Name: Enrolment No:	UPES University of Tomorrow

UPES

End Semester Examination, December 2023

Programme Name: M.Tech - PE **Semester: I**
Course Name: Drilling Engineering **Time: 3 hrs**
Course Code: PEAU 7001 **Max. Marks: 100**
Instructions:

- **All questions are compulsory.**

However, internal choice has been provided. You must attempt only one of the alternatives in all such questions.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	You are the company man on a well being drilled, well takes a kick. What will be your course of action? Name the steps you will take to kill the well.	**04**	**CO1**
Q 2	Explain the key points to decide casing setting depth.	**04**	**CO2**
Q 3	Define PDC Bits and major components of PDC bit design?	**04**	**CO1**
Q 4	Define KOP, inclination angle and azimuth angle?	**04**	**CO1**
Q 5	Distinguish between MWD & LWD	**04**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q 6	a) Draw the flow diagram of a “Mud Circulation System b) Explain any two properties of a drilling fluid and illustrate their importance.	**5+5**	**CO1 + CO2**
Q 7	a) Explain the types of drilling bits and design factors considered while designing a drill bit. b) Summarize different considerations needed while planning a directional well.	**5+5**	**CO3**

<table>
<tr><td></td><td>OR

List out the different deflection tools used in directional drilling? Explain whip stock tool types with their advantages and disadvantages?</td><td>10</td><td>CO3</td></tr>
<tr><td>Q 8</td><td>Assam's Baghjan gas well blowout on June 9 ,2020 –Case Study
Explain briefly –
i. The path of tragedy: Background
ii. What went wrong: investigation.
iii. The consequences: Ecology, Economics, etc.
iv. Long term & short-term effects on environment
v. What lessons learnt for future: Key recommendations.</td><td>10</td><td>CO4</td></tr>
<tr><td>Q 9</td><td>Discuss the properties of class G & H cement powders and role of accelerators and retarders in cement slurry additives.

OR
Differentiate between single stage cementing operation and multi-stage cementing operation?</td><td>10</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td rowspan="2">Q 10</td><td>A drilling string consists of 750 ft of Drill Collar have weight of 90 ppf and Drill Pipes have weight of 25 ppf was used to drill a well to a depth of 16,500 ft using 11.4 ppg drilling mud. If yield strength of drill pipe is 600,000 lbf and steel density is 65 ppg calculate the safety factor at this situation. And if the maximum overpull that can be applied to the drill string is 75,000 lbf, to what depth can the current drill string be used to drill this well?

OR</td><td>20</td><td>CO5</td></tr>
<tr><td>a) Designing a Deviated Well. It has been decided to sidetrack a well from 1500 ft. The sidetrack will be a build and hold profile with the following specifications:

Target Depth : 10000 ft.
Horizontal departure : 3500 ft.
Build up Rate : 1.5° per 100 ft.

Calculate the following:
i. the drift angle of the well.
ii. the TVD and horizontal deviation at the end of the buildup section.
iii. the total measured depth to the target.</td><td>15+5</td><td>CO5</td></tr>
</table>

	b) Discuss the advantages of Rotary steerable system over mud motor systems		
Q 11	I. Calculate the Drill collar Dimensions and weights: a. What is the weight in air of 200 ft of 9 1/2" x 2 13/16" drill collar? b. What is the weight of this drill collar when immersed in 11 ppg mud? c. It is not uncommon for 5" 19.5 lb/ft drill pipe to be used in the same string as 8 1/4" x 2 13/16" drill collars. Compare the nominal I.D. of this drill pipe and Drill collar size and note the differences in wall thickness of these tubulars. II. The highest rate of penetration for a particular 12 1/4" bit will be achieved when 25,000lbs weight on bit (Wob) is applied to the bit. Assuming that the bit will be run in 12 ppg mud, calculate the length of drill collars required to provide 25,000 lbs Wob. a) Calculate the weight (in air) of 10000 ft of 5" 19.5 lb/ft Grade G drill pipe with 4 1/2" IF connections. b) Calculate the weight of this string in 14 ppg mud. Calculate the length of 9 1/2" x 2 13/16" drill collars that would be required to provide 25,000 lbs Wob and keep the drill pipe in tension in 12 ppg mud	**20**	**CO6**
	OR		
	The 13 3/8" casing string of a well is to be cemented using class 'G'cement. Calculate the following for two stage cementing calculation: a) The required number of sacks of cement for a 1^{st} stage of 700 ft. and a 2^{nd} stage of 500 ft. (Allow 20% excess in open hole) b) The volume of mixwater required for each stage. c) The total hydrostatic pressure exerted at the bottom of each stage of cement (assume a 10 ppg mud is in the well when cementing) d) The displacement volume for each stage.	**20**	**CO6**

