K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109

DEPARTMENT OF CIVIL ENGINEERING

CO-PO Mapping

2022-23 (ODD SEM)

Course: Strength of Materials				
Type: Integrated Professional Core Course			Course Code: 21CV33	
No of Hours				
Theory (Lecture Class)	Tutorials	Practical/Field Work/Allied Activities	Total/Week	Total hours of Pedagogy
2	2	2	6	50

Marks			
CIE	SEE	Total	Credits
50	50	100	4

Aim/Objectives of the Course

1. To understand the basic concepts of the stresses and strains for different materials and strength of structural elements and analyze principal stresses due to the combination of two dimensional stresses on an element.
2. To know the development of internal forces and resistance mechanism for one dimensional and two-dimensional structural elements.
3. To analyse and understand different internal forces and stresses induced due to representative loads on structural elements.
4. To determine slope and deflections of beams.
5. To evaluate the behavior of torsion members, columns and struts.

Course Learning Outcomes

After completing the course, the students will be able to

CO1	**Determine** the stresses, strains and strengths of various structural elements and **investigate** the behaviour of structural elements under the action of compound stresses.	**Applying (K3)**
CO2	**Investigate** the behaviour of beams subjecting to various loading conditions and **draw** shear force and bending moment diagrams.	**Applying (K3)**
CO3	**Determine** the bending and shear stresses in beams.	**Applying (K3)**
CO4	**Investigate** the behaviour of members subjected to torsion, behaviour of thick and thin cylinders subjected to internal & external pressures and **determine** the diameter of members subjected to torsion and pressures on cylinders.	**Applying (K3)**
CO5	**Investigate** the behaviour of structural elements such as beams (deflection), columns and struts.	**Applying (K3)**

Syllabus Content

Module 1: Simple Stresses and Strains: Introduction, Properties of Materials, Stress, Strain, Hooke's law, Poisson's Ratio, Stress - Strain Diagram for structural steel, Principles of superposition, Total elongation of tapering bars of circular and rectangular cross sections.

Composite section, Volumetric strain, expression for volumetric strain, Elastic constants, relationship among elastic constants (No Numerical), Thermal stress and strains

Compound stresses: Introduction, Stress components on inclined planes, General two-dimensional stress system, Principal planes and stresses, maximum shear stresses and their planes (shear planes). Compound stress using Mohr's circle method.

LO: At the end of this session the student will be able to

1. Define stress, strain, elastic limit, and modulus of elasticity, Hooke's law, Poisson's ratio, elastic constants, composite member, temperature stresses, principle of superposition, and modulus of elasticity, modular ratio, and lateral strain.
2. Derive expressions for deformation of tapering circular and rectangular bars subjected to axial force, deformation of a member due to self-weight, and relation between elastic constants.
3. Explain the salient features of stress-strain diagram for structural steel.
4. Determine stress, strain for the given member, Poisson's ratio, elongation of bars, temperature stresses induced, deformation in compound sections, and elastic constants.
5. Define principle stresses, principal planes, Mohr's circle, thick and thin cylinders, hoop stress, longitudinal stress, and radial stress.
6. Explain the procedure for determining normal and tangential stresses, lame's equation and construction of Mohr's circle for compound stress in 2D system.
7. Construct Mohr's circle for the given data.
8. Show that sum of any two orthogonal components of stresses at a point is constant and that longitudinal stress is equal to half of hoop stress.
   Determine the magnitude of principal stresses, direction of the principal planes and magnitude of maximum shear stress and direction from the given data.

Laboratory Experiments:

Dimensionality of bricks, Water absorption, Initial rate of absorption, Specific gravity of coarse and fine aggregate.

LO: At the end of this session the student will be able to

1. To study the dimensionality of bricks and determine its suitability for use in construction.
2. To determine the specific gravity of the given aggregate sample.

