



ROLL NO.	
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PRESIDENCY UNIVERSITY, BENGALURU
SCHOOL OF ENGINEERING

Max Marks: 40

Max Time: 120 Mins

Weightage: 40 %

ENDTERM FINAL EXAMINATION

I Semester AY 2017-18

Course: **PET 210 WELL LOGGING AND
FORMATION EVALUATION**

19 DECEM 2017

Instructions:

- i. Write legibly
 - ii. Scientific and non-programmable calculators are permitted
 - iii. Refer the tables which are attached with question paper for any data required
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Part A

[2 Q x 5 M= 10 Marks]

1. Define formation density logging. Explain the interaction of gamma rays emitted by a source of density log tool.
2. Solve the following
 - a. A sandstone rock which is of Mesozoic age with 32% porosity and 12 Ωm resistivity is found to contain a saturation exponent of 2. What is the water saturation of this rock if the water resistivity is 0.15 Ωm and also find bulk volume of water?
 - b. Find the actual bulk density of halite formation whose apparent bulk density which was recorded from the density tool is given as 2.032 g/cc. Halite rock consists of NaCl. (Atomic number of Sodium is 11 and Chlorine is 17. Atomic mass of Sodium is 23 and Chlorine is 35.5)

Part B

[2 Q x 5 M= 10 Marks]

3. What is the principle of sonic log also mention any three uses of it.
4. Which are the four main interactions of neutron with matter? Explain any two.

Part C

[2 Q x 10 M= 20 Marks]

5. Interpret the Well log graph which is given in figure 1 for the depth starting from 2000 m to 4500 m. The graph consists of three tracks namely 1, 2 and 3.

In track 1 there are three logs which are:

1. Differential Caliper log (in)
2. S P log (mV)
3. Natural Gamma ray log (API)

In track 2 there are two logs which are:

4. Laterolog Deep (Ωm)
5. Laterlog Shallow (Ωm)

In track 3 there are two logs which are:

6. Density log (gm/cc)
7. Neutron porosity log Φ_N (%)

6. Compare the porosity value obtained by density log, neutron log and sonic log for an oil reservoir which is obtained at a depth of 3000 m. While logging borehole is filled with water based mud (contains 200,000 ppm of salts). The formation of this reservoir is found to be Dolomite which contains 6.4 m^3 of shale volume with 10% shale porosity. In the invaded zone it is found that mud filtrate has 30% saturation. The following log data have been obtained from following logs at 3000m depth:

Sonic log $\Delta t = 100 \mu\text{seconds}$

Density log $\rho_b = 2.2 \text{ gm/cc}$

Neutron log $\Phi_{N,\text{apparent}} = 40\%$

Table 1: Bulk density values for different compounds

Compound	Comj	Actual Bulk Density, ρ_b
Quartz	SiO ₂	2.654
Calcite	CaCO ₃	2.710
Dolomite	CaCO ₃ .MgCO ₃	2.870
Anhydrite	CaSO ₄	2.960
Sylvite	KCL	1.984
Halite	NaCl	2.165
Gypsum	CaSO ₄ .2H ₂ O	2.320
Anthracite (low)		1.400
Anthracite (high)		1.800
Coal (Bituminous)		1.200
Coal		1.500
Pure Water	H ₂ O	1.000
Salt Water	200,000 ppm NaCl	1.146
Oil	(CH ₂) _n	0.850
Methane	CH ₄	ρ_m
Gas	C _{1.1} H _{4.2}	ρ_g

Table 2: The value of tortuosity factor (a) and cementation factor (m) for different lithologies.

Description of rock	a	m
Weakly cemented detrital rocks, such as sand, sandstone, and some limestones, with a porosity range from 25 to 45%, usually Tertiary in age	0.88	1.37
Moderately well cemented sedimentary rocks, including sandstones and limestones, with a porosity range from 18 to 35%, usually Mesozoic in age	0.62	1.72
Well-cemented sedimentary rocks with a porosity range from 5% to 25%, usually Paleozoic in age	0.62	1.95
Highly porous volcanic rocks, such as tuff, aa, and pahoehoe, with porosity in the range 20% to 80%	3.5	1.44
Rocks with less than 4% porosity, including dense igneous rocks and metamorphosed sedimentary rocks	1.4	1.58

Archie's formula for different lithologies.
(From Keller, 1987.)

