BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION
SECOND SEMESTER 2015-2016
Course Handout Part-II

Date: 13/01/2016

In addition to part -I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : CE C432
Course Title : STRUCTURAL DYNAMICS
Instructor-in-charge : DIPENDU BHUNIA

❖ **Scope and Objective of the Course:**

The course aims how to model discrete single-degree and multiple-degree vibratory systems and calculate the free and forced response of these systems. It also describes about the calculation of the mode shapes and frequencies for the free response and using modal methods how to calculate the forced response of these systems. This course explains about modeling of continuous vibratory systems. At the last, this course discusses application in the design of civil engineering structures.

Therefore, this course is necessary for students how to apply the methods learned to a realistic engineering vibration problem related to civil engineering.

❖ **Text Book**

TB. Mukhopadhyay,M. (2006) "Structural Dynamics: Vibrations & Systems" Ane Books Pvt. Ltd.

❖ **Reference Books** :

R1. Chopra, A.K. (2007) "Dynamics of Structures: Theory and Application to Earthquake Engineering" Pearson Education, 3rd edition.

R2. Agarwal, P. and Shrikhande, M. (2006), "Earthquake Resistant Design of Structures" Prentice-Hall of India.

❖ **Course Plan**

Lec. No.	Learning Objective	- Topics to be covered	Ref. to Ch.
I. Introduction and Scope of Structural Dynamics			
1	Importance of the course	Introduction and Scope of dynamic analysis of structures; origins of vibration theory and experiment; review of earlier concepts: d'Alembert's principle, equations of motion.	1TB
2-3	Fundamentals of structural dynamics	Elements of a structural system: mass, stiffness and damping, methods to formulate equations of motion	1TB
II. Single Degree of Freedom (S.D.O.F) Dynamic System(Discrete mass systems)			
4-5	Free vibration analysis	Formulation (equation of motion) and solution of undamped and damped free vibration analysis of S.D.O.F system. Logarithmic decrement.	2TB
6-7	Forced vibration analysis	Formulation (equation of motion) and solution of undamped and damped forced vibration analysis of S.D.O.F system.	3TB
8-9	Forced vibration	Forced vibration under harmonic, periodic,	3TB

	analysis (evaluation of response to general dynamic loading)	impulse, step, ramp, general dynamic forces (time and frequency domain analysis) and response spectrum load, support excited vibration, transmissibility, vibration measuring seismic instruments.	
10-11	Numerical methods for free and forced vibration analysis (evaluation of dynamic response)	Numerical techniques for evaluation of dynamic response of SDOF system; time domain analysis; direct integration techniques; finite difference method (Central Difference method); Newmark beta method; average and linear acceleration method.	4TB
III. Multi Degree of Freedom (M.D.O.F) Dynamic System(Discrete mass systems)			
12-13	Analysis of two degree of freedom	Development of equation of motion and solution for two degree of freedom systems.	5TB
14-17	Analysis of two degree of freedom with applications	Coupled vibration and vibration isolation; base isolation mechanism; vibration measuring instruments; vibration absorber and tuned mass damper.	5TB
18-19	Analysis of multi-degree of freedom systems	Structural matrices; structural modeling and development of equation of motion for MDOF systems, mass, stiffness, damping and loading matrices.	6TB
20-21	Free vibration (Eigen value) analysis of lumped MDOF systems	Free vibration analysis of MDOF systems; State-space solution for response; Sensitivity analysis for frequencies; mode shapes and response; orthogonality condition of mode shapes;	6TB
22-24	Method of solving Eigen value problems	Approximate methods for obtaining natural frequencies and mode shapes; Dunkerley's equation; Holzer method; Stodola's method, Inverse vector iteration and convergence of iteration; Rayleigh's method; Rayleigh's Quotient; Reyleigh-Ritz method;	6 TB
25-29	Forced vibration analysis of lumped MDOF systems	Damping in MDOF systems, Construction of damping matrix, Rayleigh damping, Mode superposition method; modal combination rules; Response of MDOF systems to support motion; Numerical techniques for evaluation of dynamic response of MDOF system.	7TB, 11,12, 15R1
IV. Free and Forced Vibration of Continuous Systems			
30	Free Vibration of Continuous system	Equations of motion; undamped free vibration; frequencies and mode shapes	8 TB
31-32	Forced Vibration of Continuous system	Vibration of bars and beam, modal analysis; bars (axial vibrations), beams (flexural vibrations and torsional vibration).	9 TB

V. Application in the Design of Civil Engineering Structures			
33-42	Determination of EQ forces as per IS1893-Part1 to 5	Determination of EQ forces using response spectrum modal analysis, Modal combination rules using absolute sum, SRSS and CQC method. Time history method of analysis. EQ analysis for multisorey buildings, tall chimneys etc.	13R1, 18R2, IS:1893-Part1-5

❖ **Evaluation Scheme:**

Component	Duration	Weightage	Date & Time	Remarks
Mid semester	90 min	25	**17/3 9:00 - 10:30 AM**	CB
Assignments/surprise tests etc.	-	10	Continuous	OB
Project/seminar	-	30	Continuous	-
Comprehensive Examination	3 hrs	35	10/5 FN	OB

❖ Chamber Consultation Hour: To be announced in the class

❖ Notice: Notices will be displayed on Civil Engg. Department notice board only.

Instructor-in-Charge