PETE 426—DRILLING ENGINEERING, Spring 2014
Class Instructor: Dr. Dare Awoleke

Midterm, Tuesday, 11th March, 2014

Duration: 7:00—8:30pm

Instructions

- Write your name at the back of your exam booklet.
- Closed book, closed notes.
- Write your answers in this booklet. You might want to use a pencil just in case of erasures.
- You need writing material and a simple calculator.
- The use of phones and all other types of electronic gadgets is not allowed.
- If in doubt about the use of any device, ask.

Relax, take a deep breath, read through all the questions once and start when you are told to!

1) Answer the following questions:

a. What is the hydrostatic pressure at the bottom of the fluid column for each case shown in **Figure 1** below? **(3 points)**

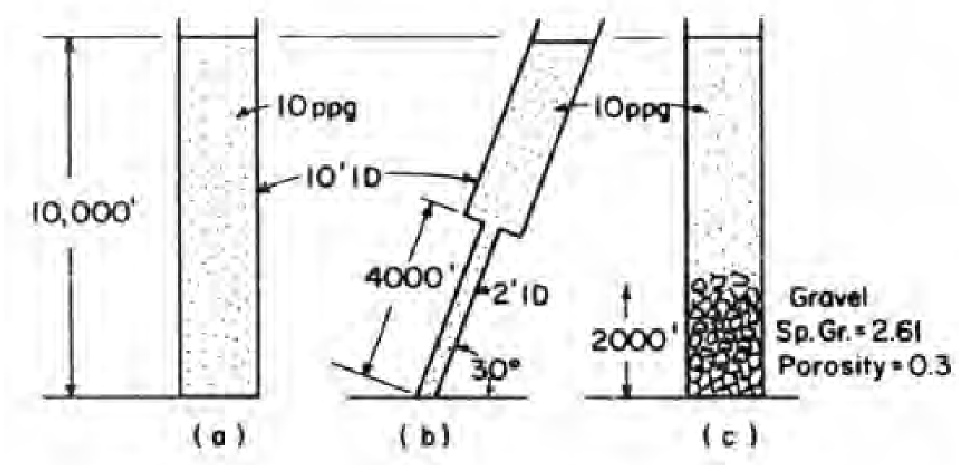

Figure 1

b. What is the mud density required to fracture a stratum at 5,000ft if the fracture pressure is 3800 psig. **(2 points)**

2) A 12,000-ft drill string is composed of 11,400 ft of 5-in, 19.5#/ft drillpipe and 600ft of 6.5 x 2.5-in drill collars. The mud density is 17.5 ppg. The mud density is 12.5 ppg and that you are circulating mud at 280 gallons per minute. Assume the drill string is suspended off bottom. The bit size is 8.5 inches. We also know the following:

$\Delta P_{dp} = 655\, psi; \Delta P_{dc} = 234\, psi; \Delta P_{bitnozzles} = 1039\, psi; \Delta P_{dc/ANN} = 32\, psi; \Delta P_{dp/ANN} = 153\, psi$

$\Delta P_{hyd} = 100\, psi$

a. Is the drill string in tension or compression at the bottom of the drill pipe? **(5 points)**

b. Is the drill string in tension or compression at the top of the drill collar? **(5 points)**

c. What is the expected pump pressure in psi? **(5 points)**

d. What is the equivalent circulating density in ppg? What is the pore pressure if this well is overbalanced by 300 psi. **(5 points)**

e. What is the bit nozzle size given that the bit has 3 equally sized nozzles. Assume C_d=0.95. **(5 points)**

f. The mud density of this well is being increased from 12.5 ppg to 14 ppg. How long will this take to displace the entire well to 14 ppg mud? (Hint: volume in question is drill pipe internal volume+ drill collar internal volume+drill collar-annulus volume+drill pipe-annulus volume). **(5 points)**

g. If the pump is stopped when the interface between the two muds in the drill pipe is at 8000ft, how much pressure does the driller expect to see on the gauge on the annulus? **(5 points)**

3) Given that you have a fluid with the following rheological properties shown in **Figure 2** below,

a. Compute the pressure drop in the annulus for the well system described in **Question 2** above. **Mud density and flow rate was changed to 13ppg and 400 gpm respectively. (10 points)**

