

| COURSE CODE | COURSE TITLE    | L | T | P | C |
|-------------|-----------------|---|---|---|---|
| 1152AE102   | Aero Elasticity | 3 | 0 | 0 | 3 |

**Course Category:**

Programme Elective

**a. Preamble :**

This course gives in-depth knowledge on Static, Dynamic aero elasticity and fundamental concepts of numerical analysis.

**b. Prerequisite Courses:**

Compressible flow Aerodynamics  
Linear system Analysis  
Solid Mechanics

**c. Related Courses:**

- Theory of Vibrations
- Flapping wing Aerodynamics
- Helicopter Dynamics

**d. Course Educational Objectives :**

- To understand the preliminary concepts aeroelasticity
- To impart knowledge on flutter analysis

**e. Course Outcomes :**

Upon the successful completion of the course, students will be able to:

| CO Nos. | Course Outcomes                                 | Knowledge Level (Based on revised Bloom's Taxonomy) |
|---------|---|---|
| CO1     | Describe the collar`s triangle                  | K2  |
| CO2     | Explain the concepts of static aeroelsticity    | K3  |
| CO3     | Compute stability in flutter and guest response | K3  |
| CO4     | Discuss the concepts of unsteady aerodynamics   | K2  |
| CO5     | Analyze flutter using numerical approach        | K3  |

**f. Correlation of COs with POs :**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | H   |     | H   | H   |     | H   | H   | H   |     |      |      |      |
| CO2 | H   |     | H   | H   |     | H   | H   | H   |     |      |      |      |
| CO3 | H   |     | H   | H   |     | H   | H   | H   |     |      |      |      |
| CO4 | H   |     | H   | H   |     | H   | H   | H   |     |      |      |      |
| CO5 | H   |     | H   | H   |     | H   | H   | H   |     |      |      |      |

H- High; M-Medium; L-Low

**g. Course Content :**

**UNIT I Introduction to aeroelasticity 9**

Aeroelastic problems in Aerospace and civil structures, General nature and classification of aeroelastic problems., Collar's triangle,, deformation of structures and influence coefficients, energy method, classification and solution of aeroelastic problems.

**UNIT II Static aeroelasticity 9**

Divergence of 2-D airfoil and Straight Wing - Aileron Reversal - Control Effectiveness. - Wing loading and deformations - Swept Wing

**UNIT III Dynamic Aeroelasticity 9**

The Physical Explanation of Flutter, Lagrange Equations, Stability Analysis and Flutter of Typical Section, Gust Response, Flutter of 1-D Structures (Straight and Swept Wings), Dynamic flutter model of 2-D airfoil, prevention of flutter, experimental determination of flutter speed, : Flutter calculation, u-g method, p-k method, Prediction of divergence speed

**UNIT IV Unsteady Aerodynamics 9**

2-D and 3-D Supersonic flow, Subsonic flow (Kernal Function Approach) ,Theodorsen Theory, Oscillations of stay cables and bridges, Finite State Model

**UNIT V Flutter Analysis 9**

Equations in the Time Domain, Derivation of the Aeroelastic Equations in the Frequency Domain, Derivation of the Aeroelastic Equations in the Laplace Domain, Lag Effects, Least Square Method Rational Form for the Generalized Aerodynamic Force, Matrix Roger Approximation

**Total: 45 Periods**

**h. Learning Resources**

**i. Text Books:**

1. R. L. Bisplinghoff, H. Ashley and R. L Halfmann, "Aeroelasticity", Addison Wesley, 2/e, 1987.
2. D. H. Hodges and G. A. Pierce, "Introduction to Structural Dynamics and Aeroelasticity,"Cambridge Aerospace Series, 2011.

**ii. Reference Books:**

1. Y. C. Fung, An Introduction to the Theory of Aeroelasticity, John Wiley, 1985.