Government of Karnataka

DEPARTMENT OF TECHNICAL EDUCATION

Programme	Mechanical Engineering	**Semester**	III
Course Code	20ME31P	**Type of Course**	Programme Core
Course Name	**Mechanics of Materials**	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1. Rationale

In this course, Diploma engineers are required to analyse the reasons for failure of components and select the suitable materials for a given applications. For this purpose, it is essential to study the concepts, principles, applications and practices covering stress, strain, stress concentration, weak points, deformations, bending moment and shearing force. The students will also study the basic principles of Finite Elements Analysis and perform stress strain analysis using Ansys software to understand and quantify the effects of real-world conditions on a part. These simulations, will allow Diploma engineers to locate potential problems in a design, including areas of tension and weak spots. FEA becomes a tremendous productivity tool, helping engineers in reducing product development time and cost. Hence, FEA is introduced in this course. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles to the solution of applied problems and to develop the required skill and competencies

2. Course Outcomes: At the end of the Course, the student will be able to:

CO-01	Analyse Simple Stresses and Strains on given Structural member that is subjected to Tensile, Compressive and Shear loads by using Destructive Test.
CO-02	Draw Shear force Diagram (SFD) and Bending moment Diagram (BMD) and Also, Analyse Bending Stresses in a Beam using Finite element methods(FEM) software
CO-03	Demonstrate the application of finite element formulations to solve both One dimensional and Two dimensional Problems.
CO-04	Demonstrate the application of FEM software for Validation of both One dimensional and Two dimensional Problems

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
			3 hours/week	1 hour/week	4 hours/week (2 hours/batch twice in a week)
1	01	01	1. Introduction to Force- Types of Forces-Resolution of forces	Refer Table 1	Resolution of forces by Graphical Method
			2. Problems on Resolution of forces- Analytical Method		Verification of Forces by Lami's Theorem
			3. Problems on Resolution of forces- Analytical Method		
2	01	01	1. Types of Loads-Tensile, Compression, Shear, Impact, Stress- Types- Strain- Types- - Hooks Law- Young's Modulus		Conduct Tensile test for the given Specimen and Determine Stress- Strain- Young's Modulus, Yield Stress- Maximum Stress-

			2. Stress - Strain Diagram - Elastic constants- Linear strain, Lateral Strain, Poison's Ratio, Volumetric Strain, Bulk Modulus, Rigidity Modulus , Fatigue - Endurance Limit 3. Stress concentration, Factor of Safety(FOS), Concept of Temperature stresses	Refer Table 1	Breaking Stress- % Elongation in Length and % Reduction in Area Also, Draw Stress- Strain Diagram for the above Parameters
3	01	01	1. Simple Problems on Stress, Strain and Elastic constants 2.. Simple Problems on Stress, Strain and Elastic constants 3. Simple Problems on Stress, Strain and Elastic constants	Refer Table 1	Conduct Compression test for the given Specimen and Determine Stress- Strain- Young's Modulus, Yield Stress- Maximum Stress- % Reduction in Length and % Increase in Area Also, Draw Stress- Strain Diagram for the above Parameters
4	01	01	1. Problems on Members subjected to combined Stresses 2. Problems on Members subjected to combined Stresses 3. Problems on Members subjected to combined Stresses	Refer Table 1	Conduct Shear test for the given specimen
5	02	02	1. Types of Beams-Types of Loads acting on Beams- Concept of Shear force - Bending moment 2 Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for Cantilever subjected to Point Load and Uniformly Distributed loads (UDL) 3. Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for Cantilever subjected to Point Load and Uniformly Distributed loads (UDL)	Refer Table 1	Conduct Bending test for the given specimen

