Course Template: Mechanics of Solids and Fluids (AML150)

1.	**Department/Centre**	Applied Mechanics
2.	**Course Title**	Mechanics of Solids and Fluids
3.	**Course No.**	AML 150
4.	**L-T-P structure**	3-1-2
5.	**Credits**	5
6.	**Status of the course**	Elective/Core for UG Programs
7.	**Prerequisite for the course**	AML110
8.	**Status vis-à-vis other courses**	
8.1	**Overlap with any UG/PG Course of the Dept./Centre**	AML140, AML160, AML170, AML180, AMP262
8.2	**Overlap with any UG/PG Course of other Dept./Centre**	CHL231, CHL204
8.3	**Supercedes any existing course**	No
9.	**Not allowed For**	NIL
10.	**Frequency of offering**	Both/Either Semester
11.	**Faculty will teach the course**	All Solid/Fluid Mechanics Faculty.
12.	**Will the course require visiting faculty**	No
13.	**Course Objectives:** This course will introduce the students to the basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.	
14.	**Course Content: I. Fluid Mechanics** MATHEMATICAL PRELIMINARIES: Cartesian Tensors, Index Notation, Integral Theorems. INTRODUCTION: Basic Concepts and Definitions, Solids and Fluids, Internal and external forces on a fluid element. PROPERTIES OF FLUID: Rheological Equation and Classification of fluids, Normal and Shear Stresses, Concept of Pressure, pressure gradient. STATICS OF FLUIDS: Types of Forces on Fluid Element, Mechanics of Fluid at Rest and in rigid body motion, Manometry, forces on fully and partially submerged bodies, stability of a floating body. KINEMATICS OF FLUID MOTION: Types of fluid motion, Stream lines, Streak and path lines, Acceleration and Rotation of a fluid particle, Vorticity and Circulation, Stream Function, Irrotational flow and Velocity Potential function. DYNAMICS OF AN IDEAL FLUID: Continuity and Euler's Equations of Motion, Bernoulli Equation, Applications to Flow Measurement and other real flow problems. MECHANICS OF VISCOUS FLOW: Navier-Stokes equations, exact	

	solutions, Laminar flow through a pipe, Turbulent flow through a pipe, Friction factor, Applications to Pipe Networks. DIMENSIONAL ANALYSIS: Similarity of motion, Dimensionless numbers, Modeling of fluid flows, Applications. INTEGRAL ANALYSIS: Reynolds Transport Theorem, Control Volume Analysis. **II. Solid Mechanics:** State of stress at a point, equations of motion, principal stress, maximum shear stress. Concept of strain, strain displacement relations, compatibility conditions, principal strains, transformation of stress/strain tensor, state of plane stress/strain. Constitutive relations, uniaxial tension test, idealized stress-strain diagrams, isotropic linear elastic and elasto-plastic materials. Energy Methods. Uniaxial stress and strain analysis of bars, thermal stresses, Torsion, Bending, Stability of Equilibrium.	
15.	**Lecture Outline (with topics and number of lectures)**	
SN.	Topic	No. of hours
i	State of stress at a point, equations of motion, principal stress, maximum shear stress.	4
ii	Concept of strain, strain displacement relations, compatibility conditions, principal strains, transformation of stress/strain tensor, state of plane stress/strain.	3
iii	Constitutive relations, uniaxial tension test, idealized stress-strain diagrams, isotropic linear elastic and elasto-plastic materials.	3
iv	Energy Methods.	2
v	Uniaxial stress and strain analysis of bars, thermal stresses.	2
vi	Torsion of circular bars and thin walled members	3
vii	Bending of straight/curves beams, transverse shear stresses, deflection of beams	3
viii	Buckling of columns	1
ix	Introduction to Properties of Fluids	2
x	Statics of Fluids	4
xi	Kinematics of Fluid Motion	3
xii	Dynamics of Ideal Fluids	4
xiii	Mechanics of Viscous Flow	4
xiv	Dimensional Analysis	2
xv	Integral Analysis: Reynolds Transport Theorem, Control Volume Analysis.	2
	Course Total	42
16.	**Brief description of tutorial activities**	

	Tutorial problems based on concepts taught in the class will reinforce the understanding of concepts. The set of problems on concept of stress/strain tensors, constitutive relation, energy methods, uniaxial stress/strain in bars, bending and deflection of beams, torsion of shafts, buckling, fluids properties, statics and kinematics of fluids, mechanics of ideal and viscous flow, dimensional analysis will be dealt.	
17.	**Brief description of laboratory activities:** The following experiments will be conducted to reinforce/augment the concepts of solid and fluid mechanics-	
SN.	Experiment Description	Hours
i	Stress-Strain curve using standard tension specimen	4
ii	Brinell and Rockwell hardness tests	2
iii	Izod and Charpy impact tests	2
iv	Strain measurement using electrical resistance strain gauges	2
v	Compression and Buckling tests	2
vi	Torsion tests on standard steel specimen	2
vii	Flow Visualization.	4
viii	Conservation of Mechanical Energy (Bernoulli's Principle)	2
ix	Performance Characteristics of Free Jets	2
x	Obstruction Type of Flow Meters.	2
xi	Principle of Linear Momentum.	2
xii	Fully Developed Flow through Pipes.	2
	Total	28
18.	**Suggested Text and Reference Material**	

1. Introduction to Solid Mechanics by I. H. Shames and J. M. Pitarresi, Prentice Hall of India.
2. Mechanics of Materials by F. P. Beer, E. R. Johnston, J. T. Dewolf and D. F. Mazurek, Tata McGraw Hill.
3. Advanced Mechanics of Solids by L. S. Srinath, Tata McGraw Hill.
4. Mechanics of Solids by S. H. Crandall, N. C. Dahl and T. J. Lardner, Tata McGraw Hill.
5. Introduction of Fluid Mechanics by R.W. Fox and A.T. McDonald, John Wiley and Sons, Edition 4 or later.
6. Fluid Mechanics by F. M. White, Tata McGraw-Hill, 7th Edition.

19.	**Resources required for the course**	
19.1	Software	Matlab/Mathematica

19.2	Hardware	Equipments available in solid and fluid mechanics labs
19.3	Teaching aides (videos etc.)	Nil
19.4	Laboratory	Solid and Fluid mechanics labs
19.5	Equipment	Available in solid/ fluid mechanics labs
19.6	Classroom infrastructure	Projection system
19.7	Site visits	Nil
20.	**Design Content of the course**	
20.1	Design type problems	20 %
20.2	Open-ended problems	5 %
20.3	Project-type activity	5 %
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date: (Signature of the Head of the Department)