INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**THEORY OF STRUCTURES**				
Course Code	AAE002				
Programme	B.Tech				
Semester	III	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. Sudhir Sastry .Y.B, Professor.				
Course Faculty	Mr. T Mahesh Kumar, Assistant Professor.				

I. COURSE OVERVIEW:

The primary objective of The Theory of Structures is concerned with establishing an understanding of the behavior of structures such as beams, columns, frames, plates and shells, when subjected to applied loads or other actions which have the effect of changing the state of stress and deformation of the structure.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AHS007	I	Applied Physics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Theory of Structures	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

The 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 CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

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 units and each unit 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 unit. 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.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignments, term paper
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Term paper, quiz
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Assignments, Practical's

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	2	Lecture, Assignments.
PSO 2	**Problem solving skills:** imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles	-	-
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	-	-
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the several of Concepts of stress and strain in mechanical components by stressing the fundamentals
II	Calculate bending stresses and shear stresses for in a beam of symmetric and un-symmetric sections
III	Explain the deflections of beams with various load conditions by different approaches
IV	Discuss the buckling behavior of columns with different load and boundary conditions

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
AAE002.01	CLO 1	Calculate the stress strain relations in conjunction with elasticity and material properties	PO1	3
AAE002.02	CLO 2	Describe the resistance and deformation in members which are subjected to axial, flexural and torsion loads.	PO1	2
AAE002.03	CLO 3	Discuss thermal explanations in solid bars and induced thermal stresses	PO2	2
AAE002.04	CLO 4	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions	PO2	1
AAE002.05	CLO 5	Calculate the shear stresses developed in various sections of beams.	PO4	2
AAE002.06	CLO 6	Calculate the flexural developed in various sections of beams of real field problems.	PO2	2
AAE002.07	CLO 7	Differentiate between redundant structures and determinate structures.	PO1	3
AAE002.08	CLO 8	Analyze the redundant complex structural components subjected to different loading and boundary conditions.	PO1	2
AAE002.09	CLO 9	Solve for deflections of beams under loading with various approaches	PO2	2
AAE002.10	CLO 10	Calculate the stability of structural elements and determine buckling loads.	PO4	1
AAE002.11	CLO 11	Discuss critical buckling load for column with various loading and end conditions	PO1	2
AAE002.12	CLO 12	Apply a theories and to predict the performance of bars under axial loading including buckling.	PO2	2
AAE002.13	CLO 13	Describe the behavior of structural components subjected to various loading and support conditions based on principles of equilibrium and constitutional relationships.	PO1	3
AAE002.14	CLO 14	Explain the stress transformation and concept of principle plane and principle stresses	PO4	3
AAE002.15	CLO 15	Evaluate principal stresses, strains and apply the concept of failure theories for design	PO2	2
AAE002.16	CLO 16	Acquire Basic knowledge to solve real time problems in Aircraft structure with different loading conditions	PO4	1
AAE002.17	CLO 17	Apply the fundamental concepts in competitive examinations	PO2	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3															
CLO 2	2												1			
CLO 3		2														
CLO 4		1											2			
CLO 5				2												
CLO 6		2														
CLO 7	3															
CLO 8	2															
CLO 9		2											2			
CLO 10				1												
CLO 11	2															
CLO 12		2														
CLO 13	3															
CLO 14				3									1			
CLO 15		2														
CLO 16				1												
CLO 17		3											2			

