STRUCTURAL DYNAMICS

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PRE-REQUISITES : Basic understanding of structural analysis and knowledge of engineering mathematics.

COURSE OUTLINE :

The objective of the course is to understand the behaviour of structure especially building to various dynamic loads: such as wind, earthquake, machine vibration and ambient vibration.

ABOUT INSTRUCTOR :

Prof. Ramancharla Pradeep Kumar worked in L&T-ECC for about a year (1997-98) and went to Tokyo, Japan for pursuing Ph.D. After receiving degree, he worked as a post-doctoral research fellow for one year (2001-02). He joined IIIT Hyderabad in September 2002 and started Earthquake Engineering Research Centre (EERC). He was also instrumental in initiating graduate program on Computer Aided Structural Engineering (CASE) at IIIT Hyderabad in 2002 and 5-year Dual Degree program in Building Science & Engineering in 2013. Dr. Ramancharla's research interests are; i) Numerical Modeling of tectonic plates and faults ii) Ground Motion Simulation on faults, iii) nonlinear structural response & damage estimation, iv) health diagnosis of historical and critical structures, v) sustainable construction technologies (with local & natural materials) and v) capacity building on earthquake disaster safety. In addition to the above, Dr. Ramancharla has keen interest in research on humanities and human values.

Prof. Ramancharla is leading an active research group of around 35 people. He is presently supervising 12 Ph.D/MS by Research students. Dr. Ramancharla published around 180 papers in journals and conferences. He visited Bhuj, Gujarat for conducting reconnaissance survey after 26th January 2001 Bhuj Earthquake. He also visited tsunami affected areas of Andhra Pradesh after 24 Dec 2004. He is a member of few committees at state level and also at national level. He is a member of Post Earthquake Reconnaissance Team (PERT) of NDMA, GoI. As a member of expert committee of NDMA he contributed in the preparation of National Disaster Management Policy and Guidelines for Earthquakes and Tsunamis. He also contributed in the preparation of policy for restructuring of Fire and Emergency Services Department, Govt of AP. He is also a member of expert committees on Disaster Mitigation of Cyclones and Urban Floods. He is currently a BIS panel member of IS 456 & IS 1343 (CED2), Earthquake Engineering Sectional Committee (CED39) and also a member of National Building Code of India (CED 46:P16).

COURSE PLAN :

Week 1: Basics of Structural Dynamics

- Module 1: Introduction of Structural Dynamics
- Module 2: Differential Equations in Civil Engineering
- Module 3: Types of Analysis/Static and Dynamic load
- Module 4: Degrees of Freedom (Ex: Generation of Stiffness matrix)
- Module 5: Dynamic Equilibrium Equation
- Module 6: Solution of Equilibrium Equation

Week 2: Free Vibration of SDOF

- Module 1: Undamped free Vibration
- Module 2: Solution, Natural Period/Frequency
- Module 3: Energy in Free Vibration
- Module 4: Damped Free Vibration
- Module 5: Types of damping
- Module 6: Logarithmic decrement equation

Week 3: Forced Vibration of SDOF

- Module 1: Undamped Forced vibration
- Module 2: Amplitude & Phase Angle
- Module 3: Dynamic amplification factor for deflection (Rd)
- Module 4: Damped Forced vibration
- Module 5: Relationship between Rd, Rv and Ra

Week 4: Force Transmission, Vibration Measurement

- Module 1: Resonant frequency and Half power band width
- Module 2: Force Transmission and Isolation
- Module 3: Design of Vibration Measuring Instruments

Week 5: Response to Arbitrary Motions

- Module 1: Response to Unit Impulse
- Module 2: Response to Arbitrary Force (Duhamel's Integral)
- Module 3: Response to Step and Ramp Forces
- Module 4: Response to Rectangular Pulse, Half Sinusoidal wave

Week 6: Numerical Methods of Solution

- Module 1: Time Stepping Methods
- Module 2: Central Difference Method
- Module 3: Newmark's Method

Week 7: Response Spectrum

- Module 1: Concept of Response Spectrum
- Module 2: Uses of Response Spectrum
- Module 3: Special Cases in Spectrum
- Module 4: Development of Tripartite Plot
- Module 5: Example: Base Shear and Base Moment
- Module 6: Response of Structure in Frequency Domain

Week 8: Multi-Degree of Freedom Systems

- Module 1: Equation of Motion for MDOF System
- Module 2: Solution of Equation, Natural Frequencies and mode Shapes (60)
- Module 3: Modal Orthogonality
- Module 4: Approximate Method for finding Natural frequency

Week 9: Earthquake Response of MDOF Systems

- Module 1: Time History Analysis
- Module 2: Response Spectrum Analysis
- Module 3: 3D Dynamic Analysis

Week 10: Dynamic Response of Continuous Systems

- Module 1: Vibration of Continuous systems
- Module 2: Shear behavior and bending behavior
- Module 3: Generalized SDOF

Week 11: Dynamics of Rigid Blocks

- Module 1: Dynamics of Rigid Blocks
- Module 2: Non Structural Elements
- Module 3: Floor Response Spectrum

Week 12: Vibration Control

- Module 1: Introduction to Vibration Control
- Module 2: Active Control
- Module 3: Passive Control
- Module 4: Design of Tuned Mass Damper