INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTATIONAL STRUCTURAL ANALYSIS LABORATORY**				
Course Code	AAE111				
Programme	B.Tech				
Semester	VII	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	-	-	-	3	2
Chief Coordinator	Mr. G S D Madhav, Assistant Professor				
Course Faculty	Mr. G S D Madhav, Assistant Professor Ms. Y Shwetha, Assistant Professor				

I. COURSE OVERVIEW:

The aim of this lab complements the computational structural analysis course. Students will gain experience in computing structural problems and understanding flow physics over flat plate, pipe, cylinder, over a wedge and flow over an airfoil. They can gain knowledge in estimating flow analysis for different mach numbers in determining the pressure coefficients over different structural objects and can find lift and drag counters.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE002	III	Theory of Structures	4
UG	AAE006	IV	Analysis of Aircraft Structures	4
UG	AAE009	V	Finite Element Methods	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computational Structural Analysis Laboratory	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:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.

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

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	**Laboratory**		**Total Marks**
Type of Assessment	Day to day performance	Final internal lab assessment	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):
One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

Preparation	**Performance**	**Calculations and Graph**	**Results and Error Analysis**	**Viva**	**Total**
2	2	2	2	2	10

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	Calculations of the observations
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.	3	Calculations of the observations
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Lab Practices
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	Term observations
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Presentation on real-world problems

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	Lab Practices
PSO2	**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.	2	Guest Lectures
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	1	Presentation on real-world problems
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aeronautical/aerospace allied systems to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	To apply the basic principles learnt from pre-requisites subjects to solve the structural problem.
II	To adopt any computational structural analysis software and learns how to perform analysis.
III	Analyze structural problems related to Aerospace industry.
IV	Interpret the results and how to apply them on the real-life structure.

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
AAE111.01	CLO 1	Understand the basic features of an analysis package.	PO 1	3
AAE111.02	CLO 2	Understand how to apply the theoretical process to solve the problem computationally.	PO 1, PO 3, PO 4	3
AAE111.03	CLO 3	Build the mathematical model using modern tools to formulate the problem.	PO 3, PO 4, PO 5	3
AAE111.04	CLO 4	Computationally solve the 2D and 3D trusses, beams, plates under various loadings.	PO 1, PO 2	2
AAE111.05	CLO 5	Determined different stresses, deflections, shear force and bending moment diagrams.	PO 1, PO 2	3
AAE111.06	CLO 6	Demonstrate the modal analysis on different structural members of different materials.	PO 1, PO 2	2
AAE111.07	CLO 7	Calculate the natural frequencies under various boundary conditions and analyze with forcing functions.	PO 2, PO 3	1
AAE111.08	CLO 8	Analyze the non-linear behavior of the material to determine the large deflections.	PO 2, PO 3	1
AAE111.09	CLO 9	Illustrate the harmonic responses of the spring-mass systems and interpret them for real time problem.	PO 1, PO 2, PO 3	2
AAE111.10	CLO 10	Model the 3D components and execute the results for the applied loads to measure the results.	PO 1, PO 2	2
AAE111.11	CLO 11	Apply the static analysis results to assess the dynamic behavior of the structure.	PO 2, PO 3	3
AAE111.12	CLO 12	Identify tshe forces acting on landing gear and analyze the basic landing gear to find the stresses.	PO 1, PO 2	3
AAE111.13	CLO 13	Use the ANSYS ACP application for building the composite structure.	PO 2, PO 3	3
AAE111.14	CLO 14	Examine the composite behavior of the structure and evaluate the results.	PO 2, PO 3, PO 4	2

AAE111.15	CLO 15	Work on ANSYS APDL & Workbench platforms to evaluate the results for basic aerospace structure.	PO 2, PO 3	2

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	3		3	2										1		
CLO 3			3	3	2								2	2	1	
CLO 4	2	3														
CLO 5	3	3														
CLO 6	3	3														
CLO 7		3	2													
CLO 8		3	2													
CLO 9	2	2	3													
CLO 10	2	2											1	2		
CLO 11		2	3													
CLO 12	2	3											2	1		
CLO 13		3	3													
CLO 14		2	3	3									1	2	1	
CLO 15		3	3													

