COURSE FILE CONTENTS

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SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE FILE

ACADEMIC YEAR	**: 2025-26**
NAME OF THE SUBJECT	**: MECHANICS OF SOLIDS**
DEPARTMENT	**: MECHANICAL ENGINEERING**
YEAR AND SEMESTER	**: II B.Tech / III Sem.**
CLASS STRENGTH	**: 12**
SUBJECT CODE	**: 23MEC232T**
REGULATION	**: R23**
NAME OF THE FACULTY	**: Mr. M.HITHESH SAI**
DESIGNATION	**: ASSISTANT PROFESSOR**

II B.Tech III Semester	L	T	P	C
	4	-	-	3
23MEC232T MECHANICS OF SOLIDS				

Course Educational Objectives:

1. Understand the behaviour of basic structural members subjected to uniaxial and biaxial loads.
2. Apply the concept of stress and strain to analyse and design structural members and machine parts under axial, shear and bencing loads, moment and torsional moment.
3. Students will learn all the methods to analyse beams, columns, frames for normal, shear, and torsion
4. Students will learn stresses and to solve deflection problems in preparation for the design of such structural components.
5. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams
6. Students attain a deeper understanding of the loads, stresses, and strains structure and their relations in the elastic beaavior acting on a Design and analysis of Industrial components like pressure vessels.

Unit – I: SIMPLE STRESSES & STRAINS: (12)

Elasticity and plasticity Types of stresses & strains-Hooke's law-stress-strain diagram for mild steel - Working stress-Factor of safety Lateral strain, Poisson's ratio & volumetric strain-Bars of varying section composite bars-Temperature stresses- Complex Stresses Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses Mohr's circle - Relation between elastic constants, Strain energy - Resilience -Gradual, sudden, impact and shock loadings.

Unit –II: SHEAR FORCE AND BENDING MOMENT : (12)

Definition of beam-Types of beams - Concept of shear force and bending moment-S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads - Point of contra flexure-Relation between S.F. B.M and rate of loading at a section of a beam.

Unit – III: FLEXURAL STRESSES & SHEAR STRESSES : (12)

Theory of simple bending. Derivation of bending equation, Determination of bending stresses section modulus of rectangular, circular, I and T sections-Design of simple beam sections. Derivation of formula Shear stress distribution across various beams sections like rectangular, circular, triagular, I and T sections.

Unit – IV:DEFLECTION OF BEAMS & TORSION : (12)

Bending into a circular arc slope, deflection and radius of curvature - Differential equation for the clastic line of a beam - Double integration and Macaulay's methods - Determination of scope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method-application to simple cases. Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

Unit – V: THIN AND THICK CYLINDERS & COLUMNS: (12)

Thin seamless cylindrical shells Derivation of formula for longitudinal and circumferential stresses hoop, longitudinal and volumetric strains changes in dia, and volume of thin cylinders- Thin spherical shells. Wire wound thin cylinders. Lame's equation cylinders subjected to inside & outside pressures compound cylinders. Buckling and Stability, Colunıns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

Total Hours: 60

COURSE OUTCOMES:

On successful completion of the course, students will be able to		POs
CO1	Learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components	PO1, PO2, PO4
CO2	Analyse beams and draw correct and complete shear and bending moment diagrams for beams.	PO1, PO2, PO4
CO3	Apply the concept of stress and strain to analyze ard design structural members and machine parts under axial, shear and bending loads, and moments.	PO1, PO2, PO4
CO4	Model & Analyze the behavior of basic structural members subjected to various loads	PO1, PO2, PO4
CO5	Design and analysis of Industrial components like pressure vessels	PO1, PO2, PO4

TEXT BOOKS:

1. B.C. Punmia, Strength of materials,Lakshmi publications Pvt.Ltd, New Delhi, 2018.
2. GH Ryder, Strength of materials, Palgrave Macmillan publishers India Ltd, 1961.

REFERENCE BOOKS:

1. Gere & Timoshenko, Mechanics of material, 2/c, CBS publications, 2004.
2. U.C.Jindal, Strength of Materials, 2/e, Pearson Educ. tion, 2017.
3.Timoshenko, Strength of Materials Part-18. 11, 3/e, CBS Publishers, 2004.
4. Andrew Pytet and Ferdinand L. Singer. Strength of Materials, 4/c, Longman Pulications, 1990.
5. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

ONLINE LEARNING RESOURCES:

- https://onlinecounts aptel ac.in/noc19 celt/preview.
- https://youtubeAV ypych VNY?si-310htc4kTOJ8Fv6.
- https://www.youtube.com/watch?v=WEx93°Rkd M&t=2s
- https://www.classcentral.com/course/swayan-strength-of-materials-iitm-184204
- https://www.coursera.org/learn/mechanics-1
- https://www.cdx.org/learn/engineering/Anassachusetts-institute-of-technology-
- mechanical-behavior-of-materials-part-1-liner-elastic-behavior
- https://archive.nptel.ac.in/courses/112/107/112107146/

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	2	-	1	-	-	-	-	-	-	-	-
CO.2	3	2	-	1	-	-	-	-	-	-	-	-
CO.3	3	2	-	1	-	-	-	-	-	-	-	-

CO.4	3	2	-	1	-	-	-	-	-	-	-	-	
CO.5	3	2	-	1	-	-	-	-	-	-	-	-	
CO*	**3**	**2**	-	**1**	-	-	-	-	-	-	-	-	

Bloom's Taxonomy

Bloom's Level	Descriptions	Bloom's Level	Descriptions
BT 1	Remember	BT 2	Understand
BT 3	Apply	BT 4	Analyze
BT 5	Evaluate	BT 6	Create

STUDENT NOMINAL ROLL

Name of the Course with Code : Mecanics of Solids(23MEC232T)
Class & Semester / Academic Year : II B.Tech / III Sem. / 2025-26
Name of the Faculty Member : Mr. M.HITHESH SAI

S. NO	Roll Number	Name of the Student
1	24751A0301	Arram Chetty Chaithanya
2	24751A0302	K Jeremiah
3	24751A0303	Kanipakam Charan
4	24751A0304	M Kiran Kumar
5	24751A0305	Middi Prabhas
6	24751A0306	Pakilla L Yogeswar
7	24751A0307	P Madhan
8	24751A0308	R Franklin
9	24751A0309	Shaik Muskhan Davood
10	25755A0301	Punith Kumar
11	25755A0302	Jeevananthan
12	25755A0303	K Vijayendra Babu

Faculty Signature
(Mr.M.Hithesh Sai)

ACADEMIC CALENDAR

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

(Approved by AICTE, New Delhi & Permanently Affiliated to JNTUA, Ananthapuramu)

ACADEMIC CALENDAR
(2025 – 2026)

DATE: 13.06.2025

II YEAR B.TECH, I SEMESTER

Commencement of Class Works	02.07.2025	--
Instruction Period for the Semester	02.07.2025 to 25.10.2025	17 weeks
First Spell of Instructions	02.07.2025 to 23.08.2025	8 weeks
I Mid-Term Examinations	25.08.2025 to 30.08.2025	1 week
Second Spell of Instructions	01.09.2025 to 25.10.2025	8 weeks
II Mid-Term Examinations	27.10.2025 to 01.11.2025	1 week
Semester End Practical Examinations	03.11.2025 to 08.11.2025	1 week
Semester End Theory Examinations	10.11.2025 to 22.11.2025	2 weeks
Commencement of Class Work For II Year II Semester	24.11.2025	--

II YEAR B.TECH, II SEMESTER

Commencement of Class Works	24.11.2025	--
Instruction Period for the Semester	24.11.2025 to 21.03.2026	17 weeks
First Spell of Instructions	24.11.2025 to 17.01.2026	8 weeks
I Mid-Term Examinations	19.01.2026 to 24.01.2026	1 week
Second Spell of Instructions	27.01.2026 to 21.03.2026	8 weeks
II Mid-Term Examinations	23.03.2026 to 28.03.2026	1 week
Semester End Practical Examinations	30.03.2026 to 04.04.2026	1 week
Semester End Theory Examinations	06.04.2026 to 18.04.2026	2 weeks
Community Service Project	20.04.2026 to 13.06.2026	8 weeks
Commencement of Class Work For III Year I Semester	15.06.2026	--

Note: In the event of a slippage of up to 90 working days due to unavoidable circumstances, compensation classes will be conducted in online mode or other available holidays, including Sundays

13/6/25

Dean (Academics)

PRINCIPAL

INDIVIDUAL TIME TABLE

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

Name of the Course with Code : Mecanics of Solids (23MEC232T)
Class & Semester / Academic Year : II B.Tech / III Sem. / 2025-26
Name of the Faculty Member : Mr. M.HITHESH SAI

DAYS/ PERIODS	Period I (9.00AM – 10.00AM)	Period II (10.00AM – 11.00AM)	Period III (11.15AM – 12.15PM)	Period IV (12.15PM – 1.15PM)		Period V (2.00PM – 3.00PM)	Period VI (3.00PM – 4.00PM)
MON				MOS	LUNCH BREAK		
TUE			MOS			TD	
WED			MOS				
THU				MOS LAB		MOS LAB	MOS LAB
FRI							
SAT			MOS				

Faculty Signature **Time-Table In-charge** **HOD**
(Mr.M.Hithesh Sai) **(Mr.D.Raju)**

LESSON PLAN

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

Name of the Course with Code : Mechanics of Solids (23MEC232T)
Class & Semester / Academic Year : II B.Tech / III Sem. / 2025-26
Name of the Faculty Member : Mr. M.HITHESH SAI

S. No.	Topic	No. of Hours Required	Book(s) Followed
Unit-1: SIMPLE STRESSES & STRAINS			
1.	Elasticity and plasticity Types of stresses & strains-Hooke's law-stress-strain diagram for mild steel	2	T1,T2
2.	Working stress-Factor of safety Lateral strain, Poisson's ratio	2	T1,T2
3.	volumetric strain-Bars of varying section composite bars-Temperature stresses	1	T1,T2
4.	Principal planes and principal stresses Mohr's circle	2	T1,T2
5.	Relation between elastic constants,	1	T1,T2
6.	Strain energy - Resilience -Gradual, sudden, impact and shock loadings.	2	T1
7.	Complex Stresses Stresses on an inclined plane under different uniaxial and biaxial stress conditions	2	T1,T2
	Total of Hours required:	**12**	
Unit-2: SHEAR FORCE AND BENDING MOMENT			
8.	Definition of beam-Types of beams - Concept of shear force and bending moment-S.F	3	T1
9.	Concept of B.M diagrams for cantilever, simply supported and overhanging	2	T1
10.	SF & BF diagram for Cantilever, simply supported and overhanging beams with UDL,UVL,Point Load	3	T1,T2
11.	Point of contra flexure-Relation between S.F. B.M	2	T1
12.	rate of loading at a section of a beam.	1	T1
	Total of Hours required:	**11**	
Unit-3: FLEXURAL STRESSES & SHEAR STRESSES			
13.	Theory of simple bending. Derivation of bending equation	2	T1
14.	Determination of bending stresses section modulus of rectangular, circular, I and T sections	3	T1
15.	Design of simple beam sections.	2	T1,T2
16.	Derivation of formula Shear stress distribution across various beams sections like rectangular, circular, triagular, I and T sections.	3	T1,T2
	Total of Hours required:	**10**	
Unit-4: DEFLECTION OF BEAMS & TORSION			
17.	Bending into a circular arc slope, deflection and radius of curvature	2	T1
18.	Differential equation for the clastic line of a beam	2	T1
19.	Double integration and Macaulay's methods	3	T1
20.	Determination of scope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL.	3	T1,T2
21.	Mohr's theorem and Moment area method	2	T1,T2
22.	Introduction-Derivation- Torsion of Circular shafts	1	T1,T2
23.	Pure Shear-Transmission of power by circular shafts	1	T1,T2
24.	Shafts in series, Shafts in parallel	1	T1,T2
	Total of Hours required:	**15**	
Unit-5: THIN AND THICK CYLINDERS & COLUMNS			

25.	Derivation of formula for longitudinal and circumferential stresses	1	T1
26.	hoop, longitudinal and volumetric strains changes in dia, and volume of thin cylinders	2	T1
27.	Thin spherical shells	1	T1
28.	Wire wound thin cylinders.	1	T1
29.	Lame's equation cylinders subjected to inside & outside pressures compound cylinders	2	T1
30.	Buckling and Stability	1	T1
31.	Colunıns with Pinned ends, Columns with other support Conditions	1	T1,T2
	Total of Hours required:	**9**	
	Grand total of Hours required:	**60**	

TEXT BOOKS:

- ✓ B.C. Punmia, Strength of materials,Lakshmi publications Pvt.Ltd, New Delhi, 2018.
- ✓ GH Ryder, Strength of materials, Palgrave Macmillan publishers India Ltd, 1961.

