Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY

COURSE PLAN

Academic Year 2019 - 2020

Program:	B E – Civil Engineering
Semester :	3
Course Code:	18CV32
Course Title:	Strength of Materials
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	50
Course Plan Author:	SHIVASHANKAR R

Academic Evaluation and Monitoring Cell

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Note : Remove "Table of Content" before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	Civil Engineering	Program:	B.E
Year / Semester :	2019/III	Academic Year:	2019-20
Course Title:	Strength of Materials	Course Code:	18CV32
Credit / L-T-P:	04	SEE Duration:	180 Minutes
Total Contact Hours:	50	SEE Marks:	60 Marks
CIA Marks:	40	Assignment	1 / Module
Course Plan Author:	SHIVASHANKAR R	Sign	Dt:
Checked By:	MOHAN K T	Sign	Dt:
CO Targets	CIA Target : 73%	SEE Target:	40 %

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	**Simple Stresses and Strain**: Introduction, Definition and concept and of stress and strain. Hooke's law, Stress-Strain diagrams for ferrous and non-ferrous materials, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Elongation due to self-weight. Saint Venant's principle, Compound bars, Temperature stresses, Compound section subjected to temperature stresses, state of simple shear, Elastic constants and their relationship	10 (5, 5)	Stress and Strain	Understand L2 Apply L3
2	**Compound Stresses**: Introduction, state of stress at a point, General two dimensional stress system, Principal stresses and principal planes. Mohr's circle of stresses. Theory of failures: Max. Shear stress theory and Max. principal stress theory. **Thin and Thick Cylinders**: Introduction, Thin cylinders subjected to internal pressure; Hoop stresses, Longitudinal stress and change in volume. Thick cylinders subjected to both internal and external pressure; Lame's equation, radial and hoop stress distribution.	10 (5, 5)	2D Stress System Cylinders	Analyze L4
3	**Shear Force and Bending Moment in Beams**: Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, Sign conventions, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to points load, uniformly distributed loads, uniformly varying loads, couple and their combinations.	10 (5, 5)	Shear Force and Bending moment	Understand L2 Analyze L4
4	**Bending and Shear Stresses in Beams**: Introduction, pure bending theory, Assumptions, derivation of bending equation, modulus of rupture, section modulus, flexural rigidity. Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections. Shear centre (only concept). **Torsion in Circular Shaft**: Introduction, pure torsion, Assumptions, derivation of torsion equation for circular shafts, torsional rigidity and polar modulus Power transmitted by a shaft.	10 (5, 5)	Bending Stress And Torsion	Analyze L4
5	**Deflection of Beams:** Definition of slope, Deflection and curvature, Sign conventions, Derivation of moment curvature equation. Double integration method and Macaulay's	10 (5, 5)	Deflection of beam Columns and	Understand L2 Analyze L4

	method: Slope and deflection for standard loading cases and for determinate prismatic beams subjected to point loads, UDL, UVL and couple. **Columns and Struts**: Introduction, short and long columns. Euler's theory; Assumptions, Derivation for Euler's Buckling load for different end conditions, Limitations of Euler's theory. Rankine-Gordon's formula for columns.		Strut	
-	**Total**	**50**	-	-

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	-	-
1, 2, 3, 4, 5	B.S. Basavarajaiah, P.Mahadevappa "Strength of Materials" in SI Units, University Press (India) Pvt. Ltd., 3 rd Edition, 2010.	1, 2, 3, 4	In Dept
1, 2, 3, 4, 5	R K Bansal, "A Textbook of Strength of Materials", 4th Edition, Laxmi Publications, 2010	1,2, 3, 4	In dept
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
1, 2	D.H. Young, S.P. Timoshenko " Elements of Strength of Materials" East West Press Pvt. Ltd., 5 th Edition (Reprint 2014)		In Lib
1, 2	Ferdinand P. Beer, E. Russell Johnston and Jr.John T. DeWolf "Mechanics of Materials", Tata McGraw-Hill, Third Edition, SI Units.		Not Available
3, 4, 5	S.S. Rattan " Strength of Materials" McGraw Hill Education (India) Pvt. Ltd., 2nd Edition (Sixth reprint 2013)		In lib
C	**Concept Videos or Simulation for Understanding**	-	-
C1	https://youtu.be/GkFgysZC4Vc		
D	**Software Tools for Design**	-	-
E	**Recent Developments for Research**	-	-
F	**Others (Web, Video, Simulation, Notes etc.)**	-	-
?			

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
3	18CIV14	Elements of Civil Engineering and Mechanics	Beams, Loads, Supports, Centroid and Moment of Inertia	1	-	Understand L2

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
3	Knowledge of Shear force and bending moment diagrams	Higher Study		Understand L2

