Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – December 2025

Date: 09 – 12- 2025 **Time:** 09:30am – 12:30pm

School: SOE	**Program:** B.Tech. (PET)	
Course Code: PET2103	**Course Name:** Drilling Fluids and Cements	
Semester: III	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	CO1	CO2	CO3	CO4	CO5	CO6
Marks	02	04	30	20	22	22

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2 marks. **10Q x 2M=20M**

1.	Match the following: **Column A (Property)** – **Column B (Description/Function)** 1. Plastic Viscosity (PV) – A. Measures acidity or alkalinity of the fluid 2. Apparent Viscosity (AV) – B. Ability of fluid to develop structure when static 3. Gel Strength – C. Indicates the flow resistance at a given shear rate 4. pH – D. Measures the fluid's ability to suspend cuttings	**2 Marks**	**L1**	**CO3**
2.	**State True/False:** a) Filtration Control additives help reduce the invasion of drilling fluid into the formation. b) Increasing Plastic Viscosity always reduces the rate of cuttings transport. c) Apparent Viscosity (AV) is always higher than Plastic Viscosity (PV) in a drilling fluid. d) Proper Gel Strength prevents settling of cuttings when the fluid circulation stops.	**2 Marks**	**L1**	**CO3**

3.	Explain the difference between Plastic Viscosity (PV) and Apparent Viscosity (AV) in drilling fluids.	**2 Marks**	**L1**	**CO4**
4.	Define Yield Point (YP) and explain its significance in the rheology of drilling fluids.	**2 Marks**	**L1**	**CO4**
5.	Describe the importance of a mud pit/reservoir in the drilling fluid circulation system.	**2 Marks**	**L1**	**CO5**
6.	Relate how the mud hose and standpipe contribute to the safe and efficient circulation of drilling fluid.	**2 Marks**	**L1**	**CO5**
7.	List the purpose of centrifuges in the mud circulation system.	**2 Marks**	**L1**	**CO5**
8.	Describe the functions of cement in oil well operations.	**2 Marks**	**L1**	**CO6**
9.	State the desired properties of a cement slurry for oil well applications.	**2 Marks**	**L1**	**CO6**
10.	Tell the differences between drilling mud and cement slurry.	**2 Marks**	**L1**	**CO6**

Part B

Answer the Questions. **Total Marks 80M**

11.	**Solve the following:** **a)** Calculate the area of upper plate which is spaced 3 cm above a stationary plate. The viscosity of the fluid is 30 cp if a force of 1500 dynes is required to move the upper plate at a constant velocity of 7 cm/s. (5M) **b)** A Marsh funnel is used to measure the density of the drilling fluid which is 1.2 g/cm^3 in 50 seconds. Calculate the effective viscosity using Marsh funnel equation. (5M) **c)** Two fluids have densities of 9.6 pgg and 8.9 ppg, respectively. If both fluids read exactly the same reading in the March funnel at the same conditions, find out the relation between the viscosities of both fluids. And if the first fluid read 61 seconds, calculate the viscosity of both fluids. (5M) **d)** A drilling fluid has a plastic viscosity of 22 cp and yield point of 6.25 lbf/100 ft^2 using a rotational viscometer instrument. If another fluid reads 0.85 of the reading of the first fluid at speed of 300 rpm and 42^o at speed of 600 rpm, calculate the viscosity and yield point of the second fluid. (5M)	**20 Marks**	**L3**	**CO3**
	Or			
12.	**a.** A moving plate is set 2.5 cm above a stationary plate which has a cross sectional area of 30 cm^2. If a force of 450 dynes is required to just initiate the upper plate and a force of 650 dynes is needed to move the plate with a uniform velocity of 8 cm/s, calculate the yield point and plastic viscosity of the fluid.	**10 Marks**	**L3**	**CO3**

	b.	In the drilling fluid laboratory, a student was conducting an experiment for the Bingham fluid where he was using the Fann V-G meter to measure the viscosity of the fluid and he found the following Fann data: $\theta_{300} = 35$; $\theta_{600} = 60$, and $\theta_{200} = 32$; $\theta_{400} = 54$. Calculate the plastic viscosity, and yield point of the fluid using Bingham plastic model.	**10 Marks**	**L3**	**CO3**

