Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Sem. Examination, June 2021

Course: Reservoir Geomechanics **Semester: II**
Programme: M.Tech (PE) **Time: 03 hrs.**
Course Code: PEAU7010 **Max. Marks: 100**

SECTION A

1. Each Question will carry 5 Marks
2. Instruction: Complete the statement / Select the correct answer(s)

Sl. No.	Question	CO
Q 1	(A) The theory of elasticity rests on which of the concepts (i.) Stress (ii.) Strain (iii.) Both (iv.) None (B) The elasticity of the material is defined as (i.) An ability to resist and recover from deformations produced by forces (ii.) The ability to flow of material (iii.) The ability to deform permanently (iv.) The ability to break easily (C) The data source for the least principal stress in GEM is (i.) Leak-off Test (ii.) Extended leak-off Test (iii.) Minifrac (iv.) All (D) As per the Anderson scheme of classification, an area as being characterized by normal fault depending on the condition (i.) $S_v>S_{Hmax}>S_{Hmin}$ (ii.) $S_v=S_{Hmax}>S_{Hmin}$ (iii.) $S_v<S_{Hmax}>S_{Hmin}$ (iv.) $S_{Hmax}>S_v>S_{Hmin}$ (E) As per the Anderson scheme of classification, an area as being characterized by reverse fault depending on the condition (i.) $S_{Hmax}>S_{Hmin}>S_v$ (ii.) $S_{Hmax}>S_v>S_{Hmin}$ (iii.) $S_v>S_{Hmax}>S_{Hmin}$ (iv.) $S_{Hmax}=Sv>S_{Hmin}$	**CO1**
Q 2	(A) Rock mechanics deals with issues in geosciences related to (i.) Rock mass characterization (ii.) Rock mass mechanics	

	(iii.) Rock drilling (iv.) All (B) The geomechanics deals with which of the following disciplines (i.) Soil mechanics (ii.) Rock mechanics (iii.) Both (iv.) None (C) Formation bulk density at any given depth is the combination of which of the following (i.) Rock grain density (ii.) Pore fluid density (iii.) Porosity of rock formation (iv.) All (D) Which of the following is/are the direct approach to measure in-situ stresses, as suggested by Hudson and Harrison (i.) Hydraulic fracture test (ii.) The flatjack test (iii.) The overcoring gauge test (iv.) All (E) Which of the following is/are the indirect approach to measure in-situ stresses (i.) Acoustic emission (ii.) Fault plane solutions (iii.) Both (iv.) None	**CO1**
Q 3	(A) which of the following is true for the Blowout Preventer (i.) It is a large automatically operated safety valve at the top of a well that may be closed in case of loss of control over the formation fluids (ii.) The pressure below which a critical stress level is reached (iii.) A solid cylindrical sample or plug of rock cut from the location of the formation under study for use in laboratory tests and analyses (iv.) All (B) which of the following is true for the Effective Stress (i.) The pressure below which a critical stress level is reached, due to high shear stress causing the rock formation to collapse into the borehole (ii.) The average normal stress transmitted directly from particle to particle of a porous material (iii.) The maximum engineering stress, in compression, expressing the capacity of a material to withstand axially directed pushing forces without fracture (iv.) The elements of the stress tensor that cause distortion in the volume (C) Which of the following will take place due to the decrease in mud level in the wellbore annulus (i.) The flow of formation fluid into the wellbore (ii.) Underground cross-flow/blowout (iii.) Wellbore instability (iv.) All (D) After the borehole is fractured the hole strength consists of the following (i.) Stress bridge	**CO1**

	(ii.) Least in-situ stress (iii.) Both (iv.) None (E) Which of the following is/are correct about Lost circulation in drilling operation (i.) Increase in non-productive time (ii.) Decrease in mud level in the wellbore annulus (iii.) The bottom hole pressure may become insufficient to balance fluid pressure from the formation (iv.) All	
Q 4	(A) The drill stem test (DST) is mainly used for measurement of (i.) Formation pore pressure (ii.) Pressure (iii.) Permeability (iv.) All (B) The critical breakout width/angle is very much dependent on (i.) Rock formation properties (ii.) Complexity in the location (iii.) Orientation, operation and condition of the wellbore (iv.) All (C) The shallow holes are often drilled without blowout (BOP) preventers (i.) True (ii.) False	**CO2**
Q 5	(A) "A short post, constructed from a tube of concrete, supports a compressive load of 24.5 metric tonnes. The inner and outer diameters of the tube are 91 cm and 127 cm, respectively, and its length is 100 cm. The shortening of the post is measured as 0.056 cm. The effect of post's weight is neglected. It is also assumed that the post does not buckle under the load. The axial compressive stress in the post is (i.) 2.36 MPa (ii.) 3.46 MPa (iii.) 5.36 MPa (iv.) 4.46 MPa (B) Assuming the data given in the question number 5A the strain developed in the post is (i.) 0.0056 (ii.) 0.056 (iii.) 0.00056 (iv.) 0.56	**CO2**
Q 6	(A) For a vertical borehole, oriented in a principal stress direction, the fracture pressure for a normal fault stress state is given by (i.) $P_{wf} = 3\sigma_h-\sigma_H-P_0$ (ii.) $P_{wf} = 6\sigma_h+\sigma_H-P_0$ (iii.) $P_{wf} = \sigma_h-P_0$ (iv.) $P_{wf} = 3\sigma_h+\sigma_H-P_0$ (B) In an oil field the pore pressure has declined to 0.6 s.g. Assuming the Poisson's ratio as 0.25, the changes in horizontal stress and fracture pressure are (i.) 0.3 s.g. and 0.5 s.g. (ii.) 0.4 s.g. and 0.2 s.g.	**CO2**