Table 3: Values of travel transit time (Δt) for different compounds.

Material	Δt ($\mu\text{s}/\text{ft.}$)	V (ft./s)	V (m/s)
Compact sandstone	55.6 – 51.3	18000 – 19500	5490 – 5950
Limestone	47.6 – 43.5	21000 – 23000	6400 – 7010
Dolomite	43.5 – 38.5	23000 – 26000	7010 – 7920
Anhydrite	50.0	20000	6096
Halite	66.7	15000	4572
Shale	170 – 60	5880 – 16660	1790 – 5805
Bituminous coal	140 – 100	7140 – 10000	2180 – 3050
Lignite	180 – 140	5560 – 7140	1690 – 2180
Casing	57.1	17500	5334
Water: 200,000 ppm, 15 psi	180.5	5540	1690
Water: 150,000 ppm, 15 psi	186.0	5380	1640
Water: 100,000 ppm, 15 psi	192.3	5200	1580
Oil	238	4200	1280
Methane, 15 psi	626	1600	490

Table 4: Values of apparent neutron porosity for different compounds.

Apparent Thermal Neutron Porosities of Some Common Reservoir Materials	
Material	Apparent Neutron Porosity, ϕ_{CNL}
Quartz	-0.020
Calcite	0.000
Dolomite	0.020
Siderite	0.120
Kaolinite	-0.370
Illite	-0.030
Anhydrite	-0.020
Water	1.000
Brine (200 kppm)	0.920
Gas (reservoir conditions*)	0.540
Oil	-0.900

* Reservoir conditions, 200 deg F and 7000 psia



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Max Marks: 20

Max Time: 60 Mins

Weightage: 20 %

TEST 2

I Semester AY 2017-2018 Course: **PET210 Well Logging and Formation Evaluation** 26 OCT 2017

Instructions:

- i. Write legibly
 - ii. Scientific and non-programmable calculators are permitted
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Part A

(4 Q x 2 M= 08 Marks)

1. What is depth of investigation and vertical resolution for a well logging tool?
2. A formation with high bulk density corresponds to low gamma ray count rate recorded at sensors. Justify the above statement.
3. Explain the concepts.
 - i) Photoelectric effect
 - ii) Compton scattering
4. Calculate true and apparent porosity for a 0.85 g/cc oil-bearing sandstone (2.67 g/cc) characterized by 25% oil saturation. The formation was invaded by a mud filtrate of 1.1 g/cc. Bulk density was read from density log as 2.2 g/cc.

Part B

(1 Q x 6 M= 06 Marks)

5. Analyze the well log graph given in figure 1 and write its interpretation for depths from 2200 m to 2800 m.

Part C

(1 Q x 6 M= 06 Marks)

6. Calculate a,b,c and d from the below given information's.
 - a. Calculate the volume of mud in the Drillpipe, Heavy-weight and collars.
 - b. Calculate the annular volume for each annular section.
 - c. Add the section annular volumes to give the total annular volume.
 - d. Calculate the lag in minutes.

Pump information

Pump output = 0.125 bbls/stroke

Pump rate = 75 spm

Drill string information

Drill pipe: 5" OD 4.276" ID length 8075'

Heavy-weight Drill pipe: 5" OD 3.000" ID Length 275'

Drill collars: 8" OD 2.813" ID Length 650'

Hole information

Casing: 13 3/8" OD 12.415" ID Length 3500'

Open hole: 12.25" diameter

TD: 9000'