REFERENCE BOOKS:

1. Gere & Timoshenko, Mechanics of material, 2/c, CBS publications, 2004.
2. U.C.Jindal, Strength of Materials, 2/e, Pearson Educ. tion, 2017.
3. Timoshenko, Strength of Materials Part-18. 11, 3/e, CBS Publishers, 2004.
4. Andrew Pytet and Ferdinand L. Singer. Strength of Materials, 4/c, Longman Pulications, 1990.
5. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

Faculty Signature **HOD**
(Mr.M.Hithesh Sai)

COURSE OF ACTION

Name of the Course with Code : **Mechanics of Solids (23MEC232T)**
Class & Semester / Academic Year : **II B.Tech / III Sem. / 2025-26**
Name of the Faculty Member : **Mr. M.HITHESH SAI**

S.No	Date	Period	Topics Covered
1	2-Jul-25	3	Elasticity and plasticity Types of stresses
2	5-Jul-25	1	strains-Hooke's law-stress-strain diagram for mild steel
3	7-Jul-25	5	Working stress-Factor of safety Lateral strain
4	8-Jul-25	3	Poisson's ratio & volumetric strain
5	14-Jul-25	1	Bars of varying section composite bars
6	15-Jul-25	5	Temperature stresses on composite bars
7	16-Jul-25	3	Concept of Complex Stresses Stresses on an inclined plane
8	19-Jul-25	1	Complex Stresses on an inclined plane under different uni axial stress conditions
9	21-Jul-25	5	Complex Stresses on an inclined plane under different Bi-axial stress conditions
10	22-Jul-25	3	Principal planes and principal stresses Mohr's circle
11	23-Jul-25	1	Relation between elastic constants
12	26-Jul-25	5	Strain energy - Resilience -Gradual
13	28-Jul-25	3	Strain energy - sudden, impact and shock loadings.
14	29-Jul-25	3	Complex Stresses on an inclined plane under different Bi-axial stress conditions
15	30-Jul-25	3	Problems on Complex Stresses on an inclined plane under different Bi-axial stress conditions
16	28-Jul-25	4	Problems on Complex Stresses on an inclined plane under different Uni-axial stress conditions
17	2- Aug -25	3	Definition of beam-Types of beams
18	4-Aug -25	3	Concept of shear force and bending moment
19	5-Aug-25	4	Problem on S.F and B.M diagrams for cantilever
20	11-Aug-25	4	Problem on S.F and B.M diagrams for Simply Supported Beam
21	12-Aug-25	3	Problem on S.F and B.M diagrams for Over Hanging Beam
22	13-Aug-25	3	Problems on point loads, u.d.l, uniformly varying loads and combination of these loads
23	18-Aug-25	4	Concept about Point of contra flexure
24	19-Aug-25	3	Relation between S.F. B.M
25	20-Aug-25	3	rate of loading at a section of a beam.

26	21-Aug-25	3	Concept on Theory of simple bending
27	23-Aug-25	3	Derivation of bending equation,
28	25-Aug-25	4	Determination of bending stresses & section modulus for rectangular
29	26-Aug-25	3	Determination of bending stresses & section modulus for Circular
30	8-Sep-25	3	Determination of bending stresses & section modulus for I-Section
31	9-Sep-25	3	Determination of bending stresses & section modulus for T-Section
32	10-Sep-25	4	Design of simple beam sections.
33	15-Sep-25	3	Derivation of formula Shear stress distribution across various beams sections like rectangular
34	16-Sep-25	3	Derivation of formula Shear stress distribution across various beams sections like Circular
35	17-Sep-25	3	Derivation of formula Shear stress distribution across various beams sections like I-Section
36	20-Sep-25	3	Derivation of formula Shear stress distribution across various beams sections like T-Section
37	22-Sep-25	3	Problems on Shear stress distribution across various beams sections like T-Section
38	23-Sep-25	4	Problems on Shear stress distribution across various beams sections like I-Section
39	24-Sep-25	4	Problems on Shear stress distribution across various beams sections like Circular,Rectangular
40	27-Sep-25	4	Bending into a circular arc slope
41	29-Sep-25	3	deflection and radius of curvature
42	7-Oct-25	3	Differential equation for the clastic line of a beam
43	8-Oct-25	4	Double integration and Macaulay's methods
44	11-Oct-25	3	Determination of slope and deflection for cantilever and simply supported beams subjected to point loads.
45	13-Oct-25	3	Determination of slope and deflection for cantilever and simply supported beams subjected to UDL and UVL
46	14-Oct-25	3	Mohr's theorem and Moment area method
47	15-Oct-25	3	Derivation- Torsion of Circular shafts & Transmission of power by circular shafts, Shafts in series, Shafts in parallel.
48	18-Oct-25	3	Derivation of formula for longitudinal and circumferential stresses hoop, longitudinal and volumetric strains changes in dia, and volume of thin cylinders
49	21-Oct-25	3	Thin spherical shells. Wire wound thin cylinders. Lame's equation cylinders subjected to inside & outside pressures compound cylinders.
50	22-Oct-25	3	Buckling and Stability, Colunıns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

Particulars	Months			
	Jul	Aug	Sep	Oct
Number of Periods taken	15	17	15	18
%of syllabus covered	20	30	20	30
Number of class tests / Assignments	1A	1A	2A	1A

Faculty Signature
(Mr. M.Hithesh Sai)

HOD

INTERNAL EXAM ANALYSIS

Name of the Course with Code : Mechanics of Solids (23MEC232T)
Class & Semester / Academic Year : II B.Tech / III Sem. / 2025-26
Name of the Faculty Member : Mr. M.HITHESH SAI

S.No	Roll Number	Name of the Student	Mid-I Marks			
			Objective	Descriptive	Conversion	Total
			10	30	15	25
1	24751A0301	Arram Chetty Chaithanya	AB	AB	0	0
2	24751A0302	K Jeremiah	6	18	15	15
3	24751A0303	Kanipakam Charan	7	0	7	7
4	24751A0304	M Kiran Kumar	6	4	2	2
5	24751A0305	Middi Prabhas	7	23	12	19
6	24751A0306	Pakilla L Yogeswar	7	0	0	7
7	24751A0307	P Madhan	7	4	2	9
8	24751A0308	R Franklin	7	10	5	12
9	24751A0309	Shaik Muskhan Davood	7	19	10	17
10	25755A0301	Punith Kumar	6	7	10	16
11	25755A0302	Jeevananthan	6	15	8	14
12	25755A0303	K Vijayendra Babu	7	22	11	18

Total Appeared	No.of student score <50% of total mark	No. of boys scored < 50% of total mark	No. of girls scored < 50% of total mark	No. of students attended remedial classes	No. student scored >50% of total mark in MID – I
12	7	7	0	12	

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

S.No	Roll Number	Name of the Student	Mid-II Marks			
			Objective	Descriptive	Conversion	Total
			10	30	15	25
1	24751A0301	Arram Chetty Chaithanya				
2	24751A0302	K Jeremiah				
3	24751A0303	Kanipakam Charan				
4	24751A0304	M Kiran Kumar				
5	24751A0305	Middi Prabhas				
6	24751A0306	Pakilla L Yogeswar				
7	24751A0307	P Madhan				
8	24751A0308	R Franklin				
9	24751A0309	Shaik Muskhan Davood				
10	25755A0301	Punith Kumar				
11	25755A0302	Jeevananthan				
12	25755A0303	K Vijayendra Babu				

Faculty Signature
(Mr. M.Hithesh Sai)

HOD

REMEDIAL CLASS

Name of the Course with Code : **Mechanics of Solids (23MEC232T)**
Class & Semester / Academic Year : **II B.Tech / III Sem. / 2025-26**
Name of the Faculty Member : **Mr. M.HITHESH SAI**

S. No	ROLL NO (A Sec)	NAME OF THE STUDENT	Mid-I										Mid-II
			Obj	Des	Total	Out of ≤50%							
			10M	30	40M	20M							
1	24751A0301	Arram Chetty	AB	AB	15	0							
2	24751A0302	K Jeremiah	6	18	0	15							
3	24751A0303	Kanipakam Charan	7	0	15	7							
4	24751A0304	M Kiran Kumar	6	4	7	2							
5	24751A0305	Middi Prabhas	7	23	2	19							
6	24751A0306	Pakilla L Yogeswar	7	0	12	7							
7	24751A0307	P Madhan	7	4	0	9							
8	24751A0308	R Franklin	7	10	2	12							
9	24751A0309	Shaik Muskhan Davood	7	19	5	17							
10	25755A0301	Punith Kumar	6	7	10	16							
11	25755A0302	Jeevananthan	6	15	10	14							
12	25755A0303	K Vijayendra Babu	7	22	8	18							

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

REMEDIAL CLASS QUESTIONARIES'

Q.No	PART-A (Two Marks Questions)
1	Derive the relationship between **Young's modulus**, **Bulk modulus**, and **Poisson's ratio**, and explain under what conditions this relation holds true.
2	A mild steel specimen is subjected to a gradually increasing axial tensile load. Sketch and explain the different stages of the **stress–strain curve** up to fracture and indicate the yield point clearly.
3	A composite bar consists of steel and copper fixed between rigid supports and subjected to a temperature rise. Derive the expression for **thermal stresses** developed in each material.
4	Explain why the **factor of safety** is generally higher in structures subjected to shock or impact loads compared to gradual loads.
5	A circular bar is subjected to **biaxial stresses** σx and σy. Derive the formula for **principal stresses** and **principal planes** without using Mohr's circle.
6	A rectangular bar of length LLL is subjected to an axial force PPP. Show how **Poisson's ratio** influences the **volumetric strain** of the bar.
7	State **Hooke's Law**. A bar is loaded beyond the elastic limit. Explain the deviation from Hooke's law with reference to **plasticity** and **elastic limit**.
8	Explain how **Mohr's circle** can be used to determine **maximum shear stress** and **orientation of principal planes** in a biaxial stress system.
9	A steel bar is subjected to an **impact load** due to a falling weight. Derive the expression for **maximum stress** developed and compare it with stress due to static load.
10	A bar of uniform cross-section is subjected to a **gradually applied tensile load**, while another identical bar is subjected to a **sudden load**. Prove mathematically that the stress in the second bar is twice that in the first.
11	Derive the **differential relationship** between shear force, bending moment, and loading intensity for a general beam subjected to any type of loading.
12	A simply supported beam is subjected to a uniformly varying load. Derive expressions for **shear force** and **bending moment** at any section.
13	Define **point of contraflexure**. For what type of loading and support conditions does it occur? Derive the condition mathematically.
14	For a **cantilever beam** subjected to a point load at the free end, sketch and explain the shape of S.F and B.M diagrams. Also, explain why the bending moment is maximum at the fixed end.
15	A beam is subjected to a combination of point load, UDL, and UVL. Explain step-by-step how to construct the **S.F and B.M diagrams** systematically.
16	A simply supported beam of span LLL carries a **uniformly distributed load** www over the entire span. Derive the expressions for **maximum shear force** and **maximum bending moment**.
17	A cantilever beam is subjected to a **linearly varying load** from zero at the free end to www at the fixed end. Derive the expression for bending moment at a distance xxx from the free end.
18	Explain how a **negative bending moment** is represented on a bending moment diagram. Give an example of where this occurs in overhanging beams.
19	Two beams of identical span carry the same UDL, but one is simply supported and the other is fixed at both ends. Which one develops **higher maximum bending moment** and why? Derive the expressions to justify.
20	For a beam subjected to **non-uniform loading**, explain how **areas under shear force diagrams** can be used to determine bending moments. Show the mathematical relation.
	PART-B (Ten Marks Questions)
1	Derive the relationship between **Young's modulus (E)**, **Bulk modulus (K)**, **Shear modulus (G)**, and **Poisson's ratio (μ)** for an isotropic material. Discuss how this relationship is useful in determining material properties when only two constants are known.
2	A steel rod and a copper rod of equal length are rigidly fixed between two supports. The temperature of the assembly is increased by 50∘ C50^\circ C50∘ C. Derive the expressions for the **thermal stresses** induced in each rod, assuming no expansion is allowed. State all assumptions clearly and show the complete step-by-step derivation.
3	A point in a strained material is subjected to normal stresses of 100 MPa (tensile) and 40 MPa (compressive) on mutually perpendicular planes, with a shear stress of 30 MPa. Construct **Mohr's circle** and determine:Principal stresses & Principal planes & Maximum shear stress and its orientation & Provide a neat diagram and full solution.

