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**PRESIDENCY UNIVERSITY**

**Bengaluru**

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| **End - Term Examinations – JANUARY 2025** |
| **Date:** 11- 01- 2025 **Time:** 01:00 pm – 04:00 pm |

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| **School:** SOE | **Program:** B.Tech in Petroleum | |
| **Course Code :** PET3002 | **Course Name :** Directional Drilling Technology | |
| **Semester**: III | **Max Marks**: 100 | **Weightage**: 50% |

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| **Marks** | **-** | **20** | **50** | **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 any two major disadvantage of PDM in oilfield applications. | **2 Marks** | **L1** | **CO3** |
| **2** | Mention any two Turbine motor used in Directional Drilling characteristics | **2 Marks** | **L1** | **CO3** |
| **3** | List out any two reason for directional survey. | **2 Marks** | **L1** | **CO3** |
| **4** | Provide the full form of NMDC and specify the components it comprises. | **2 Marks** | **L1** | **CO3** |
| **5** | Define the Cushioning Effect and provide measures to minimize or avoid it. | **2 Marks** | **L1** | **CO3** |
| **6** | Match the following: | **2 Marks** | **L1** | **CO4** |
| **7** | Match the following: | **2 Marks** | **L1** | **CO4** |
| **8** | Identify the odd one out related to wellbore stability issues:   1. Differential Sticking, Keyseating, Junk in the Hole, Borehole Collapse 2. Pipe Sticking, Drill Pipe Fatigue, Lost Circulation, Twist-Off 3. Fishing Tools, Mud Lubrication, Wireline Logging, Junk Basket, Wireline Logging 4. Differential Sticking, Sloughing Shale, Drill Bit Wear, Keyseating | **2 Marks** | **L1** | **CO4** |
| **9** | Fill in the Blanks from the given options:   1. Differential sticking occurs when the drill string becomes stuck against the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ due to high differential pressure. **(drill bit/formation top/wellbore wall/annular space)** 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a problem caused by the drill pipe wearing a groove into the side of the wellbore, leading to stuck pipe. **(Junk in the hole/Keyseating/Differential sticking/ Lost circulation)** 3. Junk in the hole can include lost tools, metallic debris, or pieces of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which obstruct the wellbore and hinder operations. **(drill bit/casing/mud pumps/shale shakers)** 4. Borehole collapse is often a result of inadequate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pressure to counteract formation pressures. **(hydrostatic/reservoir/mud/cement)** | **2 Marks** | **L1** | **CO4** |
| **10** | Find True/False:   1. Differential sticking occurs when the drill string becomes stuck against the borehole wall due to a high-pressure differential between the wellbore and the formation. 2. Keyseating happens when the drill string rotates at a higher speed, creating a circular groove in the casing rather than the open hole. 3. Junk in the hole refers to foreign objects such as broken drill bits, tools, or debris that may fall into the wellbore and obstruct operations. 4. Differential sticking is typically resolved by increasing the weight of the drill string. | **2 Marks** | **L1** | **CO4** |