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2 PO4	SEE Exams	PO,1PO2 PO4	Assignments	PO1, PO4	Seminars	PO2
Laboratory Practices	PO1	Student Viva	PO4	Mini Project	-	Certification	-
Term Paper	PO1, PO2						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	INTRODUCTION
Mechanical properties of materials; Stresses and strains; Hooke‘s law, elastic constant, relation between modulii, working stress, factor of safety, poisons ratio ; bars of varying cross section; Thermal stresses. Torsion of solid and hollow circular shafts and shear stress variations; Power transmission in shafts; Shear force and bending moment diagrams for different types of beams with various loads.	
Unit-II	**STRESSES IN BEAMS**
Bending stresses and Shear stress variation in beams of symmetric and un-symmetric sections; Beams of uniform strength; Flexural stresses: Bending equations, calculation of bending stresses for different sections of beams like I, L, T, C, angle section.	
Unit-III	**BEAMS AND COLUMNS**
Deflection of beams by Double integration method, Macaulay‘s method, moment area method, conjugate beam method; Principle of superposition. Columns, types of columns, Euler‘s formula instability of columns, Rakine‘s and Jonson‘s formula, Eigen values and Eigen modes, concept of beam-column.	
Unit-IV	**REDUNDANT STRUCTURES**
Trusses, perfect frames, analysis of trusses; Determinate and indeterminate structures, order of redundancy; Redundant analysis, analysis of determinate structures, area movement method, Clayperons method, slope deflection method, moment distribution method	
Unit-V	**THEORY OF ELASTISITY**
Equilibrium and compatibility conditions and constitute relations for elastic solid and plane: generalized plane strain cases Airy‘s stress function Stress on inclined planes, stress transformations determination of principal stresses and strains by analytical method and graphical method - Mohr‘s circles and its constructions.	
Text Books:	
1. R. K Bansal, ―Strength of Materials‖, Laxmi publications, 5th Edition, 2012. 2. T. H. G. Megson, ―Aircraft Structures for Engineering Students‖, Butterworth-Heinemann Ltd, 5th Edition, 2012 3. Gere, Timoshenko, ―Mechanics of Materials‖, McGraw Hill, 3rd Edition, 1993.	
REFERENCES:	
1. Dym, C. L, Shames, I. H, ―Solid Mechanics‖, McGraw Hill, Kogakusha, Tokyo, 7th Edition, 2007. 2. Stephen Timoshenko, ―Strength of Materials‖, Vol I & II, CBS Publishers and Distributors, 3rd Edition, 2004. 3. R. K. Rajput, ―Strength of Materials‖, S. Chand and Co., 1st Edition, 1999 4. Timoshenko, S, Young, D. H. ―Elements of Strength of Materials‖, T. Van Nostrand Co. Inc., Princeton N.J, 4th Edition, 1977.	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	**UNIT 1** **INTRODUCTION** Equilibrium and Compatibility conditions for elastic solids, 2D elasticity equations for plane stress,	CLO1	T2:5.5 R1:1.12.1
4-6	2D elasticity equations plane strain and generalized plane strain cases Airy's stress function	CLO1	T2:5.6 R1:1.12.3
7-8	Simple problems in bars of varying cross sections and thermal stresses	CLO1	T2:5.10 R1:1.15
9-11	2D Elastic equations of torsion of solids an hollow circular shafts	CLO2	T2:5.15 R1:1.16
12-14	Concept of principal planes, principal stress and Strains Power transmission in shafts	CLO3	T2:5.17 R1:1.13.1
15-17	Problems on different beams of Shear force and bending moment diagrams for different types of beams with various loads	CLO4	T2:5.18 R1:1.13.2
18-20	**UNIT 2** **STRESSES IN BEAMS** Bending stresses and Shear stress variation in beams of symmetric and un-symmetric sections;	CLO5	T2:5.19 R1:1.13.3
21-23	Beams of uniform strength; Flexural stresses	CLO5	T2:5.20 R1:1.17.1
24-26	Bending equations, calculation of bending stresses for different sections of beams like I, L, T, C, angle section.	CLO6	T2:5.24 R1:1.17.3
27-30	**UNIT 3** **BEAMS AND COLOUMNS** Deflection of beams by Double integration method, Macaulay's method	CLO7	T2:6.1 R1:2.3
31-33	Deflection of beams using moment area method, conjugate beam method; Principle of superposition.	CLO8	T2:6.3 R1:2.6.1
34-37	Columns, types of columns, Euler's formula instability of columns,	CLO9	T2:6.5 R1:2.6.2
38-39	Rakine's and Jonson's formula, Eigen values and Eigen modes, concept of beam-column.	CLO10	T2:7.3 R1:2.8
39-41	**UNIT 4** **REDUNDANT STRUCTURES** Indeterminate structures and order of redundancy, Introduction to redundant analysis, Statically determinate models, Use of free body diagrams to explain compatibility and redundant analysis principles.	CLO11	T2:7.5,7.6 R1:2.9.2
42-44	Statically determinate models- Area movement method use of free body diagrams to explain compatibility and redundant analysis principles.	CLO12	T2:7.7 R1:2.10
45-47	Statically determinate models- Clayprons method use of free body diagrams to explain compatibility and redundant analysis principles.	CLO13	T2:7.7 R1:2.10
48-50	Singularity method for uniform beams with various boundary	CLO14	T2:7.11

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	and support conditions (props, hinges and fixities) subjected to distributed / discrete loads (including moments).		R1:2.10.2
51-53	**UNIT 5** **THEORY OF ELASTISITY** Equilibrium and compatibility conditions and constitute relations for elastic solid and plane.	CLO15	T2:7.11 R1:2.32
54-56	generalized plane strain cases Airy‘s stress function).	CLO16	T2:15.2 R1:8.2
57-59	Stress on inclined planes, stress transformations	CLO16	T2:15.7 R1:8.3.3
60-62	determination of principal stresses and strains by analytical method and graphical method - Mohr‘s circles and its constructions..	CLO17	T2:15.13 R1:8.7.2

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Broad knowledge of engineering materials and material properties	Seminars / Guest Lectures	PO1	PSO1
2	Practical Exposure about the stress deflections and stability of elements	Seminars / Guest Lectures / NPTEL	PO2	PSO1

Prepared by:

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HOD, AE