

**Indian Institute of Technology Mandi**  
**Proposal for a New Course**

**Course Number** : CE610  
**Course Name** : Analysis and Design for Earthquake Resistant Structures  
**Credits** : 3-0-0-3  
**Prerequisites** : Structural Dynamics with Application to Earthquake Engineering (CE511) or Equivalent  
**Intended for** : M.Tech. (Structural Engineering); UG (4<sup>th</sup> year), PG (M.S., Ph.D.)  
**Distribution** : Elective (UG/PG)/ Specialization Elective (M.Tech. - Structural Engineering)  
**Semester** : Odd/Even

1. **Preamble:** Earthquake resistant design is becoming more common practice in the industry as a significant portion of our country comes under high seismic zone. It is expected from a structural engineer to know the concept of earthquake resistant design and be conversant with various design guidelines. This course will cover various analysis methods for calculation of earthquake induced forces in building. Thereafter it will provide in-depth insight into design of buildings to withstand earthquake forces and related seismic safety issues. Evaluation of this course will include a design project to give the students hands-on experience of seismic analysis and design, and preparation of design report.

2. **Course Modules with Quantitative Lecture Hours:**

**Module 1:** (4 hours)  
 Basic Concepts: Behavior of structures and structural components under earthquake loading; Introduction to seismology; Seismic inputs to structures; Examples of earthquake resistant structures and their behavior during actual earthquakes.

**Module 2:** (4 hours)  
 Seismic Design Philosophy: Historical development of earthquake resistant design philosophy; Concept of strength, overstrength and ductility; Concept of equal displacement and equal energy principles, capacity design.

**Module 3:** (12 hours)  
 Modeling and Analysis of Buildings: Equivalent static analysis; Response spectrum analysis; Mode superposition method; Time history analysis; Non-linear analysis consideration; Pushover analysis; Modeling concept of reinforced concrete building; Consideration of irregularities in seismic design of buildings; Introduction to modeling and analysis of reinforced masonry buildings; Simulation of structures using software for seismic analysis.

**Module 4:** (14 hours)  
 Seismic Design of Building Components: Earthquake resistant properties of reinforced concrete; Seismic behavior and design of linear reinforced concrete elements; Seismic behavior of planar reinforced concrete elements; Codal provisions; Detailing for ductility; Design guidelines specific for reinforced masonry building; Earthquake resistant design considerations for steel structures. Consideration for computer aided seismic design using

software simulation.

**Module 5:** (8 hours)

Advanced Topics in Earthquake Resistant Design: Performance based earthquake engineering; Introduction to earthquake resistant design for special structures; Retrofitting and strengthening of structures; Concept of base isolation technique and other seismic vibration control.

**3. Textbooks:**

- (i) Pauley T. and Priestley M.J.N. (1992), "Seismic Design of Reinforced Concrete and Masonry Buildings", John-Wiley & Sons New Jersey, USA.
- (ii) Data T.K. (2010), "Seismic Analysis of Structures", 1<sup>st</sup> Edition, John Wiley & Sons (Asia) Pte Ltd, Singapore.

**4. References:**

- (i) Chopra A.K. (2017), "Dynamics of Structures - Theory and Application to Earthquake Engineering", 5<sup>th</sup> Edition, Pearson Education India, New Delhi, India.
- (ii) Shrikhande M., Agrawal P. (2006), "Earthquake Resistant Design of Structures" Prentice Hall India Learning Private Limited, 1<sup>st</sup> Edition, New Delhi, India.
- (iii) Taly N. (2010), "Design of Reinforced Masonry Structures", McGraw-Hill Education; 2<sup>nd</sup> Edition, USA.
- (iv) Rai D.C. (2005), "TK-GSDMA Guidelines for Structural use of Reinforced Masonry - Provisions with Commentary and Explanatory Examples", IIT Kanpur, Gujrat State Disaster Mitigation Authority.
- (v) ATC-40 (1996), "Seismic Evaluation and Retrofit of Concrete Building – Vol. I & II", Applied Technology Council, California, USA.
- (vi) AISC 341-10 (2010), "Seismic Provisions for Structural Steel Buildings", American Institute of Steel Construction, Illinois, USA.
- (vii) Naem F., Kelly J.M. (1999), "Design of Seismic Isolated Structures: From Theory to Practice", John Wiley & Sons, USA.
- (viii) IS 1893 (Part 1) (2016), "Criteria for Earthquake Resistant Design of Structures: Part 1 General Provisions and Buildings", Bureau of Indian Standard, New Delhi, India.
- (ix) IS 13920 (2016), "Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces-Code of Practice", Bureau of Indian Standard, New Delhi, India.

**5. Similarity content declaration with existing courses:**

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	CE511 (Structural Dynamics with Application to Earthquake Engineering)	Seismic response analysis methods; Concept of base isolation	10%
2	CE605 - Engineering Seismology and Seismic Hazard Assessment	Earthquake inputs	5%