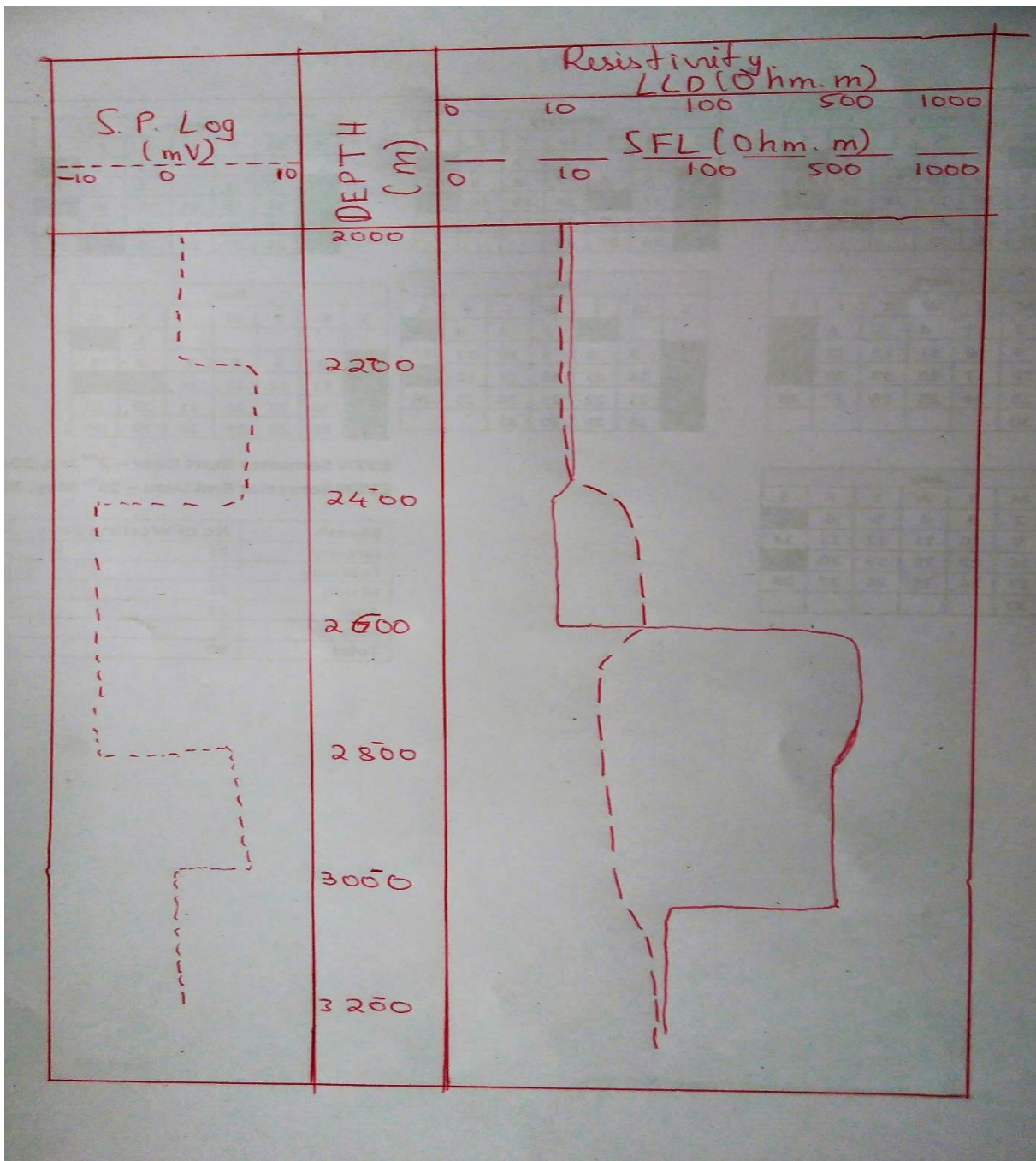


Figure 1



PRESIDENCY UNIVERSITY, BENGALURU
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Max Marks: 20

Max Time: 60 Mins

Weightage: 20 %

TEST 1

I Semester 2017-2018

Course: **PET210 Well Logging and Formation
Evaluation**

18 SEPT 2017

Instructions:

- i. Write legibly
 - ii. Scientific and non-programmable calculators are permitted
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Part A

(3 Q x 2 M= 06 Marks)

1. Explain the importance of well logging.
2. How does hole diameter affect the readings in well log measurement?
3. Write the properties of gamma ray.

Part B

(2 Q x 4 M= 08 Marks)

4. Which are the different types of logging? Explain any three.
5. With neat diagrams explain liquid junction potential and membrane potential.

Part C

(1 Q x 06 M= 06 Marks)

6. For a 4 arm caliper explain the concepts of on gauge, key seat, wash out and break out with neat diagrams.