INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ADVANCED SOLID MECHANICS**				
Course Code	BSTB02				
Programme	M.Tech				
Semester	III	STE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr. J S R Prasad, Professor, Civil Engineering				
Course Faculty	Dr. J S R Prasad, Professor, Civil Engineering				

I. COURSE OVERVIEW:

This course is sequel to a Strength of Materials Course that already studied in undergraduate. This course introduces the principles of elasticity, components of stresses and strains, differential equations of equilibrium, boundary conditions, compatibility conditions and stress function. This course also covers the two dimensional problems in rectangular coordinates and polar coordinates, Fourier series for two dimensional problems stress distribution symmetrical about an axis, pure bending of curved bars, strain components in polar coordinates, displacements for symmetrical stress distributions, simple symmetric and asymmetric problems, analysis of stress strain in three dimensions, torsion of prismatical bars and plasticity. This course in reached to student by power point presentations, lecture notes, and assignment questions, seminars, previous model question papers, and question bank of long and short answers.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	Strength of Materials – I	-
-	-	-	Structural Analysis	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Advanced Solid Mechanics	70 Marks	30	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✗	Chalk & Talk	✗	Quiz	✓	Assignments	✗	MOOCs
✓	LCD / PPT	✗	Seminars	✗	Mini Project	✓	Videos
✗	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

Each theory course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIE during the semester, marks are awarded by taking average of two sessional examinations.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.
50 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):

For each theory course the CIA shall be conducted by the faculty/teacher handling the course as given in Table 4. CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Technical Seminar and Term Paper	
Max. CIA	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 3	Capable to apply the core, multidisciplinary knowledge for understanding the problems in structural engineering and allied fields.	2	Assignments, Tutorials
PO 4	Apply appropriate techniques, resources, modern engineering and Information Technology (IT) tools including predictions, modeling of complex structural engineering activities.	2	Assignments
PO 5	Able to identify and analyze the impact of Structural Engineering in development projects and find a suitable solution from number of alternatives.	2	Assignments
PO 6	Conceptualize and design civil engineering structures considering various socio-economic factors.	2	Presentation on realworld problems

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Solve advanced solid mechanics problems using classical methods
II	Apply commercial software on select, applied solid mechanics problems.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the theory of elasticity including strain/displacement and Hooke's law relationships	CLO 1	Understand the Displacement, Strain and Stress Fields
		CLO 2	Understand the Constitutive Relations, Cartesian Tensors
		CLO 3	Solve the problems on Equations of Elasticity
		CLO 4	Know the Elementary Concept of Strain
CO 2	Analyse solid mechanics problems using classical	CLO 5	Understand the Strain at a Point
		CLO 6	Know concept of Principal Strains and Principal

COs	Course Outcome	CLOs	Course Learning Outcome
	methods and energy methods		Axes
		CLO 7	Understand the concept of Compatibility Conditions
		CLO 8	Understand the concept of Stress at a Point
		CLO 9	Develop the Stress Components on an Arbitrary Plane
CO 3	Solve for stresses and deflections of two-dimensional under unsymmetrical loading	CLO 10	Understand the concepts on differential Equations of Equilibrium
		CLO 11	Know the Hydrostatic and Deviatoric Components.
		CLO 12	Understand the Equations of Equilibrium, Strain Displacement and Compatibility Relations
		CLO 13	Understand the formulation of Stress- Strain relations
		CLO 14	Concept of Strain Displacement
		CLO 15	Understand the solutions for boundary value problems
CO 4	Obtain stresses and deflections of torsion of beams on elastic foundations	CLO 16	Know the co-axiality of the Principal Directions
		CLO 17	Understand the Plane Stress and Plane Strain Problems
		CLO 18	Know the Two-Dimensional Problems in Polar Coordinates
		CLO 19	Understand the Saint Venant's Method, Prandtl's Membrane Analogy
CO 5	Apply various failure criteria for general stress states at points	CLO 20	Formulation of Torsion of Rectangular Bar and thin plates
		CLO 21	Understand the concept of Plastic Stress-Strain Relations
		CLO 22	Solution of Principle of Normality and Plastic Potential, Isotropic Hardening

