Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Geomechanics **Semester: VI**
Program: B.Tech. (GIE) **Time: 03 hrs.**
Course Code: PEAU 3003 **Max. Marks: 100**

Instructions: All questions are compulsory

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Write short notes on the following? (a) E. M. Anderson's faulting theory (b) Geomechanical Earth Model (GEM)	**4**	**CO1**
Q 2	A cylindrical rock sample was collected and tested using a compression-testing rig to examine its stress/strain behavior. The length of the sample was 108 mm with L/D ratio 2.0. The sample was fractured at the load of 85 kN applied by the loading cell. The axial deformation in the sample was observed 1.5 mm. Determine the compressive stress as well as strain of the rock samples.	**4**	**CO2**
Q 3	Differentiate between the following with suitable examples. (i.) 1-D and 4-D Geomechanical Earth Model (ii.) Model Calibration and Model Validation	**4**	**CO2**
Q 4	Describe the following pore pressure prediction method in brief and write suitable formulation. (i.) Effective stress method (ii.) d-Exponent method	**4**	**CO1**
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	**4**	**CO2**

<table>
<tr><td></td><td>(iii.) 0.00056
(iv.) 0.56</td><td></td><td></td></tr>
<tr><td colspan="4">SECTION B
(4Qx10M= 40 Marks)</td></tr>
<tr><td>Q 6</td><td>The matrix below defines a given stress state. Determine the principal stresses.
$$[\sigma] = \begin{bmatrix} 16 & 3 & 3 \\ 3 & 12 & 6 \\ 3 & 6 & 12 \end{bmatrix}$$
OR
A vertical well was drilled in the Gulf of Mexico and the following in situ pressure and rock properties data were collected.
$\sigma v = 10$ MPa
$\sigma H = \sigma h = 9$ MPa
$P0 = 5$ MPa
$\mu = 0.3$
Determine the following
(a) Fracture pressure for non-deviated well
(b) Fracture pressure at the deviation $\Upsilon = 40^o$ and $\phi = 165^o$</td><td>10</td><td>CO1</td></tr>
<tr><td>Q 7</td><td>(a) The triaxial testing data of the rock samples are illustrated in the table below.
<table>
<tr><td>$(\sigma_{1+}\sigma_{3)/2}$</td><td>1561.5</td><td>1245</td><td>974</td><td>735</td><td>312</td><td>156.5</td></tr>
<tr><td>$(\sigma_{1-}\sigma_{3)/2}$</td><td>1054.5</td><td>807</td><td>674</td><td>573</td><td>288</td><td>156.5</td></tr>
</table>
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.</td><td>10</td><td>CO2</td></tr>
<tr><td>Q 8</td><td>Derive the formula to determine principal stresses and its orientation in two dimensions.</td><td>10</td><td>CO3</td></tr>
<tr><td>Q 9</td><td>It has been determined that a point in a load-carrying member is subjected to the following stress condition:
$\sigma x = 400$ MPa $\sigma y = -300$ MPa $\tau xy = 200$ MPa (CW)
Perform the following:
(a) Find maximum and minimum principal stress and maximum shear stress
(b) Draw the complete Mohr’s circle, labeling critical points</td><td>10</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td>Q 10</td><td>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:</td><td>20</td><td>CO3</td></tr>
</table>

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 Justify your reasons for the statement.

OR

Derive the formula using Mohr's Coulomb criteria to determine the following:

(i) Shear stress

(ii) Normal Stress

(iii) Relation between triaxial stress

(iv) Compressive Stress and Tensile Stress

Q 11

A core sample of 54 mm diameter and L/D ration 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.

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

20

CO4