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Modules	Course Code.#	Course Outcome **At the end of the course, student should be able to . . .**	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	18cv32.1	understand one dimensional stresses and strains	5	Stress and Strain	Lecture	CIA and Assignment	Understand L2
1	18cv32.2	apply simple stresses and strains on engineering materials	5	Stress and Strain	Lecture/ Tutorial	CIA and Assignment	Apply L3
2	18cv32.3	analyse 2D compound stress system and plotting principal stresses and planes by using mohr's circle	5	2D Stress System	Lecture	CIA and Assignment	Analyze L4
2	18cv32.4	analyse the thin and thick cylinders subjected to internal and external pressures and draw stress distribution patterns	5	Cylinders	Lecture	CIA and Assignment	Analyze L4
3	18cv32.5	plot shear force and bending moment diagrams for statically determinate beams	5	Shear Force and Bending moment	Lecture	CIA and Assignment	Analyze L4
3	18cv32.6	understand the behaviour of statically determinate beams under external loads	5	Shear Force and Bending moment	Lecture/ Tutorial	CIA and Assignment	Understand L2
4	18cv32.7	plot combined shear and bending stresses distribution for circular, rectangular and T geometric sections	5	Bending Stress	Lecture/ Tutorial	CIA and Assignment	Analyze L4
4	18cv32.8	analyse the circular shafts under torsion and its behaviour in combined bending and torsion criteria	5	Torsion in shaft	Lecture/ Tutorial	CIA and Assignment	Analyze L4
5	18cv32.9	Deflection and curvature of beam	5	Deflection of beam	Lecture	CIA and AssignmentAnalyze L4	Analyze L4
5	18cv32.10	analyse the behaviour of columns and struts under buckling load and end conditions	5	Buckling of columns	Lecture	CIA and Assignment	Analyze L4
-	-	**Total**	**50**	-	-	-	**L2-L4**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Engineering materials	CO1	L2
1	Helpful to suggest suitable material in the field of construction and manufacturing	CO2	L3

2	Elasticity and Plasticity	CO3	L4
2	Oil and gas industries	CO4	L4
3	Designing and construction fields	CO5	L4
3	Structural behaviour under the application of loads/Structural analysis	CO6	L2
4	Designing and construction sites of engineering materials	CO7	L4
4	Infrastructure development	CO8	L4
5	Engineering constructions and machinaries	CO9	L4
5	Research methodology	CO10	L2

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	**-**	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	**-**
1	CO1	PO1	1	Knowledge of engineering fundamentals is required to understand one dimensional stress and strain.	L2
1	CO2	PO1	1	Knowledge of engineering fundamentals is required to understand simple stress and strain on materials.	L3
1	CO2	PO2	1	Problem analysis of simple stress and strain on material is required	L3
2	CO3	PO1	1	Knowledge of engineering fundamentals is required to understand 2D compound stress system	L4
2	CO3	PO2	1	To analyse problem on 2D compound stress system and plotting principal stresses and planes by using mohr's circle	L4
2	CO4	PO1	1	Knowledge of engineering fundamentals is required to understand thick and thin cylinders.	L4
2	CO4	PO2	1	To analyse the thin and thick cylinders subjected to internal and external pressures	L4
2	CO4	PO3	1	Design thin and thick cylinders subjected to internal and external pressures	L4
3	CO5	PO1	1	Knowledge of engineering fundamentals is required to understand shear force and bending moment.	L4
3	CO5	PO2	1	To plot shear force and bending moment diagrams for statically determinate beams	L4
3	CO6	PO1	1	Knowledge of engineering fundamentals is required to understand behaviour of statically determinate beams under external loads	L2
3	CO6	PO2	1	Should analyze the behaviour of statically determinate beams under external loads.	L2
4	CO7	PO1	1	Knowledge of engineering fundamentals is required to understand combined shear and bending stresses	L4
4	CO7	PO2	1	To plot combined shear and bending stresses distribution for circular, rectangular and T geometric sections	L4
4	CO7	PO3	1	Design circular, rectangular and T geometric sections.	L4
4	CO8	PO1	1	Knowledge of engineering fundamentals is required to understand buckling of columns.	L4
4	CO8	PO2	1	To analyse the behaviour of columns and struts under buckling load and end conditions	L4
4	CO8	PO3	1	Design circular and rectangular column for various end condition.	L4
5	CO9	PO1	1	Knowledge of engineering fundamentals is required to understand torsion in circular shaft.	L4
5	CO9	PO2	1	To analyse the circular shafts under torsion.	L4
5	CO9	PO3	1	To design the circular shafts.	L4
5	CO10	PO1	1	Should have knowledge to understand the theory of failures.	L2
5	CO10	PO2	1	To analyze the failure theories of circular shafts under torsion phenomenon	L2

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes															-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Level
1	18cv32.1	understand one dimensional stresses and strains	1	-	-	-	-	-	-	-	-	-	-	-				L3
1	18cv32.2	apply simple stresses and strains on engineering materials	2	2	-	-	-	-	-	-	-	-	-	-				L4
2	18cv32.3	analyse 2D compound stress system and plotting principal stresses and planes by using mohr's circle	2	2	-	-	-	-	-	-	-	-	-	-				L4
2	18cv32.4	analyse the thin and thick cylinders subjected to internal and external pressures and draw stress distribution patterns	2	2	2	-	-	-	-	-	-	-	-	-				L4
3	18cv32.5	plot shear force and bending moment diagrams for statically determinate beams	2	2	-	-	-	-	-	-	-	-	-	-				L4
3	18cv32.6	understand the behaviour of statically determinate beams under external loads	1	1	-	-	-	-	-	-	-	-	-	-				L4
4	18cv32.7	plot combined shear and bending stresses distribution for circular, rectangular and T geometric sections	2	2	2	-	-	-	-	-	-	-	-	-				L4
4	18cv32.8	analyse the circular shafts under torsion and its behaviour in combined bending and torsion criteria	2	2	2	-	-	-	-	-	-	-	-	-				L4
5	18cv32.9	Deflection and curvature of beam	2	2	2	-	-	-	-	-	-	-	-	-				L4
5	18cv32.10	analyse the behaviour of columns and struts under buckling load and end conditions	1	1	-	-	-	-	-	-	-	-	-	-				L4
-	**18cv32PC**	**Average attainment (1, 2, or 3)**	**1.7**	**1.8**	**2**													**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1						
1						
2						
2						
3						
3						
4						
4						
5						
5						