20" Casing shoe	: 1500 ft
13 3/8" Casing 77 lb/ft	: 0 - 1000 ft
13 3/8" Casing 77 lb/ft	:1000 - 7000 ft.
17 1/2" open hole Depth	: 7030 ft.
Stage Collar Depth	: 1500 ft.
Shoetrack	: 60 ft.
Cement stage 1	(7000-6300 ft.)
Class 'G'	
Density	:15.9 ppg
Yield	: 1.18 ft^3/sk
Mixwater Requirements	: 0.67 ft^3/sk
Cement stage 2	(1500-1000 ft.)
Class 'G' + 8% bentonite	
Density	: 13.3 ppg
Yield	: 1.89 ft^3/sk
Mixwater Requirements	: 1.37 ft^3/sk

VOLUMETRIC CAPACITIES

	bbls/ft	ft^3/ft
Drillpipe		
5" drillpipe :	0.01776	0.0997
Casing		
13 3/8" 72 lb/ft :	0.1480	0.8314
13 3/8" 77 lb/ft :	0.1463	0.8215
Open Hole		
26" Hole	0.6566	3.687
17 1/2" Hole	0.2975	1.6703
Annular Spaces		
26" hole x 20" Casing:	0.2681	1.5053
17 1/2" hole x 13 3/8" Casing:	0.1237	0.6946
30" Casing x 20" Casing:	0.3730	2.0944
20" Casing x 13 3/8" Casing:	0.1816	1.0194

Tables

CAPACITY AND DISPLACEMENT OF DRILLPIPE

SIZE AND CONN.	NOMINAL WEIGHT LB/FT	GRADE	APPROX WEIGHT LB/FT	CAPACITY		OPEN END DISPLACEMENT		CLOSED END DISPLACEMENT	
				L/M	GALL/FT	L/M	GALL/FT	L/M	GALL/FT
$2\frac{3}{8}$ $2\frac{3}{8}$ IF NC26	6.65	E75	7.00	1.68	0.135	1.39	0.107	3.01	0.242
		X95	7.08			1.34	0.108	3.02	0.243
		G105	7.08			1.34	0.108	3.02	0.243
$2\frac{7}{8}$ $2\frac{7}{8}$ IF NC 31	10.4	E75	10.82	2.36	0.190	2.05	0.165	4.41	0.355
		X95	10.89			2.06	0.166	4.42	0.356
		G105	10.89			2.06	0.166	4.42	0.356
		S135	11.20			2.12	0.171	4.48	0.361
$3\frac{1}{2}$ $3\frac{1}{2}$ IF NC38	9.5	E75	10.39	4.54	0.366	1.97	0.159	6.51	0.525
	13.3	E75	13.86	3.88	0.312	2.63	0.212	6.51	0.524
		X95	14.32	3.96	0.319	2.71	0.218	6.67	0.537
		G105	14.38	3.87	0.312	2.73	0.220	6.60	0.532
	15.5	E75	16.42	3.46	0.279	3.11	0.250	6.57	0.529
		X95	16.54			3.14	0.253	6.60	0.532
		G105	16.61			3.15	0.254	6.61	0.533
5 $4\frac{1}{2}$ IF NC50	19.5	E75	20.99	9.16	0.738	3.98	0.320	13.14	1.058
		X95	21.09			4.00	0.322	13.16	1.070
		G105	21.50			4.08	0.329	13.24	1.087
		S135	22.09			4.19	0.337	13.35	1.075
	25.6	E75	27.01	8.11	0.653	5.12	0.412	13.23	1.065
		X95	28.30	8.10	0.652	5.36	0.432	13.46	1.084
		G105	28.11	8.09	0.651	5.33	0.429	13.42	1.080