CO1

10 hrs

PO1-3
PO2-3
PO12 -1
PSO1-3
PSO2-2

Module 2: Bending moment and shear force diagrams in beams: Definition of shear force and bending moment, Sign convention, Relationship between loading, shear force and bending moment, Shear force and bending moment equations, development of Shear

Force Diagram(SFD) and Bending Moment Diagram (BMD) with salient values for cantilever, simply supported and overhanging beams for point loads, UDL(Uniformly Distributed Load), UVL(Uniformly Varying Load) and Couple. **LO:** At the end of this session the student will be able to 1. Define shear force, bending moment, shear force diagram, bending moment diagram, point of contra flexure. 2. Explain hogging bending moment and sagging bending moment. 3. List and explain the different types of beams, loading and supports with sketches. 4. Derive the relation between load intensity, bending moment and shear force. 5. Calculate shear force and bending moment at salient points and sketch SFD and BMD for the given beam. Locate point of contra flexure if any. 6. Obtain the loading pattern and also draw the BMD from the given shear force diagram. 7. Derive general expressions for shear force and bending moment for various standard loading conditions and sketch relevant diagrams. **Laboratory Experiments:** Fineness modulus of Fine and Coarse aggregate, Compressive strength tests on building blocks (brick, solid blocks and hollow blocks). **LO:** At the end of this session the student will be able to 3. To determine the fineness modulus of aggregates. 4. To determine the strength of the given specimen under compressive loading.	**CO2** 10hrs PO1-3 PO2-3 PO12 -1 PSO1-3 PSO2-2
Module 3: Bending stress in beams: Introduction – Bending stress in beam, Pure bending, Assumptions in simple bending theory, derivation of Simple bending equation (Bernoulli's equation), modulus of rupture, section modulus, Flexural rigidity, Problems **Shear stress in beams:** Derivation of Shear stress intensity equations, Derivation of Expressions of the shear stress intensity for rectangular, triangular and circular cross sections of the beams. Problems on calculation of the shear stress intensities at various critical levels of T, I and Hollow rectangular cross sections of the beam. **LO:** At the end of this session the student will be able to 1. Define bending stress, shear stress, pure bending theory, modulus of rupture, section modulus, flexural rigidity, short and long column, effective length, slenderness ratio, radius of gyration, buckling load, neutral axis, moment of resistance and shear centre. 2. List the assumptions made in Bernoulli's pure bending theory, Euler's theory of columns and limitations of Euler's theory. 3. Relate between bending stresses and radius of curvature, moment and radius of curvature. 4. Calculate the bending stress and shear stress across the section and draw the stress distribution diagram for the same at various points on the beam.	**CO3** 10 hrs. PO1-3 PO2-3 PO12 -1 PSO1-3 PSO2-2

Laboratory Experiments: Tension test on Mild steel and HYSD bars, Compression test on HYSD, Cast iron. **LO:** At the end of this session the student will be able to 1. To study the behaviour of given specimen under tensile and compressive loading and determine the modulus of elasticity value for the given specimen.	
Module 4: Torsion: Twisting moment in shafts, simple torque theory, derivation of torsion equation, tensional rigidity, polar modulus, shear stress variation across solid circular and hollow circular sections, Problems **Thin cylinders:** Introduction: Longitudinal, circumferential (hoop) stress in thin cylinders. Expressions for longitudinal and circumferential stresses. Efficiency of longitudinal and circumferential joints. Problems on estimation of change in length, diameter and volume when the thin cylinder subjected to internal fluid pressure. **Thick cylinders:** Concept of Thick cylinders Lame's equations applicable to thick cylinders with usual notations, calculation of longitudinal, circumferential and radial stresses – simple numerical examples. Sketching the variation of radial stress (pressure) and circumferential stress across the wall of thick cylinder. **LO:** At the end of this session the student will be able to 1. Define torsion, torsional rigidity, polar moment of inertia. 2. List the assumptions made in the theory of pure torsion. 3. Show that hollow shaft is stronger and stiffer than a solid shaft of same material, length and weight. 4. Derive expressions for the theory of pure torsion and relationship between the torque transmitted and shear stress induced in the shaft. 5. Determine suitable diameter for the shaft from the given data. 6. Compare the strengths of a hollow shaft to that of a solid shaft and calculate the percentage saving in weight that can be achieved by changing over to hollow shaft. 7. Calculate stresses for the given thick and thin cylinders for the given data. 8. Derive expressions for stresses in thin and thick cylinders (Lame's equation). **Laboratory Experiments:** Bending Test on Wood under two-point loading, Shear Test on Mild steel – single and double shear **LO:** At the end of this session the student will be able to 1. To study the behaviour of given specimen under bending and determine the modulus of elasticity value. 2. To find the shear strength of given material when subjected to single and double shear.	**CO4** 10 hrs PO1-3 PO2-3 PO3-2 PO12 -1 PSO1-3 PSO2-2

