Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-2

Subject: Structural Dynamics and Earthquake Engineering - METSE12510

Type of Course: Major Core

Prerequisite: Mechanics of Solids, Structural Analysis, Matrix Methods of Structural Analysis and Engineering Mathematics

Rationale: Earthquakes are one of the most devastating natural hazards that cause great loss of life and livelihood because of collapse of structures. Earthquakes impose time-dependent lateral inertia forces on the structure. To make a structure earthquake resistant, it is to be designed for lateral loads in addition to gravity loads. The lateral loads acting on structure are calculated using theory of structural dynamics. Therefore, the understanding of structural dynamics, characteristic of earthquakes and its effect on structure is essential for safe design of civil engineering structures.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
04	00	02	05	60	30	10	20	30	150

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Sr. No	Course content	Hrs	% Weightage
1	**Structural Dynamics** The examination of single-degree-of-freedom (SDOF) structures under harmonic and various dynamic loads, as well as the vibration analysis of multiple-degree-of-freedom (MDOF) systems, form the core of this study. It also encompasses the application of numerical methods for determining natural frequencies and mode shapes, along with understanding the	16	30

	orthogonality principles of principal modes as per Rayleigh's and Dunkerley's principles. Additionally, the evaluation of dynamic responses through mode superposition methodology and the analysis via response spectrum theory are significant components of this research.		
2	**Fundamental of Earthquake Engineering** The factors contributing to earthquakes and their distinct characteristics, earthquake parameters, seismic zoning strategies specific to India, insights derived from historical earthquake events, and the corresponding mitigation strategies constitute the focal points of this investigation. Furthermore, the examination of response spectra and the synthesis of combined D-V-A (Displacement-Velocity-Acceleration) plots are integral components of this research endeavor.	05	05
3	**Exploring Structural Dynamics** The study encompasses the behavior of floor diaphragms and the impact of different structural irregularities, as well as the lateral force analysis of buildings, considering both torsional uncoupled and coupled systems.	16	30
4	**Ductile Detailing and Lateral Load-Resistance in Structural Engineering** The examination includes the implementation of ductile detailing in different structural elements, exploring diverse lateral load-resisting structural systems such as moment-resisting frames with shear walls and bracing, and the incorporation of guidelines outlined in IS 1893 and IS 13920.	10	20
5	**Structural controls** Passive Controls – Base isolation, various dampers, Active Controls Earthquake resistant design of masonry structure as per IS 4326	13	15

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
01	**Design of Ductile Reinforced Concrete Shear Wall** Design a ductile reinforced concrete shear wall system to resist lateral loads in a multi-story building located in a seismic zone. The building has the following parameters: Height: 30 meters Plan dimensions: 20 meters by 20 meters Seismic Design Category: D	10

	Seismic Design Parameters: Importance factor (I) = 1.25, Response modification factor (R) = 5.5 Student will design submit it on GMIU Web Portal.	
02	**Seismic Design of a Reinforced Concrete Building** Design a reinforced concrete building to resist seismic forces in a high seismic zone. The building is located in a region with an annual probability of exceedance (APOE) of 10% in 50 years. Student will submit it on GMIU Web Portal.	10
03	**Modal Analysis of a Simple Structure** Perform modal analysis on a simple structure to determine its natural frequencies and mode shapes. Student will submit it on GMIU Web Portal.	10
Total		**30**

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks **(Revised Bloom's Taxonomy)**						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	10%	20%	25%	10%	15%	20%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course the students should be able to:	
CO1	Understand characteristics of earthquake and its effect on structures
CO2	Estimate lateral forces acting on symmetric as well as asymmetric buildings,
CO3	Find mode shapes and natural frequency, carry out seismic response analysis of a structure,
CO4	Design and detail to enhance ductility
CO5	design earthquake resistant masonry structures.

List of Practical:-

Tutorial work shall consist of presentations / problems / preparation of learning material based on above topics. Apart from above assignments a group of students has to undertake one open ended design problem based on engineering application.

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Dynamics of Structures - A. K. Chopra
[2] Structural Vibrations - Theory and Computation - Mario Paz
[3] Earthquake Resistant Design - Manish Shrikhande & Pankaj Agrawal
[4] Design Structural Dynamics - Clough & Penzien
[5] Elements of earthquake engineering - Jaikrishna & Chandrasekaran.
[6] Advanced reinforce of concrete design – P.C.Vergesh.
[7] IS 1893-2002 ,IS 13920- 1993 & IS 4326