INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**AIRCRAFT VEICLE STRUCTURES II**			
Course Code	**A52109**			
Regulation	**R13-JNTUH**			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	4	-	-	4
Course Coordinator	Dr. Y B Sudhir Shastry, Professor			
Team of Instructors	Dr. Y B Sudhir Shastry, Professor			

I. COURSE OVERVIEW

Study key issues, concepts and developments in the aviation industry, and improve your understanding of a range of specialized subjects and global best practices. Learn how aviation business planning interrelates with current regulatory and evolving state policy issues. Evaluate current air transport economic issues and the industry value chain, and learn how to apply your air transport economic knowledge in the workplace. Some prior industry experience is useful to fully understand course content, although sessions are accessible to new industry professionals.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	4	Basic concepts of aviation management, air traffic control and air transportation systems.

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
Mid Semester Test There shall be two midterm examinations. Each midterm examination consists of subjective type and objective type tests. The subjective test is for 10 marks of 60 minutes duration. Subjective test of shall contain 4 questions; the student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks of 20 minutes duration. It consists of 10 Multiple choice and 10 objective type questions, the student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. **Assignment** Five marks are marked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course	75	100

IV. EVALUATION SCHEME

S. No	Component	Duration	Marks
1	I Mid examination	80 minutes	20
2	I Assignment	--	05
3	II Mid examination	80 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES:

I. **Understand** the basic ideas and relationships of the theory of elasticity for nonlinear and linear elastic bodies.
II. **Learn** the primary and secondary structural instability
III. **Understand** the technology and basic components of wings, fuselage, tail units, and control surfaces.
IV. **Discuss** the various types of structural components found in aircraft construction and the various loads they support
V. **Analyse** the thin walled beams which consists of wither completely closed cross section or open cross section and combination of open closed section beams
VI. **Understand** the method of structural idealization for complex structures to simpler mechanical model.
VII. **Analyse** the major aircraft structural components such as wings and fuselages are usually tapered along their lengths for greater structural efficiency.

VI. COURSE OUTCOMES

At the end of the course the students are able to:

1. **Understand** the maximum and minimum loading conditions for all the aircraft structural components
2. **Evaluate** any type of complex structures.
3. **Analyze** a efficient aircraft structural member.
4. **Analyze** the critical loading condition and can give the factor of safety to the components
5. **Evaluat**e the expression for the complex structures and find the loading condition to the structure.
6. **Apply** the analysis of fuselage, wings, frames, and ribs and consider the effects of cutouts in the wings and fuselages.
7. **Understand** to perform a simpler, quicker, and cheaper approximate methods can be used to provide the insight behavior of structures which computer-based techniques do not.
8. **Solve** the three-dimensional problem in elasticity.
9. **Analyze** the effect of a variety of loading and support conditions on the small deflection of rectangular plates.
10. **Apply** the structural analysis to any aircraft component.
11. **Demonstrate** the various types of Stiffeners and Stringers used to prevent buckling.
12. **Distinguish** the Stress Analysis of wing and fuselage structures.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	**General knowledge:** An ability to apply the knowledge of mathematics, science and Engineering for solving multifaceted issues of Aeronautical Engineering	S	Assignments, Tutorials
PO2	**Problem Analysis**: An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for Aeronautical systems	H	Assignments
PO3	**Design/Development of solutions**: To develop Broad theoretical knowledge in Aeronautical Engineering and learn the methods of applying them to identify, formulate and solve practical problems involving Aerodynamics	H	Mini Projects

PO4	**Conduct investigations of complex problems**: An ability to apply the techniques of using appropriate technologies to investigate, analyze, design, simulate and/or fabricate/commission complete systems involving complex aerodynamics flow situations.	S	Projects
PO5	**Modern tool usage**: An ability to model real life problems using different hardware and software platforms, both offline and real-time with the help of various tools along with upgraded versions.	H	Mini Projects
PO6	**The engineer and society**: An Ability to design and fabricate modules, control systems and relevant processes to meet desired performance needs, within realistic constraints for social needs	H	Projects
PO7	**Environment and sustainability**: An ability To estimate the feasibility, applicability, optimality and future scope of power networks and apparatus for design of eco-friendly with sustainability	S	-
PO8	**Ethics**: To Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources	S	Projects
PO9	**Individual and team work**: An Ability to design schemes involving signal sensing and processing leading to decision making for real time Aeronautical systems and processes at individual and team levels.	H	-
PO10	**Communication**: an Ability to work in a team and comprehend his/her scope of work, deliverables, issues and be able to communicate both in verbal, written for effective technical presentation	S	Tutorials
PO11	**Project management and finance**: To be familiar with project management problems and basic financial principles for a multi-disciplinary work	H	Projects
PO12	**Life-long learning**: An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	H	Projects