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Simple Stresses and Strains	10	2	-	-	1	1	2	CO1, CO2	L3
2	Compound Stresses, Thin and Thick Cylinders	10	2	-	-	1	1	2	CO3, CO4	L4
3	Shear Force and Bending Moment in beams	10	-	2	-	1	1	2	CO5, CO6	L2, L4
4	Bending and Shear Stresses in Beams Torsion in Circular Shaft	10	-	2	-	1	1	2	CO7, C08	L2, L4
5	Deflection of Beams , Columns and Struts	10	-	-	4	1	1	2	CO9, CO10	L2, L4
-	**Total**	**50**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels
1,2	CIA Exam – 1	30	CO1, CO2, CO3, CO4	L2, L3, L2, L4
3,4	CIA Exam – 2	30	CO5, CO6, CO7, C08	L2, L4, L2, L4
5	CIA Exam – 3	30	CO9, CO10	L2, L4
1,2	Assignment - 1	10	CO1, CO2, CO3, CO4	L2, L3, L2, L4
3,4	Assignment - 2	10	CO5, CO6, CO7, CO8	L2, L4, L2, L4
5	Assignment - 3	10	CO9, CO10	L2, L4
	Final CIA Marks	**40**	**-**	**-**

D1. TEACHING PLAN - 1

Module - 1

Title:	Simple Stresses and Strains	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	understand one dimensional stresses and strains	CO1	L2
2	apply simple stresses and strains on engineering materials	CO2	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction.	C01	L2
2	Definition and concept and of stress and strain.		
3	Hooke's law, Stress-Strain diagrams for ferrous and non-ferrous materials, factor of safety.		
4	Elongation of tapering bars of circular and rectangular cross sections.		
5	Elongation due to self weight.		
6	Saint Venant's principle, Compound bars.	C02	L3
7	Temperature stresses.		
8	Compound section subjected to temperature stresses.		
9	state of simple shear.		
10	Elastic constants and their relationship.		
c	**Application Areas**	**CO**	**Level**
1	Engineering material	CO1	L2
2	Helpful to suggest suitable material in the field of construction and manufacturing	CO2	L3
d	**Review Questions**	-	-
1	A 25mm square-cross-section bar of length 300mm carries an axial compressive load of 50kN. Determine the stress set up in the bar and its change of length when the load is applied. For the bar material E = 200GN/m 2.	CO2	L3
2	Define the terms shear stress and shear strain, illustrating your answer by means of a simple sketch. Two circular bars, one of brass and the other of steel, are to be loaded by a shear load of 30 kN. Determine the necessary diameter of the bars (a) in single shear, (b) in double shear, if the shear stress in the two materials must not exceed 50 MN/m 2 and 100 MN/Sq.mm respectively.	CO2	L3
3	A steel tube, 25 mm outside diameter and 12 mm inside diameter, carries an axial tensile load of 40 kN. What will be the stress in the bar? What further increase in load is possible if the stress in the bar is limited to 225 MN/Sq.mm	CO2	L3
4	A test piece is cut from a brass bar and subjected to a tensile test. With a load of 6.4 kN the test piece, of diameter 11.28 mm, extends by 0.04 mm over a gauge length of 50 mm. Determine: (i) the stress, (ii) the strain, (iii) the modulus of elasticity.	CO2	L3
5	A bar ABCD consists of three sections: AB is 25 mm square and 50 mm long, BC is of 20 mm diameter and 40 mm long and CD is of 12 mm diameter and 50 mm long. Determine the stress set up in each section of the bar when it is subjected to an axial tensile load of 20 kN. What will be the total extension of the bar under this load? For the bar material, E = 210 GN/m 2.	CO2	L3
e	**Experiences**	-	-
1			
2			
3			

4			
5			

Module – 2

Title:	Compound Stresses, Thin and Thick Cylinders	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Student should be able to analyse 2D compound stress system and plotting principal stresses and planes by using mohr's circle	CO3	L4
2	Student should be able to analyse the thin and thick cylinders subjected to internal and external pressures and draw stress distribution patterns	CO4	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
11	Introduction, state of stress at a point.	CO3	L4
12	General two dimensional stress system.		
13	Principal stresses and principal planes.		
14	Mohr's circle of stresses.		
15	Introduction,	CO4	L4
16	Thin cylinders subjected to internal pressure; Hoop stresses.		
17	Longitudinal stress and change in volume.		
18	Thick cylinders subjected to both internal and external pressure.		
19	Lame's equation.		
20	Radial and hoop stress distribution.		
c	**Application Areas**	**CO**	**Level**
1	Elasticity and Plasticity	CO3	L4
2	Oil and gas industries	CO4	L4
d	**Review Questions**	-	-
1	Define : i) Principal stresses ii) Principal planes.	CO3	L4
2	Show that principal planes and maximum shearing planes are inclined at 45˚ with each.	CO3	L4
3	Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60˚ to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.	CO3	L4
4	Derive expressions for principal stresses and their planes for two dimensional stress systems.	CO3	L4
5	Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.	CO3	L4
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	18CV32	Sem:	III	Marks:	30	Time:	75 minutes
Course:	Strength of Materials						