4	A steel bar is subjected to a **falling weight impact load**. Derive the expression for maximum stress induced in the bar. Compare this with the stress developed under **static loading**, and explain why impact loads are more critical in design. Illustrate your answer with a solved example.
5	Derive the **general expression for strain energy stored** in a prismatic bar under axial loading. Using this, determine the **proof resilience** and **modulus of resilience**. Apply the derived expression to calculate the energy stored in a steel rod of known dimensions and load.
6	Starting from the fundamental equilibrium of a beam element, derive the **differential relationship** between **shear force**, **bending moment**, and **load intensity**. Explain the **physical significance** of each term and illustrate with appropriate S.F. and B.M. diagrams.
7	A simply supported beam of span 6 m carries a point load of 20 kN at midspan and a uniformly distributed load of 5 kN/m on the entire span. In addition, there is an overhang of 2 m on one side with a 10 kN load at its end. Draw the **shear force and bending moment diagrams**, locate the **point of contraflexure**, and calculate the **maximum bending moment**. Show all steps clearly.
8	A cantilever beam of span LLL is subjected to a **uniformly varying load (UVL)** from zero at the free end to www at the fixed end. Derive the equations for **shear force** and **bending moment** at a distance xxx from the free end, and draw the corresponding diagrams. Also, find the **maximum bending moment** at the fixed support.
9	Two beams of the same span and subjected to identical UDL are supported differently: (a) simply supported, and (b) fixed at both ends. Derive the bending moment equations for both cases and **compare the maximum bending moments**. Explain how support conditions influence the bending moment distribution and structural behavior.
10	Derive the **general expressions for shear force and bending moment** for a simply supported beam subjected to **an arbitrary loading** using calculus. Show how **the area under the shear force diagram equals the change in bending moment** between two sections. Illustrate the derivation with an example involving a combination of point loads and UDL.

Faculty Signature **HOD**
(Mr. M.Hithesh Sai)

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

TUTORIAL CLASS

Name of the Course with Code : **Mechanics of Solids (23MEC232T)**
Class & Semester / Academic Year : **II B.Tech / III Sem. / 2025-26**
Name of the Faculty Member : **Mr. M.HITHESH SAI**

S.No	Date	Period	Topics Covered
1	19-7-2025	3rd	Tutorial Revision.
2	26-7-2025	3rd	Tutorial Revision.
3	16-8-2025	3rd	Tutorial Revision.
4	23-8-2025	3rd	Tutorial Revision.
5	30-8-2025	3rd	Tutorial Revision.
6	6-9-2025	3rd	Tutorial Revision.
7	20-9-2025	3rd	Tutorial Revision.
8	27-9-2025	3rd	Tutorial Revision.
9	11-10-2025	3rd	Tutorial Revision.
10	18-10-2025	3rd	Tutorial Revision.

TUTORIAL QUESTIONARIES'

Q

Problem 1.10. *The bar shown in Fig. 1.8 is subjected to a tensile load of 160 kN. If the stress in the middle portion is limited to 150 N/mm², determine the diameter of the middle portion. Find also the length of the middle portion if the total elongation of the bar is to be 0.2 mm. Young's modulus is given as equal to 2.1 × 10⁵ N/mm².*

A

Sol. Given :

Tensile load, $P = 160 \text{ kN} = 160 \times 10^3 \text{ N}$

Stress in middle portion, $\sigma_2 = 150 \text{ N/mm}^2$

Total elongation, $dL = 0.2 \text{ mm}$

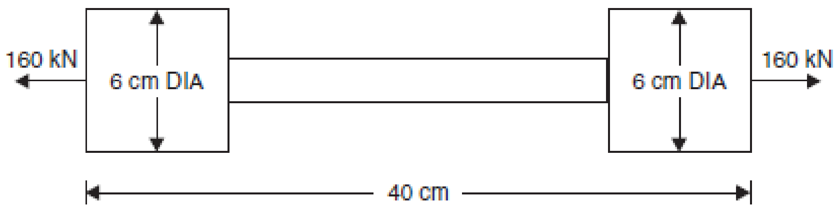
Total length of the bar, $L = 40 \text{ cm} = 400 \text{ mm}$

Young's modulus, $E = 2.1 \times 10^5 \text{ N/mm}^2$

Diameter of both end portions, $D_1 = 6 \text{ cm} = 60 \text{ mm}$

∴ Area of cross-section of both end portions,

$$A_1 = \frac{\pi}{4} \times 60^2 = 900\,\pi \text{ mm}^2.$$



[CO1] [PO1]

Let D_2 = Diameter of the middle portion

L_2 = Length of middle portion in mm.

$\therefore$ Length of both end portions of the bar,

$$L_1 = (400 - L_2) \text{ mm}$$

Using equation (1.1), we have

$$\text{Stress} = \frac{\text{Load}}{\text{Area}}.$$

For the middle portion, we have

$$\sigma_2 = \frac{P}{A_2} \qquad \text{where } A_2 = \frac{\pi}{4} D_2^2$$

or $$150 = \frac{160000}{\frac{\pi}{4} D_2^2}$$

$\therefore$ $$D_2^2 = \frac{4 \times 160000}{\pi \times 150} = 1358 \text{ mm}^2$$

or $$D_2 = \sqrt{1358} = 36.85 \text{ mm} = \mathbf{3.685 \text{ cm.}}$$ Ans.

$\therefore$ Area of cross-section of middle portion,

$$A_3 = \frac{\pi}{4} \times 36.85 = 1066 \text{ mm}^2$$

Now using equation (1.8), we get

Total extension, $$dL = \frac{P}{E}\left[\frac{L_1}{A_1} + \frac{L_2}{A_2}\right]$$

or $$0.2 = \frac{160000}{2.1 \times 10^5}\left[\frac{(400 - L_2)}{900\pi} + \frac{L_2}{1066}\right]$$

$[\because\ L_1 = (400 - L_2) \text{ and } A_2 = 1066]$

or $$\frac{0.2 \times 2.1 \times 10^5}{160000} = \frac{(400 - L_2)}{900\,\pi} + \frac{L_2}{1066}$$

or $$0.2625 = \frac{1066(400 - L_2) + 900\,\pi\,L_2}{900\,\pi \times 1066}$$

or $$0.2625 \times 900\pi \times 1066 = 1066 \times 400 - 1066\,L_2 + 900\pi \times L_2$$

or $$791186 = 426400 - 1066\,L_2 + 2827\,L_2$$

or $$791186 - 426400 = L_2\,(2827 - 1066)$$

or $$364786 = 1761\,L_2$$

$\therefore$ $$L_2 = \frac{364786}{1761} = 207.14 \text{ mm} = \mathbf{20.714 \text{ cm.}}$$ Ans.

Q

Problem 1.19. *A steel rod of 3 cm diameter is enclosed centrally in a hollow copper tube of external diameter 5 cm and internal diameter of 4 cm. The composite bar is then subjected to an axial pull of 45000 N. If the length of each bar is equal to 15 cm, determine :*

(i) The stresses in the rod and tube, and

(ii) Load carried by each bar.

Take E for steel = 2.1 × 10^5 N/mm² and for copper = 1.1 × 10^5 N/mm².

[CO1] [PO2]

A

Sol. Given :

Dia. of steel rod = 3 cm = 30 mm

$\therefore$ Area of steel rod,

$$A_s = \frac{\pi}{4}(30)^2 = 706.86 \text{ mm}^2$$

External dia. of copper tube = 5 cm = 50 mm

Internal dia. of copper tube = 4 cm = 40 mm

$\therefore$ Area of copper tube,

$$A_c = \frac{\pi}{4}[50^2 - 40^2] \text{ mm}^2 = 706.86 \text{ mm}^2$$

Axial pull on composite bar, $P = 45000$ N

Length of each bar, $L = 15$ cm

Young's modulus for steel, $E_s = 2.1 \times 10^5$ N/mm²

Young's modulus for copper, $E_c = 1.1 \times 10^5$ N/mm²

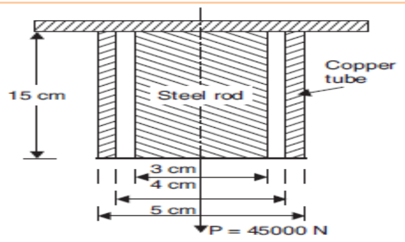


Fig. 1.16

(i) The stress in the rod and tube

Let σ_s = Stress in steel,
P_s = Load carried by steel rod,
σ_c = Stress in copper, and
P_c = Load carried by copper tube.

Now strain in steel = Strain in copper

$$\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_c} \qquad \left(\because \frac{\sigma}{E} = \text{strain}\right)$$

$$\therefore \quad \sigma_s = \frac{E_s}{E_c} \times \sigma_c = \frac{2.1 \times 10^5}{1.1 \times 10^5} \times \sigma_c = 1.909\,\sigma_c \qquad \ldots(i)$$

Now $\text{stress} = \frac{\text{Load}}{\text{Area}}$, $\therefore$ Load = Stress × Area

Load on steel + Load on copper = Total load

$$\sigma_s \times A_s + \sigma_c \times A_c = P \qquad (\because \text{Total load} = P)$$

$$1.909\,\sigma_c \times 706.86 + \sigma_c \times 706.86 = 45000$$

$$\sigma_c\,(1.909 \times 706.86 + 706.86) = 45000$$

$$2056.25\,\sigma_c = 45000$$

$$\therefore \quad \sigma_c = \frac{45000}{2056.25} = 21.88\ \text{N/mm}^2. \quad \textbf{Ans.}$$

Substituting the value of σ_c in equation (*i*), we get

$$\sigma_s = 1.909 \times 21.88\ \text{N/mm}^2 = 41.77\ \text{N/mm}^2. \quad \textbf{Ans.}$$

(ii) Load carried by each bar

As load = Stress × Area

∴ Load carried by steel rod,

$$P_s = \sigma_s \times A_s = 41.77 \times 706.86 = 29525.5\ \text{N}. \quad \textbf{Ans.}$$

Load carried by copper tube,

$$P_c = 45000 - 29525.5 = 15474.5\ \text{N}. \quad \textbf{Ans.}$$

Q	A steel rod of 25 mm diameter and 2 m length is subjected to a sudden axial load of 50 kN. Determine the **maximum stress** developed in the rod.& A bar of 20 mm diameter and 1.5 m length is subjected to a **falling weight of 200 N** from a height of 50 mm. Calculate the maximum stress developed.E=200 GPA = 200 A composite bar consists of a **steel rod** of 20 mm diameter and a **copper rod** of 25 mm diameter, both of 1 m length and fixed between rigid supports. If the temperature rises by50∘ C, determine the stresses in both materials.	[CO1] [PO2]

A

$$A = \frac{\pi}{4}d^2 = \frac{\pi}{4}(0.025)^2 = 4.909 \times 10^{-4}\,\text{m}^2$$

Static stress

$$\sigma_s = \frac{P}{A} = \frac{50 \times 10^3}{4.909 \times 10^{-4}} = 101.9\,\text{MPa}$$

