Name: **Enrolment No:**	UPES

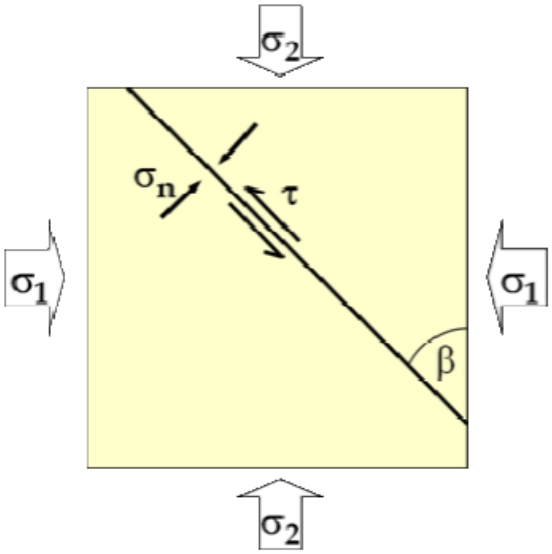
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Program Name: B.Tech GIE & B.Tech GSE **Semester** : VI
Course Name : Geomechanics **Time** : 03 hrs
Course Code : GSEG 312 **Max. Marks:** 100
Nos. of page(s) : Three only
Instructions: All questions are compulsory. ***Answer should be precise & to the point.***

SECTION A

S. No.		**Marks**	**CO**
Q 1	i. List out the key components of a Geomechanical Earth Model. Define each term briefly.	4 marks each (4x5=20)	CO1
	ii. Represent stress state at the wellbore in cartesian & cylindrical coordinate systems.		CO2
	iii. Draw a neat sketch of triaxial compression test rig. Label the name of any four components on it.		CO3
	iv. Define in-situ stresses & explain their criticality in the failure analysis of rock material.		CO1
	v. Link the knowledge of Geomechanics for the future applications in your branch of engineering.		CO1
SECTION B			
Q 2	• Explain Mohr-Coulomb & Mogi-Coulomb failure criterion. • Also highlight which are used more the others and give reasons. • Why the results of Mogi-Coulomb failure criterion could be a safe approach in drilling of the wellbore.	4+3+3	CO2
Q 3	Drilling & hydraulic fracturing are affected by the stress changes accompanying depletion. ➢ List out the expected drilling difficulties when there is need to drill through depleted reservoirs to reach deeper formations.	5+5	CO2

	➢ Explain probable solution to overcome it.		
Q 4	It is a common practice in the petroleum industry to assume a horizontal and vertical principal in-situ stress state, it should be noted that the three principal stresses may not always take a horizontal and vertical orientation. This can be confirmed by analyzing image logs where the deviations may occur. In such a case the in-situ stresses have to be transformed to a horizontal and vertical principal orientation. Write equations defining all transformed stress components.	10	CO3
Q 5	For an oil field , where a vertical well is drilled to a maximum depth of 11,500 ft, the average specific gravity and pore pressure gradient are given as 2.2 and 0.36 psi/ft, respectively. Assuming the Biot's constant and Poisson's ratio as 0.9 and 0.26, respectively, calculate the overburden and horizontal in-situ stresses for the surrounding rock formation at the bottom of the vertical well.	10	CO3
	SECTION-C		
Q 6	An oil field has a vertical well in a sandstone reservoir with variable rock strength. One of the important issues is to determine the need for sand control equipment, such as screens. Investigate the possibility of sand production for both initial conditions and the depleted phase of the field. Use the following data as obtained from the field. Depth (m) 1000 Overburden Stress (s.g.) 1.80 Max/Min Horizontal Stresses (s.g.) 1.50/1.50 Initial Pore Pressure (s.g.) 1.03 Depleted Pore Pressure (s.g.) 0.55 Rock Cohesive Strength (s.g.) 0.40 Rock Friction Angle (Degrees) 30	8+12	CO4
Q7	Two principal stresses are shown, $\sigma 1$ and $\sigma 2$. If $\sigma 1$ is 20 MPa and $\sigma 2$ is 6 MPa.	10+10	CO1



(a) Use Mohr's circle method to find the normal stress (σ n) and the shear stress (τ) at a plane inclined at an angle β= 30°.

(b) Verify the results analytically.

Note: Please clearly mention the sign convention used & scale assumed.

