



**National University of Engineering (UNI)**  
School of Civil Engineering  
Syllabus 2026-II

**1. COURSE**

CE2M1. Mechanics of Materials I (Elective)

**2. GENERAL INFORMATION**

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| <b>2.1 Course</b>                 | : | CE2M1. Mechanics of Materials I                                                                                                            |
| <b>2.2 Semester</b>               | : | 4 <sup>th</sup> Semester.                                                                                                                  |
| <b>2.3 Credits</b>                | : | 5                                                                                                                                          |
| <b>2.4 Hours</b>                  | : | 4 HT; 4 HP;                                                                                                                                |
| <b>2.5 Duration of the period</b> | : | 16 weeks                                                                                                                                   |
| <b>2.6 Type of course</b>         | : | Elective                                                                                                                                   |
| <b>2.7 Learning modality</b>      | : | Face to face                                                                                                                               |
| <b>2.8 Prerequisites</b>          | : | <ul style="list-style-type: none"><li>• CE1M1. Statics. (3<sup>rd</sup> Sem)</li><li>• MA210. Calculus III. (3<sup>rd</sup> Sem)</li></ul> |

**3. PROFESSORS**

Meetings after coordination with the professor

**4. INTRODUCTION TO THE COURSE**

Mechanics of Materials I studies the behavior of deformable solid bodies subjected to different types of loading. For the civil engineer, understanding concepts such as stress, strain, and elasticity is fundamental, since these allow the strength and stiffness of structural elements to be predicted. This knowledge is the basis for the safe design of beams, columns, and shafts, ensuring that materials operate within their allowable limits.

**5. GOALS**

- Understand the concepts of stress and strain under axial, torsional, and bending loads.
- Analyze the mechanical properties of materials from tension and compression tests.
- Determine internal stresses and deformations in statically determinate structural elements.

**6. COMPETENCES**

**ABET-1)** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)

**ABET-6)** An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Usage)

**7. TOPICS**

| Unit 1: Mechanics of Materials and Structural Behavior (24 hours)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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| Competences Expected: ABET-1,ABET-6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>• Stress and strain concepts including normal, shear, and principal stresses</li> <li>• Axial loading and deformation of members</li> <li>• Torsion of circular and non-circular sections</li> <li>• Bending stress and deflection in beams</li> <li>• Shear stress distribution in beams</li> <li>• Combined loading and stress transformation</li> <li>• Buckling of columns and stability analysis</li> <li>• Fatigue and fracture mechanics</li> <li>• Elastic and plastic behavior of materials</li> <li>• Energy methods for structural analysis</li> </ul> | <ul style="list-style-type: none"> <li>• Define stress, strain, and their relationships through constitutive laws [Familiarity]</li> <li>• Calculate stresses and deformations in members under axial loading [Usage]</li> <li>• Determine torsional stresses and angles of twist in shafts [Usage]</li> <li>• Analyze bending stress distribution and deflection in beams [Assessment]</li> <li>• Compute shear stress distribution in beam cross-sections [Usage]</li> <li>• Apply stress transformation equations for combined loading conditions [Assessment]</li> <li>• Evaluate column stability and calculate critical buckling loads [Assessment]</li> <li>• Explain fatigue failure mechanisms and predict fatigue life [Familiarity]</li> <li>• Distinguish between elastic and plastic material behavior under loading [Usage]</li> <li>• Use energy methods to solve deflection and indeterminate structural problems [Usage]</li> </ul> |
| Readings : [GG17], [Hib17]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| Unit 2: Axial Stress and Strain (16 hours)                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                        |
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| Competences Expected: ABET-1,ABET-6                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                        |
| Topics                                                                                                                                                                                                                                                                    | Learning Outcomes                                                                                                                                                                                                                                                                      |
| <ul style="list-style-type: none"> <li>• Average normal and shear stress.</li> <li>• Normal and shear strain.</li> <li>• Hooke's law and the modulus of elasticity.</li> <li>• Axially loaded members: changes in length and statically indeterminate systems.</li> </ul> | <ul style="list-style-type: none"> <li>• Calculate stresses and deformations in bars subjected to axial load considering cross-sectional variations [Evaluation].</li> <li>• Solve simple statically indeterminate structure problems using the deformation method [Usage].</li> </ul> |
| Readings : [Hib17]                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                        |

| Unit 3: Torsion and Pure Bending (20 hours)                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                       |
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| Competences Expected: ABET-1,ABET-6                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                       |
| Topics                                                                                                                                                                                                                                                                                                               | Learning Outcomes                                                                                                                                                                                                                                                     |
| <ul style="list-style-type: none"> <li>• Torsion in circular shafts: the torsion formula and angle of twist.</li> <li>• Pure bending: bending deformation and the elastic flexure formula.</li> <li>• Shear stresses in beams: the shear flow formula.</li> <li>• Design of prismatic beams for strength.</li> </ul> | <ul style="list-style-type: none"> <li>• Determine the distribution of shear stresses in circular sections subjected to torque [Usar].</li> <li>• Calculate the maximum tensile and compressive stresses in beams under various bending moments [Evaluar].</li> </ul> |
| Readings : [GG17]                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                       |

| Unit 4: Stress Transformation and Combined Loading (20 hours)                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                 |
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| Competences Expected: ABET-1,ABET-6                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                 |
| Topics                                                                                                                                                                                                                                                                                             | Learning Outcomes                                                                                                                                                                                                                                               |
| <ul style="list-style-type: none"> <li>• Plane stress transformation: general equations.</li> <li>• Mohr's circle for plane stress and strain.</li> <li>• Principal stresses and maximum shear stress.</li> <li>• Stress analysis under combined loading (axial, bending, and torsion).</li> </ul> | <ul style="list-style-type: none"> <li>• Use Mohr's circle to identify the planes where maximum stresses occur [Evaluar].</li> <li>• Analyze the state of stress at a critical point of an element subjected to multiple types of loading [Evaluar].</li> </ul> |
| Readings : [Hib17], [GG17]                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                 |

## 8. WORKPLAN

### 8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

### 8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

### 8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

## 9. EVALUATION SYSTEM

\*\*\*\*\* EVALUATION MISSING \*\*\*\*\*

## 10. BASIC BIBLIOGRAPHY

[GG17] James Gere and Barry Goodno. *Mechanics of Materials*. 9th. Cengage Learning, 2017.

[Hib17] Russell Hibbeler. *Mechanics of Materials*. 10th. Pearson, 2017.