

Answer all questions

Question One (12 marks)

1. Mention only three steps to plan a trajectory.
2. List the three main types of trajectories.
3. Give the potential advantage of horizontal wells over vertical or deviated wells.
4. Define the following terms:

(a) Tangent angle (b) True vertical depth (c) Survey azimuth

Question Two (18 marks)

1. It is desired to drill a directional well. For this well, a build and hold trajectory will be used. Horizontal departure to target (X_3) is 1655 ft. at a TVD of 8650 ft. The recommended rate of build is $2^\circ/100$ ft. The kickoff depth is 1500 ft. determine the following:
 - A. The radius of the curvature (r_1)
 - B. The maximum inclination angle (θ)
 - C. The measured depth to the end of the build (D_m)
 - D. The total measured depth (D_{tot})
 - E. The horizontal departure to the end of the build (X_2)
 - F. The TVD at the end of the build section (D_2)
 - G. The measured depth at a TVD of 1815 ft.
 - H. The horizontal displacement at a TVD of 1815 ft.
 - I. The measured depth at a TVD of 6614 ft.
 - J. The horizontal departure at a TVD of 6614 ft.
2. What are the direction, in alternative format, of each of the following wells:
 - A. Well A 79°

- B. Well B S 67 W
- C. Well C 90°
- D. Well D N19W

Question Three (18 marks)

1. Calculate the trajectory for the well from 8000 to 8400 ft. where the kickoff is at 8000 ft and the rate of build is $1^{\circ}/100$ ft, using a lead of 10° and right hand walk rate of $1^{\circ}/100$ ft. direction to the bull s eye is 30° . Assume that the first 200 ft is to set the lead, where the direction is held constant to 8200 ft. and then turns right at rate of $1^{\circ}/100$ ft.

Note: for the first point the direction should not be averaged.

2. Determine the maximum axial stress for a 36-ft joint of 7.625-in. (ID is 6.625 in), 39-lbf/ft., N-80 casing with API long, round-thread couplings. The casing has young modulus of $(E) = 30 \times 10^6$, minimum yield strength 80000 psi, and minimum ultimate strength 100000 psi, if the casing is subjected to a $(F_a)400000$ -lbf axial- tension load in a portion of a directional wellbore having a dogleg severity of $4^{\circ}/100$ ft. Compute the maximum axial stress assuming (1) uniform contact between the casing and the borehole wall, and (2) contact between the casing and the borehole wall only at the coupling. Also compute the joint strength of the API round- thread coupling.

Question Four (12 marks)

1. Determine the new direction for a deflection tool set at 705m with a tool face setting of 45° right of high side for a course length of 10m. The inclination is 7° and the direction is N15W of 705m. The dog leg severity is 3° and index of angle change is 30m.
2. Calculate the total angle change of 3650 ft. of 4.5-in [3.826-in. ID] Grade E 16.60 lbf /ft. drill-pipe and 300 ft. Of 7in. Drill collars [2.8125- in. ID] for a bit generated torque of 1000 ft-lbf. Assume that the motor has the same properties as the 7-in. drill collars. Use the shear modulus of steel $(G= 11.5 \times 10^6$ psi) for the BHA and drill-string . calculate the total angle change if 7300 ft. of drill-pipe was used.