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SECTION A

S. No.		Marks	CO
Q 1	i. List out the key applications of Geomechanics. Briefly explain any one out of them. ii. What is the relation between angle of friction and fracture angle? Support your answer with a sketch. iii. Which stress is developed when the drill bits are taken out from the well? iv. Define in-situ stresses & explain their criticality in the failure analysis of rock material. v. Link the impact of far field stresses on local conditions around the wellbore issues related to drilling.	4 marks each (4x5=20)	CO4 CO2 CO4 CO1 CO1

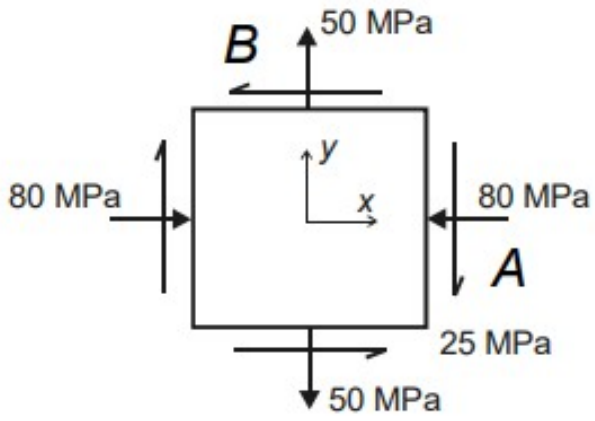
SECTION B

Q 2	i. Explain Mohr-Coulomb & Mogi-Coulomb failure criterion. Also highlight which are used more the others and give reasons. ii. The so-called compaction model has been very useful in geomechanics analysis. Write the key assumptions.	6 4	CO2 CO3
Q 3	Fracturing and mechanical collapse are the two main mechanisms of borehole failure. i. Explain briefly under which conditions these may occur in a wellbore. ii. Represent wellbore differential pressure stability behavior identifying underbalanced and overbalanced critical points of stability and failure.	4+6	CO3
Q 4	It is a common practice in the petroleum industry to assume a horizontal and vertical principal in-situ stress state, it should be noted that the three principal	10	CO1

<table>
<tr><td></td><td>stresses may not always take a horizontal and vertical orientation. This can be confirmed by analyzing image logs where the deviations may occur. In such a case the in-situ stresses have to be transformed to a horizontal and vertical principal orientation.
Derive equations defining all transformed stress components.</td><td></td><td></td></tr>
<tr><td>Q 5</td><td>Draw the neat diagrams to represent the variation of stress magnitudes with depth in normal, strike slip and reverse faulting stress regimes for hydrostatic and overpressure conditions</td><td>10</td><td>CO1</td></tr>
<tr><td colspan="4">SECTION-C</td></tr>
<tr><td>Q 6</td><td>(a) For an oil field, where a vertical well is drilled to a maximum depth of 11,400 ft, the average specific gravity and pore pressure gradient are given as 2.4 and 0.33 psi/ft, respectively. Assuming the Biot’s constant and Poisson’s ratio as 0.9 and 0.26, respectively.
i. Calculate overburden and horizontal stresses
ii. Determine normal and shear stresses at the bottom of the wellbore wall in a Cartesian coordinate system.
(b) Using the data given in the table :
<table><tr><th>Test No.</th><th>Minimum Compressive Stress σ_3 (ksi)</th><th>Maximum Compressive Stress σ_1 (ksi)</th></tr><tr><td>1</td><td>0</td><td>10</td></tr><tr><td>2</td><td>0·6</td><td>11·5</td></tr><tr><td>3</td><td>1</td><td>13·5</td></tr><tr><td>4</td><td>2</td><td>15·5</td></tr></table>
i. Plot Mohr-Coulomb failure model in a normal & shear stress plane and identify the intact and failure regions.
ii. Evaluate the magnitude of cohesive strength and angle of internal friction.</td><td>5+5

5+5</td><td>CO4

CO3</td></tr>
<tr><td>Q7</td><td>The state of plane stress at a point in rock formation is represented by the stress element as shown below -</td><td>2+4+7+7</td><td>CO2</td></tr>
</table>



i. Please clearly mention the sign convention used & scale assumed.
ii. Draw the Mohr's circle for the above stressed element.
iii. Determine the maximum & minimum principal stress planes & represent it on a stress element.
iv. Determine the maximum shear stress plane & represent it on a stress element.