-	-	Note: Answer any 3 questions, each carry equal marks.	Marks	CO	Level
1	a	Define i) stress ii) strain iii) modulus of elasticity.	03	CO1	L3
	b	Determine the value and total deformation of stepped bar. Take E= 2.1×10^5 N/mm².	12	CO1	L4
		OR			
2	a	Derive an expression for the deformation of tapering circular bar subjected to axial force.	08	CO2	L4
	b	A brass tube 100 mm diameter and 10 mm thick is enclosed in a steel tube 120 mm diameter and 10 mm thick. Both the tubes are rigidly fixed to each other and carries an axial load of 3000 kN. The tubes are of same length 3 m. Determine the load carried and stress induced in each material. Also determine the amount by which it shortens. Es = 200 kN / mm² & E_B =100 kN/mm².	07	CO2	L3
3	a	Name and Define Elastic constants.	04	CO3	L2
	b	A steel tie rod 40mm in diameter and 2m long is subjected to a pull of 80 kN. To what length the bar should be bored centrally so that the total extension will increase by 20% under the same pull, the bore being 20mm diameter. Take E=2×10^5 N/mm².	11	CO3	L4
		OR			
4	a	Derive relationship b/w Young's Modulus and rigidity Modulus	08	CO4	L3
	b	A compound bar made of steel plate 60mm wide and 10mm thick to which the copper plate 60mm wide and 5mm thick are rigidly connected to each other. The length of the bar is 0.7m.If the temperature is raised by 80°C. Determine the stress in each metal and the change in length. Take: Es = 200 GPa and α_s= 12 x 10^{-6}/°C Ecu = 100 GPa and α_{cu} = 17 x 10^{-6}/°C	07	CO4	L4

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	18CV32	Sem:	III	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Strength of Materials						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
2		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3
3		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
4		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
5		A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of l.6 kN, if the movement at the signal end is to be 250 mm. Assume 'E'	5	CO2	L3
6		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
7		Show that principal planes and maximum shearing planes are inclined at 45° with each.	5	CO3	L4
8		Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60° to major principal stress plane, when the bar is subjected to principal stresses at a	5	CO3	L4

		point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.			
9		Derive expressions for principal stresses and their planes for two dimensional stress systems.	5	CO3	L4
10		Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.	5	CO3	L4
11		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
12		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3
13		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
14		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
15		A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume ‘E’	5	CO2	L3
16		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
17		Show that principal planes and maximum shearing planes are inclined at 45˚ with each.	5	CO3	L4
18		Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60˚ to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.	5	CO3	L4
19		Derive expressions for principal stresses and their planes for two dimensional stress systems.	5	CO3	L4
20		Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.	5	CO3	L4
21		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
22		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3
23		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
24		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
25		A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume ‘E’	5	CO2	L3
26		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
27		Show that principal planes and maximum shearing planes are inclined at 45˚ with each.	5	CO3	L4
28		Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60˚ to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.	5	CO3	L4
29		Derive expressions for principal stresses and their planes for two dimensional stress systems.	5	CO3	L4
39		Define: i) Principal stresses,	5	CO3	L4

		ii) Critical planes, iii) Principal planes.			
31		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
32		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3
33		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
34		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
35		A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume 'E'	5	CO2	L3
36		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
37		Show that principal planes and maximum shearing planes are inclined at 45° with each.	5	CO3	L4
38		Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60° to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.	5	CO3	L4
39		Derive expressions for principal stresses and their planes for two dimensional stress systems.	5	CO3	L4
40		Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.	5	CO3	L4
41		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
42		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3
43		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
44		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
45		A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume 'E'	5	CO2	L3
46		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
47		Show that principal planes and maximum shearing planes are inclined at 45° with each.	5	CO3	L4
48		Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60° to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.	5	CO3	L4
49		Derive expressions for principal stresses and their planes for two dimensional stress systems.	5	CO3	L4
50		Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.	5	CO3	L4
51		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
52		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3

53		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
54		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
55		A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume 'E'	5	CO2	L3
56		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
57		Show that principal planes and maximum shearing planes are inclined at 45° with each.	5	CO3	L4
58		Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60° to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.	5	CO3	L4
59		Derive expressions for principal stresses and their planes for two dimensional stress systems.	5	CO3	L4
60		Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.	5	CO3	L4
61		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
62		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3
63		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
64		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
65		A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume 'E'	5	CO2	L3
66		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
67		Show that principal planes and maximum shearing planes are inclined at 45° with each.	5	CO3	L4
68		Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60° to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.	5	CO3	L4
69		Derive expressions for principal stresses and their planes for two dimensional stress systems.	5	CO3	L4
70		Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.	5	CO3	L4
71		Define i) stress ii) strain iii) modulus of elasticity.	5	CO1	L2
72		Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.	5	CO2	L3
73		A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.	5	CO2	L3
74		Briefly explain the behaviour of ductile material under gradually increasing tensile load	5	CO1	L2
75		A signal is being worked by a steel wire 750 m long and 6 mm	5	CO2	L3

		in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume 'E'			
76		Define : i) Principal stresses ii) Principal planes.	5	CO3	L4
77		Show that principal planes and maximum shearing planes are inclined at 45° with each.	5	CO3	L4

D2. TEACHING PLAN - 2

Module – 3

Title:	Shear Force and Bending Moment in beams	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Student should be able to plot shear force and bending moment diagrams for statically determinate beams	CO5	L4
2	Student should be able to understand the behaviour of statically determinate beams under external loads	CO6	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction to types of beams.	C6	L2
2	Supports and loadings.		
3	Definition of bending moment and shear force, Sign conventions.		
4	Relationship between load intensity.		
5	Bending moment and shear force.	C5	L4
6	Shear force and bending moment diagrams for statically determinate beams subjected to points load.		
7	Numericals.		
8	Shear force and bending moment diagrams for statically determinate beams subjected to uniformly distributed loads.		
9	Shear force and bending moment diagrams for statically determinate beams subjected to uniformly varying loads.		
10	Shear force and bending moment diagrams for statically determinate beams subjected to couple and their combinations.		
c	**Application Areas**	**CO**	**Level**
1	Designing and construction fields	CO5	L4
2	Structural behaviour under the application of loads/Structural analysis	CO6	L2
d	**Review Questions**	-	-
1	Derive the relationship between BM, SF and intensity of udl.	CO6	L2
2	Define i) Bending moment ii) Point of contraflexure.	CO6	L2
3	A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.	CO5	L4
4	Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	CO6	L2
5	Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	CO5	L4
e	**Experiences**	-	-
1			
2			

