Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JUN 2023

Semester : Semester IV - B.Tech PET - 2021

Course Code : PET2002

Course Name : Sem IV - PET2002 - Fundamentals of Geophysical Logging Techniques

Program : PET

Date : 19-JUN-2023

Time : 9.30AM - 12.30PM

Max Marks : 100

Weightage : 50%

Instructions:
(i) Read all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and non-programmable calculator are permitted.
(iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ALL THE TEN QUESTIONS **10 X 2 = 20M**

1. Outline the applications of Formation Micro Scanner (FMS) in the oil and gas industry.
(CO4) [Knowledge]

2. List down the major applications of Cement Bond Logging (CBL) Tools.
(CO4) [Knowledge]

3. List down two variables that could have effects on the resistivity of natural porous media as per the Formation Factor or Formation Resistivity Factor equation.
(CO2) [Knowledge]

4. Describe laminar shale.
(CO2) [Knowledge]

5. Summarize the uses of cross-plot techniques in petrophysics.
(CO5) [Knowledge]

6. Write down at least two uses of the sonic log.
(CO3) [Knowledge]

7. Name at least two open hole logs.
(CO1) [Knowledge]

8. Highlight the main uses of Spontaneous Potential (SP) Log measurements.
(CO3) [Knowledge]

9. Write down the condition for using the Sonic-Neutron cross-plot method.

(CO5) [Knowledge]

10. Explain the objective of petrophysics.

(CO1) [Knowledge]

PART B

ANSWER ALL THE FOUR QUESTIONS **4 X 10 = 40M**

11. The Cement Bond Log (CBL) continuously measures the amplitude of sound pulses from a transmitter to a receiver. This amplitude (mV) is maximum in unsupported pipe and minimum in the well-cemented casing. This curve shows how much acoustic signal reaches a receiver and is an important indicator of cement bond. Record the amplitude on the 3-foot spaced receiver. The Travel Time (μs) curve shows the amount of time it takes an acoustic signal to travel between the source and a receiver. The travel time between points is very predictable for a free pipe of a given size and weight. Travel time is required as a quality control measurement. Record the travel time on the 3-foot spaced receiver. The wave train can be displayed as a Variable Density Log (VDL) where the positive and negative cycles of the wave train are shaded in black and white respectively. Pipe, formation, and fluid signals are usually easily recognizable on the VDL. If these signals can be identified, a practical determination of the presence or absence of cement can be made. VDL is logged on the 5-foot spaced receiver. The Casing Collar Locator (CCL) is used to correlate the bond log with cased hole logs and match casing collars with the collars that appear on the display's VDL portion. Figure 03 is displaying the parameters measured and presented on the Radial Bond Log (RBL). List any five of the parameters labeled 1 through 8 in Figure 03.

