**INSTITUTE OF AERONAUTICAL ENGINEERING**

**(Autonomous)**

Dundigal, Hyderabad -500 043

**AERONAUTICAL ENGINEERING**

**OPEN ENDED EXPERIMENTS / PROBLEMS / PROJECT IDEAS**

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| **Course Title** | AEROSPACE STRUCTURAL DYNAMICS | | | | |
| **Course Code** | AAEB25 | | | | |
| **Program** | B.Tech | | | | |
| **Semester** | VII | | | | |
| **Course Type** | Core | | | | |
| **Regulation** | IARE - R18 | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| 3 | - | 3 | - | - |
| **Course Coordinator** | Mr. GootyRohan, Assistant Professor | | | | |

**COURSE OBJECTIVES:**

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| **The students will try to learn:** | |
| I | Demonstrate the knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response. |
| II | Understand to identify, formulate and solve engineering problems. This will be accomplished by having students model, analyze and modify a vibratory structure order to achieve specified requirements. |
| III | Introduce to structural vibrations which may affect safety and reliability of engineering systems. |
| IV | Describe structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components of space structures. |

**COURSE OUTCOMES:**

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| **After successful completion of the course, students will be able to:** | | |
| **Course Outcomes** | | **Knowledge Level (Bloom’s Taxonomy)** |
| CO 1 | **Explain**the concepts of the equation of motion of free vibration and its responsefor determining the nature of single degree of freedom. | Understand |
| CO 2 | **Demonstrate**the response of step function, periodic excitation (Fourier series and transform, Laplace transform) of Single DOF for determining the freely vibrating of a body. | Understand |
| CO 3 | **Construct**the equation of motion of free vibration for the design of the analysis of the spring-mass system. | Apply |
| CO 4 | **Apply**the various equations of forced vibrationfor determining the frequency of the body. | Apply |
| CO 5 | **Understand**the torsional vibrations of rotor and geared systemsfor determining the DOF of the vibrating systems. | Understand |
| CO 6 | **Develop**the formulation of stiffness and flexibility influence coefficientsfor simplifying solution of multi DOF systems. | Apply |
| CO 7 | **Analyze**the transverse, longitudinal, torsional and lateral vibrations of cables, rods and beamsfor the design of continue elastic body. | Analyze |
| CO 8 | **Understand**the difference between the static and dynamic aeroelasticityfor determining the aeroelastic model of airfoils. | Understand |
| CO 9 | **Analyze**the static and dynamic aeroelasticity of the typical airfoil and wing sections of aircraft using Eigen functions and Laplace equationfor design of aircraft wing. | Analyze |

**OPEN ENDED EXPERIMENTS / PROBLEMS / PROJECT IDEAS**

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| **S.NO** | **TOPIC’S** | **CO’S** |
| 1 | Introduction to theory of vibration | CO 1 |
| 2 | Equation of motion, free vibration | CO 1 |
| 3 | Response to harmonic excitation, | CO 2 |
| 4 | Response to an impulsive excitation | CO 2 |
| 5 | Response to a step excitation, | CO 2 |
| 6 | Response to periodic excitation (Fourier series) | CO 2 |
| 7 | Response to a periodic excitation (Fourier transform), | CO 2 |
| 8 | Laplace transform (Transfer Function). | CO 2 |
| 9 | Equations of motion, free vibration, | CO 3 |
| 10 | The Eigenvalue problem, | CO 3 |
| 11 | response to an external applied load | CO 3 |
| 12 | Damping effect; | CO 3 |
| 13 | Multi degree of freedom systems, | CO 3 |
| 14 | Modeling of continuous systems as using Newton’s second law to derive equations of motion | CO 3 |
| 15 | Influence coefficients - stiffness influence coefficients, | CO 3 |
| 16 | Flexibility influence coefficients, | CO 3 |
| 17 | Inertia influence coefficients; | CO 3 |
| 18 | Potential and kinetic energy expressions in matrix form, | CO 4 |
| 19 | generalized coordinates and generalized forces | CO 4 |
| 20 | Lagrange‘s equations to derive equations of motion, | CO 4 |
| 21 | equations of motion of undamped systems in matrix form | CO 4 |
| 22 | Solution of the Eigenvalue problem, expansion theorem, | CO 5 |
| 23 | unrestrained systems, free vibration of undamped systems | CO 5 |
| 24 | Forced vibration of undamped systems using modal analysis, | CO 5 |
| 25 | forced vibration of viscously damped systems | CO 5 |
| 26 | Introduction to nonlinear vibrations, simple examples of nonlinear systems, | CO 6 |
| 27 | Physical properties of nonlinear systems | CO 6 |
| 28 | Solutions of the equation of motion of a single-degree-of-freedom nonlinear system nonlinear systems | CO 6 |
| 29 | Solutions of the equation of motion of a multi-degree-of-freedom nonlinear systems | CO 6 |
| 30 | Introduction to random vibrations; | CO 6 |
| 31 | Classification of random processes, | CO 6 |
| 32 | Probability distribution and density functions, | CO 6 |
| 33 | description of the mean values in terms of the probability density function | CO 6 |
| 34 | Properties of the autocorrelation function, | CO 7 |
| 35 | Power spectral density function, | CO 7 |
| 36 | Properties of the power spectral density function, | CO 7 |
| 37 | White noise and narrow and large bandwidth, | CO 7 |
| 38 | Single-degree-of-freedom response, response to a white noise | CO 7 |
| 39 | Introduction, transverse vibration of a string or cable | CO 7 |
| 40 | longitudinal vibration of a bar or rod | CO 7 |
| 41 | torsional vibration of a bar or rod | CO 7 |
| 42 | Lateral vibration of beams, the Rayleigh-Ritz method. | CO 7 |
| 43 | Collar's aero elastic triangle, static aeroelasticity phenomena | CO 8 |
| 44 | Dynamic aero elasticity phenomena, aero elastic problems at transonic speeds | CO 8 |
| 45 | Aero elastic tailoring, active flutter suppression | CO 9 |
| 46 | Effect of aero elasticity in flight vehicle design | CO 9 |

**Course Coordinator: HOD, AE**

**Mr. K Arun Kumar, Assistant Professor**