Module 5: Elastic stability of columns: Introduction – Short and long columns, Euler's theory on columns, Effective length, slenderness ratio, radii of gyration, buckling load, Assumptions, derivations of Euler's Buckling load for different boundary conditions, Limitations of Euler's theory, Rankine's formula and related problems. **Deflection of determinate Beams:** Introduction, Elastic curve –Derivation of differential equation of flexure, Sign convention, Slope and deflection using Macaulay's method for statically determinate beams subjected to various vertical loads, moment, couple and their combinations. Numerical problems. **LO:** At the end of this session the student will be able to 1. Define the terms, slope, deflection and curvature. 2. Derive the moment-curvature equation. 3. Determine the slope and deflection of the given beams. 4. Distinguish between long and short columns. 5. Derive the crippling load for different end conditions of columns. 6. Determine the crippling load for the column from the given data by Euler's and Rankine's formula. **Laboratory Experiments:** Impact test on Mild Steel (Charpy& Izod) **LO:** At the end of this session the student will be able to 1. To determine the impact strength of the given material by Izod and Charpy tests.	**CO5** 10hrs PO1-3 PO2-3 PO12 -1 PSO1-3 PSO2-2

Suggested Learning Resources:

1.Timoshenko and Young, "Elements of Strength of Materials" ,EastWest Press, 5th edition 2003
2.R. Subramanyam, "Strength of Materials", Oxford University Press, 3rd Edition -2016
3.B.C Punmia Ashok Jain, Arun Jain, "Strength of Materials", Laxmi - 2018-22 Publications, 10th Edition-2018

Web links and Video Lectures (e-Resources):

1.Strength of Materials web course by IIT Roorkee https://nptel.ac.in/courses/112107146/
2.Strength of Materials video course by IIT Kharagpur https://nptel.ac.in/courses/105105108/
3.Strength of Materials video course by IIT Roorkee https://nptel.ac.in/courses/112107147/18
4.All contents organized http://www.nptelvideos.in/2012/11/strengthof-materials-prof.html
5.http://www.aboutcivil.org/strength-of-materials.html

Useful Journals

- International Journal of Mechanical and Materials Engineering
- International Journal of Materials Science and Engineering

Teaching and Learning Methods

1. Lecture class: 20 hrs
2. Tutorial classes: 10 hrs
3. Practical: 20 hrs

Assessment

Type of test/examination: Written examination
Continuous Internal Evaluation (CIE): Theory component: Two out of Three Tests each of 20 marks and Two assignments each of 10 Marks reduced to 30 Marks.
Practical component 20 Marks. **Total CIE: 50 Marks**
Semester End Exam (SEE): 100 marks (students have to answer all main questions) which will be reduced to 50 Marks.
Test duration: 1 hrs
Examination duration: 3 hrs

CO to PO Mapping

PO1: Science and engineering Knowledge	**PO7:** Environment and Sustainability
PO2: Problem Analysis	**PO8:** Ethics
PO3: Design & Development	**PO9:** Individual & Team Work
PO4: Investigations of Complex Problems	**PO10:** Communication
PO5: Modern Tool Usage	**PO11:** Project Management & Finance
PO6: Engineer & Society	**PO12:** Life long Learning

PSO1: The proficiency in mathematics, physical and management sciences helps to excel in the areas of planning, analysis related to Civil Engineering systems.

PSO2: Identify sustainable materials and technologies, code of practices in construction industry and transportation systems.

CO	PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
21CV33	K-level														
CO1	K3	3	3	-	-	-	-	-	-	-	-	-	1	3	2
CO2	K3	3	3	-	-	-	-	-	-	-	-	-	1	3	2
CO3	K3	3	3	-	-	-	-	-	-	-	-	-	1	3	2
CO4	K3	3	3	2	-	-	-	-	-	-	-	-	1	3	2
CO5	K3	3	3	-	-	-	-	-	-	-	-	-	1	3	2

Course In charge	Head - Dept	IQAC Coordinator	Principal

Professor & Head
Dept. of Civil Engineering
K.S. Group of Institutions
K.S. School of Engineering & Management
Bangalore-560 062.

Principal / Director
K.S. School of Engineering & Management
Bangalore-560 062