For sudden load:

$$\sigma_{max} = 2 \times \sigma_s = 203.8\,\text{MPa}$$

$$A = \frac{\pi}{4}(0.02)^2 = 3.142 \times 10^{-4}\,\text{m}^2$$

$$\delta_{static} = \frac{PL}{AE} = \frac{200 \times 1.5}{(3.142 \times 10^{-4})(200 \times 10^9)} = 4.77 \times 10^{-6}\,\text{m}$$

Impact energy:

$$H = 0.05\,\text{m}$$

σ_{max} using

$$\frac{\sigma^2 AL}{2E} = W\left(H + \frac{\sigma L}{AE}\right)$$

$\Rightarrow \sigma \approx 260.1$ MPa (after solving quadratic)

	$\alpha_{steel} = 12 \times 10^{-6}/°C, \quad \alpha_{copper} = 18 \times 10^{-6}/°C$ $E_{steel} = 200\,\text{GPa}, \quad E_{copper} = 100\,\text{GPa}$ **Answer:** Using thermal stress compatibility and force balance: $\sigma_s A_s + \sigma_c A_c = 0$ and $\frac{\sigma_s}{E_s} + \alpha_s \Delta T = \frac{\sigma_c}{E_c} + \alpha_c \Delta T$ $\sigma_s = -23.4\,\text{MPa}$ (compressive), $\sigma_c = 20.1\,\text{MPa}$ (tensile)	
Q	A **simply supported beam** of span 6 m carries a point load of 30 kN at midspan. Determine the **maximum shear force** and **maximum bending moment**.A **cantilever** beam of 4 m length is subjected to a UDL of 5 kN/mDetermine S.F. and B.M. at fixed end.A simply supported beam of span 8 m carries a **uniformly varying load** from 0 at left end to 6 kN/m at right end. Find **maximum bending moment**.	[CO2] [PO2]
A	$R_A = R_B = \frac{30}{2} = 15\,\text{kN}$ $\text{Max S.F.} = 15\,\text{kN}$ $\text{Max B.M. at midspan} = \frac{WL}{4} = \frac{30\times6}{4} = 45\,\text{kNm}$ $\text{Total load} = 5 \times 4 = 20\,\text{kN}$ S.F. at fixed end $= 20\,\text{kN}$ B.M. at fixed end $= \frac{wL^2}{2} = \frac{5\times4^2}{2} = 40\,\text{kNm}$ $W_{total} = \frac{1}{2} \times 8 \times 6 = 24\,\text{kN}$ $R_A = \frac{W}{3} = 8\,\text{kN}, R_B = \frac{2W}{3} = 16\,\text{kN}$ $\text{Max B.M. at B} = \frac{wL^2}{6} = \frac{6\times8^2}{6} = 64\,\text{kNm}$	
Q	**Problem 6.1.** *A cantilever beam of length 2 m carries the point loads as shown in Fig. 6.15. Draw the shear force and B.M. diagrams for the cantilever beam.*	[CO2] [PO1]
	S.F. at D, $F_D = +800$ N S.F. at C, $F_C = +800 + 500 = +1300$ N S.F. at B, $F_B = +800 + 500 + 300 = 1600$ N S.F. at A, $F_A = +1600$ N.	

Bending Moment Diagram

The bending moment at D is zero :

(i) The bending moment at any section between C and D at a distance x and D is given by,

$$M_x = -800 \times x \text{ which follows a straight line law.}$$

At C, the value of $x = 0.8$ m.

$\therefore$ B.M. at C, $M_C = -800 \times 0.8 = -640$ Nm.

(ii) The B.M. at any section between B and C at a distance x from D is given by (At C, $x = 0.8$ and at B, $x = 0.8 + 0.7 = 1.5$ m. Hence here x varies from 0.8 to 1.5).

$$M_x = -800\,x - 500\,(x - 0.8) \quad \ldots(i)$$

Bending moment between B and C also varies by a straight line law.

B.M. at B is obtained by substituting $x = 1.5$ m in equation (i),

$$\therefore \quad M_B = -800 \times 1.5 - 500\,(1.5 - 0.8)$$
$$= -1200 - 350 = -1550 \text{ Nm.}$$

(iii) The B.M. at any section between A and B at a distance x from D is given by (At B, $x = 1.5$ and at A, $x = 2.0$ m. Hence here x varies from 1.5 m to 2.0 m)

$$M_x = -800\,x - 500\,(x - 0.8) - 300\,(x - 1.5) \quad \ldots(ii)$$

Bending moment between A and B varies by a straight line law.

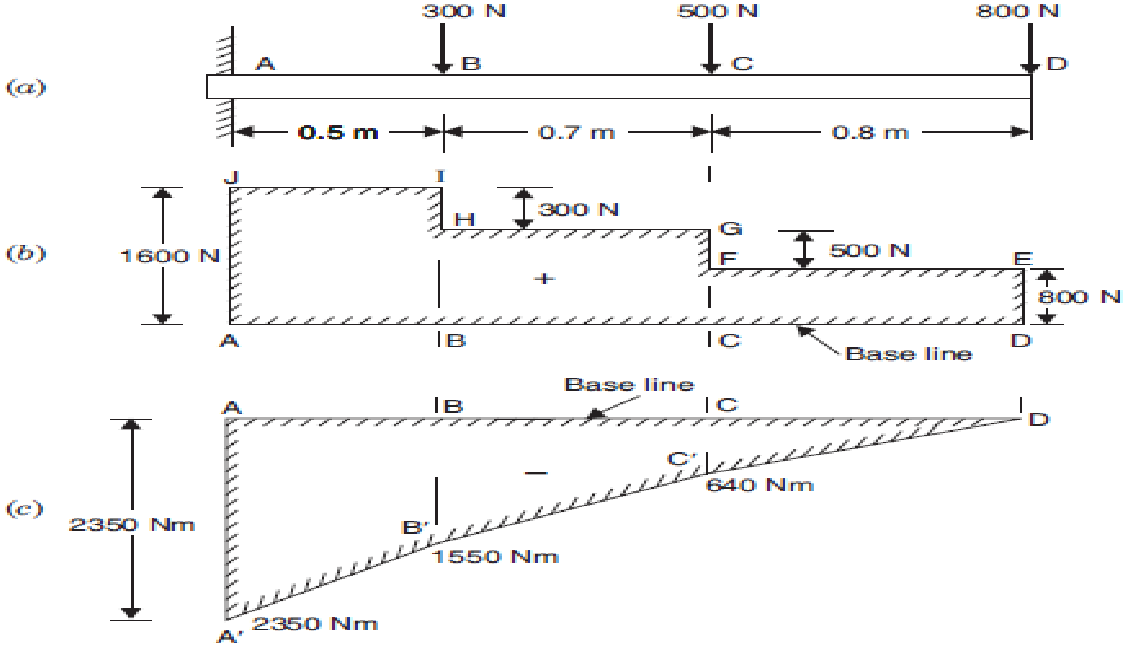
B.M. at A is obtained by substituting $x = 2.0$ m in equation (ii),

$$\therefore \quad M_A = -800 \times 2 - 500\,(2 - 0.8) - 300\,(2 - 1.5)$$
$$= -800 \times 2 - 500 \times 1.2 - 300 \times 0.5$$
$$= -1600 - 600 - 150 = -2350 \text{ Nm.}$$

Hence the bending moments at different points will be as given below :

$$M_D = 0$$
$$M_C = -640 \text{ Nm}$$
$$M_B = -1550 \text{ Nm}$$
and $$M_A = -2350 \text{ Nm.}$$

A



Q	**Problem 6.8.** *A simply supported beam of length 6 m, carries point load of 3 kN and 6 kN at distances of 2 m and 4 m from the left end. Draw the shear force and bending moment diagrams for the beam.*	
A	(solution below)	[CO2] [PO2]

Sol. First calculate the reactions R_A and R_B.

Taking moments of the force about *A*, we get

$$R_B \times 6 = 3 \times 2 + 6 \times 4 = 30$$

$$\therefore \quad R_B = \frac{30}{6} = 5 \text{ kN}$$

$$\therefore \quad R_A = \text{Total load on beam} - R_B = (3 + 6) - 5 = 4 \text{ kN}$$

Shear Force Diagram

Shear force at *A*, $F_A = + R_A = + 4$ kN

Shear force between *A* and *C* is constant and equal to + 4 kN

Shear force at *C*, $F_C = + 4 - 3.0 = + 1$ kN

Shear force between *C* and *D* is constant and equal to + 1 kN.

Shear force at *D*, $F_D = + 1 - 6 = - 5$ kN

The shear force between *D* and *B* is constant and equal to – 5 kN.

Shear force at *B*, $F_B = - 5$ kN

The shear force diagram is drawn as shown in Fig. 6.26 (*b*).

Bending Moment Diagram

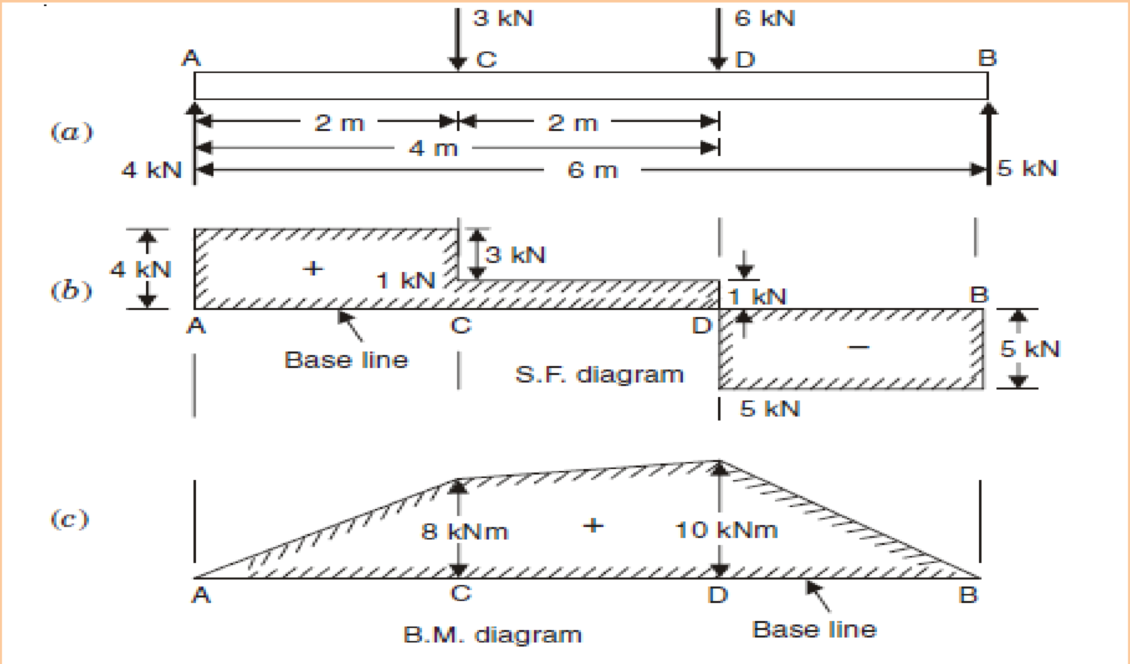
B.M. at *A*, $M_A = 0$

B.M. at *C*, $M_C = R_A \times 2 = 4 \times 2 = + 8$ kNm

B.M. at *D*, $M_D = R_A \times 4 - 3 \times 2 = 4 \times 4 - 3 \times 2 = + 10$ kNm

B.M. at *B*, $M_B = 0$

The bending moment diagram is drawn as shown in Fig. 6.26 (*c*).



Q	**Problem 6.17.** *Draw the S.F. and B.M. diagrams for the beam which is loaded as shown in Fig. 6.38. Determine the points of contraflexure within the span AB.*	[CO 2]

A

Sol. First calculate the reactions R_A and R_B.

