VIBRATION OF CONTINUOUS SYSTEMS

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PRE-REQUISITES : BE/B.Tech in Civil/Mechanical/Aerospace Engg/ Marine Engg.

INTENDED AUDIENCE : B.E Final year/M.Tech/ PhD students/Industrial persons

INDUSTRY SUPPORT : Aeronautics Research & Development Board, Delhi; Indian Space Research Org., Bangalore

COURSE OUTLINE :

All structures or mechanical systems are in fact, continuous having their physical parameters, external forces and their response are distributed in space. The dynamic behavior of the structures or machine components, can only be truly reflected in the continuous systems. The slenderness of the structures necessitates the adoption of continuous modelling. The exact solutions that can be obtained from continuous models provide true physical behavior in addition to yielding various bench mark results for testing the efficacy of many numerical methods used in discrete approaches. Keeping this in mind, the present course has been framed to teach the students about the formulation and solution of vibration problems of the continuous systems by exact method as well as by numerical techniques with application of MATLAB tool box. The course is designed for 12 modules in which each module will consist of 3 or 4 lecture hours.

ABOUT INSTRUCTOR :

Prof. Sudip Talukdar is currently working as a faculty member of Civil Engineering Department of Indian Institute of Technology Guwahati. He is specialized in Structural Engineering. He obtained his B.E (Civil) from Regional Engineering College Silchar (presently NIT Silchar) with a Gold Medal. He completed his Masters in Structural Engineering from Department of Civil Engineering of Indian Institute of Technology Kharagpur and PhD from Indian Institute of Technology Kanpur in Structural Dynamics in Department of Aerospace Engineering. He is in teaching profession for about 38 years. Prior to joining IIT Guwahati in 1999, he was Assistant Professor in Civil Engineering at Regional Engineering College, Silchar (presently, NIT Silchar). He has published 131 papers till date in reputed International/ National Journals and Conference Proceedings. His research area includes theoretical and experimental works in wide areas of Structural Engineering with major contribution of research in the field of Structural Dynamics. He is the member of Institution of Engineers (Ind), Indian Road Congress and Indian Society of Theoretical and Applied mechanics.

COURSE PLAN :

Week 1: Introduction to continuous system:
1. Modelling of undamped and damped system
2. Concepts of time domain and frequency domain approach
3. Generalized approach for forced vibration

Week 2: Different approaches for problem formulation
1. Equation of motion of continuous system by force balance
2. Energy approach and Hamilton's principle
3. Lagranges equations and their applications.

Week 3: One dimensional wave equation:
1. D,Alembert solution of the wave equation
2. Transverse vibration of stretched string
3. Modal analysis and dynamic response of flexible string

Week 4: Axial and torsional vibration of bar:
1. Development of equation of motion by force balance and energy principle
2. Free vibration problems in axially loaded bar and torsional system,
3. Dynamic response of Shaft subjected to distributed couple or concentrated couple.

Week 5: Flexural vibration of beams:
1. Equation of motions of slender beams
2. Eigen value problems in beams
3. Forced vibration analysis using mode superposition techniques

Week 6: Vibration of beams subjected to moving load:
1. Formulation of problems in vibration of beams subject to moving load
2. Solution of Problems using mode superposition principles
3. Some practical applications

Week 7: Combination of continuous and lumped parameter system:
1. Exact solution of beam vibration with a concentrated mass
2. Semi-analytical approach for vibration of beams with several concentrated masses
3. Beam vibration problem with moving oscillator

Week 8: Vibration of membranes and plates:
1. Equation of motion for the vibration of stretched membranes
2. Vibration of rectangular plates
3. Practical applications of vibration of plates

Week 9: Approximate methods in vibration of continuous system:
1. Rayleigh-Ritz method
2. Gallerkin's approach
3. Finite difference method in vibration of beams and plates.

Week 10: Vibration isolation:
1. Continuous system subject to support excitation
2. Force transmission and vibration isolation
3. Tuned mass damper for vibration reduction.

Week 11: Transient vibration analysis:
1. Unit impulse and response to arbitrary excitation
2. Response to step, ramp and pulse excitation 3. Dynamic analysis using ground motion data

Week 12: Numerical techniques with MATLAB applications:
1. Eigenvalues and eigen vector computation including state space form
2. Direct integration methods
3. Spectral analysis of structures for earthquake excitation