



**Birla Institute of Technology & Science, Pilani**  
Hyderabad Campus

**FIRST SEMESTER: 2021-22**  
**Course Handout (Part-II)**

Date: 20/08/2021

In addition to Part-I (General Handout for all courses appended to the Time Table) this portion gives further specific details regarding the course.

**Course No.** : CE F211

**Course Name** : Mechanics of Solids

**Instructor-in-Charge** : Dr. Shivang Shekhar (shivangshekhar@hyderabad.bits-pilani.ac.in)

## **1. Course Description**

Introduction to mechanics of rigid bodies and deformable bodies, Thermal stresses, Equilibrium of forces, Bending moment and shear force diagrams for determinate beams and frames, Analysis of statically determinate trusses; Flexural and shear Stresses in beams, Combined stresses, Stresses and strains on inclined planes, Introduction to torsion, Torsion in shafts, Slope and deflection in beams due to bending, Introduction to Energy Methods, Stresses in thin cylindrical shells, Suspension cables, Failure theories, Buckling of columns using Euler's Theory.

## **2. Scope and Objective**

This course is designed to study the mechanics of deformable solids under the action of different kinds of loads. The main objective of the course is to understand the stress, strain, and deflection in determinate structures when subjected to different loads such as normal, shear, torsion, bending, and combined loads. Utilizing the state of stresses and strains in a structural element, the student will be able to evaluate the allowable loads and associated allowable stresses before structural failure. Understanding the adequacy of structural elements under different loads is essential for the design and safety evaluation of structure. Therefore, this course is a major subject in Civil Engineering curriculum. Upon successful completion of this course, students should be able to:

1. Calculate and represent pictorially internal forces in statically determinate structures.
2. Visualize the concept of stress and strain and calculate the variation based on the plane of action
3. Calculate stresses caused due to axial, bending and torsional, and combined loading
4. Calculate deflections in statically determinate structures



Student Learning Outcomes (SLOs) assessed in this course – (a), (g), (e), and (k).

### 3. Text Books

**T1.** Mechanics of Materials by R.C. Hibbeler, 10th Edition, 10<sup>th</sup> Edition, 2014, Pearson Education Inc.

**T2.** Structural Analysis by R.C. Hibbeler, 9th Edition, 2017 Pearson Education Inc.

### 4. Reference Books

**R1.** Mechanics of Materials; F. P. Beer, E. R. Johnston, J. T. DeWolf, and DF. Mazurek, Seventh Edition, 2002, McGraw-Hill International Edition.

**R2.** Engineering Mechanics of Solids by Egor P. Popov, 2<sup>nd</sup> Edition Pearson Education Inc.

**R3.** Mechanics of Materials by Gere and Timoshenko, 2<sup>nd</sup> Edition, CBS Publishers

### 5. Course Plan

Lecture No.	Learning Objectives	Topics to be Covered	Chapters in the Text Book	SLO*
1-2	To understand the scope and objective of the course	<i>Topic 0 - Introduction to Solid Mechanics</i>	Class notes	(a)
3-4	To understand type of bodies and possible deformation modes, the conditions of equilibrium	<i>Topic 1 - Review of Statics</i> Introduction to mechanics of rigid bodies, Equilibrium of forces	T1 – Ch1 R1 – Ch 1	(a), (e)
5-8	To understand different type of stress and strain, and material properties	<i>Topic 2 - Concept of Stress and Strain</i> Normal Stress (Tension, Compression), Shear Stress, Bearing Stress, Hooke's law, Factor of safety, Material properties	T1 - Ch 2, 3 R1 – Ch 1,2	(a), (e), (k)
9-11	To visualize the concept of axially loaded members and calculate the stresses due to axial loads	<i>Topic 3 - Axially loaded members</i> Deformation under uniform axial loads, Deformation under non-uniform axial loads, Statically indeterminate axially loaded structures, Stresses on inclined planes, Generalized Hooke's law, Plane stress and strain, Hydrostatic stress, Stress concentrations, Thermal Stress	T1 - Ch 4 R1 – Ch 2	(a), (e), (k)
12-16	To calculate the stresses caused due to torsional loads and combination of loadings	<i>Topic 4 – Torsion</i> Introduction to torsion, Torsion shearing stress and strain, Torsion formula, Torsional stresses in shafts, Torsional stresses under combined loading, Non-uniform and indeterminate problems, Thin-walled tubes, Introduction to torsion of non-circular sections.	T1 – Ch 5 R1 – Ch 3	(a), (e), (k)
17-21	To calculate and represent pictorially internal forces in	<i>Topic 5 - Shear force and bending moment diagrams</i> Type of beams and loadings, Internal forces on	T1 – Ch 6 R1 – Ch 5	(a), (e), (k)