3			
4			
5			

Module – 4

Title:	Bending and Shear Stresses in Beams Torsion in Circular Shaft	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	plot combined shear and bending stresses distribution for circular, rectangular and T geometric sections	CO7	L4
2	analyse the behaviour of columns and struts under buckling load and end conditions	CO8	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction, pure bending theory.	CO7	L2
2	Assumptions, derivation of bending equation.	CO7	L2
3	Modulus of rupture, section modulus, flexural rigidity..	CO7	L4
4	Expression for transverse shear stress in beams,	CO7	L4
5	Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections. Shear centre (only concept).	CO7	L4
6	Introduction, pure torsion.	CO8	L2
7	Assumptions.	CO8	L4
8	Derivation of torsion equation for circular shafts.	CO8	L4
9	Torsional rigidity and polar modulus Power transmitted by a shaft.	CO8	L4
10	Combined bending and torsion.	CO8	L4
c	**Application Areas**	**CO**	**Level**
1	Designing and construction sites of engineering materials	CO8	L4
2	Infrastructure development	CO7	L4
d	**Review Questions**	-	-
1	Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	CO7	L4
2	Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	CO7	L4
3	Derive the equation of theory of simple bending with usual notations.	CO7	L4
4	Derive an expression for Euler's crippling load for a column with both ends fixed.	CO8	L4
5	Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?	CO8	L4
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	17CV32	Sem:	III	Marks:	30	Time:	75 minutes
Course:	Strength of Materials						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
1	a	Derive the relationship between intensity of load, shear force and bending moment.	10	CO3	L2
	b	Draw the shear force and bending moment diagrams for the cantilever.	05	CO3	L4
		OR			
2	a	Define i) shear force ii) Bending moment iii) Point of contraflexure	03	CO3	L2
	b	Draw the shear force and bending moment diagrams for the beams.	12	CO3	L4
3	a	For the Cantilever beam, obtain SFD and BMD.	10	CO4	L4
	b	Draw SFD and BMD for the beam loaded. Indicate the values at various points and locate point of contraflexure, if any..	05	CO4	L4
		OR			
4	a	A simply supported beam AB of span ' L ' is subjected to an eccentric point load 'W' a distance of 'a' from left support and 'b' from right support. Develop the general expressions for shear force and bending moment. Draw BMD and SFD.	10	CO4	L2
	b	Draw the shear force and bending moment diagrams for the beams.	05	CO4	L4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions

Crs Code:	17cv32	Sem:	III	Marks:	5	Time:	90 – 120 minutes
Course:	Strength of Materials				Module : 3, 4		

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
2		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
3		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO5	L4
4		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
5		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4
6		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
7		Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	5	CO7	L4
8		Derive the equation of theory of simple bending with usual notations.	5	CO7	L4
9		Derive an expression for Euler's crippling load for a column with both ends fixed.	5	CO8	L4
10		Compare the crippling loads given by Euler's and Rankine's	5	CO8	L4

		formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?			
11		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
12		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
13		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO5	L4
14		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
15		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4
16		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
17		Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	5	CO7	L4
18		Derive the equation of theory of simple bending with usual notations.	5	CO7	L4
19		Derive an expression for Euler's crippling load for a column with both ends fixed.	5	CO8	L4
20		Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?	5	CO8	L4
21		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
22		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
23		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO5	L4
24		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
25		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4
26		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
27		Draw the shear stress diagram for a rectangular beam section	5	CO7	L4

		and show that maximum shear stress is 1.5 times average shear stress.			
28		Derive the equation of theory of simple bending with usual notations.	5	CO7	L4
29		Derive an expression for Euler's crippling load for a column with both ends fixed.	5	CO8	L4
39		Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?	5	CO8	L4
31		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
32		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
33		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO5	L4
34		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
35		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4
36		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
37		Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	5	CO7	L4
38		Derive the equation of theory of simple bending with usual notations.	5	CO7	L4
39		Derive an expression for Euler's crippling load for a column with both ends fixed.	5	CO8	L4
40		Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?	5	CO8	L4
41		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
42		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
43		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO5	L4
44		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
45		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4

46		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
47		Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	5	CO7	L4
48		Derive the equation of theory of simple bending with usual notations.	5	CO7	L4
49		Derive an expression for Euler's crippling load for a column with both ends fixed.	5	CO8	L4
50		Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?	5	CO8	L4
51		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
52		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
53		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO5	L4
54		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
55		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4
56		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
57		Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	5	CO7	L4
58		Derive the equation of theory of simple bending with usual notations.	5	CO7	L4
59		Derive an expression for Euler's crippling load for a column with both ends fixed.	5	CO8	L4
60		Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?	5	CO8	L4
61		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
62		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
63		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the		CO5	L4

		point of contra-flexure if any.			
64		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
65		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4
66		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
67		Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	5	CO7	L4
68		Derive the equation of theory of simple bending with usual notations.	5	CO7	L4
69		Derive an expression for Euler's crippling load for a column with both ends fixed.	5	CO8	L4
70		Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?	5	CO8	L4
71		Derive the relationship between BM, SF and intensity of udl.	5	CO6	L2
72		Define i) Bending moment ii) Point of contraflexure.	5	CO6	L2
73		A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO5	L4
74		Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.	5	CO6	L2
75		Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.	5	CO5	L4
76		Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	5	CO7	L4
77		Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.	5	CO7	L4

