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Indian Institute of Technology Kanpur

Proposal for a New Course

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1. **Course No.:** CE4xx

2. **Course title.:** Advanced topics in mechanics and analysis of skeletal structures

3. **Per Week Lectures:** 3 (L), 0 (T), 0 (P), 0 (A), Credits: 9

4. **Duration of course:** Full Semester

5. **Proposing Department/IDP:** Civil Engineering

   Other departments/IDP which may be interested in the proposed course: None

   Other faculty members interested in teaching the proposed course: Prof. Chinmoy Kolay

6. **Proposing Instructor(s):** Amar Nath Roy Chowdhury, and Suparno Mukhopadhyay

7. **Course Description:**

   A) Objectives: Skeletal structures such as trusses, frames, etc., are widely used in structural engineering applications such as buildings, bridges, long span roofs, reticulated shells etc. Design of these structural systems require advanced knowledge in structural mechanics, and matrix structural analysis covering material and geometric nonlinear behavior. This course aims to cover the necessary structural mechanics theories, and their implementation using matrix method for the analysis of skeletal structures.

   B) Contents (*preferably in the form of 5 to 10 broad titles)*:

S. No	Broad Title	Topics	No. of Lectures* (50 min)
1	Twisting of beams	• Saint Venant's theory for torsion of general uniform section • Torsion of thin-walled section, shear flow	5
2	Bending of thin-walled beams	• Shear stress due to bending • Determination of shear centre	4
3	Matrix method of linear elastic structural analysis	• Force method and displacement methods • Direct stiffness method for rods, beams, trusses and frames	10-12
4	Virtual work principles	• Principles of virtual force and displacement • Application of virtual work to formulate element stiffness matrix for rods, beams, and frames	5-6
5	Geometric nonlinear elastic analysis	• An introduction to geometric nonlinear analysis • Nonlinear strain displacement relations for 1D elements • Derivation geometric nonlinear stiffness matrix • Elastic critical load analysis	7-8
6	Small deformation inelastic analysis	• A brief review of metal plasticity, yield surface, flow rule • A review of plastic analysis of beams • A plastic hinge method for analysis of simple frames	5-6

   *Tentative number of lectures. Total number of lectures requested = 39.

   C) Pre-requisites: ESO202, CE272 or equivalent.

8. **Recommended books:**

   • Advanced mechanics of materials, Arthur P. Boresi, Richard J. Schmidt, 6th Ed.

   • Plasticity for structural engineers, Wai Fah Chen, and Da Jian Han, 2nd Ed..

   • Nonlinear continuum mechanics for finite element analysis, Javier Bonet, and Richard D. Wood, 2nd Ed.

   • Matrix structural analysis, William Mc Guire, Richard H. Gallagher, Ronald D. Zieman, 2nd Ed.

- Matrix analysis of structures, Aslam Kassimali, 3rd Ed.
- Matrix analysis of framed structures, William Weaver, James M. Gere, 2nd Ed.
- Structural analysis: a matrix approach, G S Pandit, S Gupta, 2nd Ed.

9. **Any other remarks: None**

Dated: 08/10/2025 Proposer: Amar Nath Roy Chowdhury and Suparno Mukhopadhyay

Dated:_____ DUGC/DPGC Convener:_____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:_____