13.	You are the drilling engineer on the Sundari-1 well being drilled from Platform-C in the Krishna–Godavari Basin. At a depth of 7,400 ft, the driller reports a slight gas show in the cuttings, and the company geologist asks you to verify the hydraulic and rheological parameters before proceeding. The mudlogger provides a Fann viscometer report along with the rig sheet, which shows the following information: the Fann viscometer readings are $\theta_{600} = 40$ and $\theta_{300} = 28$ (dial units). The hole diameter is 12.25 inches, and the drillpipe outer diameter is 5.0 inches. The flow rate during circulation is 650 gpm. The total hole depth is 7,400 ft, out of which the bottom 700 ft consists of drill collars with an outer diameter of 8.5 inches, while the remaining 6,700 ft is drillpipe. The static mud weight for the well is 78 pcf. Using this information, you are required to perform the following tasks: (a) Using the Bingham-plastic model, calculate the plastic viscosity (PV) and yield point (YP) from the given Fann viscometer readings. Then determine the apparent or effective viscosity (η_eff) to be used for hydraulic calculations. All steps, equations, and intermediate values must be shown clearly. (8M) (b) Using the Power-law (Ostwald-de Waele) model, determine the flow behavior index (n) and the consistency index (K) based on the two viscometer readings provided. Using these parameters, calculate the effective viscosity at the same shear rate used in part (a). (8M) (c) Using the Bingham-plastic model only, calculate the Equivalent Annular Circulating Density (ECD) at the bit in pcf. (4M)	**20 Marks**	**L4**	**CO4**
	Or			
14.	It was close to midnight on the Candyland-7 offshore rig when Sherlock Holmes, hired as an operations investigator, stepped onto the drill floor. The rig had been shaken by three days of bad weather, and the night crew looked exhausted. Ethan Hunt, acting as the senior driller for this mission, waved Holmes over to the flowline. "*We've got unusual cuttings returning*," Ethan whispered. "*Looks like a gas interval may be stirring up trouble*." Holmes raised an eyebrow. "*Then we must examine the mud. Everything leaves a trace*." The mud technician handed him the rheology sheet and drilling parameters. Holmes quickly scanned the values:	**20 Marks**	**L4**	**CO4**

FANN readings: $\theta_{600} = 36$, $\theta_{300} = 24$

Mud weight: 75 pcf

Flow rate: 600 gpm

Open hole diameter: 12 in

Drillpipe OD: 5 in

Total depth to bit: 7,100 ft

Drill collars: OD 8 in for the bottom 620 ft

Holmes tapped his pipe thoughtfully. "*Your problem is not just the cuttings. Before you circulate again, we must compute two things: the behavior of the mud under flow, and whether your equivalent circulating density will risk breaking the formation*."

He laid out his investigation plan on the rig's chalkboard:

Task 1 — Fluid Behavior Analysis (8M + 8M)

A. Using the Bingham-Plastic model

Calculate:

a) Plastic Viscosity (PV)
b) Yield Point (YP)
c) Then calculate the apparent viscosity at the representative annular shear rate.

B. Using the Power-Law Model

Calculate:

a) Flow behavior index n
b) Consistency index K
c) Then compute the effective viscosity at the same shear rate used in A.

Task 2 — ECD (Formation Safety Check) (4M)

Holmes pointed at the depth chart.

"To avoid a fracture, we must compute the Equivalent Circulating Density at 7,100 ft using the Power-Law model."

He wrote down the required formulas:

Annular area: $A\_ann = (\pi/4)(Dh^2 - Dp^2)$

Annular velocity: $v\_ann = Q / A\_ann$

Compute annular friction loss through both drillpipe and drill collars

	Holmes turned to Ethan: "*The clues are all there. Solve the equations, check your ECD, and only then may you circulate safely*." Ethan nodded. "*Time to run the numbers*." Assume, you are Ethan and complete the task.			

15.	With the support of a neatly drawn and properly labelled sketch, explain the complete drilling fluid circulatory system in detail. Clearly describe the function of each major component involved in the circulation process. (10 Marks) Important Instructions (Must Follow): → The diagram must be drawn using a pencil only. (8 Marks) → Every component of the system must be clearly labelled. Any diagram with missing or unclear labels will not be evaluated. (2 Marks) → Your sketch should represent the actual physical shape and appearance of the equipment (e.g., shale shaker, mud tanks, pumps, standpipe, rotary hose, drill string, annulus, etc.). → Do NOT draw a flowchart, symbolic blocks, arrows, or abstract diagrams. → The figure must resemble the real arrangement of surface and downhole circulation equipment.	**20 Marks**	**L2**	**CO5**
	Or			
16.	Explain how drilling mud is mixed and conditioned before it enters the active circulating system on a rig. Your explanation should cover the sequence of operations involved in preparing the mud, adding chemicals, maintaining uniformity, and ensuring proper fluid properties through agitation and conditioning equipment. You must also include a clearly drawn pencil sketch that depicts the actual physical appearance of each component associated with the mud mixing and conditioning section. The drawing must not be symbolic or diagrammatic; it should represent real equipment such as the mud hopper, mixing lines, mud pits, agitators, and mud guns. All parts must be labelled, and any sketch without proper labels will not be evaluated. Only pencil drawings will be accepted. Following this, explain how drilling mud is treated when it becomes contaminated by sodium chloride, anhydrite/gypsum, and cement, outlining the corrective measures and additives used in each case. (3M+4M+5M+8M)	**20 Marks**	**L2**	**CO5**