D3. TEACHING PLAN - 3

Module – 5

Title:	Deflection of Beams , Columns and Struts	Appr Time:	10Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Deflection and curvature of beam	CO9	L4
2	analyse the behaviour of columns and struts under buckling load and end conditions	CO10	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Definition of slope, Deflection and curvature, Sign conventions,	CO9	L2
2	Derivation of momentcurvature equation. Double integration method and Macaulay's method:	CO9	L4
3	Problems	CO9	L4
4	Slope and deflection for standard loading cases and for determinate prismatic beams subjected to point loads, UDL, UVL and couple.	CO9	L4
5	Problems	CO9	L4
6	Introduction.	CO10	L2
7	Short and long columns. Euler's theory; Assumptions.	CO10	L2
8	Derivation for Euler's Buckling load for different end conditions.	CO10	L4
9	Limitations of Euler's theory.	CO10	L4
10	Rankine-Gordon's formula for columns.	CO10	L4
c	**Application Areas**	**CO**	**Level**
1	Engineering constructions and machinaries	CO9	L4
2	Research methodology	CO10	L2
d	**Review Questions**	-	-
1	Prove the torsional formula, with usual notations.	CO10	L2
2	A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	CO9	L4
3	State the assumptions made in the theory of Pure Torsion.	CO10	L2
4	Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	CO9	L4
5	A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	CO9	L4
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	18CV32	Sem:	III	Marks:	30	Time:	75 minutes
Course:	Strength of Materials						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Define Neutral axis, Section modulus and Moment of resistance.	03	CO9	L2
	b	Derive the equation of theory of simple bending with usual notation or Derive a general bending equation	12	CO9	L2

		OR			
2	a	State assumptions made in simple bending.	05	CO9	L2
	b	A beam simply supported at ends and having cross section (Assumed). is loaded with a udl over a span of 8m. The allowable bending stress in tension is 30 N/mm² and that in compression is 45 N/mm². Determine the maximum value of udl, the beam can carry.	10	CO9	L4
3	a	List the assumptions made in Euler's theory of long coloumns	05	CO10	L2
	b	A coloumn 6m long has both of its ends fixed and has a timber section of 150 mm x 200 mm. Determine the crippling load on the coloumn. Take E=17.5 x 10^3 N/mm².	07	CO10	L4
	c	Differentiate between short and long coloumns	03	CO10	L2
		OR			
4	a	Using Euler's theory, derive an equation for the crippling load of a coloumn pointed or pinned at both ends.	08	CO10	L2
	b	Find the Euler's critical load for a hollow cylindrical cast iron coloumn 150 mm external diameter, 20 mm wall thickness if it is 6m long with hinges at both ends. Assume Young's modulus of cast iron as 80 KN/mm².Compare this load with given by Rankine's formula. using Rankine's constant a=1/1600 and f_c=567 N/mm².	07	CO10	L4

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	18cv32	Sem:	III	Marks:	5	Time:	90 – 120 minutes
Course:	Strength of Materials			Module : 5			
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Prove the torsional formula, with usual notations.	5	CO10	L2
2		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
3		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
4		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
5		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
6		Prove the torsional formula, with usual notations.	5	CO10	L2
7		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
8		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
9		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
10		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
11		Prove the torsional formula, with usual notations.	5	CO10	L2
12		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4

13		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
14		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
15		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
16		Prove the torsional formula, with usual notations.	5	CO10	L2
17		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
18		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
19		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
20		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
21		Prove the torsional formula, with usual notations.	5	CO10	L2
22		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
23		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
24		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
25		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
26		Prove the torsional formula, with usual notations.	5	CO10	L2
27		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
28		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
29		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
39		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
31		Prove the torsional formula, with usual notations.	5	CO10	L2
32		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
33		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
34		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
35		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2

36		Prove the torsional formula, with usual notations.	5	CO10	L2
37		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
38		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
39		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
40		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
41		Prove the torsional formula, with usual notations.	5	CO10	L2
42		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
43		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
44		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
45		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
46		Prove the torsional formula, with usual notations.	5	CO10	L2
47		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
48		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
49		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
50		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
51		Prove the torsional formula, with usual notations.	5	CO10	L2
52		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
53		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
54		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
55		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
56		Prove the torsional formula, with usual notations.	5	CO10	L2
57		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
58		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
59		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2

60		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
61		Prove the torsional formula, with usual notations.	5	CO10	L2
62		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
63		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
64		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
65		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
66		Prove the torsional formula, with usual notations.	5	CO10	L2
67		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
68		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
69		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
70		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
71		Prove the torsional formula, with usual notations.	5	CO10	L2
72		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4
73		State the assumptions made in the theory of Pure Torsion.	5	CO10	L2
74		Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	5	CO10	L2
75		A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.	5	CO9	L2
76		Prove the torsional formula, with usual notations.	5	CO10	L2
77		A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.	5	CO9	L4

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Strength of Materials					Month / Year	May /July 2018	
Crs Code:	18CV32	Sem:	III	Marks:	100	Time:	180 minutes	
-	**Note**	Answer all FIVE full questions. All questions carry equal marks.				**Marks**	**CO**	**Level**
1	a	For a bar of uniform section derive an expression for elongation due to self weight.				16 / 20	CO1	
	b	Evaluate the deformation of the bar, given, El = E2 = E3 = 200GPa.					C01	

