UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, DEC, 2014

COURSE NO: **PE 275**
COURSE NAME: **PROPERTIES OF RESERVOIR ROCKS AND FLUIDS**
CLASS: **PE II** TIME**: 3 HOURS.**

Name**:** _____ Index Number: _____

INSTRUCTIONS:

Answer **All** questions. Each correct answer in section A carries **0.75 marks**. Show all the necessary workings on your answer sheets.

Use the options below to answer SECTION A (Questions 1 – 6)

gas-cap reservoir,	paraffin,	secondary,
capillary pressure,	arenas,	aromatics,
carbon,	density,	decreases,
olefins,	gas reservoirs,	increases,
wettability,	melting points,	drainage,
phase diagram,	boiling points,	imbibitions,
oil reservoirs,	physical properties,	relative permeability,
interfacial tension,	trap,	saturated oil reservoir,
surface tension,	phase,	absolute permeability,
homogeneous,	naphthenes,	grain size,
heterogeneous,	primary,	undersaturated oil reservoir,

1. Crude oil is separated into fractions according to the range of their……..
2. Another name for alkanes is ……..
3. …… is a subsurface condition restricting further movement of hydrocarbon such that it may accumulate in commercial quantities.
4. The irreducible wetting phase saturation is a function of ……, ……. and …….
5. The pressure exerted by the fluids within the pore volume of the reservoir formation is known as…….
6. The differential pressure across the interfaces of immiscible fluids that keeps them in equilibrium in a confinement (system) is known as……

THE UMaT FIELD

Fill in the empty spaces in this section with your own answers to make the statements valid.

The UMaT Field operated by PE II Plc has oil with a gas cap hosted in Devonian sandstones. The reservoir rock is **water-wet** and the reservoir has an underlying aquifer.

7. If the **water saturation** in this reservoir is **increasing**, the process will be called……

8. A **plot of pressure versus volume** to **characterize the behaviour** of the fluids in this reservoir as pressure and/or volume are/is changed is known as a ……..

9. If the reservoir fluid is a **single component** system how many **degrees of freedom** are required so that it will be at **the triple point**? ……..

10. A look at the permeability of this reservoir shows that the permeability is **independent of position** within the reservoir. The reservoir is therefore ……. with respect to permeability.

11. In the calculating the hydrocarbon initially in place in this reservoir by the volumetric method, the **1-S_{wc}** term which will be in the formula represents……

12. Pressure measurements have revealed that the **initial reservoir pressure** is equal to the **bubble-point pressure** of the reservoir fluid, therefore the reservoir can be referred to as…… reservoir.

13. 11. The **hydrostatic pressure** at any point in this reservoir is equal to **0.45*D – C**. therefore this reservoir is an …… reservoir.

14. During the **drilling** of the reservoir, significant amount of **fracturing** occurred in some parts of the reservoir. The **space** introduced by fracturing is an example of……**porosity**.

15. The rock grains are in contact with both **oil** and **water** in reservoir, because the reservoir is **water-wet,** the **contact angl**e of oil will be …….. than that of water.

16. When oil was accumulating in this rock, it displaced water to a point where the water could no longer be displaced. The saturation of the water at this point is called……. and the effective permeability of the water at this point would be ……..

17. For the displacement to occur a minimum amount of pressure called ……had to be applied to the oil and this amount of pressure depended on ……in the rock.

18. Because of capillary action, there is now a ……..zone in this reservoir between the OWC and the oil leg where there is variable water saturation. Champion drilling engineer Chakpo overlooked the instruction of chief reservoir engineer Suzzy Sistofe and sank a well into this zone. Can the water in this zone be produced?.....

Choose the letter that bears the answer to the following questions from the list of answers provided under each question.

19. The force exerted per unit length at the boundary or the interface of two immiscible fluids is known as …….
    a. capillary pressure b. wettability c. interfacial tension d. surface tension.

20. What is the property of the reservoir rock that allows fluids to move easily through its pore space?
    a. Permittance b. Permeability c. Permissibility

21. The measure of the gross space occupied by fluid in the reservoir is called……..
    a. Saturation b. porosity c. reserve b. volume
22. The force exerted per unit at length at the boundary or the interface of two immiscible fluid (gas and liquid) is known as …….
    a. capillary pressure b. wettability c. interfacial tension d. surface tension.

