INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVILENGINEERING

COURSE DESCRIPTOR

Course Title	**STRUCTURAL DYNAMICS**				
Course Code	BSTB12				
Programme	M.Tech				
Semester	II	STE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	0	3	-	-
Chief Coordinator	Dr. Venu M, Professor				
Course Faculty	Dr. Venu M, Professor				

I. COURSE OVERVIEW:

Structural Dynamics is of utmost importance for understanding the analysis and design consideration of structures subjected to dynamic loading. This course introduces the basic concepts of dynamic loading and the response of structures to such loads, and then uses these concepts to illustrate applications in practical structures. It begins with the derivation of the basic equations of motion for an ideal single degree-of-freedom structure using various approaches, and the solution of these equations for different types of loading, with the emphasis on the physical behavior of the structure to different types of loads to establish simplified methods of analysis. An emphasis on earthquake response of structures is also provided. Further, the development of equations for multi-degree-of-freedom structures is considered, with multi- storied buildings as the example structures, and free and forced vibration response analysis of these multi- storied buildings shall be discussed. An introduction to the dynamics of continuous systems is provided.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
PG	BSTB01	I	Advanced Structural Analysis	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Structural Dynamics	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✔	Mini Project	✔	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into fiveunits and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are

be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.		Assignments/ Exams
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.		Assignments/ Exams
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.		Assignments/ Mini Project
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.		Seminars / Open ended experiments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO1	**Engineering Knowledge**: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.		Lectures, Seminars
PSO2	**Broadness and Diversity**: Graduates will have a broad understanding of economic, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	-	-
PSO3	**Self-Learning and Service**: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze and study dynamics response of single degree freedom system using fundamental theory and equation of motion.
II	Analyze and study dynamics response of Multi degree freedom system using fundamental

	theory and equation of motion.
III	Use the available software for dynamic analysis.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BSTB12.01	CLO 1	Know the importance of the vibration.	PO 1, PO 4	2
BSTB12.02	CLO 2	Understand the nature of exciting forces.	PO 1	2
BSTB12.03	CLO 3	Know the mathematical modeling of dynamicsystems.	PO 1	3
BSTB12.04	CLO 4	Understand the free and forced vibration without damping.	PO 2	2
BSTB12.05	CLO 5	Understand the free and forced vibration with damping.	PO 1, PO 2	2
BSTB12.06	CLO 6	Understand the response to harmonic loading.	PO 2	2
BSTB12.07	CLO 7	Understand the response to generaldynamic loading using duhamel's integral.	PO 3	2
BSTB12.08	CLO 8	Understand the fourier analysis for periodic loading.	PO 1, PO 3	3
BSTB12.09	CLO 9	Know the space solution forresponse of structure.	PO 3, PO 4	2
BSTB12.10	CLO 10	Understand the accuracy and stability of structure.	PO 3	2
BSTB12.11	CLO 11	Find the solution to response using new mark method.	PO 1	1
BSTB12.12	CLO 12	Find the solution to response using wilson method.	PO 1	3
BSTB12.13	CLO 13	Know the space solution for response numerical solution.	PO 3, PO 4	1
BSTB12.14	CLO 14	Know the space response using direct integration.	PO 2, PO 4	3
BSTB12.15	CLO 15	Understand thetwo degree of freedom system.	PO 3	1
BSTB12.16	CLO 16	Understand themultiple degree of freedom system.	PO 3, PO 4	2
BSTB12.17	CLO 17	Understand theinverse iteration method fordetermination of natural frequencies and mode shapes.	PO 3, PO 4	2
BSTB12.18	CLO 18	Understand thedynamic response by modal superpositionmethod, direct integration of equation of motion.	PO 2, PO 3	2
BSTB12.19	CLO 19	Understand themultiple degree of freedom system (distributed mass and load): single span beams.	PO 2, PO 3	1
BSTB12.20	CLO 20	Understand thefree and forcedvibration, generalized single degree of freedom system.	PO 2, PO 3	2
BSTB12.21	CLO 21	Understand thedynamic effects of wind loading.	PO 2, PO 3	2
BSTB12.22	CLO 22	Understand themoving loads,vibrations caused by traffic.	PO 3, PO 4	1
BSTB12.23	CLO 23	Understand theblasting and pile driving, foundations for industrial machinery, base isolation.	PO 3, PO 4	2

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X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2			2									1		
CLO 2	3														
CLO 3	3	2													
CLO 4		2													
CLO 5		2											1		
CLO 6	3	1													
CLO 7			2										2		
CLO 8		2		2									2		
CLO 9	3	3	2										1		
CLO 10		2	2												
CLO 11			3										2		
CLO 12	1	2													
CLO 13	3			1									1		
CLO 14			2	2											
CLO 15	1		1										2		
CLO 16		3	1	2											
CLO 17			3	1											
CLO 18		3	2										2		
CLO 19		2	1										2		
CLO 20			3	1											
CLO 21	1	3	3										2		
CLO 22		2	2	1											
CLO 23			1	1									1		

