PART ONE – Horizontal Drilling:
1- A) Mention four information required starting and completing a horizontal well?

1) Kick off Point (KOP)
2) Dogleg severity
3) Azimuth
4) End of Build (EOB) .... etc....

B) In horizontal drilling, both measured depth (MD) and true vertical depth (TVD) are important. Give two field applications of each, in which MD and TVD are necessary.

MD: To determine volume (cement, Mud, etc..) and length (drill string, casing, etc..) related items and pressure losses

TVD: Hit the target and to obtain hydrostatic pressure

C) Mention two systems of measurement while drilling (MWD) and which system would you use in case of lost circulation potential and argue Why?

- Positive pulse system (This system is suitable in case of lost circulation, since the communication and transmission of the signals will be through the drill string and not through the annulus)

- Negative pulse system (Transmission is thru annulus)

2- Explain the following items related to horizontal drilling:

Dog leg severity: The combination of changes in inclination and azimuth between two survey stations [°/100ft].

- Azimuth: The direction of borehole on the horizontal plane, measured clockwise (0-360°)

- Tangent section: The straight bath used to increase the TVD and might be served as completion requirement

-Fatigue: The tendency of metal to fracture due to repeated cycles of loads.

- Sliding: Drilling and rotating the drill bits using Downhole motors (Drillstring should not rotate)

- Dump sub: One of the parts in the PDM and it is used to release the mud above the motor while tripping out.

- Closure: The straight line drawn from the rig reference point to any rectangular coordinate in horizontal plane

- Vertical section: The total horizontal deviation of the well projected onto horizontal plane.
3- The plan is to run a PDC bit with mud motor either of 7/8 lobe or 4/5 lobe. **Which** type of mud motor would you select and **why**? 4/5 lobe might be selected, since lobe configuration provides higher RPM than 7/8 lobe.

What is the other important performance specification, which has to be considered in this case? **Number of stages (high torque), Speed (RPM), Pressure drop.**

4- Calculate the **toolface setting** and the direction of **bit turning** to achieve the following hole target.

<table>
<thead>
<tr>
<th></th>
<th>Inclination</th>
<th>Azimuth</th>
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<tbody>
<tr>
<td><strong>Current</strong></td>
<td>2°</td>
<td>314°</td>
</tr>
<tr>
<td><strong>Desired</strong></td>
<td>3°</td>
<td>282°</td>
</tr>
</tbody>
</table>

![Toolface Diagram]

Toolface = \( \tan^{-1}(\frac{DL}{2}) \) = 71.2°

Direction to turn the bit is from North to West

5- A combination horizontal well consist of a tangent section and two different build sections, is to be drilled with the following data:

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Upper build</strong></td>
<td>5 deg/100 ft to 60°</td>
</tr>
<tr>
<td>Tangent Section Length</td>
<td>400 feet</td>
</tr>
<tr>
<td><strong>Lower build</strong></td>
<td>8 deg/100 ft to 90°</td>
</tr>
<tr>
<td>Length of horizontal section</td>
<td>1500 ft</td>
</tr>
</tbody>
</table>

The KOP-depth is 5254 ft

Answer the following:
1- Provide a drawing of the well profile
2- The total true vertical depth (TVD) of the well
3- The total horizontal displacement
4- The measured depth of the well
5- What might be the reason behind such well configuration?
3) Total horizontal displacement \( = 1277.5 \text{ ft} + 1500 \text{ ft} \)

4) Total MD \( = 5254 \text{ ft} + 1200 \text{ ft} + 400 \text{ ft} + 375 \text{ ft} + 1500 \text{ ft} = 8729 \text{ ft} \)

5) Reasons might be:
   - Completion requirement
   - Increase the TVD
   - to hit the target (one or two targets)

Part Two - Well Control

6- Given are the following Data of a well:

Casing Size = 13-3/8” OD (ID = 12.615”)
Casing Shoe depth = 5210 ft
Bit Diameter = 12.25”
Hole depth = 5410 ft
Drill Collars = 8.25” OD and 2.75” ID
Length of Drill collars = 279 ft
Drill pipe = 5” OD and 4.276” ID

Capacities
- DP-capacity = 0.0177 bbls/ft
- DC-capacity = 0.0073 bbl/ft
- CSG to pipe Annulus = ?
- OH to DC annulus = 0.1304 bbl/ft
- OH to DC annulus = 0.0797 bbl/ft

Pumping Data
- Pump Output = 0.109 bbls/strke
- Slow Circulating Rate Pressure at 45 SPM = 1100 psi
Fracture Data

- Max. Allow. Annular Surface Pressure: 1119 psi
- Mud Weight in Hole at Test: 9.5 ppg

Kick Data

- Present Mud Weight: 9.8 ppg
- SIDPP: 480 psi
- SICP: 580 psi
- Pit Gain: 27 bbl’s

Calculate the following:

A) Kill Mud Weight: 11.6 ppg
B) Fracture Mud Weight: 13.7 ppg
C) Leak off test pressure with current mud in hole: 1057 psi
D) Surface to Bit strokes and time: 852 strokes, 19 min.
E) Total Circulation strokes for Driller's method: 2X7200 = 14402 strokes
F) Gradient of Influx: 0.187 psi/ft, Gas
G) ICP and FCP: 1580 psi, 1302 psi
H) Drill pipe pressure using kill mud weight after pumping 700 strokes and 950 strokes:
   - 1350 psi after 700 strokes
   - 1302 psi (FCP) after 950 strokes

I) What would be the influx gradient and type of influx, if the SIDPP is equal to SICP:
   - 0.052 x 9.8 ppg = 0.51 psi/ft (brine)

J) Provide plots of drill pipe pressure and annulus pressure of start up procedure to kill the well.

7- Mention the reason behind the difference between SIDPP and SICP.
   - The Ph in the annulus will decrease due to the influx and to keep the BHP constant, the back pressure in the annulus (SICP) should increase

8- Explain the term "Drilling Break" as an indication of kick.
   - Sudden change in rate of penetration. Underbalance situation in the well will lead to increase the ROP

9- Mention one advantage and disadvantage of the soft shut in procedure.
   - Avoid hydraulic shock (hammering effect) on the csg shoe
   - Time consuming resulted in larger amount of pit gain.

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