		OR			
2	a	Derive an expression between Young's modulus, Modulus of rigidity and' Poisson's ratio.	16 / 20	C02	
	b	A circular rod of dia 200mm and 500mm long is subjected to a tensile force of 45kN modulus of elasticity = 200 kN/mm2 , Find stress, strain and elongation of bar due to applied load.		C02	
3	a	At a certain point in a stressed body, the principal stresses are sigma x = 80 MPa and sigma y = -4OMPa. Determine a and t on the planes whose normal's are at +30° and +120° with x — axis.	16 / 20	CO3	
		OR			
4	a	Derive an expression of tangential stress and longitudinal stress of thin walled pressure vessels.	16 / 20	CO4	
	b	A rectangular block of material is subjected to a tensile stress of 100N/mm2 on one plane and a tensile stress of 50N/Sq.rnm on a plane at right angles together with shear stress of 60 N/mm2 on same planes, find : i) direction of the principal plane ii) magnitude of the principal plane iii) magnitude of greatest shear stress.		C04	
5	a	Define : i) bending moment ii) shear force iii) shear force diagram iv) bending moment diagram.	16 / 20	CO5	
	b	Draw SFD and BMD for the cantilever beam.		C05	
		OR			
6	a	Derive the relation between load intensity, bending moment and shear force.	16 / 20	C06	
	b	A beam ABC, 8m long has supplied at A and B, it is long between A and B. The beam carries an udl of 10kN/m between A and B. At free end point C, a point load of 15 kN acts. Draw BMD and locate point of contra-flexure, if any.		CO6	
7	a	A steel beam of hollow section of outer side 100 mm and inner side 80 mm is used on a span of 4 mt. Find the uniformly distributed load the beam can carry if the bending stress is not to exceed 120 N/mm2 . The beam is taken as simply supported.	16 / 20	CO7	
	b	The moment of inertia of a beam section 500 mm deep is 69.49 x 10 mm power 4. Find the longest span over which a beam of this section, when simply supported, could carry a uniformly distributed load of 50 kN per meter run. The flange stress in the material is not to exceed 110 N/mm2.		CO7	
		OR			
8	a	Prove that maximum shear stress in a rectangular section of width b and depth d is equal to 1.5 times of its average shear stress.	16 / 20	CO8	
	b	State the assumptions made in the theory of pure bending.		CO8	
	c	A rolled I section of size 75 mm x 50 mm is used as a beam with an effective span of 3m. The flanges are 5 mm thick and web 3.7 mm thick. Calculate the uniformly distributed load the beam can carry if the maximum shear stress is 40 N/mm2.		CO8	
9	a	State the assumptions in the theory of pure torsion.	16 / 20	CO9	
	b	Define: i) Polar section modulus, ii) Torsional rigidity.		C09	
	c	The external and internal diameters of a hollow shaft are 160 mm and 120 mm respectively. If the shaft is subjected to a torque of 20 kN-m, find: i) Shear stress at the outer surface of the shaft ii) Shear stress at the inner surface of the shaft iii) Angle of hoist per metre length of the shaft. Take C = 7.5 x 104 N/mm2.		C09	
		OR			
10	a	Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.	16 / 20	CO10	

	b	Determine the diameter of the solid shaft transmitting 120 kW at 120 rpm if the permissible shear stress is 80 N/mm2. What would be the diameter of a hollow shaft of same length having external diameter twice the internal diameter to transmit same power at same rate of revolution. What is the percentage saving in weight by changing over to hollow shaft?		CO10	

2. SEE Important Questions

Course:	Strength of Materials					Month / Year	May /July 2018
Crs Code:	18CV32	Sem:	III	Marks:	100	Time:	180 minutes

	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	Define i) stress ii) strain iii) modulus of elasticity.	16 / 20	CO1	2011
	2	Derive an expression for the deformation to the tapering circular cross - sectional bar subjected to an axial force P. . Use standard notations.		CO1	2011
	3	A rod of 12mm diameter and 1m long subjected to a tensile load "P" such way that elongation should not be more than 0.4mm. Find the value of 'W. Take E = 2 x 105N/mm2.		CO2	2012
	4	Briefly explain the behaviour of ductile material under gradually increasing tensile load		CO2	2013
	5	A signal is being worked by a steel wire 750 m long and 6 mm in diameter. Find the movement which must be given to the signal box end of wire at a pull of I.6 kN, if the movement at the signal end is to be 250 mm. Assume 'E'		CO2	2014
2	1	Define : i) Principal stresses ii) Principal planes.	16 / 20	CO3	2014
	2	Show that principal planes and maximum shearing planes are inclined at 45° with each.		CO3	2014
	3	Determine the magnitude and direction of resultant stresses on a plane inclined at an angle of 60° to major principal stress plane, when the bar is subjected to principal stresses at a point 200MPa tensile and 100MPa compressive. Also determine the resultant stress and its obliquity.		CO3	2016
	4	Derive expressions for principal stresses and their planes for two dimensional stress systems.		CO4	2015
	5	Define: i) Principal stresses, ii) Critical planes, iii) Principal planes.		CO4	2018
3	1	Derive the relationship between BM, SF and intensity of udl.	16 / 20	CO5	2014
	2	Define i) Bending moment ii) Point of contraflexure.		CO5	2016
	3	A beam ABCD, 8m long has supports at 'A' and at 'C' which is 6m from 'A'. The beam carries a UDL of 10kN/m between 'A' and 'C' at point B a 30kN concentrated load acts 2m from the support A and a point load of 15kN acts at the free end 'W. Draw the SFD and BMD giving salient values. Also locate the point of contra-flexure if any.		CO6	2015
	4	Define: i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure.		CO6	2018
	5	Draw SFD and BMD for a cantilever beam of span length 'l' carrying a point load w at its free end.		CO6	2017

