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

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

Course: Geomechanics **Semester: III**
Programme: M.Sc. (PETRO-GEOSCIENCES) **Time: 03 hrs.**
Course Code: PEGS 8007 **Max. Marks: 100**

SECTION A

1. Each Question will carry 4 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.) $S_{Hmax} > S_v > S_{Hmin}$	**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	**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 (ii.) Least in-situ stress (iii.) Both (iv.) None	**CO1**
Q 4	(A) The drill stem test (DST) is mainly used for measurement of (i.) Formation pore pressure (ii.) Formation 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	**CO2**

	(iii.) Orientation, operation and condition of the wellbore (iv.) All (C) For a vertical borehole, oriented in a principal stress direction, the fracture pressure for a normal fault stress state is given by (i.) $Pwf = 3\sigma h-\sigma H-P0$ (ii.) $Pwf = 6\sigma h+\sigma H-P0$ (iii.) $Pwf = \sigma h-P0$ (iv.) $Pwf = 3\sigma h+\sigma H-P0$ (D) The shallow holes are often drilled without blowout (BOP) preventers (i.) True (ii.) False	
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**
	SECTION B **1. Each question will carry 10 marks** **2. Instruction: Write short / brief notes**	
Q 6	Explain the following: (a) Write a short note on Deviatoric and Octahedral Stress (b) 2-D Mohr's Circle with associated formula and suitable diagram OR Write detailed notes on the following with suitable examples? (a) 2-D and 3-D Geomechanical Earth Model with suitable sketch (b) Any two model for the prediction of pore pressure with suitable formulations.	**CO1**
Q 7	Derive the formula to determine principal stress and its orientation in two dimension.	**CO2**
Q 8	The following data is given for a vertical well drilled. $\sigma_v = 10$ MPa $\sigma_H = \sigma_h = 9$ MPa $P_0 = 5$ MPa $\mu = 0.3$ Determine the following (a) Fracture pressure for non-deviated well (b) Fracture pressure at the deviation $\Upsilon = 40^o$ and $\phi = 165^o$	**CO2**
Q 9	The matrix below defines a given stress state. Determine the principal stresses.	**CO3**

$$[\sigma] = \begin{bmatrix} 16 & 3 & 3 \\ 3 & 12 & 6 \\ 3 & 6 & 12 \end{bmatrix}$$

SECTION-C

1. Each Question carries 20 Marks.

2. Instruction: Write long answer.

Q 10

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 on vertical plane

(d) Shear Stress on vertical plane

OR

A core sample of 54 mm diameter and L/D ratio 2.0 was obtained from the field for the determination of geomechanical properties as per the standard procedure. There was no confinement during the testing. The results of the testing are tabulated below. Draw stress-strain graph and determine the compressive strength, Elastic modulus and Poisson's ratio of the sample.

CO4

Load(kN)	Axial Displacement (mm)	Lateral displacement (mm)
227.1	0.26	0.014
293.5	0.3	0.053
376.7	0.34	0.014
391.4	0.35	0.029
415.5	0.38	0.048
414	0.42	0.054

Q 11

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.

CO3