paper consists of 3 parts.*
3. *Scientific and non-programmable calculator are permitted.*
4. *Do not write any information on the question paper other than Roll Number.*

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| **PART A** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 2M=10M** | | | |
| 1 | State first law of thermodynamics and its mathematical expression. | (CO1) | [Knowledge] |
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| 2 | State the applications of PT-diagram. | (CO3) | [Knowledge] |
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| 3 | Define internal energy. | (CO1) | [Knowledge] |
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| 4 | State Gibbs phase rule. | (CO3) | [Knowledge] |
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| 5 | Discuss the classification of crude oil based on ºAPI | (CO2) | [Knowledge] |
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| 6 | Define oil formation volume factor. | (CO2) | [Knowledge] |
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| 7 | List the conditions for a system to be in thermodynamic equilibrium | (CO1) | [Knowledge] |
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| **PART B** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 10M=50M** | | | |
| 8 | The significance of PMM in thermodynamics lies in illustrating the principles and limitations set by the laws of thermodynamics, particularly the First and Second Laws.  Explain PMM-1 and PMM-2.  If a reversible heat engine operating in a cycle between a source and sink temperature of 666℃ and 20℃ respectively. Predict the work done per KJ heat supplied to the engine. | (CO1) | [Comprehension] |
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| 9 | A heat engine receives heat at the rate of 1500 kJ/min and gives an output of 8.2 kW. Determine: (i) The thermal efficiency (ii) The rate of heat rejection. | (CO1) | [Comprehension] |
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| 10 | The Pressure-Temperature diagram is a fundamental tool in the exploration, production, and processing of reservoir fluids. It provides valuable insights into the behavior of fluids under different conditions, guiding engineering decisions and ensuring the safe and efficient operation of oil and gas facilities. A pressure-temperature (P-T) diagram representing a multi-component mixture, as seen in natural gas or intricate hydrocarbon systems, is more complicated compared to a straight forward P-T diagram for a single-component fluid.  Explain each curve and property of the P-T diagram for a multi-component mixture with a clear illustration. | (CO2) | [Comprehension] |
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| 11 | State Raoult’s law. What are the partial pressures of benzene and toluene in a solution in which the mole fraction of benzene is 0.6? What is the total vapor pressure? The vapor pressure of pure benzene is 95.1 mm Hg and the vapor pressure of pure toluene 28.4 mm Hg at 25oC | (CO3) | [Comprehension] |
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| 12 | The importance of calculating work in a closed system is foundational in thermodynamics and engineering. It allows for a comprehensive understanding of energy transfer, supports the application of the First Law of Thermodynamics, aids in the analysis of mechanical processes, and guides the design and optimization of various energy systems and devices.  Express and derive the expression of work in a closed system for a process and also deduce the work done for isochoric and isobaric process. | (CO1) | [Comprehension] |
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| 13 | A pressure-temperature (P-T) diagram, commonly known as a phase diagram or phase envelope, visually depicts the phases and boundaries of reservoir fluids (usually oil and gas) across various pressure and temperature scenarios. In the oil and gas sector, this diagram is essential for comprehending and forecasting the actions of reservoir fluids.  Draw and explain the P-T diagrams of different types of reservoir fluids with an analytical approach. | (CO3) | [Comprehension] |
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| 14 | PVT experiments offer valuable information for tasks in reservoir engineering, optimizing production, and designing facilities for oil and gas processing. Demonstrate and briefly explain the methods of collecting fluid properties data in the oil and gas industry through Constant Mass/Composition Expansion and Constant Volume Depletion experiments with a neat diagram. | (CO2) | [Comprehension] |
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| **PART C** | | | |
| **ANSWER ANY 2 QUESTIONS 2Q X 20M=40M** | | | |
| 15 | The refrigerating effect is a fundamental parameter in the design, operation, and optimization of refrigeration and air conditioning systems. It provides valuable information for assessing system performance, ensuring energy efficiency, and addressing economic and environmental considerations. You have been assigned to estimate the cooling effect of a combined heat engine and refrigerator so that overall cooling can be done for the following situation. A reversible heat engine operates between 600℃ and 40℃. This engine derives a reversible refrigerator operating between 40℃ and -18℃ (minus 18℃), still there is a network output of 370KJ while the heat received by the engine is 2100KJ. Estimate the cooling effect of the refrigerator. | (CO1) | [Application] |
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| 16 | Flash expansion and differential expansion are important considerations in the oil and gas industry. Flash expansion is relevant in the context of fluid separation and processing, while differential expansion is crucial for designing and operating equipment exposed to varying temperatures to ensure the reliability and safety of oil and gas facilities. Laboratory experiments are carried out under precise conditions to replicate the characteristics of reservoir fluids in actual reservoirs. Discuss in detail with a well-drawn illustration of laboratory experiments for Flash Expansion and Differential Expansion**.** | (CO2) | [Application] |
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| 17 | The gas compressibility factor is a fundamental parameter with broad applications in various scientific and engineering disciplines. Its significance lies in providing a correction factor for real gas behavior, enabling more accurate predictions and analyses in fields such as reservoir engineering, natural gas processing, and process engineering.  A gas reservoir has the following gas composition. The initial reservoir pressure and temperature are 3000 psia and 180 ºF, respectively. Predict the gas compressibility factor under initial reservoir conditions using the following chart:.   |  |  |  |  | | --- | --- | --- | --- | | **Component** | **Yi** | **Tci(ºR)** | **Pci** | | CO2 | 0.02 | 547.91 | 1071 | | N2 | 0.01 | 227.49 | 493.1 | | C1 | 0.85 | 343.33 | 666.4 | | C2 | 0.04 | 549.92 | 706.5 | | C3 | 0.03 | 666.06 | 616.4 | | i-C4 | 0.03 | 734.46 | 527.9 | | n-C4 | 0.02 | 765.62 | 550.6 | | (CO3) | [Application] |
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