S – Supportive **H – Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	H	Lectures and Assignments
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	S	Tutorials
PSO3	**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	H	Projects
PSO4	**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	S	Seminars and Projects

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IX. SYLLABUS

UNIT – I

THIN PLATE THEORY, STRUCTURAL INSTABILITY:

Analysis of thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading- thin plates having small initial curvature, energy methods of analysis.

Buckling of thin plates- elastic, inelastic, experimental determination of critical load for a flat plate, local instability, instability of stiffened panels, failure stresses in plates and stiffened

panels. Tension field beams- complete diagonal tension, incomplete diagonal tension, post buckling behavior.

UNIT- II

BENDING AND SHEAR AND TORSION OF THIN WALLED BEAMS:

Unsymmetrical bending- resolution of bending moments, direct stress distribution, position of neutral axis. Deflections due to bending- approximations for thin walled sections, temperature effects.

Shear loaded thin walled beams- general stress, strain and displacement relationships- direct stress and shear flow system- shear centre, twist and warping.

Torsion of beams of closed section- displacements associated with Bredt-Batho shear flow. Torsion of open section beams. Warping of cross section- conditions for zero warping. Bending, shear, and torsion of combined open and closed section beams.

UNIT- III

STRUCTURAL IDEALIZATION OF THIN WALLED BEAMS:

Structural idealization- principal assumptions, idealization of panel, effect on the analysis of thin walled beams under bending, shear, torsion loading- application to determining deflection.

UNIT- IV

STRUCTURAL AND LOADING DISCONTINUITIES IN THIN WALLED BEAMS:

Closed section beams- shear stress distribution of a closed section beam built in at one end under bending, shear and torsion loads.

Open section beams- I section beam subjected to torsion, torsion of beam of arbitrary section, torsion bending constant, distributed torque loading- extension of theory for general systems of loading.

Shear lag- effect of shearing strains in beams- redistribution of bending stresses due to restraining of warping, limitation of elementary bending theory, effect of accounting for shear lag on the estimated strength.

UNIT- V

STRESS ANALYSIS OF AIRCRAFT COMPONENTS- WING, FUSELAGE:

Wing spars and box beams- tapered wing spar, open and closed section beams, beams having variable stringer areas. Wings- Three-boom shell in bending, torsion, shear, tapered wings, deflections, cut-outs in wings.

Bending, shear, torsion, cut-outs in fuselages. Fuselage frames and wing ribs- principles of stiffener/ web construction, fuselage frames, wing ribs.

TEXT BOOKS:

1. Megson, T.H.G., *Aircraft Structures for Engineering Students*, 4th edn., Elsevier, 2007, ISBN 0-750-667397.
2. Peery, D.J. and Azar, J.J., *Aircraft Structures*, 2nd edn, McGra-Hill, 1982, ISBN 0-07-049196-8.

REFERENCES:

1. Allen, D.H. and Haisler, W.E., *Introduction to Aerospace Structural Analysis*, John Wiley, 2010.
2. Bruhn. E.H, *Analysis and Design of Flight Vehicles Structures*, Tri-state Off-set Company, USA, 1965.
3. Lakshmi Narasaiah, G., *Aircraft Structures*, BS Publications, 2010.
4. Sechler.E.E. and Dunn, L.G., *Airplane Structural Analysis and Design*, John Wiley & Sons.

