20PEB205					Geomechanics and Strength of Materials					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To learn stress and strain concept with numerical problems and mechanical properties of material and learn the concept of material failure
- Understand different classes of material, phase diagram of various alloys, their properties and structure
- To study strength of geological material such as rock and soil filled with or without pore fluid and applicable failure theories
- Understand the tectonic stress field and stress classification in subsurface, understanding the effect of pore pressure at depth and various laws governing strength of rock in the presence or absence of pore fluid

UNIT 1 Basics of mechanics **10 Hrs.**

Fundamental assumptions in elementary mechanics of materials; viscoelasticity or rheology; mechanical properties of metals – concepts of stress and strain; stress-strain behavior; inelasticity; elastic properties of materials; tensile properties; elastic recovery during plastic deformation; compressive, shear, and torsional deformation; hardness; variability of material properties; design/safety factors. Testing of material properties. Thermal stresses – bars subjected to tension, asymmetric loading, and stress calculation of cylindrical bodies. Scalar, vector, tensor; composition and resolution of stresses; stress vector acting on a surface; analysis of stress; stress field acting at a point – derivation of equations for □n and □n. Mohr's circle; deviatoric and mean stress; special states of stresses by Mohr's circle; Mohr-Coulomb failure envelope.

UNIT 2 Introduction to Materials Science and Engineering **8 Hrs.**

Introduction to materials science and materials engineering; engineering materials; classes of materials; concepts of processing, structure, properties, and performance of materials; atomic structure of materials – BCC lattice, FCC lattice, cubic centered lattice grain boundaries – computation of volumes and atomic packing factors of various lattices; combining various metals – alloys; solid solution, eutectic, and eutectoid; iron–iron carbide (Fe–Fe3C) phase diagram; classification of steel and cast iron; development of microstructures in iron–carbon alloys – hypoeutectoid, eutectoid, and hypereutectoid; influence of other alloying elements in the iron-iron carbide system; ductile to brittle transition temperature vis-à-vis impact energy

UNIT 3 Introduction to Rock Mechanics **10 Hrs.**

Structural rock mechanics and comminution; strength of geological materials; influence of geological history (burial and uplift) on rocks – normally consolidated and over consolidated rocks; effective stress, undrained modulus of elasticity, coefficient of compressibility, coefficient of consolidation, Significance of drainage path length and the rate of consolidation; stress and strain in geological materials and their measurements; cohesion, friction, and failure; influence of fabric; drained and undrained strength; Atterberg limits.

UNIT 4 Introduction to Reservoir Geomechanics **11 Hrs.**

The tectonic stress field; pore pressure at depth in sedimentary basins; basic constitutive laws; rock failure in compression; tension and shear; faults and fractures at depth; compressive and tensile failures in vertical wells; determination of S3 from mini-fracs and extended leak-off tests and constraining the magnitude of SHmax from wellbore failures in vertical wells; wellbore failure and stress determination in deviated wells; stress fields – from tectonic plates to reservoirs around the world; wellbore stability; critically stressed faults and fluid flow; effects of reservoir depletion

Total 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the structure and mechanical properties of different materials viz., metals, soil, minerals and rocks

CO2 - Determine the geo-mechanical properties of materials and predicting the failure based on the various failure theories

CO3 - Estimate the changes in shear strength of reservoir rocks vis-à-vis reservoir production, and its effect on the petrophysical properties

CO4 - Apply the understanding of stress-field to optimize production

CO5 - Evaluate the failure of the wall of the wellbore during drilling activities.

CO6 - Analyze stress-field around boreholes using laboratory data and extending it to field situations.

TEXT/REFERENCE BOOKS

1. Zobak, M. D. Reservoir Geomechanics; (2) Longuemare, P. Geomechanics in reservoir simulation; (3) Nauroy, J. F. Geomechanis applied to petroleum Engineering; (4) Valentin Popov, Contact Mechanics and Friction: (5) Physical Principles and Applications; Bansal R. K. A Textbook of Strength of Materials.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

PART A: <Question: <Short Notes, Problems, Numerical> **20 Marks**

PART B: <Justification, Criticism, Long answers, Interpretation > **80 Marks**