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4, PO 5	SEE Exams	PO 1, PO 2 PO 3, PO 4, PO 5	Assignments	-	Seminars	-
Laboratory Practices	PO 1, PO 2 PO 3, PO 4, PO 5	Student Viva	-	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

LIST OF EXPERIMENTS	
Week-l	**INTRODUCTION AND BASIC FUCTIONS**
a. Starting up of ANSYS/Nastran b. Description of user interface	
Week-2	**STATIC ANALYSIS: TRUSS AND FRAME STRUCTURES**
a. 2-D truss structures b. 3-D truss structures	
Week-3	**STATIC ANALYSIS: BEAMS**
a. Straight beams b. Tapered beams	
Week-4	**STATIC ANALYSIS: TWO DIMENSIONAL PROBLEMS**
a. 2-D structure with various loadings b. 2-D structures with different materials c. Plate with hole	
Week-5	**DYNAMIC ANALYSIS: MODAL AND TRANSIENT ANALYSES**
a. Modal analysis b. Transient Response (spring-mass system)	
Week-6	**THERMAL ANALYSIS**
a. Bars and beams b. 2D structures	
Week-7	**NON LINEAR ANALYSIS**
a. Nonlinear behavior (Large deflections) b. Nonlinear behavior (Materials)	
Week-8	**HARMONIC RESPONSE ANALYSIS**
a. Random Vibration Analysis of a Deep Simply-Supported Beam b. Harmonic Response of a Spring-Mass System	
Week-9	**ANALYSIS OF AIRCARFT STRUCTURE: WING**
a. Static analysis of Aircraft wing structure b. Modal analysis of aircraft wing structure	
Week-10	**ANALYSIS OF AIRCARFT STRUCTURE:FUSELAGE**
a. Static analysis of Aircraft Semi monoque fuselage structure b. Modal analysis of aircraft Semi monoque fuselage structure	
Week-11	**ANALYSIS OF AIRCARFT STRUCTURE:LANDING GEAR**
a. Static analysis of main landing gear b. Modal analysis of main landing gear	
Week-12	**ANALYSIS OF COMPOSITE STRUCTURES**
a. Static analysis of composite bar and beam b. Static analysis of composite plate	

Text Books:
1. Huei-Huang Lee, "Finite Element Simulations with ANSYS Workbench 16", SDC publications, 2nd Edition, 2016. 2. Anderson, William J "MSC/Nastran: Interactive Training Program" Wiley 1st Edition 2015.
3. "ANSYS Mechanical APDL Basic Analysis Guide", ANSYS,Inc Release 16.0.
Web References:
1. https://www.ansys.com/services/learning-hub
2. https://caeai.com/ansys-software-support/ansys-software/mechanical-simulation-software

XIV. COURSE PLAN:

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

Week No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to Computational Structures	CLO 1 , CLO 2	T1: 1.2
2	Introduction to ANSYS APDL	CLO 3	T3: 3.5
3	APDL User interface, preprocessing, post processing & modeling.	CLO 3	T1: 3.4
4	Static analysis of 2D & 3D truss at various loading conditions.	CLO 4	T1: 2.2
5	Static analysis of different beams under various loading conditions.	CLO 5	T1: 2.4
6	Static analysis of plate with a cutout for various materials.	CLO6, CLO 7	T1: 4.5
7	Modal & transient analysis of beams for various materials.	CLO 10, CLO 12	T2: 2.6
8	Non-linear analysis of the mild steel beam for large deflection.	CLO 11, CLO 12	T2: 2.6
9	Harmonic analysis of the spring mass system.	CLO 8, CLO 13, CLO 15	T1: 5.2
10	Static analysis of aircraft wing structure.	CLO 9, CLO 13, CLO 15	T1: 5.2
11	Static and modal analysis of main landing gear.	CLO 14, CLO 15	T1:7.2
12	Static analysis of composite beam and plate.	CLO 15	T1:7.3

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Guest Lectures	PO 1, PO 2, PO 4	PSO 1, PSO 2
2	Encourage students to solve real time applications and prepare towards competitive examinations. .	NPTEL	PO 2, PO 3	PSO 1, PSO 2

Prepared by:
Mr. G.S.D Madhav, Assistant Professor

HOD, AE