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Course Learning Outcomes	Topics to be covered	Reference
1-18	**Derive** the expression to analyze the thin plates	**UNIT- I Thin plate theory, Structural Instability**	T1.1
	EXPLAIN the types and causes of deformations	Buckling of thin plate's local instability, instability of stiffened panels, failure stresses in plates and stiffened panels.	T1.1
	EXPLAIN AND DERIVE	Tension field beams- complete diagonal tension, incomplete diagonal tension, post buckling behavior.	T1.1
19-41	**EXPLAIN** Bending and Shear and Torsion of Thin Walled Beams	**UNIT 2: Bending and Shear and Torsion of Thin Walled Beams** Explain the various types of loads acting on the aircraft structural parts, the behavior of structural elements during these loads.	T1.1
	DIRIVE Bending and Shear and Torsion of Thin Walled Beams	Unsymmetrical bending- resolution of bending moments, direct stress distribution, position of neutral axis. Deflections due to bending- approximations for thin walled sections, temperature effects. Shear loaded thin walled beams- general stress, strain and displacement relationships- direct stress and shear flow system- shear centre, twist and warping. Torsion of beams of closed section- displacements associated with Bredt-Batho shear flow. Torsion of open section beams. Warping of cross section- conditions for zero warping. Bending, shear, torsion of combined open and closed section beams.	T1.1
	ANALATYCAL PROBLEMS Bending and Shear and Torsion of Thin Walled Beams	Unsymmetrical bending- resolution of bending moments, direct stress distribution, position of neutral axis. Deflections due to bending- approximations for thin walled sections, temperature effects. Shear loaded thin walled beams- general stress, strain and displacement relationships- direct stress and shear flow system- shear centre, twist and warping. Torsion of beams of closed section- displacements associated with Bredt-Batho shear flow. Torsion of open section beams. Warping of cross section- conditions for zero warping. Bending, shear, torsion of combined open and closed section beams.	T2.2
42-52	**EXPLAIN** Structural Idealization of Thin Walled Beams:	**UNIT-III: Structural Idealization of Thin Walled Beams:** Explain how to idealize the structure and its assumptions based theory.	T2.2
	ANALATYCAL PROBLEMS Structural Idealization of Thin Walled Beams:	Structural idealization- principal assumptions, idealization of panel, effect on the analysis of thin walled beams under bending, shear, torsion loading- application to determining deflection	T2.2
53-69	**EXAMINE** THE Structural and Loading Discontinuities in Thin Walled Beams:	**UNIT-IV: Structural and Loading Discontinuities in Thin Walled Beams:** Closed section beams- shear stress distribution of a closed section beam built in at one end under bending, shear and torsion loads. Open section beams- I section beam subjected to torsion, torsion of beam of arbitrary section, torsion bending constant, distributed torque loading- extension of theory for general systems of loading. Shear lag- effect of shearing strains in beams- redistribution of	T2.2

		bending stresses due to restraining of warping, limitation of elementary bending theory, effect of accounting for shear lag on the estimated strength	
	ANALATYCAL PROBLEMS THE Structural and Loading Discontinuities in Thin Walled Beams:	Closed section beams- shear stress distribution of a closed section beam built in at one end under bending, shear and torsion loads. Open section beams- I section beam subjected to torsion, torsion of beam of arbitrary section, torsion bending constant, distributed torque loading- extension of theory for general systems of loading. Shear lag- effect of shearing strains in beams- redistribution of bending stresses due to restraining of warping, limitation of elementary bending theory, effect of accounting for shear lag on the estimated strength	T1.17
70-94	**EXPLAIN** Stress Analysis of Aircraft Components- Wing, Fuselage**:**	**UNIT-V:** Explain the stress analysis of aircraft components such as wing, fuselage, ribs and frames	T1.17
	ANALYTICAL PROBLEMS Stress Analysis of Aircraft Components- Wing, Fuselage**:**	Variable stringer areas. Wings- Three-boom shell in bending, torsion, shear, tapered wings, deflections, cut-outs in wings. Bending, shear, torsion, cut-outs in fuselages. Fuselage frames and wing ribs- principles of stiffener/ web construction, fuselage frames, wing ribs.	T1.17

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Course Objectives	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
I		H	S							S					H	S
II	H	S													S	
III				S	H							H	H			
IV	H	H											S			H
V														H		
VI			H	S	S					S	H	S		S	S	S

S – Supportive **H - Highly related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1		H		S	H							H		H		
2									S							
3	S												S		S	H
4			S										H			
5		H		H										H		
6			S										H		S	
7		S			H											H
8	H			S					H			S				
9	H								S			H				

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Prepared by: Dr Y B Sudhir Shastry, Professor

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