Course: Solid Mechanics for Civil Engineers (APL 108) (3-1-2)
Semester I, 2025-2026

Lecture Schedule and Course Coordinators:

| | Lectures: Tue, Thu, Fri 11 AM-12 PM |
|---|---|
| Course Instructor | Prof. Rajdip Nayek,<br>Department of Applied Mechanics<br>4B-24, Block IV<br>rajdipn@iitd.ac.in<br>Office hours: Fri, 4-5 PM |

Tutorial Schedule* and Tutorial Teachers:

| | Mon | Tue | Thu | Fri |
|---|---|---|---|---|
| Afternoon batch<br>Room 605, LHC<br>1-2 PM | Group T2<br>Prof. Rajdip Nayek<br>rajdipn@iitd.ac.in | Group T3<br>Prof. Vikrant Tiwari<br>tiwariv@iitd.ac.in | Group T4<br>Prof. Sitikantha Roy<br>sroy@iitd.ac.in | Group T1<br>Prof. Vikrant Tiwari<br>tiwariv@iitd.ac.in |

**Tutorial sessions start July 28, 2025.*

**A. Textbook:**

1. Archer, Cook, Crandall, Dahl, Lardner, McClintock, Rabinowicz, Reichenbach, "An Introduction to Mechanics of Solids", Tata McGraw Hill, 2012
2. Kumar, A., "Solid Mechanics for Undergraduates - Using Vectors and Tensors", White Falcon Publishing, 2024.

**B. Selected references:**

1. Boresi, A., and Schmidt, R., "Advanced Mechanics of Materials", Wiley, 2019
2. Srinath, L.S., "Advanced Solid Mechanics", Tata McGraw-Hill, 2008.

***If you do not follow the notations used in the lecture notes, your work will not be evaluated.***

**C. Course content**:

1. **Analysis of Mechanical System**: Study of forces, Study of forces, Equilibrium conditions, Additional requirements for deformable solid bodies.
   **(2 lectures)**

2. **Traction Vector, Stress Tensor and Stress Matrix:** Definition of traction vector, Relating traction on different planes at a point, Stress Tensor, Stress matrix as a representation of stress tensor, Transformation of Stress Matrix
   **(4 lectures)**

3. **Stress Equilibrium Equations:** Linear Momentum Balance, Angular Momentum Balance, Derivation of Traction boundary condition.
   **(3 lectures)**

4. **Principal Stress and Principal Planes**: Finding principal planes, maximizing shear component of traction, Mohr's circle, Stress invariants, Hydrostatic and Deviatoric parts in stress tensor
   **(5 lectures)**

5. **Concept of Strain**: Strain Tensor, Normal and Shear components, Strain-displacement relationship, Strain compatibility, Similarity of stress and strain tensors
   **(3 lectures)**

6. **Stress-strain-temperature relation**: General stress-strain curves, isotropic linear elastic material, thermal strain.
   **(3 lectures)**

7. **Complete equations of linear elasticity**
   **(1 lecture)**

8. **Application to torsion-inflation in cylindrical coordinates:** LMB in cylindrical coordinate, Relating stress-strain in cylindrical coordinates, extension, torsion and inflation in cylinders
   **(5 lectures)**

9. **Bending of beams:** Uniform (pure) bending of beams, Non-uniform bending of beams, Bending of unsymmetrical beams, Concept of shear center
   **(6 lectures)**

10. **Beam Theory:** Motivation for beam theory, Euler-Bernoulli beam theory, Timoshenko beam theory, Buckling
    **(4 lectures)**

11. **Energy Methods:** External work done, strain energy, Castigliano's theorems, Principle of virtual work, Minimum Potential Energy
    **(4 lectures)**

12. **Failure Theories**
    **(2 lectures)**

**D. Tutorials:**

Tutorial sheets will be uploaded on the course MOODLE (and course webpage) and on the weekend before the tutorial session. Solutions will be uploaded on MOODLE (and course webpage) along with the tutorial sheet.

*Students are required to review and try both the problems BEFORE attending the tutorials*

If you miss a tutorial due to genuine reasons, you must inform the tutorial teacher **on the same day as the tutorial session.** In case of medical absence, medical certificate issued by IIT Hospital is required **within 3 weeks of the medical absence**. The tutorial teacher will assess the reason and evidence provided, and their decision regarding the award of marks will be final.

**E. Assessments:**

1. Minor exam: 20%
2. Major exam: 35%
3. Quiz (x 3): 20% (best two out of three quizzes)
4. Practical: 20%
5. Tutorial attendance: 5% (=5*total number of tutorial sessions attended/total number of tutorial sessions held during the semester)

A single make-up exam will be arranged for students who miss the minor exam due to medical reasons. **Only medical certificates issued by the IIT Hospital will be accepted.**

**To earn an A grade, a student must be within the top 10% of the class. Below 30% will be F grade.**

**F. Lecture class attendance policy:**

Students are required to maintain a **minimum attendance of 75% in lecture classes**. If a student's lecture attendance falls below 75%, their grade in the course may be reduced, in line with the institute's policy on attendance. Any student who is caught signing on the attendance sheet for another student in any lecture/tutorial session will get zero on the tutorial attendance part (zero on 5%, Item E.5).

**G. Accessibility:**

Students with special needs have to send the course instructor an email by the end of the first week. Please inform us about any requests you may have.

**H. Academic Integrity:** Cases of unethical practices will be dealt with sternly, and all parties involved will receive identical punishment. Finding any evidence of plagiarism will lead to zero being awarded to all parties on that entire exam.