$lbs/ft = 2.67\ (OD^2 - ID^2)$

DRILL COLLAR WEIGHTS (STEEL) POUNDS PER FOOT

Collar O.D.	BORE OF COLLAR 1-1/2	1-3/4	2	2-1/4	2-1/2	2-13/16	3	3-1/4	3-1/2	3-3/4	4
3-3/8	24.4	22.2									
3-1/2	26.7	24.5									
3-3/4	31.5	29.3									
3-7/8	34.0	31.9	29.4	26.5							
4	36.7	34.5	32.0	29.2							
4-1/8	39.4	37.2	34.7	31.9							
4-1/4	42.2	40.0	37.5	34.7							
4-1/2	48.0	45.8	43.3	40.5							
4-3/4	54.2	52.0	49.5	46.7	43.5						
5	60.2	58.5	55.9	53.1	49.9						
5-1/4	67.5	65.3	62.8	59.9	56.8	53.3					
5-1/2	74.7	72.5	69.9	67.2	63.9	60.5	56.7				
5-3/4	82.1	79.9	77.5	74.6	71.5	67.9	64.1				
6	89.9	87.8	85.3	82.5	79.3	75.8	71.9	67.8	63.3		
6-1/4	98.1	95.9	93.5	90.6	87.5	83.9	80.1	75.9	71.5		
6-1/2	106.6	104.5	101.9	99.1	95.9	92.5	88.6	84.5	79.9		
6-3/4	115.5	113.3	110.8	107.9	104.8	101.3	97.5	93.3	88.8		
7	124.6	122.5	119.9	117.1	113.9	110.5	106.6	102.5	97.9	93.1	87.9
7-1/4	134.1	131.9	129.5	126.6	123.5	119.9	116.1	111.9	107.5	102.6	97.5
7-1/2	143.9	141.7	139.3	136.5	133.3	129.8	125.9	121.8	117.3	112.5	107.3
7-3/4	154.1	151.9	149.5	146.6	143.5	139.9	136.1	131.9	127.5	122.6	117.5
8	164.6	162.5	149.9	157.1	153.9	150.5	146.6	142.5	137.9	133.1	127.9
8-1/4	175.4	173.3	170.8	167.9	164.8	161.3	157.5	153.3	148.8	143.9	138.8
8-1/2	186.6	184.4	181.9	179.1	175.9	168.6	172.5	164.5	159.9	155.1	149.9
8-3/4	198.1	195.9	193.9	190.6	187.4	183.9	180.1	175.9	171.4	166.6	161.5
9	—	207.8	205.3	202.4	199.3	195.8	191.9	187.8	183.3	178.5	173.3
9-1/2	—	232.4	229.9	227.1	223.9	220.4	216.6	212.4	297.9	203.1	197.9
10	—	—	255.9	253.1	249.9	246.4	242.6	238.4	233.9	229.1	223.9
10-1/2	—	—	283.3	280.4	277.3	273.8	269.9	265.8	261.3	256.4	251.3
11	—	—	—	—	305.9	302.4	298.6	294.4	289.9	285.1	279.9

MUD DENSITY, GRADIENT AND BUOYANCY FACTOR

NOTE: Buoyancy factor is for STEEL only

Mud density			Gradient psi/ft	Buoyancy Factor	Mud density			Gradient psi/ft	Buoyancy Factor
kg/m³	lb/gall	lb/ft³			kg/m³	lb/gall	lb/ft³		
1000	8.34	62.4	.433	.873	1800	15.0	112	.779	.771
1010	8.40	62.8	.436	.872	1820	15.2	114	.790	.768
1030	8.50	64.3	.447	.869	1850	15.4	115	.800	.765
1060	8.80	65.8	.457	.866	1870	15.6	117	.810	.762
1080	9.00	67.3	.468	.862	1890	15.8	118	.821	.759
1100	9.20	68.8	.478	.860	1920	16.0	120	.831	.755
1130	9.40	70.3	.488	.856	1940	16.2	121	.842	.753
1150	9.60	71.8	.499	.853	1970	16.4	123	.852	.749
1154	9.625	72.0	.500	.853	1990	16.6	124	.862	.746
1180	9.80	73.3	.509	.850	2010	16.8	126	.873	.743
1200	10.0	74.8	.519	.847	2040	17.0	127	.883	.740
1220	10.2	76.3	.530	.844	2060	17.2	129	,894	.737
1250	10.4	77.8	.540	.841	2090	17.4	130	.904	.734
1270	10.6	79.3	.551	.838	2110	17.6	132	.914	.731
1290	10.8	80,8	.561	.835	2130	17.8	133	.925	.728
1320	11.0	82.3	.571	.832	2160	18.0	135	.935	.725
1340	11.2	83.8	.582	.829	2180	18.2	136	.945	.722
1370	11.4	85.3	.592	.826	2210	18.4	138	.956	.719
1390	11.6	86.8	.603	.823	2230	18.6	139	.966	.716
1410	11.8	88.3	.613	.820	2250	18.8	141	.977	.713
1440	12.0	89.8	.623	.817	2280	19.0	142	.987	.710
1460	12.2	91.3	.634	.814	2300	19.2	144	.997	.707
1490	12.4	92.8	.644	.810	2330	19.4	145	1.01	.704
1510	12.6	94.3	.655	.808	2350	19.6	147	1.02	.701
1530	12.8	95.8	.665	.804	2370	19.8	148	1.03	.698
1560	13.0	97.3	.675	.801	2400	20.0	150	1.04	.694
1580	13.2	98.7	.686	.798	2420	20.2	151	1.05	.692
1610	13.4	100	.696	.795	2450	20.4	153	1.06	.688
1630	13.6	102	.706	.792	2470	20.6	154	1.07	.685
1650	13.8	103	.717	.789	2490	20.8	156	1.08	.682
1680	14.0	105	.727	.786	2520	21.0	157	1.09	.679
1700	14.2	106	.738	.783	2540	21.2	159	1.10	.676
1730	14.4	108	.748	.780	2570	21.4	160	1.11	.673
1750	14.6	109	.758	.777	2590	21.6	162	1.12	.670
1770	14.8	111	.769	.774	2610	21.8	163	1.13	.667