Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-4 (B.Tech)

Subject: Aircraft Structure-I- BETAE14305

Type of course: Professional Core

Prerequisite: Basic knowledge of Engineering Mechanics, Strength of Materials, Engineering Mathematics, and Aircraft Materials

Rationale: This subject provides fundamental knowledge of how aircraft structural components behave under various loads such as bending, shear, and torsion. It helps students analyze stresses, deflections, and failure conditions in aircraft parts to ensure strength and safety. The course builds a foundation for advanced subjects like Aircraft Structure–II and Aircraft Design

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	0	2	5	60	30	10	20	30	150

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

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Course Content:

Unit No	Course content	Hrs.	% Weightage
1	**Symmetrical Bending and Shearing of Beams:** Introduction, Theory of simple bending, position of neutral axis, section modulus, Practical application of bending equation, Beam of heterogeneous materials, Beams of uniform strength, Shearing stress variation, Variation of shear stress in beam cross- section, Shear stress distribution for typical sections.	10	20 %
2	**Energy Methods:** Strain Energy due to axial, bending and torsional loads – Castigliano's theorem for displacements and moments – Maxwell's reciprocal theorem, Unit load method – Application to beams, trusses, frames, rings, etc. Concepts of statically Determinate and Indeterminate structures, Concept of kinematic Indeterminacy, Principle of Superposition, Plane stress and strain condition, Mohr's circle.	15	25 %
3	**Torsion of Shafts:** Introduction, Torsion of shafts, Torsion Equation, Hollow circular shafts, Torsional rigidity, Importance of angle of twist and various stresses in shafts, Shafts in series and parallel, Combined Bending and Torsion. **Failure Theories:** Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum strain energy theory – Application to aircraft structural problems.	20	30 %
4	**Analysis of Determinate and Indeterminate Structures – Elastic Curve, Slope, and Deflection Methods:** Concepts of statically Determinate and Indeterminate structures, Concept of kinematic Indeterminacy, Principle of Superposition, Differential equation of the elastic curve, Relationship Between Bending Moment, Slope, and Deflection, Methods for Determining Slope and Deflection, Double Integration Method, Macaulay's Method, Moment-Area Method, Conjugate Beam Method	15	25 %

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Load–Deflection Response of Wing Beam** Faculty will provide the beam setup, load points A and B, and explain the procedure. Students will apply loads at A and B, record opposite deflections, plot the graph, and verify $\delta AB = \delta BA$. They must upload a short Report or PPT with theory, data, calculations, graph, one application, and conclusion on the GMIU portal.	10
2	**Torsional Analysis of Shafts:** Students will study how solid and hollow shafts behave under twisting loads. Using simple rods or tubes, they will apply torque, observe the twist, and calculate torsional stress and angle of twist using basic torsion formulas. Results for both shafts will be compared, and findings will be presented in a short report or PPT on the GMIU portal.	10
3	**Case Study on Aircraft Wing Structural Behaviour:** Students will prepare a small model of an aircraft wing or beam using basic materials such as a ruler, cardboard, or balsa wood. Loads will be applied at different positions to simulate aerodynamic forces, and the resulting deflection and twist will be observed and recorded. Prepare a report or PPT including theory, calculations, and graphical results, and upload the pdf report on the GMIU portal.	10
	Total	30

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	**Remembrance (R)**	**Understanding (U)**	**Application (A)**	**Analyze (N)**	**Evaluate (E)**	**Create (C)**
Weightage	20%	30%	50%	-	-	-

Course Outcome:

After learning the course, the students should be able to:	
CO1	Understand the concept of symmetrical bending and shearing in beams, and analyze stress distribution across various cross-sections.
CO2	Apply energy methods, including Castigliano's and Maxwell's theorems, to determine deflection and internal forces in structural members.
CO3	Analyze torsional behavior and apply failure theories to evaluate stresses and safety of structural components.
CO4	Determine slope and deflection in determinate and indeterminate structures using analytical methods such as double integration, Macaulay's, and moment-area techniques

List of Practical:

Sr. No	Descriptions	Unit No	Hrs.
1	**Verification of the Bending Equation ($\sigma = My/I$):** To verify the theory of simple bending by measuring stresses in a simply supported beam under a known load.	1	4
2	**Determination of Shear Stress Distribution in a Beam:** To determine and plot the shear stress variation across the cross-section of a rectangular or I-section beam.	1	4
3	**Determination of Flexural Rigidity (EI) of a Beam:** To calculate the flexural rigidity of a beam using deflection measurements under different loading conditions.	2	2
4	**Torsion Test on Circular Shaft:** To perform a torsion test on a solid or hollow shaft and determine the modulus of rigidity (G).	2	4
5	**Combined Bending and Torsion on Shaft:** To study the combined effect of bending moment and torque on a circular shaft.	3	4
6	**Verification of Castigliano's Theorem:** To verify Castigliano's theorem for deflection using an experimental beam setup	3	2
7	**Determination of Deflection by Macaulay's Method:** To calculate the slope and deflection of a simply supported beam using Macaulay's method and verify experimentally.	3	2
8	**Mohr's Circle for Plane Stress and Strain:** To construct Mohr's circle for a given state of stress and determine principal stresses and maximum shear stresses.	3	4

9	**Study of Failure Theories for Aircraft Materials:** To apply different failure theories (Maximum Stress, Strain, Shear, Distortion, and Strain Energy) to predict failure in an aircraft structural component.	3	2
10	**Analysis of Aircraft Wing Beam as an Indeterminate Structure:** To analyze a model of an aircraft wing beam using the conjugate beam or moment-area method to determine slope and deflection.	4	2
		Total	30

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] "Aircraft Structure for Engineering Students" by THM Megson & Edward Arnold.

[2] "Aircraft Structures" by David J Peery and J J Azar.

[3] "Analysis of Structure Vol. 1" by S S Bhavikatti.

[4] "Mechanics of structure Vol. 1" by S B Junarkar.

[5] "Theory and Analysis of Flight Structures", by R M Rivello | Tata McGraw Hil