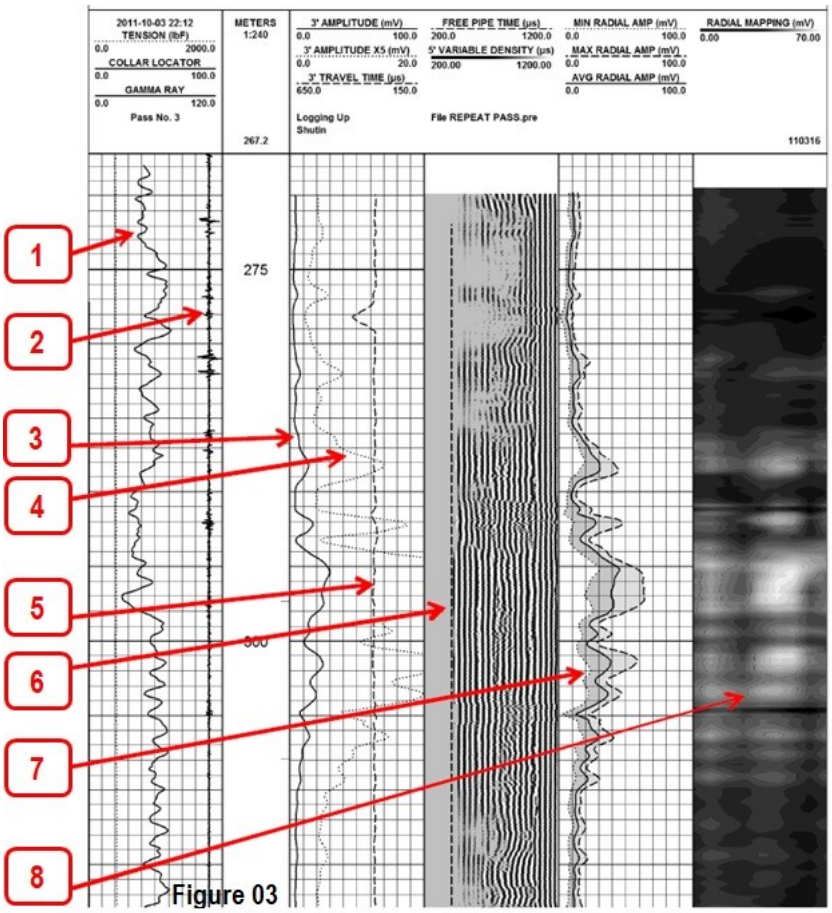
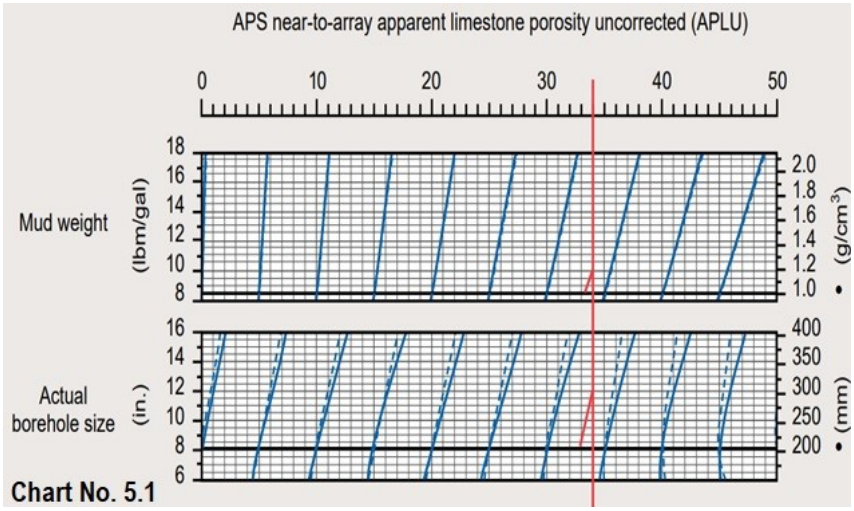
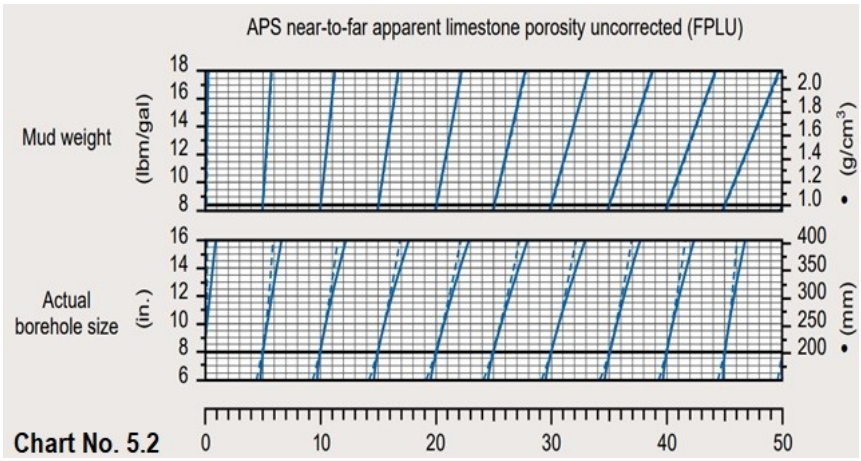


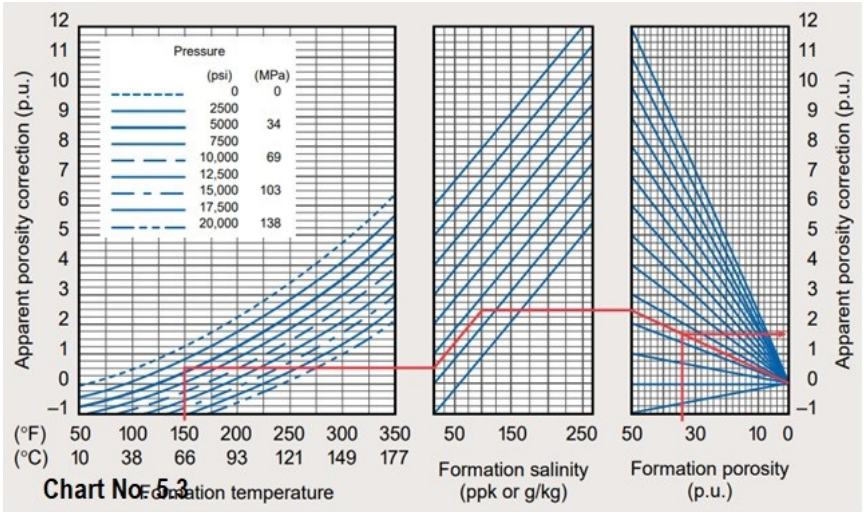
Figure 03

(CO4) [Comprehension]