Taking moments about A, we have

$$R_B \times 8 + 800 \times 3 = 2000 \times 5 + 1000(8+2)$$

or $$8R_B + 2400 = 10000 + 10000$$

$$\therefore \quad R_B = \frac{20000 - 2400}{8} = \frac{17600}{8} = 2200 \text{ N}$$

and $$R_A = \text{Total load} - R_B = 3800 - 2200 = 1600$$

S.F. Diagram

S.F at C $= -800$ N

S.F. between C and A remains -800 N

S.F. at A $= -800 + R_A = -800 + 1600 = +800$ N

S.F. between A and D remains $+800$ N

S.F. at D $= +800 - 2000 = -1200$ N

S.F. between D and B remains -1200 N

S.F. at B $= -1200 + R_B = -1200 + 2200 = +1000$ N

S.F. between B and E remains $+1000$ N

S.F. diagram is shown in Fig. 6.38.

B.M. Diagram

B.M. at C $= 0$

B.M. at A $= -800 \times 3 = -2400$ Nm

B.M. at D $= -800 \times (3+5) + R_A \times 5$

$= -800 \times 8 + 1600 \times 5$

$= -6400 + 8000 = +1600$ Nm

B.M. at B $= -1000 \times 2 = -2000$ Nm

B.M. at E $= 0$

The B.M. diagram is drawn as shown in Fig. 6.38 (c).

Points of Contraflexure

There will be two points of contraflexure O_1 and O_2, where B.M. becomes zero after changing its sign. Point O_1 lies between A and D, whereas the point O_2 lies between D and B.

(*i*) Let the point O_1 is x metre from A.

Then B.M. at O_1 $= -800(3+x) + R_A \times x = -800(3+x) + 1600x$

$= -2400 - 800x + 1600x = -2400 + 800x$

But B.M. at O_1 is zero

$$\therefore \quad 0 = -2400 + 800x \quad \text{or} \quad x = \frac{2400}{800} = 3 \text{ m.}$$ **Ans.**

(*ii*) Let the point O be x metre from B.

Then B.M. at O_2 $= 1000(x+2) - R_B \times x = 1000x + 2000 - 2200 \times x = 2000 - 1200x$

But B.M. at O_2 $= 0$

$$\therefore \quad 0 = 2000 - 1200x$$

$$\therefore \quad x = \frac{2000}{1200} = \frac{5}{3} = 1.67 \text{ m from B.}$$ **Ans.**

Q	A rectangular beam 300 mm deep and 150 mm wide is subjected to a bending moment of 50 kNm. Determine the **maximum bending stress**.For a **circular beam** of 200 mm diameter subjected to a shear force of 20 kN, determine the **maximum shear stress**.An **I-section beam** has flange 200×20 mm and web 10×16010 mm. Calculate **section modulus** about the major axis.	[CO3] [PO1]

A

$$Z = \frac{bd^2}{6} = \frac{150 \times 300^2}{6} = 2.25 \times 10^6\ \text{mm}^3$$

$$\sigma_{max} = \frac{M}{Z} = \frac{50 \times 10^6}{2.25 \times 10^6} = 22.22\ \text{MPa}$$

$$A = \frac{\pi d^2}{4} = 0.0314\ \text{m}^2$$

$$\tau_{avg} = \frac{V}{A} = \frac{20000}{0.0314} = 636.9\ \text{kPa}$$

$$\tau_{max} = \frac{4}{3}\tau_{avg} = 849.2\ \text{kPa}$$

$$I = 2\left[\frac{200(20)^3}{12} + 200(20)(90)^2\right] + \frac{10(160)^3}{12} = 1.67 \times 10^8\ \text{mm}^4$$

$$y_{max} = \frac{200}{2} = 100\ \text{mm}$$

$$Z = \frac{I}{y_{max}} = \frac{1.67 \times 10^8}{100} = 1.67 \times 10^6\ \text{mm}^3$$

Q

Problem 7.10. *A rolled steel joist of I section has the dimensions as shown in Fig. 7.15. This beam of I section carries a u.d.l. of 40 kN/m run on a span of 10 m, calculate the maximum stress produced due to bending.*

A

Sol. Given :

u.d.l., $w = 40$ kN/m $= 40000$ N/m

Span, $L = 10$ m

Moment of inertia about the neutral axis

$$= \frac{200 \times 400^3}{12} - \frac{(200-10) \times 360^3}{12}$$
$$= 1066666666 - 738720000$$
$$= 327946666\ \text{mm}^4$$

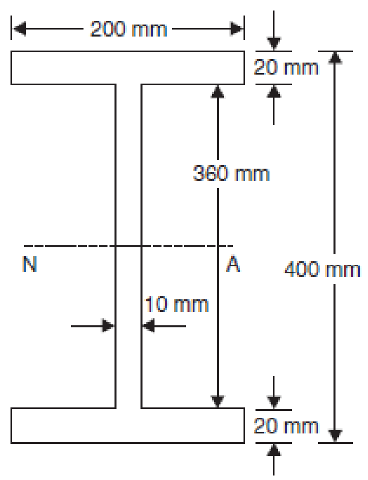


Fig. 7.15

Maximum B.M. is given by,

$$M = \frac{w \times L^2}{8} = \frac{40000 \times 10^2}{8}$$
$$= 500000\ \text{Nm}$$
$$= 500000 \times 1000\ \text{Nmm}$$
$$= 5 \times 10^8\ \text{Nmm}$$

Now using the relation,

$$\frac{M}{I} = \frac{\sigma}{y}$$

$$\therefore \quad \sigma = \frac{M}{I} \times y$$

$$\sigma_{max} = \frac{M}{I} \times y_{max} = \frac{5 \times 10^8}{327946666} \times 200 \qquad (\because\ y_{max} = 200\ \text{mm})$$

$$= \mathbf{304.92\ N/mm^2}.$$ **Ans.**

[CO3] [PO2]

Q

Problem 7.15. *A cast iron beam is of I-section as shown in Fig. 7.20. The beam is simply supported on a span of 5 metres. If the tensile stress is not to exceed 20 N/mm², find the safe uniformly load which the beam can carry. Find also the maximum compressive stress.*

A

Sol. Given :

Length of beam, $L = 5$ m

Maximum tensile stress, $\sigma_t = 20$ N/mm²

First calculate the C.G. of the section. Let $\bar{y}$ is the distance of the C.G. from the bottom face. As the section is symmetrical about y-axis, hence $\bar{y}$ is only to be calculated.

Now
$$\bar{y} = \frac{A_1 y_1 + A_2 y_2 + A_3 y_3}{(A_1 + A_2 + A_3)}$$
$$= \frac{(160 \times 40) \cdot \frac{40}{2} + (200 \times 20)\left(40 + \frac{200}{2}\right) + (80 \times 20) \cdot \left(40 + 200 + \frac{20}{2}\right)}{160 \times 40 + 200 \times 20 + 80 \times 20}$$
$$= \frac{128000 + 560000 + 400000}{6400 + 4000 + 1600} = \frac{1088000}{12000} = 90.66 \text{ mm}$$

N.A. lies at a distance of 90.66 mm from the bottom face or 260 – 90.66 = 169.34 mm from the top face.

Now moment of inertia of the section about N-axis is given by,
$$I = I_1 + I_2 + I_3$$
where I_1 = M.O.I. of bottom flange about N.A.
= M.O.I. of bottom flange about its C.G. + A_1 × (Distance of its C.G. from N.A.)²
$$= \frac{160 \times 40^3}{12} + 160 \times 40 \times (90.66 - 20)^2$$
$$= 853333.33 + 31954147.84 = 32807481.17 \text{ mm}^4$$
I_2 = M.O.I. of web about N.A.
= M.O.I. of web about its C.G. + A_2 × (Distance of its C.G. from N.A.)²
$$= \frac{20 \times 200^3}{12} + 200 \times 20 \times (140 - 90.66)^2$$
$$= 13333333.33 + 9737742.4 = 23071075.73 \text{ mm}^4$$
I_3 = M.O.I. of top flange about N.A.
= M.O.I. of top flange about its C.G. + A_3 × (Distance of its C.G. from N.A.)²
$$= \frac{80 \times 20^3}{12} + 80 \times 20 \times (250 - 90.66)^2$$
$$= 53333.33 + 40622776.96 = 40676110.29 \text{ mm}^4$$
$$\therefore \quad I = 32807481.17 + 23071075.75 + 40676110.29 = 96554667.21 \text{ mm}^4.$$

For a simply supported beam, the tensile stress will be at the extreme bottom fibre and compressive stress will be at the extreme top fibre.

Here maximum tensile stress = 20 N/mm²

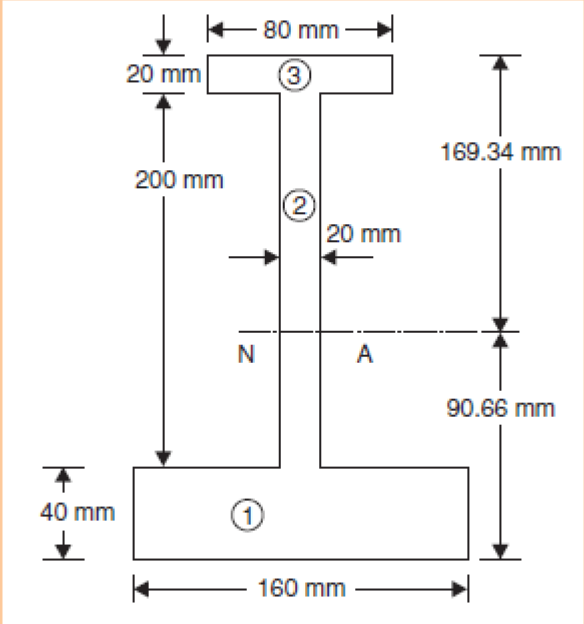
Hence for the maximum tensile stress,
$$y = 90.66 \text{ mm}$$
[*i.e.*, y is the distance of the extreme bottom fibre (where the tensile stress is maximum) from the N.A.]

Using the relation, $\frac{M}{I} = \frac{\sigma}{y}$
$$\therefore \quad M = \frac{\sigma}{y} \times I$$
$$= \frac{20}{90.66} \times 96554667.21 \qquad (\because \sigma = \sigma_t = 20 \text{ N/mm}^2)$$
$$= 21300389.85 \text{ Nmm} \qquad \text{...}(i)$$

Let w = Uniformly distributed load in N/m on the simply supported beam.

The maximum B.M. is at the centre and equal to $\frac{wL^2}{8}$

[CO3] [PO1]



$$\therefore \quad M = \frac{w \times 5^2}{8}\text{ Nm} = \frac{w \times 25 \times 1000}{8}\text{ Nmm} = 3125\,w\text{ Nmm} \quad \ldots(ii)$$

Equating the two values of M, given by equations (i) and (ii), we get

$$3125w = 21300389.85$$

$$\therefore \quad w = \frac{21300389.85}{3125} = \mathbf{6816.125\ N/m.} \quad \text{Ans.}$$

Maximum Compressive Stress

Distance of extreme top fibre from N.A.,

$$y_c = 169.34\text{ mm}$$

$$M = 21300389.85$$

$$I = 96554667.21$$

Let σ_c = Max. compressive stress

Using the relation, $\frac{M}{I} = \frac{\sigma}{y}$

$$\therefore \quad \sigma = \frac{M}{I} \times y$$

or
$$\sigma_c = \frac{M}{I} \times y_c = \frac{21300389.85}{96554667.21} \times 169.34 = \mathbf{37.357\ N/mm^2.} \quad \text{Ans.}$$

Q **Problem 7.16.** *A cast iron beam is of T-section as shown in Fig. 7.21. The beam is simply supported on a span of 8 m. The beam carries a uniformly distributed load of 1.5 kN/m length on the entire span. Determine the maximum tensile and maximum compressive stresses.*

Sol. Given :

Length, $L = 8$ m

U.D.L., $w = 1.5$ kN/m = 1500 N/m

To find the position of the N.A., the C.G. of the section is to be calculated first. The C.G. will be lying on the y-y axis.

