Course Type	Course Code	Name of Course	L	T	P	Credit
DE	**NGPD512**	**Strong Motion Seismology and Structural Responses**	**3**	**0**	**0**	**3**

Course Objectives
This course aims to introduce the fundamentals of strong ground motion, associated characteristics, surface deformation and concurrent responses of the man-made structures. Special attention would be given on the level of damping of the systems along with its comprehensive analysis in the backdrop of ground motion parameters and earthquake resistant design. Prediction of strong ground motion with a new quantifiable performance objective against soil strength and vibration analysis would another area of critical understanding of the structures. Students will also understand the decomposition of dynamic responses of a structure into uncoupled modal responses, and its seismic damages. Earthquake load prediction including response spectra, normal mode, and direct integration techniques will also be taught in this paper.
Learning Outcomes
The data seismologists record using strong motion sensors are used to improve the design of earthquake resistant structures. Therefore, the damage and loss of life due to direct impact of earthquake can be reduced considerably. Response of structures to strong ground motions and the simultaneous seismic performance outcomes under dynamic behaviour of soil-particle interactions will lead to a new understanding and better designing of the structures.

Unit No.	Description of Lectures	Lecture Hrs.	Learning Outcomes
1.	Ground Motions: Equation of motions and vibrations of single degree of freedom systems. Combination of stiffness, viscous damping, dry friction damping, negative damping, forced vibrations of a damped systems, etc.	**6**	Vibration of structures.
2.	Isolation of vibrations and vibration measuring instruments. Vibrometers: displacement meter, velocity meter, and accelerometer. Response of single degree of freedom systems under different transient loading.	**5**	Isolation of vibrations and its measurement.
3.	Green’s function for response of single degree of freedom systems under various types of forcing. Dynamic load factor and response spectra. Support Motions: Displacement and acceleration approaches, etc. Response of SDF systems related to earthquakes.	**6**	Degrees of freedom and responses of structures under different environments.
4.	Numerical methods for evaluation of acceleration, velocity and displacement of structures.	**5**	Numerical analysis of vibrations of structures.
5.	Site effects: effect from topography, earthquake source, geology, etc. Characteristics of peak ground acceleration against rock type and frequency content. Duration of vibrations. Empirical relationships between acceleration, magnitude of earthquake, epicentral distance, epicentral intensity. Acceleration in time domain and frequency domain.	**5**	Site-specific analysis related to earthquakes.

6.	Linear earthquake analysis: idealization of structures. Nonlinear earthquake analysis: force-deformation relationships, equation of motion, controlling parameters, ductility demand, allowable ductility. Response spectra: elastic and inelastic systems. Tripartite response spectra analysis.	**6**	Elastic and elastoplastic behaviour of structures. Response spectra of structures during earthquakes.
7.	Earthquake resistance design of structures: ductility-based design, detailing provisions, codal provisions, concepts of passive controls. Design seismic force by static analysis method. Base shear of RCC structure.	**5**	Resistant design of structures.
8.	Seismic design of foundations.	**4**	Structure foundation analysis.
	Total	**42**	

Text Books

1. M. Paz, Structural Dynamics: Theory and Computation, CBS Publishers and Distributors Pvt. Ltd., New Delhi, 2004
2. M. Mukhopadhyay, Structural Dynamics: Vibrations and Systems Paperback, ANE Books India, 2008.
3. S.P. Gupta and G.S. Pandit, Theory of Structures, Tata McGraw-Hill Publishing Company Ltd., 1999.

Reference Books

1. J. Krishna, A.R. Chandrasekaran and B. Chandra, Elements of Earthquake Engineering, South Asian Publishers, New Delhi, 1994.
2. M. Williams, Structural Dynamics, CRC Press, London, 2016
3. R. W. Clough and J. Penzien, Dynamics of Structures, McGraw Hill, Second edition, 1993.
4. A.K. Chopra, Dynamics of Structures-Theory and application to Earthquake Engineering, PHI, 1997.
5. T. Pauley and M.S.N. Priestly, Seismic design of reinforced concrete and masonry buildings, John Wiley and Sons, 1992.
6. M.N.S. Priestly, F. Seible and G.M. Calvi, Seismic design and retrofit of bridges, John Wiley and Sons, 1996.
7. D.J. Dowrick, Earthquake Resistant Design: for engineers and architects, John Wiley and Sons, 1987.
8. Naeim, F., The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition, 2001.