**Part B**

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| **Answer the Questions Total 80 Marks.** | | | | | |
| **11.** | **a.** | **Given Data:**  The table below presents data from a directional survey:    **Find:** Increment towards NORTH, EAST, and VERTICAL for **Station 2** using:   1. Tangential Method 2. Balance Tangential Method 3. Average Angle Method   Also, calculate the **Dog Leg Severity**. | **20 Marks** | **L3** | **CO2** |
| **or** | | | | | |
| **12.** | **a.** | A Type-I directional well profile involves building an angle from the vertical (kick-off point) to the required inclination and then maintaining that angle through the target reservoir. It is typically used for shallow targets where minimal horizontal displacement is required.  Problem Statement:  A vertical well is to be drilled using a Type-I directional well profile with the following parameters:  Kick-off Point (KOP): 1650 ft  Build-Up Rate (BUR): 1.5°/100 ft  True Vertical Depth (TVD) of the Target Reservoir: 9880 ft  Horizontal Departure to the Target: 4792.35 ft  Tasks:   1. Calculate the build-up section length. 2. Calculate the hold section length. 3. Calculate the total measured depth of the well. 4. Calculate Angle of Inclination 5. Calculate horizontal displacement at the end of BUS 6. Identify the Bottom Hole Assembly (BHA) required for this profile and the principle to be followed. | **20 Marks** | **L3** | **CO2** |
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| **13.** | **a.** | Differentiate between Positive Displacement Motors (PDM) and Turbine Motors in terms of their design, working mechanism, applications, and performance characteristics.  Explain the working principle of a Positive Displacement Motor (PDM) in detail, highlighting its components, operational process, and advantages in drilling operations. | **20 Marks** | **L2** | **CO3** |
| **or** | | | | | |
| **14.** | **a.** | Analyze the internal structure of a Positive Displacement Motor (PDM), discuss how key components such as the rotor, stator, and the flow path of drilling fluid contribute to generating torque and power. How does this design ensure smooth drilling operations, particularly in challenging downhole conditions? | **20 Marks** | **L2** | **CO3** |

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| **15.** | **a.** | Write a short note on the following:  a. Photochemical Devices  b. Magnetic Single Shot  c. Magnetic Multisport  d. Gyroscope | **20 Marks** | **L2** | **CO3** |
| **Or** | | | | | |
| **16.** | **a.** | Explain the working principle of a steering tool used in directional drilling operations, detailing its components, mechanisms, and how it adjusts the wellbore trajectory. Discuss the various advantages and disadvantages of steering tools in terms of accuracy, cost, operational complexity, and efficiency in different drilling environments.  Also, explain the working principle of an Acid Bottle Survey Tool with relevant diagram. | **20 Marks** | **L2** | **CO3** |

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| **17.** | **a.** | **Case Study: Stuck Pipe Causes in Drilling Operations**  In a recent drilling operation, the rig encountered a stuck pipe situation, leading to significant operational delays and increased costs. As a student, analyze the following causes of stuck pipe and propose possible solutions or preventive measures for each:   1. **Foreign Objects or Junk in the Hole**: How do foreign objects (e.g., broken bits, tools, or debris) cause the pipe to become stuck, and what techniques can be used to prevent or remove these obstructions? 2. **Key-Seating**: Discuss how key-seating occurs when the wellbore becomes oval-shaped or tapered, and describe methods for avoiding or mitigating this issue. 3. **Sloughing Formations**:   Explain how unstable formations can lead to sloughing (collapse) and how it affects the pipe. What measures can be implemented to prevent sloughing?   1. **Bit and Drill Collar Balling**:   Investigate the phenomenon of bit and drill collar balling (accumulation of cuttings and debris), and suggest strategies for preventing this issue to maintain smooth operations.   1. **Pressure Differential Sticking**:   Analyze how pressure differential sticking occurs when the drill pipe is held against the wellbore due to pressure imbalances, and propose methods for avoiding such situations.   1. **Cuttings Settling Above the Bit or Drill Collars**: Explore how cuttings settling in the wellbore can obstruct the flow of drilling fluid, leading to stuck pipe, and recommend ways to prevent cuttings accumulation.   Consider these causes, and propose an integrated strategy to reduce the risk of stuck pipe and ensure a smooth drilling process. | **20 Marks** | **L2** | **CO4** |
| **Or** | | | | | |
| **18.** | **a.** | In drilling operations, differential sticking is often a critical issue caused by several key factors.  Discuss how these factors interact to increase the likelihood of differential sticking, and their individual impacts on the efficiency and safety of the drilling process.  With a live numerical example discuss how much differential force generated at a particular location. Considering the differential force generated from differential sticking, what actions should be taken when a drill string becomes stuck due to differential pressure?  Elucidate how can adjusting the mud weight, applying torque, and jarring the drill string help address the situation. Explore how differential sticking affects drilling efficiency, the potential risks involved in corrective actions, and the long-term consequences if not properly managed. | **20 Marks** | **L2** | **CO4** |

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