17.	You have been appointed as the lead drilling engineer for an upcoming onshore well that requires a three-stage casing program: surface casing set at 4,500 ft, intermediate casing at 8,000 ft, and production casing reaching 12,500 ft. As part of the cementing program, you must evaluate the conditions in each interval and design a cement system that satisfies the operational and geological constraints. In the surface casing interval (0–4,500 ft), the formation temperature is very low, and the operator wants the cement to gain early compressive strength so drilling activities can resume quickly. There is also a possibility of shallow lost circulation, and the casing must be equipped with appropriate accessories to maintain proper centralization and support uniform cement placement. In the intermediate casing interval (4,500–8,000 ft), the formation temperature increases to a moderate–high range, causing a tendency for cement to set too rapidly. The operator plans to use a two-stage cementing operation to stay below the fracture pressure of the formation. Certain zones contain poorly consolidated sand, demanding improved mud removal before cement is placed. In the production casing interval (8,000–12,500 ft), the formation pressure is significantly high, requiring a high-density cement system. Because a gas-bearing reservoir exists in the lower section, achieving strong zonal isolation is critical. Additionally, the long production string requires a slurry that will remain pumpable for an extended period. Based on this information, answer the following: Tasks **I. Cement Additive Selection** For each of the three casing intervals, specify the appropriate type(s) of cement additives—accelerators, retarders, density-reducing agents, density-increasing agents—and explain with a justification why each choice is suitable for that section's temperature, pressure, and operational requirements. **II. Casing Accessories** identify the casing accessories that should be used in each interval and explain how each accessory contributes to centralization, mud displacement, and proper cement sheath formation. **III. Consequences of Improper Selection** Examine how incorrect selection of additives or casing accessories could lead to operational problems such as poor zonal isolation, channeling, gas migration, weak cement sheath, and casing corrosion. **IV. Design Adjustments for Unexpected Conditions** Analyze the modifications you would make to the cement design if: a) The shallow interval develops severe lost circulation, and	**20 Marks**	**L2**	**CO6**

	b) The bottomhole temperature in the production zone is found to be 40°C higher than originally estimated.			
	Or			
18.	You are supervising the primary cementing operation for an intermediate casing set at 10,000 ft. The wellbore stability log shows: Bottomhole circulating temperature (BHCT) = 140°C Bottomhole static temperature (BHST) = 165°C Formation contains alternating layers of shale and loosely bonded sand A weak zone exists at 8,500 ft, making the formation prone to fracturing Gas pockets (*Gas pockets are zones or intervals in the formation that contain trapped natural gas*) are suspected between 9,200–9,500 ft The cementing team notices the following operational constraints: **i.** Cement should remain pumpable for at least 2 hours due to long casing string. **ii.** Slurry density must be controlled so that it does not exceed 16.0 ppg, otherwise the weak zone at 8,500 ft may fracture. **iii.** Gas migration must be prevented during the setting period. **iv.** Good mud displacement is essential because of sandy intervals. **v.** Hardware must be selected to ensure the casing is centralized, mud is scraped off the wellbore, and the cement does not flow back after displacement. **Your Tasks (Answer All Parts)** **I.** Recommend two cement additives (name + purpose) that should be used to address the high temperature and long pump time required. Explain why each additive is necessary (4M). **II.** Because slurry density must be kept below 16.0 ppg, identify one density-modifying additive that could be used. Explain how it affects slurry properties and why it helps in this scenario (3M). **III.** Gas is suspected in a shallow interval. Identify one additive that would help control gas migration, and explain how it works (3M). **IV.** To improve mud removal in the poorly consolidated sand intervals, identify two casing accessories that should be installed. Explain the role of each accessory (3M). **V.** Select three casing hardware items that would be essential in this particular cementing job. For each selected hardware piece, explain why it is required for this well's conditions (4M). **VI.** If the slurry begins setting too fast during the job, what operational or chemical adjustments can be made immediately to ensure a safe cement placement? Provide two valid actions (3M).	**20 Marks**	**L2**	**CO6**