	statically determinate beams	beams – shear force and bending moment diagram, Relationship between shear force, bending moment and external loads		
22-24	To understand and calculate normal stresses in beams due to pure bending	<i>Topic 6 - Stresses in Beams (Part A - Pure Bending)</i> Theory of pure bending, Flexural formula, Bending stresses, Composite beams, Pure bending with axial loading, Unsymmetrical bending	T1 – Ch 6, 7 R1 – Ch 5	(a), (e), (k)
25-28	To understand the methods of calculating shear stresses in beams and built-up members	<i>Topic 7 – Stresses in Beams (Part B: Shear Stresses in Beams and Thin-walled Members)</i> Shear stresses in beams, Shear formula, Shear stresses in built-up beams	T1 – Ch 7 R1 – Ch 6	(a), (e), (k)
29-32	To understand methods of stress transformation and calculate maximum normal and maximum shear stress	<i>Topic 8 - Transformation of Stress and Strain</i> Introduction, Principal stress and maximum in-plane shear, Graphical tool for stress transformation - Mohr's circle, Principal stresses in beams, Failure theories	T1 – Ch 9 R1 – Ch 7	(a), (e), (k)
33-36	To calculate deflections in statically determinate beams and structural members	<i>Topic 9 – Deflection of Beams</i> Slope and deflection in beams due to bending, Method of superposition's for indeterminate beams, Introduction to energy methods.	T1 – Ch 12, 14, T2 – Ch 8 R1 – Ch 9	(a), (e), (k)
37-40	To understand the concept of stability and buckling of a columns	<i>Topic 10 – Columns</i> Stability of columns, Buckling of columns using Euler's theory, Concept of effective length of columns	T1 – Ch 13 R1 – Ch 10	(a), (e), (k)
41-42	To calculate and represent pictorially internal forces in statically determinate truss and cables	<i>Topic 11 – Trusses and Suspension Cables</i> Introduction to statically determinate trusses, Type of truss, forces on truss members, Suspension cables	T2 – Ch 3, Ch 5	(a), (e), (k)

**\*Student Learning Outcomes (SLOs):**

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

- (a) an ability to apply knowledge of mathematics, science and engineering
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) an ability to function on multidisciplinary teams
- (e) an ability to identify, formulate, and solve engineering problems
- (f) an understanding of professional and ethical responsibility
- (g) an ability to communicate effectively
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) a recognition of the need for, and an ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

**6. Evaluation Scheme**

SNo.	Evaluation	Duration	Weightage	Date & Time	Nature of
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	Component	(Minutes)	(%)		Component
1	Midsemester Exam	90	30	22/10/2021 9.00 - 10.30AM	OB
2	Assignment/Term Paper (2-3 Nos.)	-	15	Continuous evaluation	OB
3	Surprise Quizzes*	-	15	Continuous evaluation	OB
4	Comprehensive Exam	120	40	22/12 AN	OB

\* Surprise quizzes will be conducted during tutorial/lecture hours. A minimum of  $n+1$  (typically 4) quizzes are planned. The best marks of  $n$  quizzes will be considered.

### 7. Chamber/Online Consultation Hour

Doubt/clarifications should be raised using BITS official email ID. Specific time for online consultation will be announced in the first week of the semester.

### 8. Notices

Notices concerning this course will be displayed on Google Classroom (Class code – *qhmxlvu*)

### 9. Make up policies

Make-up would be granted only for genuine cases with **prior permission**.

### 10. Academic Honesty and Integrity Policy

Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

(SHIVANG SHEKHAR)  
Instructor-in-charge  
CE F211