

KL University, Guntur
III/IV B-Tech, 2nd Semester-2011- 2012
STRUCTURAL DYNAMICS
Course Handout

Date: 08-11-2012.

Course No : 09 CEE33
Course Title : STRUCTURAL DYNAMICS
Course Coordinator : Mr. G. V. Ramanjaneyulu
Team of Instructor : One Instructor
Course Detail : Theory
Lecture Hours : 45

1. COURSE DESCRIPTION:

The basic concepts of structure dynamics are detailed. The responses of structures to various dynamic excitations of single degree of freedom system are explained. Numerical methods for calculating the dynamic responses of the structures are illustrated. The earthquake response of linearly elastic systems, analysis of generalized single degree of freedom systems and dynamic analysis of multi-degree of freedom systems are studied.

2. COURSE OBJECTIVES & OUTCOMES:

After thorough learning of STRUCTURAL DYNAMICS

The student should be able to:

- 1) Relate the structural idealization studied to the properties of real structures.
- 2) Theory of dynamic response of structures in a manner that emphasizes physical insight into the analytical procedures.
- 3) Application of the theory to solutions of practical problems.
- 4) Interpret the theoretical results to understand the response of structures to various dynamic excitations.

3. RECOMMENDED TEXT BOOKS:

1. Dynamics of structures by Anil K Chopra; Prentice-Hall of India Limited, New Delhi.
2. Dynamics of Structures by R.W. Clough and P.E. Penzien, McGraw-Hill.

Reference Books

1. Structural Dynamics for Structural Engineers by G. C. Hart & K. Wang; John Wiley & Sons.
2. Structural Dynamics by Mario Paz, CBS Publishers.

4. SYLLABUS:

UNIT – 1

EQUATION OF MOTIONS, PROBLEM STATEMENT, SOLUTION METHODS OF SINGLE DEGREE OF FREEDOM SYSTEMS (SDOF)

Basic concepts of structural dynamics; single degree of freedom system, force displacement relationship, damping force, equation of motion, mass-spring-damper system, methods of solution of differential equation.

FREE VIBRATION (SDOF):

Undamped free vibration viscously damped free vibration, energy in free vibration.

UNIT – 2

RESPONSE TO HARMONIC AND PERIODIC EXCITATIONS (SDOF)

Harmonic vibration of undamped systems, Harmonic vibration with viscous damping, response to vibration generator, natural frequency and damping from harmonic test, force transmission and vibration isolation, vibration measuring instruments, and. Response to periodic force.

UNIT – 3

RESPONSE TO ARBITRARY, STEP AND PULSE EXCITATIONS (SDOF)

Response to unit impulse, response to arbitrary force, step force, ramp force, response to pulse excitations, solution methods, effects of viscous damping.

NUMERICAL EVALUATION OF DYNAMIC RESPONSE (SDOF)

Time step methods, methods based on interpolation of excitation, central difference method, newmark's method, stability and computational error, and analysis of nonlinear response by newmark's method.

UNIT – 4

EARTHQUAKE RESPONSE TO LINEAR SYSTEMS (SDOF)

Earthquake excitation, equation of motion, response quantities, response history, response spectrum concept, deformation, pseudo-velocity and pseudo acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics,

GENERALISED SINGLE DEGREE OF FREEDOM SYSTEMS

Generalised single degree of freedom system, rigid body assemblage, system with distributed mass and elasticity, lumped mass system-shear building, and natural vibration frequency by Rayleigh's method.

UNIT – 5

MULTI -DEGREE OF FREEDOM SYSTEMS (MDOF)

Equation of motions: simple system-two storey shear building, general approach for linear systems, static condensation, and symmetric plan systems:

FREE VIBRATION (MDOF) Natural frequencies and modes: , modal and spectral matrices, Orthogonality of modes, normalization of modes. Solution of undamped free vibration systems, solution methods for Eigenvalue problem.

5. SESSION WISE DISTRIBUTION OF UNITS

Unit	Sessions	Hours
I	1 to 8	8
II	9 to 16	8
III	17 to 25	9
IV	26 to 37	12
V	38 to 45	8
Total Hours		45

6. LESSON PLAN

No.of hours	Learning Objectives	Topics to be covered	Chapter in the text book
Unit I			
1	introduction	Introduction of the subject, Refreshing of basics	T1-1.1
2	To understand Single degree of freedom system	Single degree of freedom system	T1-1.2
3	To know about Damping force,	Damping force,	T1-1.4,
4	To know about equation of motion	equation of motion	T1-,1.5
5	Methods of solution of the differential equation	Methods of solution of the differential equation	T1-1.10.1
6	Methods of solution of the differential equation	Methods of solution of the differential equation	T1- 1.10.2
7	Equation of motion for Undamped free vibration	Undamped free vibration	T1-2.1
8	Equation of motion for Viscously damped free vibration	Viscously damped free vibration	T1-2.2
Unit II			
9	Understand the Harmonic vibration of undamped systems	Harmonic vibration of undamped systems	T1-3.1
10	To know the Solution of Harmonic vibration of undamped systems	Solution of Harmonic vibration of undamped systems	T1-3.1
11	To formulate the equation of motion for Harmonic vibration with viscous damping	Harmonic vibration with viscous damping	T1-3.2.1,3.2.2