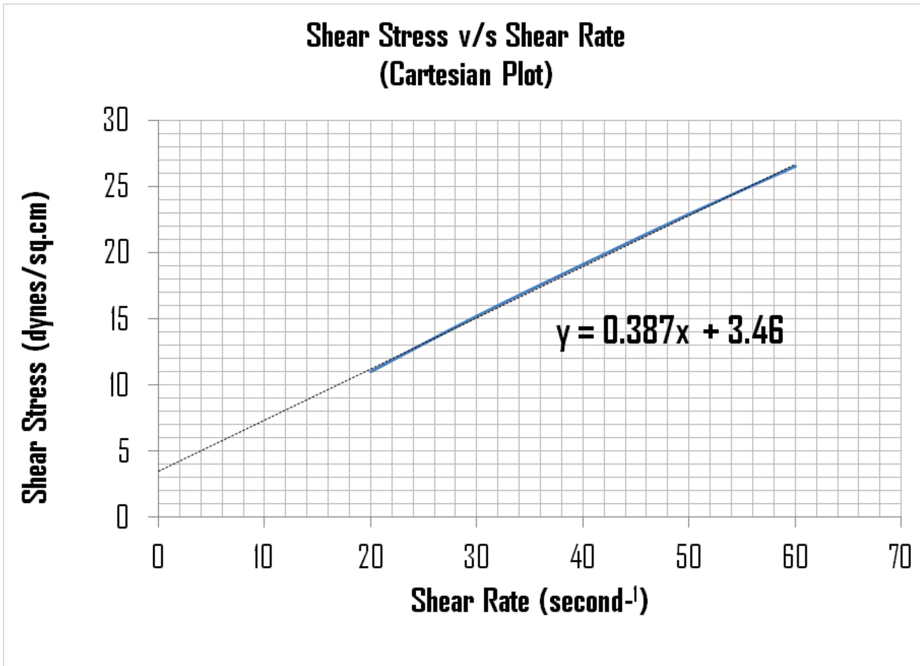

Figure 2

b. What is the ECD? **(5 points)**

4) Let **Figure 3** below describe the variation in bulk density versus depth for a given area. Normal pore pressure in this area is 0.465 psi/ft.

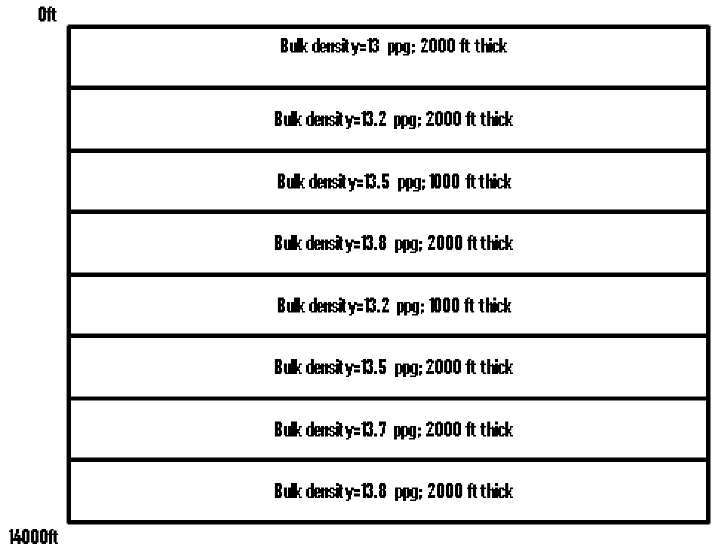

Figure 3

a. What is you best estimate of the overburden pressure at 9000ft? **(10 points)**

b. In the absence of any other data, what is your best guess of the depth at which an abnormally pressured zone starts in this area? **(5 points)**

c. What is your best guess of the pore pressure at 10,000ft? **(10 points)**

5) In the event of a kick, describe how you would compute your best estimate of the pore pressure? **(5 points)**

6) **True or False**. It is best for the drill pipe to be in compression. **(5 points)**

7) What are the main component parts (systems) of a rotary drilling rig? **(5 points)**

8) What is a kick? **(2 points)**

9) Describe three potential drilling problems and explain a possible way to fix one of them. **(3 points)**

List of formula

$$F_T\text{, axial tension} = W_2 - F_2 - F_{bit}$$

$$F_T\text{, axial tension} = \mathrm{w}_{\mathrm{dc}}(total\_depth - D) - 0.052\rho_{mud} total\_depth A_{dc} - F_{bit}$$

$$F_T\text{, axial tension} = W_1 + W_2 + F_1 - F_2 - F_{bit}$$

$$W_1 = w_{dp}(total\_depth\_dp - D)$$

$$W_2 = w_{dc} height_{dc}$$

$$F_1 = 0.052\rho_{mud} total\_depth\_dp(A_{dc} - A_{dp})$$

$$F_2 = 0.052\rho_{mud} total\_depth(A_{dc})$$

$$pressure(psi) = 0.052 * density(ppg) * height(ft)$$

$$\Delta p_{bit} = \frac{8.311\times 10^{-5}\rho q^2}{C_d^2 A_t^2}$$

$$\sigma_{ob} = \sigma_z + p_p$$

$$\mu_p = \frac{300}{N_2 - N_1}\left(\theta_{N_2} - \theta_{N_1}\right)$$

$$\tau_y = \theta_{N_1} - \mu_p \frac{N_1}{300}$$

$$tubular\ capacity\left(\frac{bbl}{ft}\right) = \frac{ID^2}{1029.4}\text{, ID is in inches}$$

$$annular\ capacity\left(\frac{bbl}{ft}\right) = \frac{OD^2 - ID^2}{1029.4}\text{, OD, ID is in inches}$$

Unit conversion

42 gal = 1 bbl

1 cp = 0.01 dynes-second/cm^2.

1 eq. cp = 0.01 dynes-second^n/cm^2.

1 dynes/cm^2=0.209 lbf/100 sq.ft