12. For an openhole well, uncorrected limestone porosity, mud weight, borehole size, borehole temperature, pressure, and formation salinity are recorded as 30 p.u., 14 lbm/gal, 13 inch, 100°F, 2.5 kpsi, and 200 kppm respectively. (a) List down the corrections that can be determined from the data shared and the Chart No. 5. (b) Determine corrected values for all the components listed above.







(CO3) [Comprehension]

13. Porosity is the percentage of void space in a rock. It is defined as the ratio of the volume of the voids or pore space divided by the total volume. It is written as either a decimal fraction between 0 and 1 or as a percentage. For most rocks, porosity varies from less than 1% to 40%.

(a) Estimate porosity indirectly with the following available data:

ρb = 2.60 g/cc (Sandstone), ρma = 2.87 g/cc (Dolomite), and ρf = 1.1 g/cc (Salt Mud)

(b) Determine the porosity by plotting the above-mentioned data on Chart No. 3.

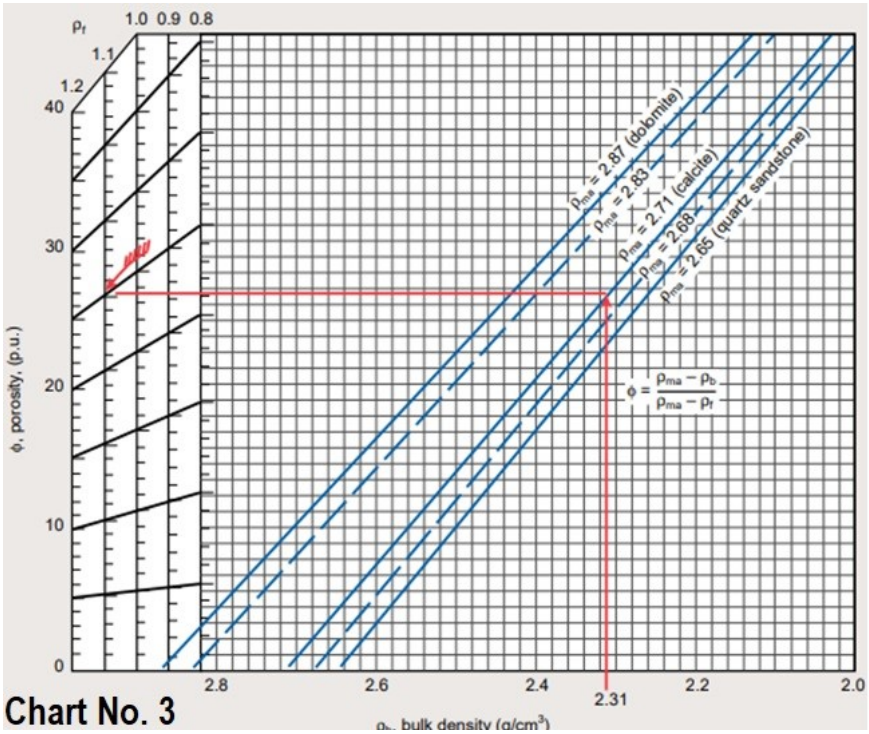


Chart No. 3

(CO3) [Comprehension]

14. The Pickett plot helps petrophysicists analyze the relationship between resistivity and porosity. In particular, it is useful for evaluating the water saturation of a formation. By examining the data points on the plot, analysts can identify different regions that correspond to different fluid saturations, such as water-filled, hydrocarbon-filled, or mixed zones. To create a Pickett plot, the resistivity measurement is plotted on the x-axis, and the porosity measurement is plotted on the y-axis. The data points from the well log are then plotted on the log-log graph. Usually, the data points are represented as a scatter plot, with each point representing a specific depth interval in the well. Illustrate the uses of the Pickett Plot in the Oil and Gas industry.