Let $\bar{y}$ = Distance of the C.G. of the section from the bottom

[CO3] [PO2]

$$\therefore \quad \bar{y} = \frac{A_1 y_1 + A_2 y_2}{A_1 + A_2} = \frac{(100 \times 20) \times \left(80 + \frac{20}{2}\right) + 80 \times 20 \times \frac{80}{2}}{(100 \times 2) + (80 \times 20)}$$

$$= \frac{180000 + 64000}{2000 + 1600} = \frac{244000}{3600} = 67.77 \text{ mm}$$

∴ N.A. lies at a distance of 67.77 mm from the bottom face or 100 – 67.77 = 32.23 mm from the top face.

Now moment of inertia of the section about N.A. is given by,

$$I = I_1 + I_2$$

where I_1 = M.O.I. of top flange about N.A.

= M.O.I. of top flange about its C.G. + A_1 × (Distance of its C.G. from N.A.)^2

$$= \frac{100 \times 20^3}{12} + (100 \times 20) \times (32.23 - 10)^2$$

$$= 66666.7 + 988345.8 = 1055012.5 \text{ mm}^4$$

I_2 = M.O.I. of web about N.A.

= M.O.I. of web about its C.G. + A_2 × (Distance of its C.G. from N.A.)^2

$$= \frac{20 \times 80^3}{12} + (80 \times 20) \times (67.77 - 40)^2$$

$$= 853333.3 + 1233876.6 = 2087209.9 \text{ mm}^4$$

$$I = I_1 + I_2 = 1055012.5 + 2087209.9 = 3142222.4 \text{ mm}^4.$$

For a simply supported beam, the maximum tensile stress will be at the extreme bottom fibre and maximum compressive stress will be at the extreme top fibre.

Maximum B.M. is given by,

$$M = \frac{w \times L^2}{8} = \frac{1500 \times 8^2}{8} = 12000 \text{ Nm}$$

$$= 12000 \times 1000 = 12000000 \text{ Nmm}$$

Now using the relation

$$\frac{M}{I} = \frac{\sigma}{y} \quad \text{or} \quad \sigma = \frac{M}{I} \times y$$

A	(*i*) For maximum tensile stress, y = Distance of extreme bottom fibre from N.A. = 67.77 mm $\therefore \quad \sigma = \frac{12000000}{3142222.4} \times 67.77 = \mathbf{258.81\ N/mm^2}$. **Ans.** (*ii*) For maximum compressive stress, y = Distance of extreme top fibre from N.A. = 32.23 mm $\therefore \quad \sigma = \frac{M}{I} \times y = \frac{12000000}{3142222.4} \times 32.23 = \mathbf{123.08\ N/mm^2}$. **Ans.**	
Q	A cantilever of length 2 m carries a point load of 5 kN at the free end. Find the **deflection** and **slope** at the free end. E=200 GPa, I=5×10−6 m4 & A simply supported beam of span 4 m carries a **central load of 10 kN**. Calculate the **maximum deflection**.&A solid circular shaft of 80 mm diameter is to transmit **150 kW** at 300 rpm. Determine the **maximum shear stress**.& Two shafts of 60 mm and 80 mm diameter are connected **in series**. Determine the **torque shared** by each if they transmit a total torque of 500 Nm. Assume G same.	[CO4] [PO1]

A

$$\theta = \frac{WL^2}{2EI} = \frac{5000\times2^2}{2\times200\times10^9\times5\times10^{-6}} = 0.01\ \text{rad}$$

$$\delta = \frac{WL^3}{3EI} = \frac{5000\times2^3}{3\times200\times10^9\times5\times10^{-6}} = 0.0133\ \text{m}$$

$$\delta_{max} = \frac{WL^3}{48EI} = \frac{10000\times4^3}{48\times200\times10^9\times8\times10^{-6}}$$

$$\delta_{max} = 0.0104\ \text{m}$$

$$T = \frac{9550\times P}{N} = \frac{9550\times150}{300} = 4775\ \text{Nm}$$

$$\tau = \frac{16T}{\pi d^3} = \frac{16\times4775}{\pi(0.08)^3} = 148.6\times10^6\ \text{Pa}$$

For shafts in series, angle of twist additive.

$$T_1/J_1 = T_2/J_2$$

$$J = \frac{\pi d^4}{32}$$

Solving: $T_1 = 122.4\ \text{Nm}$, $T_2 = 377.6\ \text{Nm}$

Q

Problem 12.1. *A beam 6 m long, simply supported at its ends, is carrying a point load of 50 kN at its centre. The moment of inertia of the beam (i.e. I) is given as equal to $78\times10^6\ mm^4$. If E for the material of the beam = $2.1\times10^5\ N/mm^2$, calculate : (i) deflection at the centre of the beam and (ii) slope at the supports.*

Sol. Given :

Length, $L = 6\ \text{m} = 6\times1000 = 6000\ \text{mm}$

Point load, $W = 50\ \text{kN} = 50{,}000\ \text{N}$

M.O.I., $I = 78\times10^6\ \text{mm}^4$

Value of $E = 2.1\times10^5\ \text{N/mm}^2$

Let y_c = Deflection at the centre and

θ_A = Slope at the support.

(*i*) Using equation (12.7) for the deflection at the centre, we get

$$y_c = \frac{WL^3}{48EI} = \frac{50000\times6000^3}{48\times2.1\times10^5\times78\times10^6}$$

$= 13.736$ mm. **Ans.**

(*ii*) Using equation (12.6) for the slope at the supports, we get

$$\theta_B = \theta_A = -\frac{WL^2}{16EI}$$

$$= \frac{WL^2}{16EI} \quad \text{(Numerically)}$$

$$= \frac{50000\times6000^2}{16\times2.1\times10^5\times78\times10^6}\ \text{radians}$$

$= 0.06868$ radians

$$= 0.06868\times\frac{180}{\pi}\ \text{degree} \quad \left(\because\ 1\ \text{radian} = \frac{180}{\pi}\ \text{degree}\right)$$

$= 3.935°$. **Ans.**

[CO4] [PO1]

Q

Problem 12.9. *A beam of length 6 m is simply supported at its ends and carries two point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Find :*

(i) deflection under each load,

(ii) maximum deflection, and

(iii) the point at which maximum deflection occurs.

Given $E = 2 \times 10^5$ *N/mm*^{2} *and* $I = 85 \times 10^6$ *mm*^{4}*.*

A

Sol. Given :

$$I = 85 \times 10^5 \text{ mm}^4 \text{ ; } E = 2 \times 10^5 \text{ N/mm}^2$$

First calculate the reactions R_A and R_B.

Taking moments about A, we get

$$R_B \times 6 = 48 \times 1 + 40 \times 3 = 168$$

$$\therefore \quad R_B = \frac{168}{6} = 28 \text{ kN}$$

$$\therefore \quad R_A = \text{Total load} - R_B = (48 + 40) - 28 = 60 \text{ kN}$$

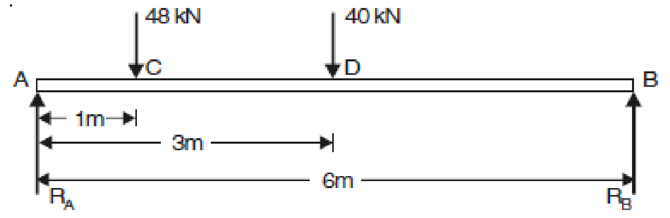


Fig. 12.8

Consider the section X in the last part of the beam (*i.e.*, in length DB) at a distance x from the left support A. The B.M. at this section is given by,

$$EI\frac{d^2y}{dx^2} = R_A . x \;\vdots\; - 48(x-1) \;\vdots\; - 40(x-3)$$

$$= 60x \;\vdots\; - 48(x-1) \;\vdots\; - 40(x-3)$$

Integrating the above equation, we get

$$EI\frac{dy}{dx} = \frac{60x^2}{2} + C_1 \;\vdots\; - 48\frac{(x-1)^2}{2} \;\vdots\; - 40\frac{(x-3)^2}{2}$$

$$= 30x^2 + C_1 \;\vdots\; - 24(x-1)^2 \;\vdots\; - 20(x-3)^2 \quad ...(i)$$

Integrating the above equation again, we get

$$EIy = \frac{30x^3}{3} + C_1x + C_2 \;\vdots\; \frac{-24(x-1)^3}{3} \;\vdots\; \frac{-20(x-3)^3}{3}$$

$$= 10x^3 + C_1x + C_2 \;\vdots\; - 8(x-1)^3 \;\vdots\; - \frac{20}{3}(x-3)^3 \quad ...(ii)$$

To find the values of C_1 and C_2, use two boundary conditions. The boundary conditions are:

(*i*) at $x = 0$, $y = 0$, and (*ii*) at $x = 6$ m, $y = 0$.

(*i*) Substituting the first boundary condition *i.e.*, at $x = 0$, $y = 0$ in equation (*ii*) and considering the equation upto first dotted line (as $x = 0$ lies in the first part of the beam), we get

$$0 = 0 + 0 + C_2 \quad \therefore \quad C_2 = 0$$

(*ii*) Substituting the second boundary condition *i.e.*, at $x = 6$ m, $y = 0$ in equation (*ii*) and considering the complete equation (as $x = 6$ lies in the last part of the beam), we get

$$0 = 10 \times 6^3 + C_1 \times 6 + 0 - 8(6-1)^3 - \frac{20}{3}(6-3)^3 \qquad (\because \; C_2 = 0)$$

or

$$0 = 2160 + 6C_1 - 8 \times 5^3 - \frac{20}{3} \times 3^3$$

$$= 2160 + 6C_1 - 1000 - 180 = 980 + 6C_1$$

[CO4] [PO2]

$\therefore \quad C_1 = \frac{-980}{6} = -163.33$

Now substituting the values of C_1 and C_2 in equation (*ii*), we get

$$EIy = 10x^3 - 163.33x \; \vdots \; - 8(x-1)^3 \; \vdots \; - \frac{20}{3}(x-3)^3 \quad ...(iii)$$

(*i*) (*a*) *Deflection under first load i.e., at point C*. This is obtained by substituting $x = 1$ in equation (*iii*) upto the first dotted line (as the point *C* lies in the first part of the beam). Hence, we get

$$EI.\,y_c = 10 \times 1^3 - 163.33 \times 1$$
$$= 10 - 163.33 = -153.33 \text{ kNm}^3$$
$$= -153.33 \times 10^3 \text{ Nm}^3$$
$$= -153.33 \times 10^3 \times 10^9 \text{ Nmm}^3$$
$$= -153.33 \times 10^{12} \text{ Nmm}^3$$

$$\therefore \quad y_c = \frac{-153.33 \times 10^{12}}{EI} = \frac{-153.33 \times 10^{12}}{2 \times 10^5 \times 85 \times 10^6} \text{ mm}$$
$$= \mathbf{-9.019 \text{ mm.}}$$ **Ans.**

(Negative sign shows that deflection is downwards).

(*b*) *Deflection under second load i.e. at point D*. This is obtained by substituting $x = 3$ m in equation (*iii*) upto the second dotted line (as the point *D* lies in the second part of the beam). Hence, we get

$$EI.y_D = 10 \times 3^3 - 163.33 \times 3 - 8(3-1)^3$$
$$= 270 - 489.99 - 64 = -283.99 \text{ kNm}^3$$
$$= -283.99 \times 10^{12} \text{ Nmm}^3$$

$$\therefore \quad y_D = \frac{-283.99 \times 10^{12}}{2 \times 10^5 \times 85 \times 10^6} = \mathbf{-16.7 \text{ mm.}}$$ **Ans.**

(*ii*) *Maximum Deflection*. The deflection is likely to be maximum at a section between *C* and *D*. For maximum deflection, $\frac{dy}{dx}$ should be zero. Hence equate the equation (*i*) equal to zero upto the second dotted line.

