SECOND SEMESTER 2020-21
COURSE HANDOUT

Date: 18.01.2021

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 F432**
Course Title : **STRUCTURAL DYNAMICS**
Instructor-in-Charge : **DIPENDU BHUNIA**
Instructor(s) : **N/A**
Tutorial/Practical Instructors: N/A

1. Course Description:

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. Elements of a structural system: springs, dashpot, mass; Springs in parallel and series; methods to formulate equations of motion; Formulation (equation of motion) and solution of undamped and damped free vibration analysis of S.D.O.F system; Formulation (equation of motion) and solution of undamped and damped forced vibration analysis of S.D.O.F system; Forced vibration under harmonic, periodic, impulse, step, ramp, general dynamic forces (time and frequency domain analysis) and response spectrum load, support excited vibration, seismic pickups; 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; Development of equation of motion and solution for two degree of freedom systems; Free vibration analysis of MDOF systems; frequencies; mode shapes and response; orthogonality condition of mode shapes; Approximate methods for obtaining natural frequencies and mode shapes; Holzer method; Stodola's method; Rayleigh's method; Rayleigh-Ritz method; Inverse iteration method; Vector iteration method; Rayleigh's Quotient iteration method; Matrix iteration method; Generation of damping matrix for MDOF; dynamic properties; modal damping; classical damping; damped response with Rayleigh and Caughey damping.Mode superposition method; mode acceleration method; modal combination rules using absolute sum, SRSS and CQC method. Response Spectrum, continuous system.

2. 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.

3. Text Books:

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

4. 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.

R3. Clough, R. W. and Penzien, J. (1972), "Dynamics of Structures," McGraw Hill Publication Ltd., USA.

5. Course Plan:

Module Number	Lecture session/Practice Session.	Reference	Learning Outcome
1. Importance of the course.	L1. 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.	T1, R1, R3	Understand the Importance of the course
2. Fundamentals of Dynamics of Structures	L2.1. Elements of a structural system: springs, dashpot, mass; Springs in parallel and series;	T1, R1, R3	Understand about the Fundamentals of Dynamics of Structures.
	L2.2. methods to formulate equations of motion	T1, R1, R3	
3. Free vibration analysis of S.D.O.F system.	L3. Formulation (equation of motion) and solution of undamped and damped free vibration analysis of S.D.O.F system.	T1, R1, R3	Understand Free vibration analysis of S.D.O.F system.
	P3. Practice problems	Class notes & Assignments	
4. Forced vibration analysis of S.D.O.F system	L4. Formulation (equation of motion) and solution of undamped and damped forced vibration analysis of S.D.O.F system.	T1, R1, R3	Understanding the Forced vibration analysis of S.D.O.F system.
	P4. Practice problems.	Class notes & Assignments	
5. Forced vibration analysis (evaluation of response to general dynamic loading).	L5.1. Forced vibration under harmonic, periodic, impulse, step, ramp, general dynamic forces (time and frequency domain analysis).	T1, R1, R3	Acquiring knowledge about the evaluation of response to general dynamic loading
	L5.2. response spectrum load, support excited vibration, seismic pickups.	T1, R1, R3	

	P5. Practice problems.	Class notes & Assignments	
6. Numerical methods for free and forced vibration analysis (evaluation of dynamic response).	L6. 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.	T1, R1, R3	Acquiring knowledge about the Numerical methods for free and forced vibration analysis.
	P6. Practice problems.	Class notes & Assignments	
7. Analysis of two degree of freedom.	L7.1. Development of equation of motion.	T1, R1, R3	Understanding the Analysis of two degree of freedom.
	L7.2. Solution for two degree of freedom systems.	T1, R1, R3	
	P7. Practice problems.	Class notes & Assignments	
8. Free vibration (Eigen value) analysis of lumped MDOF systems.	L 8. Free vibration analysis of MDOF systems; frequencies; mode shapes and response; orthogonality condition of mode shapes.	T1, R1, R3	Free vibration (Eigen value) analysis of lumped MDOF systems.
	P8. Practice problems.	Class notes & Assignments	
9. Method of solving Eigen value problems.	L9.1 Approximate methods for obtaining natural frequencies and mode shapes; Holzer method; Stodola's method; Rayleigh's method; Rayleigh-Ritz method.	T1, R1, R3	Method of solving Eigen value problems.
	L9.2 Inverse iteration method; Vector iteration method; Rayleigh's Quotient iteration method; Matrix iteration method.	T1, R1, R3	
	P 9. Practice problems.	Class notes & Assignments	
10. Forced vibration analysis of MDOF systems.	L10. Generation of damping matrix for MDOF; dynamic properties; modal damping; classical damping; damped response with Rayleigh and Caughey damping.Mode superposition method; mode acceleration method; modal combination rules using absolute sum, SRSS and CQC method. Response Spectrum, continuous system.	T1, R1, R2, R3	Understanding of Forced vibration analysis of MDOF systems.
	P 10. Practice problems.	Class notes & Assignments	

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test	90 Min.	30	<TEST_1>	OB
Comprehensive Examination	3 h	40	<TEST_C>	OB
Assignments	Continuous	10		
Projects	-do-	20		

7. Chamber Consultation Hour: To be announced in the class

8. Notices: Notices will be displayed through NALANDA ONLY.

9. Make-up Policy: If the student is unable to appear for the Regular Test/Examination due to genuine exigencies, the student must refer to the procedure for applying for Make-up Test/Examination. No make up for the assignments/projects seminar.

10. Note (if any): It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend lectures and in time assignments submission as per the schedule announced in Nalanda/lecture class. Mid Semester Test and Comprehensive Examination are according to the Evaluation Scheme given in the respective Course Handout.

(DIPENDU BHUNIA)
Instructor In charge
CE F432