(CO5) [Comprehension]

PART C

ANSWER ALL THE TWO QUESTIONS **2 X 20 = 40M**

15. In petrophysics, cross-plot analyses are carried out to determine the rock properties/attributes that better discriminate the reservoir. The geophysical log data for PU Well 2 is shared below along with a Cross-plot Chart (Chart No. 2).
(a) Identify the geophysical log data set that can be plotted on the shared Cross-plot Chart.
(b) Determine cross-plot porosity as well as lithology for the freshwater-invaded zone and fill up Table 2 with the required information. Chart No. 2 and Table 2 should be attached with the answer script.

PU Well 2: Geophysical Log Data

Sl. No.	Depth (ft)	Cal (inch)	GR (API)	RHOB (g/cc)	NPHI (frac)	RES_DEEP (Ohm_m)	RES_SHAL (Ohm_m)	RES_MICR	DT (us/ft)	DTS
1	617.830	8.918	94.643	2.652	0.112	16.986	18.492	20.651	74.788	169.102
2	622.859	8.757	48.366	2.559	0.054	15.861	18.899	66.040	64.795	118.721
3	626.669	8.524	30.027	2.471	0.075	16.415	16.735	8.591	75.611	127.859
4	637.642	8.685	53.320	2.519	0.045	16.490	19.650	10.176	66.595	124.838
5	643.280	8.649	28.015	2.398	0.115	2.412	2.347	2.033	70.945	118.962
6	647.548	8.595	27.907	2.407	0.101	0.994	0.811	1.182	68.917	123.847
7	653.491	8.595	45.926	2.554	0.089	4.337	4.334	5.940	70.828	135.342
8	667.969	8.990	60.000	2.671	0.117	2.611	2.524	3.213	68.569	137.844

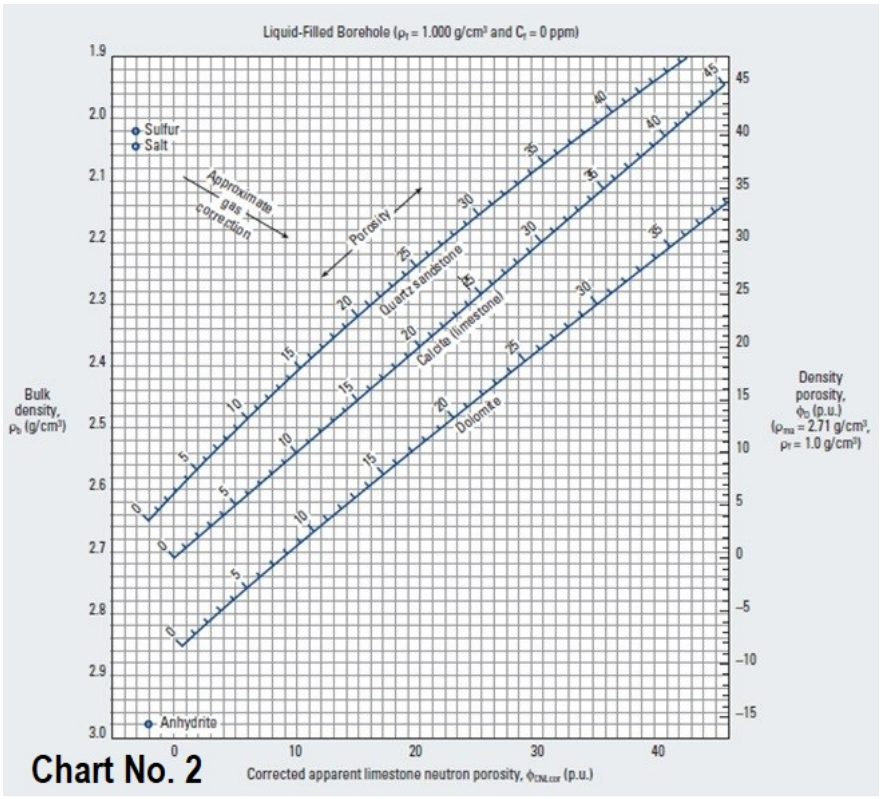


Chart No. 2

Table 2: Displaying the Cross-plot Porosity and Lithology (From Chart No. 2)

Sl. No.	Cross-plot Porosity	Lithology
1		
2		
3		
4		
5		
6		
7		
8		

(CO5) [Application]

16. Figure XY is displaying Caliper and Gamma Ray (GR) logs in Track 1, Sonic, Neutron, and Density logs in Track 2, and Deep Resistivity and Shallow Resistivity logs in Track 3 of PU Well 4. Table, PU Well 4 is displaying geophysical log data from selected depths.
(a) Pick GRsa and GRsh from the inspection of the logs,
(b) Calculate the Volume of Shale (Vsh) at 637.946 ft depth from GR Log,
(c) Pick the likely position of the OWC,
(d) Assuming that m = n = 2, choose an appropriate Rw as the well is drilled with fresh WBM, and
(e) Calculate Sw at 637.946 ft using Archie's equation.

