



# GUJARAT TECHNOLOGICAL UNIVERSITY

Programme Name: Master of Engineering

Level: PG

Subject Code : ME02000201

Course / Subject Name: Structural Dynamics

w.e.f.Academic Year:	2024-25
Semester:	2
Category of the Course:	PCC

<b>Prerequisite:</b>	Engineering Mechanics, Structural Analysis and Engineering Mathematics
<b>Rationale:</b>	Earthquake, wind, moving loads, traffic, blasting etc. impose time-dependent forces on the structure and thereby induces vibration in the structures. The analysis of structure under such time dependent forces is carried using theory of structural dynamics. Therefore, understanding of structural dynamics is essential for safe design of Civil Engineering Structures.

## Course Outcome:

After Completion of the Course, Student will able to:

No.	Course Outcomes
01	Analyze and Interpret dynamics response of single degree freedom system using fundamental theory and experiments
02	Analyze and Interpret dynamics response of Multi degree freedom system using fundamental theory and experiments
03	Differentiate the effects of various types of dynamic loads
04	Use structural engineering software for dynamic analysis
05	Perform & interpret the results of various experiments on models to understand structural behavior of symmetrical & un-symmetrical structures in plan & elevation

## Teaching and Examination Scheme:

Teaching Scheme(in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial/Practical	
			ESE (E)		PA/ CA (M)	PA/CA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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## Course Content:

Unit No.	Content	No.of Hours	% of Weightage
1.	Objectives, Importance of vibration analysis, Nature of exciting forces, Basic terminology related to vibration – natural frequency, natural period, resonance etc, Dynamic degree of freedom, Assumption to reduce dynamic DoF, Mathematical modeling of dynamic systems.	04	10
2.	Single Degree of Freedom System: Free and forced vibration with and without damping, Response to Harmonic Loading, Response to general dynamic loading using Duhamel's integral, Numerical solution of response using Newmark's method & Direct Integration, Concept of response spectrum.	14	30
3.	Multiple Degree of Freedom System: Equation of motion of symmetrical and un-symmetrical structures in plan, Natural frequencies and mode shapes of vibrating system, Orthogonality of modes, Dynamic response by Modal Superposition Method, Response Spectrum Analysis, Missing mass correction Introduction to multiple degree of freedom system with distributed mass and loading, Generalized Single Degree of Freedom System	20	40
4.	Special Topics in Structural Dynamics(Concepts only): Dynamic effects of Wind loading, Moving loads, Vibrations caused by High Speed Traffic, Blasting and Pile driving, Foundations for industrial machinery, Base-isolation.	07	20
<b>Total</b>		<b>45</b>	<b>100</b>

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	20	22	05	05

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)



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## References/Suggested Learning Resources:

### (a) Books:

1. Structural Dynamics and Introduction to Earthquake Engineering, Chopra A. K.
2. Dynamics of Structures, Clough R. W. and Penzien J., Mc Graw Hill
3. Dynamics of Structures, Humar J. L., Prentice Hall
4. Structural Dynamics - Theory and Computation, Paz Mario, CBS Publication
5. Dynamics of Structures, Hart and Wong
6. Vibration of Structures - Application in Civil Engineering Design, Smith J. W., Chapman and Hall

### (b) Open source software and website:

1. <http://nptel.ac.in/>
2. <http://ocw.mit.edu/courses/civil-and-environmental-engineering/>
3. [opensees.berkeley.edu/](http://opensees.berkeley.edu/)
4. [www.nicee.org](http://www.nicee.org)
5. <http://www.earthquakeinfo.org/>
6. [www.eeri.org/](http://www.eeri.org/)
7. [www.earthquakeengineering.com/](http://www.earthquakeengineering.com/)
8. [www.curee.org](http://www.curee.org)
9. Non-lin software

### List of Experiments/ Tutorials:

1. Study of response of various SDoF systems with variable mass/stiffness (E,I & L) Rock Specimen Coring/Specimen preparation
2. Study of response of MDoF systems through mode shapes
3. Study of response of MDoF structural systems (Model) with vertical irregularity e.g soft storey (stiffness), mass etc
4. Study of response of SDoF / MDoF structural systems (Model) with plan irregularity e.g re-



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entrant corner, mass etc

5. Study of response of structural systems (Model) during pounding of structures
6. Study the response of above experiments through structural engineering software dealing with dynamic analysis
7. Minimum 15 problems from above topics.

### Major Equipment:

1. Shake table,
2. Data acquisition System with required sensors to measure response of structural system (Model)
3. Spring Mass Model - SDoF system
4. Mode Shape Model – MDoF System
5. Model of structure with plan irregularities
6. Model of structure with vertical irregularities
7. Model of structures to exhibit pounding
8. Structural engineering software

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