$\therefore \quad 30x^2 + C_1 - 24(x-1)^2 = 0$

or $\quad 30x^2 - 163.33 - 24(x^2 + 1 - 2x) = 0 \quad (\because \; C_1 = -163.33)$

or $\quad 6x^2 + 48x - 187.33 = 0$

The above equation is a quadratic equation. Hence its solution is

$$x = \frac{-48 \pm \sqrt{48^2 + 4 \times 6 \times 187.33}}{2 \times 6} = 2.87 \text{ m.}$$

(Neglecting – ve root)

Now substituting $x = 2.87$ m in equation (*iii*) upto the second dotted line, we get maximum deflection as

$$EIy_{max} = 10 \times 2.87^3 - 163.33 \times 2.87 - 8(2.87-1)^3$$
$$= 236.39 - 468.75 - 52.31$$
$$= 284.67 \text{ kNm}^3 = -284.67 \times 10^{12} \text{ Nmm}^3$$

$$\therefore \quad y_{max} = \frac{-284.67 \times 10^{12}}{2 \times 10^5 \times 85 \times 10^6} = \mathbf{-16.745 \text{ mm.}}$$ **Ans.**

Faculty Signature **HOD**
(Mr. M.Hithesh Sai)

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

23MEC233T - MECHANICS OF SOLIDS

Assignment - I & Assignment - II(5 Marks)

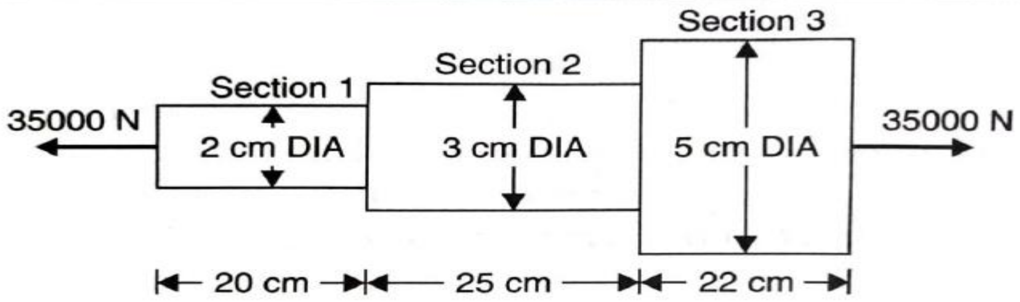
Year/Semester : II/III	**Submission Last Date: 1.8.2025**
Blooms Taxonomy(BT) Level : R-Remembering; U-Understanding; A-Applying; An-Analyzing; E-Evaluating; C-Creating	

Part-A

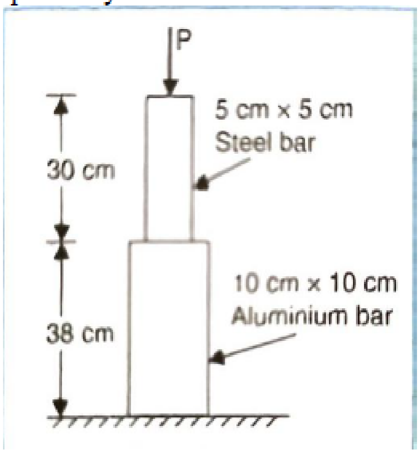
1. Define the Follwing Terms Elasticity & Plasticity
2. Define the following terms: Stress and Strain
3. State Hooke's Law.
4. Define the following terms: Tensile Stress and Compressive stress.
5. Define the following terms: Modulus of Elasticity and Modulus of Rigidity
6. Define the term bars of varying sections.
7. Define thermal stress and thermal strain.
8. State Poisson's Ratio.
9. Define the following terms: Volumetric strain and Bulk Modulus.
10. Define the following terms: Resilience and Strain energy.
11. Define principal planes and principal stresses and state their uses
12. Define & Write a Formula for Stresses on a Inclined Plane under different Uniaxial & Biaxial Condition
13. Define a Mohr's Circle & its Condition
14. Define a Strain Energy Conditions (Gradually,Suddenly,Load with Impact)

Part-B

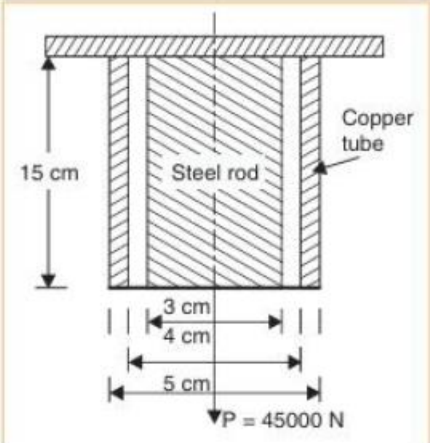
1. An axial pull of 35000 N is acting on a bar consisting of three lengths as shown in Figure If the Young's modulus = 2.1 x 10^5 N/mm²,
determine :
(i) stresses in each section and
(ii) total extension of the bar.



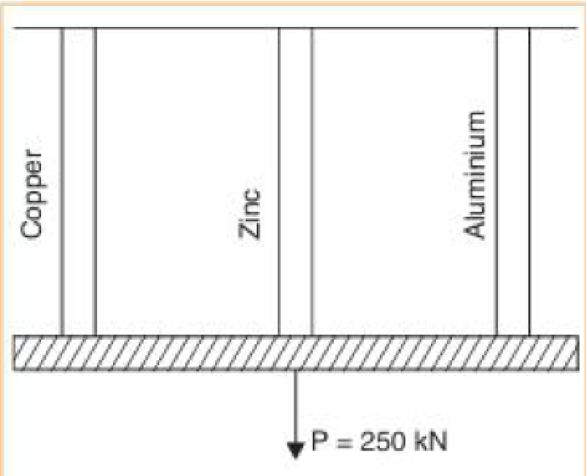
2. A member formed by connecting a steel bar to an aluminium bar is shown in Figure Assuming that the bars are prevented from buckling sideways, calculate the magnitude of force P that will cause the total length of the member to decrease 0.25 mm. The values of elastic modulus for steel and aluminium are 2.1 x 10^5 N/mm² and 7 x 10^4 N/mm² respectively.



3. A steel rod of 3 cm diameter is enclosed centrally in a hollow copper tube of external diameter 5 cm and internal diameter of 4 cm. The composite bar is then subjected to an axial pull of 45000 N. If the length of each bar is equal to 15 cm, determine :
(i) The stresses in the rod and tube, and
(ii) Load carried by each bar. Take E for steel = 2.1 × 10^5 N/mm^2 and for copper = 1.1 × 10^5 N/mm^2.



4. Three bars made of copper, zinc and aluminium are of equal length and have cross-section 500, 750 and 1000 square mm respectively. They are rigidly connected at their ends. If this compound member is subjected to a longitudinal pull of 250 kN, estimate the proportional of the load carried on each rod and the induced stresses. Take the value of E for copper = 1.3 × 10^5 N/mm2, for zinc = 1.0 × 10^5 N/mm2 and for aluminium = 0.8 × 10^5 N/mm^2



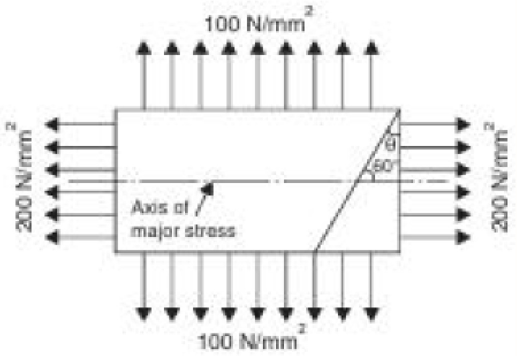
5. A rod is 2 m long at a temperature of 10°C. Find the expansion of the rod, when the temperature is raised to 80°C. If this expansion is prevented, find the stress induced in the material of the rod. Take E = 1.0 × 10^5 MN/m2 and α = 0.000012 per degree centigrade

6. A steel rod of 3 cm diameter and 5 m long is connected to two grips and the rod is maintained at a temperature of 95°C. Determine the stress and pull exerted when the temperature falls to 30°C, if
(i) the ends do not yield, and
(ii) the ends yield by 0.12 cm.

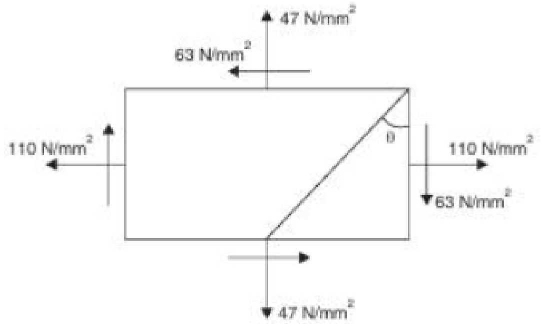
7. (a) Determine the value of Young's modulus and Poisson's ratio of a metallic bar of length 30 cm, breadth 4 cm and depth 4 cm when the bar is subjected to an axial compressive load of 400 kN. The decrease in length is given as 0.075 cm and increase in breadth is 0.003 cm.
(b) Determine the Poisson's ratio and bulk modulus of a material, for which Young's modulus is 1.2 × 10^5 N/mm^2 and modulus of rigidity is 4.8 × 10 ^4 N/mm^2.

8. (a)A bar is subjected to uniaxial tensile stress of 100 MPa along x-axis.
Find the normal and shear stresses on a plane inclined at 30° to x-axis.
(b) A rectangular element is subjected to stresses: σx = 80 MPa (tensile), σy = 40 MPa (compressive), and τxy = 0. Find normal and shear stress on a plane inclined at 45°.

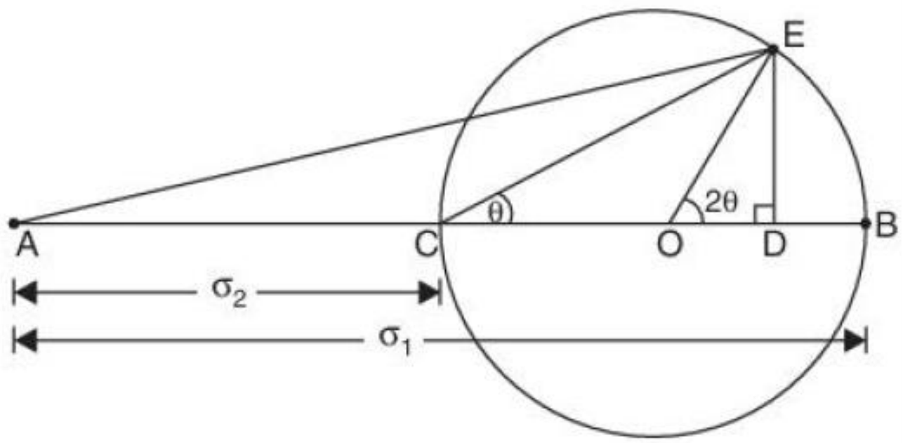
9. The stresses at a point in a bar are 200 N/mm2 (tensile) and 100 N/mm2 (compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 60° to the axis of the major stress. Also determine the maximum intensity of shear stress in the material at the point.



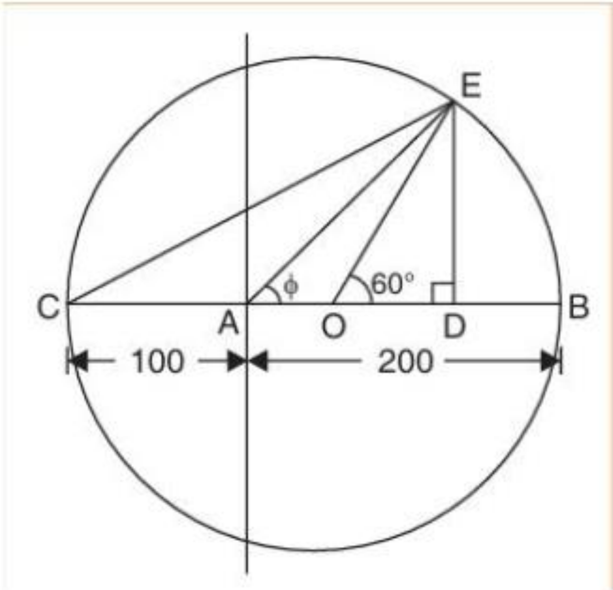
10.A rectangular block of material is subjected to a tensile stress of 110 N/mm^2 on one plane and a tensile stress of 47 N/mm^2 on the plane at right angles to the former. Each of the above stresses is accompanied by a shear stress of 63 N/mm^2 and that associated with the former tensile stress tends to rotate the block anticlockwise. Find : (i)the direction and magnitude of each of the principal stress



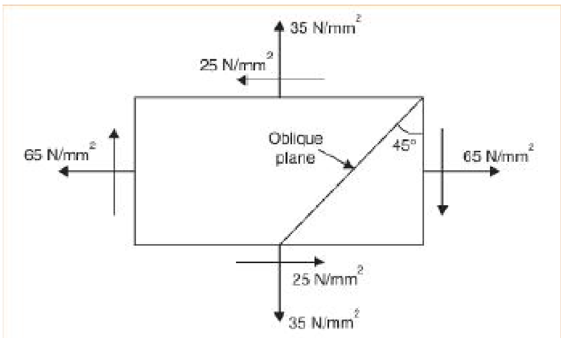
11.(a) Solve problem by using Mohr's circle method.