6	02	02	1. Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for a Simply supported beam subjected to Point Load and Uniformly Distributed loads (UDL) 2.Draw SFD and BMD for Simply supported and Cantilever beam subjected to Point Load and UDL Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for a Simply supported beam subjected to Point Load and Uniformly Distributed loads (UDL) 3 Draw SFD and BMD for Simply supported and Cantilever beam subjected to Point Load and UDL Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for a Simply supported beam subjected to Point Load and Uniformly Distributed loads (UDL)	Refer Table 1	Present You tube videos in Stress, Strain and Bending Stresses on Different mechanical members Prepare a report on the observations made Eg: https://www.youtube.com/watch?v=C-FEVzI8oe8
7	02	02	1. Pure Bending- Assumptions- Neutral Axis- Bending Equation 2. Problems on Bending Equation 3. Problems on Bending Equation	Refer Table 1	Present You tube videos in Stress, Strain and Bending Stresses on Different mechanical members Prepare a report on the observations made
8	03,04	01	1.Introduction to Finite Element Methods (FEM), Need-Back Ground 2. Methods employed in FEM- Steps in FEM 3. Advantages and Disadvantages, Limitations, Applications of FEM-Concept of Discontinuity	Refer Table 1	Practice on FEM software (Eg: Ansys)
9	02,03,04	01,02,04	1. Phases of FEA(Finite Element Analysis) 2. Discretization Process 3. Meshing –Element type	Refer Table 1	Validate Bending Equation Problems solved in Week 7 using FEM software (Eg: Ansys)
10	02,03,04	01,02,04	1.Stiffness Matrix of a Bar Element 2.Global Stiffness Matrix- Properties of stiffness matrix	Refer Table 1	Validate Bending Equation Problems solved in Week 7 using FEM software (Eg: Ansys)

			3. Boundary Conditions- Methods –Types		
11	03,04	02,04,07	Problems on 1-D elements	Study the latest technological changes in this course and present the impact of these changes on industry	Validate using FEM software (Eg: Ansys)
12	03,04	02,04,07	Problems on 1-D elements		Validate using FEM software (Eg: Ansys)
13	03,04	02,04,07	Problems on 2-D elements		Validate using FEM software (Eg: Ansys)
Total in hours			**39**	**13**	**52**

- ***PO= Program Outcome as listed and defined in year 1 curriculum**
- **Course Coordinator must prepare PO – CO mapping with strength (Low/Medium/High) before course planning**

TABLE 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution).

Sl. No.	Suggestive Activities for Tutorials
01	Understand Static Equilibrium using common examples, try to apply the principles and demonstrate in class the importance of static equilibrium in daily life, at home or at work.
02	Study the behavior of Aluminum under the action of Tensile/Compression Load. Plot Stress Strain Diagram and Demonstrate in the class the behavior of Aluminum different from that of a Cast Iron.
03	A seesaw is occupied by two children of equal weight "W" N. The center of gravity of each child is x meters from the fulcrum. The length of the board is 3x meters, y mm wide and z mm thick. Determine the maximum bending stress and shear stress in the board.
04	Tapered elastic bar subjected to an applied tensile load P at one end and attached to a fixed support at the other end. The cross-sectional area varies linearly from A_0 at the fixed support at x = 0 to $A_0/2$ at x = L. Calculate the displacement of the end of the bar (a) by modelling the bar as a single element having cross-sectional area equal to the area of the actual bar at its midpoint along the length, (b) using two bar elements of equal length and similarly evaluating the area at the midpoint of each, and compare to the exact solution By FEM.
05	Identify the type Beam in Traffic Light Post. Determine the displacement field for this beam subjected to UDL throughout its length.
06	Discuss procedure using the commercial package available today for solving problems of FEM. Take a Structural Problem to Demonstrate the same.
07	In 1989, Jason, a research-type submersible with remote TV monitoring capabilities and weighing 35 200 N, was lowered to a depth of 646 m in an effort to send back to the attending surface vessel photographs of a sunken Roman ship offshore from Italy. The submersible was lowered at the end of a hollow steel cable having an area of 452 × 10–6 m^2 and E = 200 GPa. Determine the extension of the steel cable. Due to the small volume of the entire system, buoyancy may be neglected.
08	Laboratory tests on human teeth indicate that the area effective during chewing is approximately 0.25 cm^2 and that the tooth length is about 1.1 cm. If the applied load in the vertical direction is 880 N and the measured shortening is 0.004 cm, determine Young's modulus.