12	To understand Maximum deformation and phase lag	Maximum deformation and phase lag	T1-3.2.3
13	To determine the Dynamic response factors	Dynamic response factors	T1-3.2.4
14	Force transmission and vibration isolation	Force transmission and vibration isolation	T1-3.5
15	Equation of motion for Response to ground motion and vibration isolation	Response to ground motion and vibration isolation	T1-3.6
16	Response to periodic force	Response to periodic force,	T1- 3.13
Unit III			
17	Response to arbitrary time varying force and unit impulse	Response to arbitrary time varying force and unit impulse	T1 – 4.1, 4.2
18	To find the Response to step force and ramp force	Response to step force and ramp force	T1-4.3, 4.4
19	To find the response to pulse excitations, solution methods	response to pulse excitations, solution methods	T1 – 4.6
20	Effect of viscous damping on structure	Effect of viscous damping	T1 – 4.11
21	Numerical evaluation of dynamic response, Time stepping methods	Numerical evaluation of dynamic response, Time stepping methods	T1 – 5.1
22	Methods based on interpolation of excitation	Methods based on interpolation of excitation	T1 – 5.2
23	Central difference method	Central difference method	T1-5.3
24	Newmark's method	Newmark's method	T1-5.4
25	Newmark's method	Newmark's method	T1-5.4
Unit IV			
26	Earthquake response of linear systems, earthquake excitation	Earthquake response of linear systems, earthquake excitation	T1-6.1
27	Equation of motions for earthquake excitation	Equation of motions	T1-6.2
27	Response history of the structure	Response history	T1-6.4
28	Deformation response spectrum	Deformation response spectrum	T1-6.5, 6.6.1
29	Pseudo-velocity and Pseudo-acceleration response spectrum	Pseudo-velocity and r Pseudo-acceleration response spectrum	T1-6.6.2, 6.6.3

30	Construction of response spectrum	Construction of response spectrum	T1-6.6.5, 6.7
31	Construction of response spectrum	Construction of response spectrum	T1-6.6.5, 6.7
32	Response spectrum characteristics	Response spectrum characteristics	T1-6.8
33	Generalized SDOF systems, rigid body assemblages	Generalized SDOF systems, rigid body assemblages	T1-8.1, 8.2
34	System with distributed mass and elasticity, generalized SDOF	System with distributed mass and elasticity	T1-8.3
35	Lumped mass system: shear building	Lumped mass system: shear building	T1-8.4
36	Natural vibration frequency by Rayleigh's method	Natural vibration frequency by Rayleigh's method	T1-8.5
37	Natural vibration frequency by Rayleigh's method	Natural vibration frequency by Rayleigh's method	T1-8.5
Unit V			
38	Multi-degree of freedom system: two storey shear building	Multi-degree of freedom system: two storey shear building, general approach	T1-9.1,
39	Multi-degree of freedom system: two storey shear building	Multi-degree of freedom system: two storey shear building	T1-9.2
40	static condensation	static condensation	T1-9.3
41	Natural frequencies and modes: systems without damping	Natural frequencies and modes: systems without damping	T1-10.1, 10.2
42	Natural frequencies and modes: systems without damping	Natural frequencies and modes: systems without damping	T1-10.1, 10.2
43	modal and spectral matrices	modal and spectral matrices	T1-10.3
44	To have knowledge about orthogonality of modes and normalization of modes	orthogonality of modes, normalization of modes	T1-10.4, 10.6
45	Solution of un-damped free vibration systems	Solution of undamped free vibration systems, eigenvalue problem	T1-10.8

Self Learning Topics:

Unit	Topic	Source
I	Equation of motions, problem statement, solution methods of single degree of freedom systems (sdof), free vibration (sdof):	http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/ve/index.htm http://en.wikipedia.org/wiki/Structural_dynamics http://ascelibrary.aip.org/
II	Response to harmonic and periodic excitations (sdof)	http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/ve/index.htm http://en.wikipedia.org/wiki/Structural_dynamics http://ascelibrary.aip.org/
III	Response to arbitrary, step and pulse excitations (sdof), numerical evaluation of dynamic response (sdof)	http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/ve/index.htm http://en.wikipedia.org/wiki/Structural_dynamics http://ascelibrary.aip.org/
IV	Earthquake response to linear sys generalised single degree of freedom systems Tems (sdof)	http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/ve/index.htm http://en.wikipedia.org/wiki/Structural_dynamics http://ascelibrary.aip.org/
V	Multi -degree of freedom systems (mdof) Free vibration (mdof)	http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/ve/index.htm http://en.wikipedia.org/wiki/Structural_dynamics http://ascelibrary.aip.org/

7.Evaluation Scheme: As per KL University Format

8. EXAMINATION PATTERN

Attendance will be considered for 5 marks. The demarcation is as follows:

95% and above: 5 marks
90% and above: 4 marks
85% and above: 3 marks
80% and above: 2 marks
75% and above: 1 mark.

9. NOTICE/COURSE MATERIALS: All notices, assignments and course materials will be uploaded in the e-learning site from time to time

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HOD

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