	(iii.) 0.6 s.g. and 0.8 s.g. (iv.) 0.4 s.g. and 0.8 s.g.	

SECTION B

1. Each question will carry 10 marks

2. Instruction: Write short / brief notes

Q 7 — **CO1**

Explain the following:

(a) Write a short notes on Deviatoric and Octahedral Stress with suitable formulations

(b) Write a short notes on Lost circulation scenarios

OR

Write detailed notes on the following with suitable examples?

(a) Model calibration by (i) Optimizing Model Performances (ii) Expert Knowledge

(b) Prediction of pore pressure by Eaton's model and Miller's model with suitable formulations

Q 8 — **CO2**

Derive the formula to determine principal stresses and its orientation in two dimensions.

Q 9 — **CO3**

(a) The triaxial testing data of the rock samples are illustrated in the table below.

$(\sigma_1 + \sigma_{3)/2}$	1561.5	1245	974	735	312	156.5
$(\sigma_1 - \sigma_{3)/2}$	1054.5	807	674	573	288	156.5

Determine the following

(i) Plot the Mohr circles for the data.

(ii) Draw a failure line on the top of the circles.

(iii) Develop equations for the failure model. Determine the cohesive strength and the internal angle of friction.

Q 10 — **CO3**

The following data is given for a vertical well drilled.

σ_v = 10 MPa

$\sigma_H = \sigma_h$ = 9 MPa

P_0 = 5 MPa

μ = 0.3

Determine the following

(a) Fracture pressure for non-deviated well

(b) Fracture pressure at the deviation $\Upsilon = 40^o$ and $\phi = 165^o$

Q 11 — **CO3**

The stress in a granitic rock mass has been measured by the hydraulic fracturing technique. Two tests were conducted in a vertical borehole: one test at a depth of 500 m, and the other test at a depth of 1000 m. The results were as follows:

Depth (m)	Breakdown pressure, P_B (MPa)	Shut-in pressure, P_S (MPa)
500	14.00	8.00
1000	24.50	16.00

Given that the tensile strength, σ_t, of the rock is 10 MPa,

(a) Estimate and list the values of σ_1, σ_2 and σ_3 at the two depths. State all of the assumptions you have to make in order to produce these estimates.

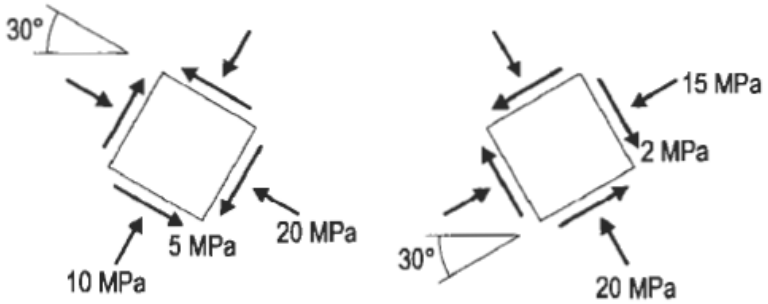
(b) State whether the two sets of results are consistent with each other

(c) Justify your reasons for the statement.

SECTION-C

1. Each Question carries 20 Marks.

2. Instruction: Write long answer.

Q 12	For an oil field, a vertical well is drilled to a maximum depth of 10,000 ft, the average specific gravity and pore pressure gradient are given as 2.3 and 0.38 psi/ft, respectively. Assume the Biot's constant and Poisson's ratio as 1 and 0.28, respectively. Calculate the following for the above data for the surrounding rock formation at the bottom of the vertical well. (a) Overburden Stress (b) Horizontal In-Situ Stress (c) Normal Stress (d) Shear Stress OR Add the following 2-D rock stress states, and find the principal stresses and directions of the resultant stress state. 	**CO4**