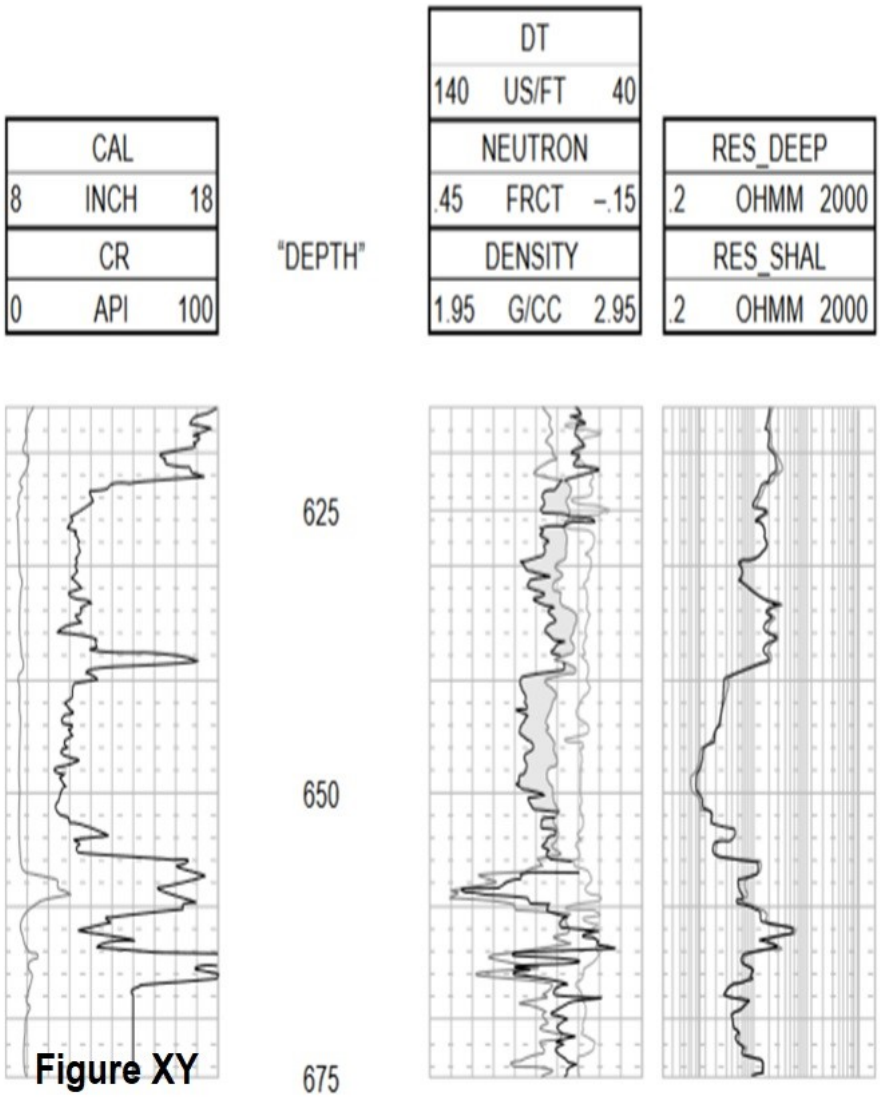


Figure XY

PU Well 4: Geophysical Log Data

Sl. No.	Depth (ft)	Cal (inch)	GR (API)	RHOB (g/cc)	NPHI (frac)	RES_DEEP (Ohm_m)	RES_SHAL (Ohm_m)	RES_MICR	DT (us/ft)	DTS
1	616.458	9.205	97.172	2.648	0.124	19.741	21.774	22.498	70.163	158.646
2	623.164	8.793	48.655	2.543	0.053	13.042	15.576	23.724	63.147	115.854
3	626.974	8.559	33.514	2.484	0.068	16.583	16.573	7.794	64.393	110.509
4	637.946	8.684	82.600	2.579	0.064	19.578	23.019	25.056	68.278	148.217
5	643.585	8.631	26.040	2.392	0.123	2.405	2.357	1.847	68.161	113.361
6	647.852	8.595	22.921	2.403	0.118	0.987	0.809	1.179	68.917	121.839
7	653.796	8.595	45.373	2.496	0.085	4.353	4.390	2.598	70.682	134.800
8	668.274	8.900	60.000	2.683	0.174	8.831	8.284	19.870	68.278	137.258

(CO3) [Application]