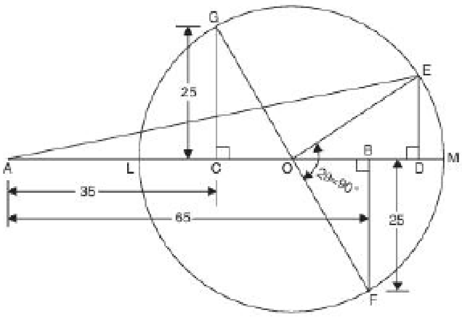


(b) Solve problem by using Mohr's circle method.



12 . A point in a strained material is subjected to stresses shown in Fig. 3.24. Using Mohr's circle method, determine the normal and tangential stresses across the oblique plane. Check the answer analytically.





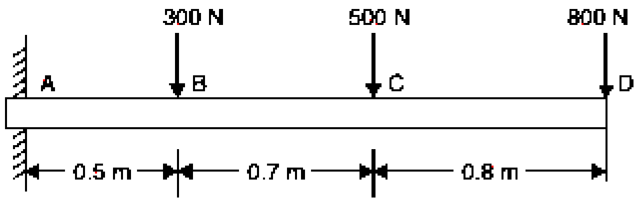
13 . A tensile load of 60 kN is gradually applied to a circular bar of 4 cm diameter and 5 m long. If the value of E = 2.0 × 10^5 N/mm2,
determine : (i) stretch in the rod,
(iii) stress in the rod,
(iv) (iii) strain energy absorbed by the rod

14 . The tensile load of 60 kN is applied suddenly determine:
(i) maximum instantaneous stress induced,
(ii) instantaneous elongation in the rod, and
(iii) strain energy absorbed in the rod.

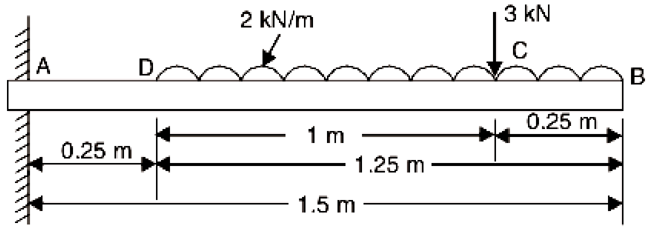
15. A load of 100 N falls through a height of 2 cm onto a collar rigidly attached to the lower end of a vertical bar 1.5 m long and of 1.5 cm2 cross-sectional area. The upper end of the vertical bar is fixed. Determine :
(i)maximum instantaneous stress induced in the vertical bar,
(ii)maximum instantaneous elongation, and
(iii)strain energy stored in the vertical rod.

16.

a) A cantilever beam of length 2 m carries the point loads as shown in Figure. Draw the shear force and B.M. diagrams for the cantilever beam.

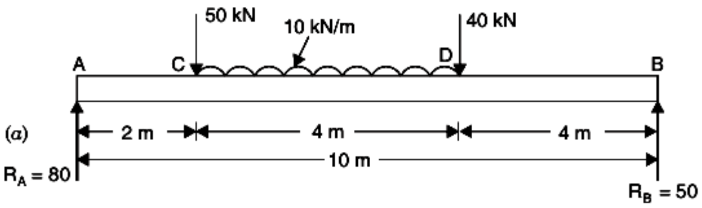


b) A cantilever 1.5 m long is loaded with a uniformly distributed load of 2kN/m run over a length of 1.25 m from the free end. It also carries a point load of 3 kN at a distance of 0.25 m from the free end. Draw the shear force and bending moment diagrams of the cantilever.

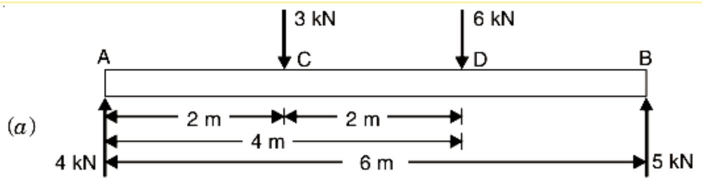


17.

a) A simply supported beam of length 10 m, carries the uniformly distributed load and two point loads as shown in Figure. Draw the S.F. and B.M. diagram for the beam. Also calculate the maximum bending moment.

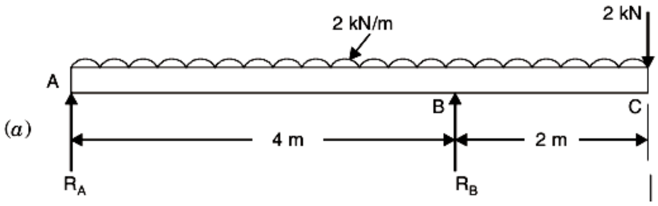


b) A simply supported beam of length 6 m, carries point load of 3 kN and6kN at distances of 2 m and 4 m from the left end. Draw the shear force and bending moment diagrams for the beam

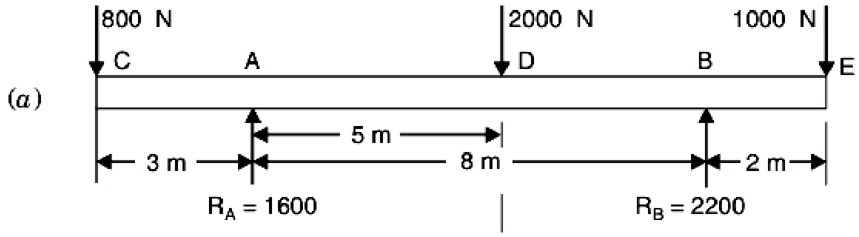


18.

a) Draw the S.F. and B.M. diagrams for the overhanging beam carrying uniformly distributed load of 2 kN/m over the entire length and a point load of 2 kN as shown in Fig. 6.36. Locate the point of contraflexure.



b) Draw the S.F. and B.M. diagrams for the beam which is loaded as shown in Fig. 6.38. Determine the points of contraflexure within the span AB.



17.

Sources : University Questions & Competitive questions.

Book Source:

Engineering MECHANICS OF SOLIDS , PK Nag, 5/e, Tata McGraw-Hill Education Pvt. Ltd., Noida, 2013.

MECHANICS OF SOLIDS -An Engineering Approach, Yunus Cengel and Boles, 4/e, Tata McGraw-Hill Education Pvt. Ltd., Noida, 2004.

Web Sources:

https://swayam.gov.in/nd1_noc19_me56/preview
https://www.classcentral.com/course/nptel-engineering-MECHANICS OF SOLIDS -7904
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SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DATA SHEET

PROGRAM: **MECHANICAL ENGINEERING**	DEGREE: **II B.Tech**
COURSE: **MECHANICS OF SOLIDS**	SEMESTER: **III** CREDITS: **3**
COURSE CODE: 23MEC232T REGULATION: **R23**	COURSE TYPE: **CORE**
COURSE AREA/DOMAIN: MECHANICS	CONTACT HOURS (Periods/Week) : **L – 3 T – 1 P/D - 0**
CORRESPONDING LAB COURSE CODE :- 23MEC235L	LAB COURSE NAME :- **MECHANICS OF SOLIDS**

SYLLABUS:

UNIT	DETAILS	HOURS
1	**SIMPLE STRESSES & STRAINS**: Elasticity and plasticity Types of stresses & strains-Hooke's law-stress-strain diagram for mild steel - Working stress-Factor of safety Lateral strain, Poisson's ratio & volumetric strain-Bars of varying section composite bars-Temperature stresses- Complex Stresses Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses Mohr's circle - Relation between elastic constants, Strain energy - Resilience - Gradual, sudden, impact and shock loadings.	**9**
2	**SHEAR FORCE AND BENDING MOMENT :** Definition of beam-Types of beams - Concept of shear force and bending moment-S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads - Point of contra flexure-Relation between S.F. B.M and rate of loading at a section of a beam.	**9**
3	**FLEXURAL STRESSES & SHEAR STRESSES :**Theory of simple bending. Derivation of bending equation, Determination of bending stresses section modulus of rectangular, circular, I and T sections-Design of simple beam sections. Derivation of formula Shear stress distribution across various beams sections like rectangular, circular, triagular, I and T sections.	**9**
4	**DEFLECTION OF BEAMS & TORSION :**Bending into a circular arc slope, deflection and radius of curvature - Differential equation for the clastic line of a beam - Double integration and Macaulay's methods - Determination of scope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method-application to simple cases. Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.	**9**
5	**THIN AND THICK CYLINDERS & COLUMNS:** Thin spherical cylindrical shells Derivation of formula for longitudinal and circumferential stresses hoop, longitudinal and volumetric strains changes in dia, and volume of thin cylinders- Thin spherical shells. Wire wound thin cylinders. Lame's equation cylinders subjected to inside & outside pressures compound cylinders. Buckling and Stability, Colunıns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula	**9**
	TOTAL HOURS	**45**

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES.

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE OUTCOMES:

On successful completion of the course, students will be able to		POs
CO1	Learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components	**PO1, PO2, PO3, PO4**
CO2	Analyze beams and draw correct and complete shear and bending moment diagrams for beams.	**PO1, PO2, PO3, PO4**
CO3	Apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, and moments.	**PO1, PO2, PO3, PO4**
CO4	Model and analyze the behavior of basic structural members subjected to various loads.	**PO1, PO2, PO3, PO4**
CO5	Design and analysis of Industrial components like pressure vessels.	**PO1, PO2, PO3, PO4**

TEXT BOOKS:

1. Dr.B.C.Punmia, Dr.Arun Kumar Jain, Er.Ashok Kumar Jain, “Mechanics of Materials”, Laxmi Publications (P) Ltd., New Delhi, 12/e, 2017.
2. S. Ramamrutham and R.Narayanan, “Strength of Materials”, DhanpatRai Publishing Company (P) Ltd., New Delhi, 20/e, 2020.
3. GH Ryder,Strength of materials, Palgrave Macmillan publishers India Ltd, 1961.

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1. Gere &Timoshenko, Mechanics of Materials, 2/e, CBS publications, 2004.
2. U.C.Jindal, Strength of Materials, 2/e, Pearson Education, 2017.
3. Timoshenko, Strength of Materials Part – I& II, 3/e, CBS Publishers, 2004.
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7. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Sanjeev Sanghi, “Mechanics of Materials”, McGraw-Hill Education Pvt. Ltd., Noida, 8/e, 2020.

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2. https://youtube/iY_ypychVNY?si=310htc4ksTQJ8Fv6
3. https://www.youtube.com/watch?v=WEy939Rkd_M&t=2s
4. https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204
5. https://www.coursera.org/learn/mechanics-1
6. https://www.edx.org/learn/engineering/massachusetts-institute-of-technology
7. mechanical-behavior-of-materials-part-1-linear-elastic-behavior
8. https://archive.nptel.ac.in/courses/112/107/112107146

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	2	2	2	-	-	-	-	-	-	-	-
CO.2	3	2	2	2	-	-	-	-	-	-	-	-
CO.3	3	2	2	2	-	-	-	-	-	-	-	-
CO.4	3	2	2	2	-	-	-	-	-	-	-	-
CO.5	3	2	2	2	-	-	-	-	-	-	-	-
CO*	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-

Faculty Signature:

Faculty Name : Mr. M.Hithesh Sai **(HOD)**