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XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO2, PO3,PO4	SEE Exams	PO1, PO2, PO3, PO4	Assignments	PO1, PO2, PO3	Seminars	PO4
Laboratory Practices	-	Student Viva	-	Mini Project	PO3	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	**INTRODUCTION**
Objectives, Importance of Vibration Analysis, Nature of Exciting Forces, Mathematical Modeling of DynamicSystems.	
Unit-II	**SINGLE DEGREE FREEDOM SYSTEM**
Free and Forced Vibration with and without Damping, Response to Harmonic Loading, Response to GeneralDynamic Loading using Duhamel's Integral, Fourier Analysis for Periodic Loading, State Space Solution forResponse.	
Unit-III	**NUMERICAL SOLUTION**
Introduction, accuracy and stability, Solution to Response using New mark Method and Wilson Method,State Space solution for response Numerical Solution for State Space Response using Direct Integration.	
Unit-IV	**MULTIPLE DEGREE OF FREEDOM SYSTEM (LUMPED PARAMETER)**
Two Degree of Freedom System, Multiple Degree of Freedom System, Inverse Iteration Method forDetermination of Natural Frequencies and Mode Shapes, Dynamic Response by Modal SuperpositionMethod, Direct Integration of Equation of Motion.	
Unit-V	**MULTIPLE DEGREE OF FREEDOM SYSTEM & SPECIAL TOPICS IN STRUCTURAL DYNAMICS**
Multiple Degree of Freedom System (Distributed Mass and Load): Single Span Beams, Free and ForcedVibration, Generalized Single Degree of Freedom System.Special Topics in Structural Dynamics(Concepts only): Dynamic Effects of Wind Loading, Moving Loads,Vibrations caused by Traffic, Blasting and Pile Driving, Foundations for Industrial Machinery, Base Isolation.	
Text Books:	
1. Clough R. W. and Penzien J, "Dynamics of Structures", McGraw Hill. 2. Chopra A. K, "Structural Dynamics and Introduction to Earthquake Engineering", illustrated, PrenticeHall, 4th Edition, 2012. 3. Smith J. W, "Vibration of Structures - Application in Civil Engineering Design", Chapman and Hall.	
Reference Books:	
1. Humar J. L., "Dynamics of Structures", Prentice Hall. 2. Paz Mario, "Structural Dynamics Theory and Computation", CBS Publication. 3. Hart and Wong, "Dynamics of Structures"	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Know the importance of the vibration.	CLO 1	T1: 12.1-12.2 R2: 7.2-7.3
3-4	Understand the nature of exciting forces.	CLO 2	T1: 12.3-12.5 R2: 7.4
5-6	Know the mathematical modeling of dynamic systems.	CLO 2	T1: 12.6-12.7 R2:7.5
7-8	Understand the free and forced vibration without damping.	CLO 3	T1: 12.8-12.11 R2:7.8
9-10	Understand the free and forced vibration with damping.	CLO 4	T1:14.1-14.6 R2:7.9
11-12	Understand the response to harmonic loading.	CLO 5	T1: 14.6-14.10 R2:7.7, 7.10
13-14	Understand the response to generaldynamic loading using duhamel's integral.	CLO 6	T1: 4.1-4.4 R1:12.1, 12.2
15-16	Understand the fourier analysis for periodic loading.	CLO 7	T1: 4.6-4.7 R1:12.3
17-19	Know the space solution forresponse of structure.	CLO 8	T2 :7.13-16 R1: 12.3
20-22	Understand the accuracy and stability of structure.	CLO 9	T2:7.17-19 R1: 12.6
23-25	Find the solution to response using new mark method.	CLO 10	T2: 7.20 R1: 7.3, 7.4
26	Find the solution to response using wilson method.	CLO 11	T1:17.1-17.3 R2:12.4
27-30	Know the space solution for response numerical solution.	CLO 12	T1: 17.4-17.7 R2:12.4
31-32	Know the space response using direct integration.	CLO 14	T1: 17.8 R2:12.5
33-34	Understand the two degree of freedom system.	CLO 14	T1: 17.9 R2:12.5.1
35-38	Understand the multiple degree of freedom system.	CLO 15	T1: 17.10-12 R2:12.5.3
39-44	Understand the inverse iteration method fordetermination of natural frequencies and mode shapes.	CLO 14	T1:14.7, 15.1-3 R2:15.2
45-49	Understand the dynamic response by modal superpositionmethod, direct integration of equation of motion.	CLO 16	T1:15.3-5 R2: 15.3
50-55	Understand the multiple degree of freedom system (distributed mass and load): single span beams.	CLO 17	T1:15.6 –7 R2:15.5, 15.6
56	Understand the free and forcedvibration, generalized single degree of freedom system.	CLO 19	T1:15.8 R1:8.1
57	Understand the dynamic effects of wind loading.	CLO 21	T1:15.8 R1:8.2, 8.3
58	Understand the moving loads,vibrations caused by traffic.	CLO 23	T1:15.8 R1:8.4, 8.5
59-60	Understand the blasting and pile driving, foundations for industrial machinery, base isolation.	CLO 23	R1:8.8, 8.10

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	The internal behavior of the material with the externally applied loading.	Seminars/Guest Lectures/NPTEL	PO 4	PSO1
2	Analysis of stresses especially for cylindrical shells.	Seminars/Guest Lectures/NPTEL	PO 1	PSO 1
3	Real world applications in sinking of supports under various conditions.	Seminars/ Assignments	PO 4	PSO 1

Prepared by:
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