



# DYNAMICS OF STRUCTURES

## PROF. MANISH KUMAR

Department of Civil Engineering  
IIT Bombay

**PRE-REQUISITES :** Basic course in Calculus

**INTENDED AUDIENCE :** B.Tech and M.Tech students, Industry professionals engaged with structural design

**INDUSTRIES APPLICABLE TO :** All Structural Engineering firms, Infrastructure and construction, companies, CPWD, Railways, Defence sector

## COURSE OUTLINE :

This course will focus on characterizing the behavior of structures subject to dynamic loads (e.g., earthquake, impact, blast). Structures would be idealized to simplified single-degree-of-freedom (SDOF) and multi-degree-of-freedom (MDOF) systems. Equation of motion for SDOF systems would be developed for periodic, non-periodic and arbitrary excitations. The numerical methods to obtain the dynamic response and their limitations would be discussed. The concept of earthquake response spectrum and design spectrum will be explained and their utility in the seismic analysis and design of structures would be discussed.

## ABOUT INSTRUCTOR

Prof. Manish Kumar is an assistant professor in the Department of Civil Engineering at IIT Bombay in Mumbai, India. He obtained his Bachelor's degree in civil engineering from IIT Kanpur, and Master's and Ph.D. degrees from State University of New York (SUNY) at Buffalo in USA. He has worked in Australia and USA as a civil engineer and is a certified professional engineer (P.E.) in the state of California, USA. His research areas include analysis and design of structures subject to earthquake, blast and impact loads. He focusses on seismic response control of structures using seismic isolation and energy dissipation devices. He has extensive experience in conducting large scale experiments to characterize static and dynamic behavior of structures. He has authored several technical papers and reports on dynamic response control of structures. He has also developed several software modules to model seismic isolators in a wide range of open-source (e.g, OpenSees) and commercial software platforms (ABAQUS, LS-DYNA). His work on seismic isolation of nuclear structures has contributed to the development of a NUREG guide on seismic isolation. He has received STSI award by Hokkaido University in Japan and was a visiting research scholar to Beijing University of Technology. He has delivered several keynote lectures in Indian conferences and workshops in the area of seismic isolation. His recently lead the efforts organize an US-Indo international workshop on seismic safety of nuclear structures. He is a currently a working group member of the BIS code committee (CED39) on seismic isolation and assisting with the efforts to develop codes and guidelines on safety of structures against extreme loads.

## COURSE PLAN :

**Week 1:** Introduction to Dynamics of Structures

**Week 2:** Free Vibration

**Week 3:** Forced Harmonic Vibrations

**Week 4:** Forced Harmonic Vibrations

**Week 5:** Non-periodic Excitations

**Week 6:** Numerical Response Evaluations & Earthquake Response Spectra

**Week 7:** Generalized SDOF systems

**Week 8:** Multi-Degree-of-Freedom Systems

**Week 9:** Free Vibration of MDOF Systems

**Week 10:** Forced Vibration of MDOF Systems

**Week 11:** Seismic Analysis of MDOF Systems

**Week 12:** Seismic isolation