State whether the following statements are true or false

23. Porosity generally increases with depth.

24. Traps normally consist of an outer layers which are permeable in nature

25. A permeable rock is always porous.

26. An increase in porosity will always lead to an increase in permeability.

27. The connate water in an oil reservoir can be produced with the oil.

28. Gas has a lower API gravity than oil.

SECTION B

1. (a) Two core samples have equal total porosity of 0.3 but have different permeabilities. State and briefly explain any three reasons why this is so. **(6 marks)**

   (b) List four factors that affect porosity. **(2marks)**

   (c) An oil reservoir is characterized by three distinct formation segments of the same thickness connected in series. Assuming a radial flow into a well bore of radius (r_w) 0.20 ft, calculate the average permeability of the reservoir. The length and permeability of each section of the six beds reservoir are given below. **(8marks)**

Length, ft	Permeability, md
100	250
120	400
150	300

   (d) Sketch and label the drainage capillary pressure curves for the following rocks from the given formations with the following properties. NB: In reality, it is possible for two capillary pressure curves to cross each other but in your sketch no two curves should cross each other. **(6 marks)**

Formation	Sorting	Grain size	Largest pore size, (mm)
Tarbett	Moderate	Coarse	2
Rannoch	Good	Coarse	2
Ettive	Good	Medium	1
Brent	moderate	medium	0.2
Ninian	Good	Very fine	0.01

2. (a) What is an abnormally pressured reservoir? **(2 marks)**
   (b) State two causes of under-pressuring in a reservoir? **(2 marks)**

   (c) A newly discovered reservoir has oil water contact (OWC) at 5000 ft and gas oil contact (GOC) at 3500 ft. Calculate P_o and P_g at 4000 ft and 2050 ft respectively **(5 marks)**

3. (a) Mention the six types of reservoir fluids we have and draw their phase diagrams of any two. **(5marks)**

   (b) With the aid of a well labeled phase diagram explain retrograde condensation. **(6 marks)**

   (c) How will you identify (i) volatile oil (i) black oil and (iii) wet gas reservoir on the field? State only two ways of identification for each. **(6marks)**

   (d) If a gas reservoir was discovered and the pressure of the reservoir was found to be above the saturation pressure (bubble point). What would YOU advise as a Reservoir Engineer that a production team should do in order to maintain oil production for very a long time? **(3marks)**

4. (a) A gas reservoir has the following gas composition: the initial reservoir pressure and temperature are 3,000 psia and 180°F, respectively. Assuming real gas behaviour, calculate: (i) the density (ii) the specific volume (iii) formation volume factor of the gas phase under initial reservoir conditions. **(12marks)**

Component	y_i	M_i	T_{ci},°R	p_{ci}, psia
CO_2	0.04	44.01	547.91	1071
C_1	0.85	16.04	343.33	666.4
C_2	0.05	30.1	549.92	706.5
i-C_3	0.04	44.1	666.06	616.4

   (b) If the gas composition was unknown at the time but specific gravity was determined to be 0.6, find the pseudo reduced temperature and pressure given that the gas contains H2S and CO2 in 0.04 and 0.12 mole fractions respectively. **(6 marks)**

   (C) Calculate the stock tank oil initially in place of an oil reservoir with grain volume of 12800ft^3 and the following properties. A = 1,600 acres, h = 32 ft, S_{wi} = 20%, and B_{oi} = 1.23 bbl/STB. **(4 marks)**

Samuel Tawiah

DATA

Natural Gas Systems $T_{pc} = 168 + 325\gamma_g - 12.5\gamma_g^2$ $p_{pc} = 677 + 15.0\gamma_g - 37.5\gamma_g^2$ **Gas-Condensate Systems** $T_{pc} = 187 + 330\gamma_g - 71.5\gamma_g^2$ $p_{pc} = 706 - 51.7\gamma_g - 11.1\gamma_g^2$	$T'_{pc} = T_{pc} - \varepsilon$ $p'_{pc} = \frac{p_{pc} T'_{pc}}{T_{pc} + B(1-B)\varepsilon}$ $\varepsilon = 120[A^{0.9} - A^{1.6}] + 15(B^{0.5} - B^{4.0})$
$\rho_g = \frac{pM_a}{zRT}$	$B_g = 0.02827\frac{ZT}{P}$ ft^3/scf,
$k_{avg} = \frac{\ln r_e/r_w}{\frac{\ln r_1/r_w}{k_1} + \frac{\ln r_e/r_1}{k_2}}$	$STOIIP = N = 7758\frac{V\phi(1-S_{wc})}{B_{oi}}$ F = C - P + 2