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BSTB02.01	CLO 1	Understand the Displacement, Strain and Stress Fields	PO 3	2
BSTB02.02	CLO 2	Understand the Constitutive Relations, Cartesian Tensors	PO 3	2
BSTB02.03	CLO 3	Solve the problems on Equations of Elasticity	PO 3, PO 4	1
BSTB02.04	CLO 4	Know the Elementary Concept of Strain	PO 3	2
BSTB02.05	CLO 5	Understand the Strain at a Point	PO 3	2
BSTB02.06	CLO 6	Know concept of Principal Strains and Principal Axes	PO 5, PO 6	1
BSTB02.07	CLO 7	Understand the concept of Compatibility Conditions	PO 3	1
BSTB02.08	CLO 8	Understand the concept of Stress at a Point	PO 3, PO 4	2
BSTB02.09	CLO 9	Develop the Stress Components on an Arbitrary Plane	PO 3	1
BSTB02.10	CLO 10	Understand the concepts on differential Equations of Equilibrium	PO 3, PO 4	1
BSTB02.11	CLO 11	Know the Hydrostatic and Deviatoric Components.	PO 3, PO 4, PO 5	2
BSTB02.12	CLO 12	Understand the Equations of Equilibrium, Strain Displacement and Compatibility Relations	PO 3, PO 4, PO 6	1
BSTB02.13	CLO 13	Understand the formulation of Stress- Strain relations	PO 3, PO 6	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BSTB02.14	CLO 14	Concept of Strain Displacement	PO 3, PO 4	2
BSTB02.15	CLO 15	Understand the solutions for boundary value problems	PO 3	2
BSTB02.16	CLO 16	Know the co-axiality of the Principal Directions	PO 3	2
BSTB02.17	CLO 17	Understand the Plane Stress and Plane Strain Problems	PO 3, PO 4 PO 5, PO 6	1
BSTB02.18	CLO 18	Know the Two-Dimensional Problems in Polar Coordinates	PO 3, PO 6	2
BSTB02.19	CLO 19	Understand the Saint Venant's Method, Prandtl's Membrane Analogy	PO 3, PO 5	2
BSTB02.20	CLO 20	Formulation of Torsion of Rectangular Bar and thin plates	PO 3, PO 4 PO 5, PO 6	2
BSTB02.21	CLO 21	Understand the concept of Plastic Stress-Strain Relations	PO 3, PO 4	1
BSTB02.22	CLO 22	Solution of Principle of Normality and Plastic Potential, Isotropic Hardening	PO 3, PO 4, PO 6	2

3= High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcomes (COs)	Program Outcomes (POs)			
	PO 3	PO 4	PO 5	PO 6
CO 1	2	1		
CO 2	2	2	2	1
CO 3	2	2	2	1
CO 4	2	1	2	1
CO 5	2	2	1	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1			2				
CLO 2			2				
CLO 3			2	1			
CLO 4			2				
CLO 5			2				
CLO 6					2	1	

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 7			1				
CLO 8			2	2			
CLO 9			1				
CLO 10			2	1			
CLO 11			2	2	2		
CLO 12			1	2		1	
CLO 13			2			2	
CLO 14			2	2			
CLO 15			2				
CLO 16			2				
CLO 17			2	1	2	1	
CLO 18			2			2	
CLO 19			2		2		
CLO 20			2	2	1	2	
CLO 21			1	2			
CLO 22			2	2		2	

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES–DIRECT:

CIE Exams	PO3, PO4, PO5,PO6	SEE Exams	PO3, PO4, PO5, PO6	Assignments	PO3, PO4, PO5, PO6	Seminars	-
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIII. SYLLABUS

UNIT-I	INTRODUCTION TO ELASTICITY
Displacement, Strain and Stress Fields, Constitutive Relations, Cartesian Tensors and Equations of Elasticity.	
UNIT-II	**STRAIN AND STRESS FIELD**
Elementary Concept of Strain, Stain at a Point, Principal Strains and Principal Axes, Compatibility Conditions, Stress at a Point, Stress Components on an Arbitrary Plane, Differential Equations of	

