BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2021-22
COURSE HANDOUT

Date: 19.08.2021

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 G551**
Course Title : **DYNAMICS OF STRUCTURES**
Instructor In-charge : **MD RUSHDIE IBNE ISLAM**
Instructor : **SUBHASIS PRADHAN**

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 Objectives

Natural phenomena and human activities impose forces of time-dependent variability on various civil engineering structures. This course deals with analysis and design of structures subjected to dynamic loads which involve consideration of time-dependent forces.
Therefore, this course is necessary for students desirous of joining design offices/ industry related to buildings, industrial plants, bridges, tanks, offshore structure, tall chimneys etc. At the end of the course work students will be able to determine the behavior of structures under dynamic loading and design a structure which is resistant to dynamic loading such as seismic, wind, sea wave, vehicle induced vibration force etc.

3. Prescribed Text Book

T1. Anil K. Chopra, "Dynamics of Structures: Theory and applications to earthquake engineering", Prentice Hall India Ltd., 2007.

4. Reference Books

R1. R.W. Clough and J. Penzien, "Dynamics of Structures", McGraw Hill International edition, 1993.
R2. Mukhopadhyay,M., "Structural Dynamics: Vibrations & Systems" Ane Books Pvt. Ltd., 2006.
R3. Paz,M., "Structural Dynamics: Theory & Computation" CBS Publishers & Distributors, 2001.

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.	T1-1, R2,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;	T1-1,2, R2,R3	Understand about the Fundamentals of Dynamics of Structures.
	L2.2. methods to formulate equations of motion	T1-1,2, R2,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.	T1-2, R2,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.	T1-3, R2,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).	T1-4, 6,7, R2,R3	Acquiring knowledge about the evaluation of response to general dynamic loading
	L5.2. response spectrum load, support excited vibration, seismic pickups.	T1-4, 6,7, R2,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.	T1-5, R2,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.	T1-9, 11, R2,R3	Understanding the Analysis of two degree of freedom.
	L7.2. Solution for two degree of freedom systems.	T1-9, 11, R2,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.	R1-11,13, R2,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.	R1-13, R2,R3	Method of solving Eigen value problems.
	L9.2 Inverse iteration method; Vector iteration method; Rayleigh's Quotient iteration method; Matrix iteration method.	R1-13, R2,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.	R1-12, 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>	Close Book
Comprehensive Examination	2 h	30	<TEST_C>	Close Book
Assignments/Class Tests		30	Spread over the semester	Open Book
Term paper		10	TBA	Open Book

7. Chamber Consultation Hour: Thursday after 5:00 PM

8. Notices: All notices concerning the course will be displayed on Nalanda.

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

(MD RUSHDIE IBNE ISLAM)
Instructor In charge
CE G551