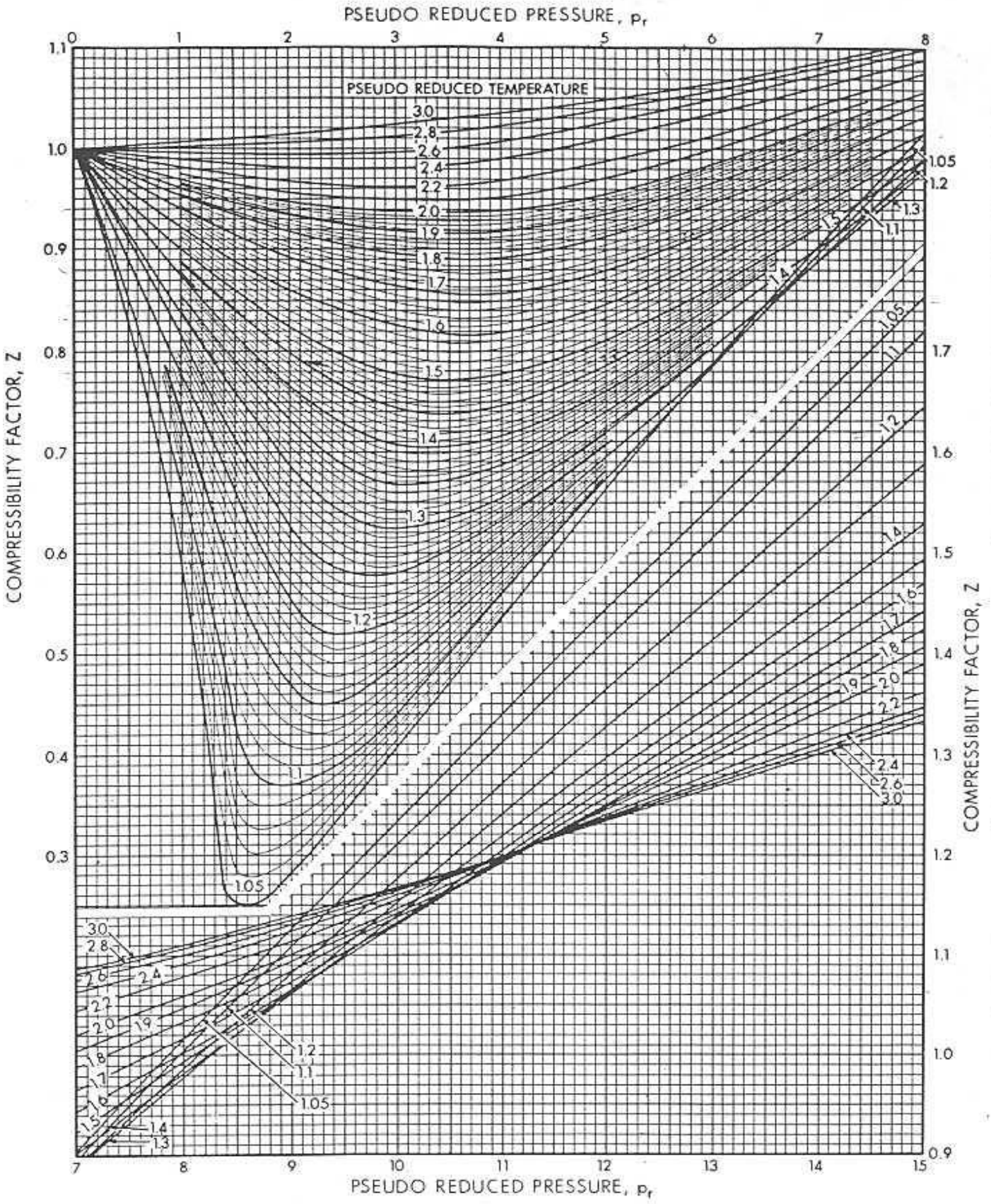
R = 10.73 psia ft^3/lb-mole °R

M_{air} =28.96

$\left(\frac{dp}{dD}\right)_{water}$ = 0.45 psi/ft

$\left(\frac{dp}{dD}\right)_{oil}$ = 0.35 psi/ft

$\left(\frac{dp}{dD}\right)_{gas}$ = 0.08 psi/ft


PSEUDO REDUCED PRESSURE, p_r
PSEUDO REDUCED TEMPERATURE
COMPRESSIBILITY FACTOR, Z
COMPRESSIBILITY FACTOR, Z
PSEUDO REDUCED PRESSURE, p_r