Equilibrium, Hydrostatic and Deviatoric Components.	
UNIT-III	**EQUATIONS OF ELASTICITY AND TWO-DIMENSIONAL PROBLEMS OF ELASTICITY**
Equations of Equilibrium, Stress-Strain relations, Strain Displacement and Compatibility Relations, Boundary Value Problems, Co-axiality of the Principal Directions. Plane Stress and Plane Strain Problems, Airy's stress Function, Two-Dimensional Problems in Polar Coordinates.	
UNIT-IV	**TORSION OF PRISMATIC BARS**
Torsion of Prismatic Bars: Saint Venant"s Method, Prandtl's Membrane Analogy, Torsion of Rectangular Bar, Torsion of Thin Tubes.	
UNIT-V	**PLASTIC DEFORMATION**
Plastic Deformation: Strain Hardening, Idealized Stress- Strain curve, Yield Criteria, von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations, Principle of Normality and Plastic Potential, Isotropic Hardening.	
Text Books:	
1. Timoshenko and Goodier , "Theory of Elasticity" , McGraw Hill Publishing Company, 1970. 2. RagabA.R.,BayoumiS.E , "Engineering Solid Mechanics"., CRC Press,1999. 3. Kazimi S. M. A, "Solid Mechanics"., Tata McGraw Hill,1994	
Reference Books:	
1. SaddM.H , "Elasticity", Elsevier, 2005. 2. Ameen.M, "Computational Elasticity", Narosa, 2005. 3. KazimiS. M. A, "Solid Mechanics", Tata McGraw Hill, 1994. 4. SrinathL.S, "Advanced Mechanics of Solids", Tata McGraw Hill, 2000.	
Web References:	
1. https://www.youtube.com/watch?v=4meZNc2wB4s&t=1464s	
E-Text Books:	
1. http://www.kstr.lth.se/fileadmin/kstr/pdf_files/forsk_kurs/Theory_of_elastic_stability_by_S._Timoshenko_and_J.M._Gere__1963_.pdf 2. https://brijrbedu.org/Brij%20Data/Advance%20Mechanics%20of%20Solids/Book/Advanced%20Mechanics%20of%20Solids%20By%20L.%20S.%20Srinath.pdf	

XIV. ASSESSMENT METHODOLOGIES–INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✗	Assessment of Mini Projects by Experts		

XV. COURSE PLAN:

Lecture No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Displacement, Strain and Stress Fields	CLO 1	T2:5-10
3-4	Constitutive Relations, Cartesian Tensors	CLO 2	T2:11-20
5-6	Equations of Elasticity	CLO 3	T2:21-28
7-9	Elementary Concept of Strain, Strain at a Point	CLO 4	T2:29-45
10-12	Principal Strains and Principal Axes, Compatibility Conditions	CLO 4	T2:50-65
13-16	Stress at a Point, Stress Components on an Arbitrary Plane	CLO 5	T2:66-75
16-17	Differential Equations of Equilibrium, Hydrostatic and Deviatoric Components	CLO 6	T2:75-85

18-19	Equations of Equilibrium, Stress-Strain relations	CLO 7	T2:90-110
20-21	Strain Displacement and Compatibility Relations	CLO 9	T2:115-130
22-24	Boundary Value Problems, Co-axiality of the Principal Directions.	CLO 10	T2:131-145
25-27	Plane Stress and Plane Strain Problems,	CLO 11	T2:146-160
28-30	Airy's stress Function, Two-Dimensional Problems in Polar Coordinates	CLO 12	T2:161-180
31-33	Torsion of Prismatic Bars: Saint Venant‟s Method, Prandtl's Membrane Analogy	CLO 13	T2:181-200
34-36	Torsion of Rectangular Bar, Torsion of Thin Tubes.	CLO 14	T2:201-215
37-41	Plastic Deformation: Strain Hardening, Idealized Stress- Strain curve, Yield Criteria	CLO 18	T2:217-240
42-46	Von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations	CLO 20	T2:240--270
47-50	Principle of Normality and Plastic Potential, Isotropic Hardening.	CLO 20	T2:240--270

XVI. GAPS IN THE SYLLABUS-TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No.	Description	Proposed Actions	Relevancewith POs
1	Understand advanced topics of rigid body kinematics and dynamics	Seminars / NPTEL	PO 3, PO 4, PO 6
2	Design dynamical systems	Seminars / NPTEL	PO 3, PO 4, PO 6

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