4	1	Compare the flexural strength of the following three beams i) I — section 320 mm x 160 mm with 20 mm thick flange and 13 mm thick web ii) Rectangular section having depth twice the width iii) Solid circular section All the three beam sections have same cross-sectional area.	16 / 20	CO7	2014
	2	Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress.		CO7	2014
	3	Derive the equation of theory of simple bending with usual notations.		CO7	2016
	4	Derive an expression for Euler's crippling load for a column with both ends fixed.		CO8	2016
	5	Compare the crippling loads given by Euler's and Rankine's formula for a column of circular section 2.3m long and of 30mm diameter. The column is hinged at both ends. Take yield stress as 335N/mm2 and Rankine's constant a = (1/7500) and E = 2 x 105N/mm2. For what ratio of L/K, the Euler's formula cease to apply for this column?		CO8	2016
5	1	Prove the torsional formula, with usual notations.	16 / 20	CO9	2014
	2	A 150 mm diameter solid steel shaft is transmitting 450 kW power at 90 rpm. Compute the maximum shearing stress. Find the change that would occur in the shearing stress, if the speed were increased to 360 rpm.		CO9	2014
	3	State the assumptions made in the theory of Pure Torsion.		CO10	2016
	4	Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight.		CO10	2018
	5	A hollow shaft of internal diameter 400mm and external diameter 460mm is required to transmit power at 180rpm. Determine the power it can transmit, if the shear stress is not to exceed 60N/mm2 and the maximum torque exceeds the mean by 30%.		CO10	2016

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	Introduction, Definition and concept and of stress and strain. Hooke's law, Stress-Strain diagrams for ferrous and non-ferrous materials, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Elongation due to self weight.	5	- L1 - L2	L2	- -	- Lecture - -	- Slip Test - -
1	Saint Venant's principle, Compound bars, Temperature stresses, Compound section subjected to temperature stresses, state of simple shear, Elastic constants and their relationship.	5	- L3 - L4	L4	- -	- Lecture - Tutorial -	- Assignment - -
2	Introduction, state of stress at a point, General two dimensional stress system, Principal stresses and principal planes. Mohr's circle of stresses.	5	- L2 - L3	L3	- -	- Lecture -	- Assignment -
2	Introduction, Thin cylinders subjected to internal pressure; Hoop stresses, Longitudinal stress and change in volume. Thick cylinders subjected to both internal and external pressure; Lame's equation, radial and hoop	5	- L2 - L2	L2	- -	- Lecture -	- Slip Test -

	stress distribution.						
3	Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, Sign conventions, relationship between load intensity, bending moment and shear force.	5	- L1 - L3	L3	- -	- Lecture -	- Slip Test -
3	Shear force and bending moment diagrams for statically determinate beams subjected to points load, uniformly distributed loads, uniformly varying loads, couple and their combinations.	5	- L3 - L2	L3	- -	- Lecture - Tutorial -	- Assignment - -
4	Bending and Shear Stresses in Beams: Introduction, pure bending theory, Assumptions, derivation of bending equation, modulus of rupture, section modulus, flexural rigidity. Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections. Shear centre (only concept).	5	- L3 - L1	L3	- -	- Lecture - Tutorial -	- Assignment - -
4	Torsion in Circular Shaft: Introduction, pure torsion, Assumptions, derivation of torsion equation for circular shafts, torsional rigidity and polar modulus Power transmitted by a shaft.	5	- L2 - L4	L4	- -	- Lecture - Tutorial -	- Assignment - -
5	Deflection of Beams: Definition of slope, Deflection and curvature, Sign conventions, Derivation of moment curvature equation. Double integration method and Macaulay's method: Slope and deflection for standard loading cases and for determinate prismatic beams subjected to point loads, UDL, UVL and couple.	5	- L2 - L2	L2	- -	- Lecture - -	- Assignment - -
5	Columns and Struts: Introduction, short and long columns. Euler's theory; Assumptions, Derivation for Euler's Buckling load for different end conditions, Limitations of Euler's theory. Rankine-Gordon's formula for columns.	5	- L2 - L2	L2	- -	- Lecture - -	- Assignment - -

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Module-#	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	- -	Stress and Strain	Stress and Strain			understand one dimensional stresses and strains
1	- -	Stress and Strain				apply simple stresses and strains on engineering

						materials
2	- -	2D Stress System	2D Stress System			analyse 2D compound stress system and plotting principal stresses and planes by using mohr's circle
2	- -	Cylinders				analyse the thin and thick cylinders subjected to internal and external pressures and draw stress distribution patterns
3	- -	Shear Force and Bending moment	Shear Force and Bending moment			plot shear force and bending moment diagrams for statically determinate beams
3	- -	Shear Force and Bending moment				understand the behaviour of statically determinate beams under external loads
4	- -	Bending Stress	Bending Stress			plot combined shear and bending stresses distribution for circular, rectangular and T geometric sections
4	- -	Torsion				analyse the circular shafts under torsion and its behaviour in combined bending and torsion criteria
5	- -	Deflection of beams	Deflection of beams			Deflection and curvature of beam
5		Buckling of columns				analyse the behaviour of columns and struts under buckling load and end conditions