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Mechanics of Materials**	Test	I/II/III	Sem	III
Course Code	20ME31P	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels(R/U/A)	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, cognitive level and course outcomes.

5. (a) For CIE Skill Test -4 **Duration :240Min**

SL. No.	CO	Particulars/Dimension	Marks
1	01	Verification of Forces by Lami's Theorem • Finding the resultant of forces - Analytical Method –15 Marks • Verification of Forces by Lami's Theorem – Practically-15Marks	30
2	02	Determine the deformation of a given specimen subjected to Tensile/Compressive/Shear loads/Bending using UTM • Writing observations and Tabular column -- 10 Marks • Writing Equations required With all notations –- 10 Marks • Conduction of Experiment --- 20 Marks • Calculation and Result with Graph if any --- 20 Marks	60
3	01,02	**Portfolio evaluation based on the average of all Practice Sessions (1-6 weeks)**	**10**
Total Marks			**100**

5.(b)For CIE Skill Test -5 **Duration :240Min**

SL. No.	CO	Particulars/Dimension	Marks
1	02	Calculate and Plot SFD and BMD for the Given Data • Finding Shear force and Bending Moment – (10+15)=25 Marks • Plot SFD and BMD – 15 Marks	40
2	03,04	Apply finite element formulations to solve the given One dimensional cases and Validate using Ansys • Solve by FEM Method —25 Marks • Validate Using FEM software (Eg: Ansys) ---25 Marks	50
3	02,03, 04	**Portfolio evaluation based on the average of all Practice Sessions (7-12 weeks)**	**10**
Total Marks			**100**

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Schaum Outlines, "Strength of Materials", 5 Edition
2	RAMAMURTHAM. S., "Strength of Materials", 14th Edition, Dhanpat Rai Publications, 2011
3	KHURMI R S, "Applied Mechanics and Strength of Materials", 5 Edition, S.Chandand company
4	NASH W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co., New York, 1995.
5	RYDER G.H, "Strength of Materials", 3rd Edition, Macmillan India Limited, 2002.
6	BANSAL R. K, "Strength of Materials", Laxmi Publications, New Delhi, 2012.
7	Schaum series, Strength of Materials
8	TIMOSHENKO S.P, "Elements of Strength of Materials", Tata McGraw-Hill, Delhi,
9	Introduction to Finite Elements in engineering by TRIRUPATHI R, CHANDRUPATLA, ASHOK D BELEGUNDA, Pearson Publications.
10	Practical Finite Element Analysis by NITIN S GOKHALE,SANJAY S DESHPANDE, Finite to Infinite Publications
11	ANSYS free software tutorial((Student version) https://www.google.co.in/search?biw=1024&bih= 667&q=ansys+software+ tutorial&sa=X&ved=0ah UKEwjm5o MndHNAh UBsI8KHbRWDhUQ1QIIXygE

8. LIST OF SOFTWARE/LEARNING WEBSITES

1. www.nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024htm
2. www.wikipedia.org/wiki/Shear_and_moment_diagram
3. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
4. www.engineerstudent.co.uk/stress_and_strain.html
5. www.**ansys**.com/Student
6. http://www.mece.ualberta.ca/tutorials/ansys

9. SEE Scheme of Evaluation **Duration: 180 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	01,02	Determine the deformation of a given specimen subjected to Tensile/Compressive/Shear loads using UTM • Writing observations and Tabular column -- 10 Marks • Writing Equations required With all notations -- 10 Marks • Conduction of Experiment --- 05 Marks • Calculation and Result with Graph if any --- 15 Marks **OR** Calculate and Plot SFD and BMD for the Given Data • Finding Shear force and Bending Moment – 10 Marks • Plot SFD and BMD – 15 Marks • Validate Using FEM software (Eg: Ansys) ---15 Marks	**40**

2	03 , 04	Apply finite element formulations to solve the given One dimensional /Two dimensional cases and Validate using Ansys • Solve by FEM Method —20Marks • Validate FEM software (Eg: Ansys)---20 Marks	**40**
3	01,02,03 ,04	Viva voce	**20**
Total Marks			**100**

10. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	Universal testing machine	Computerized 100 Ton Capacity With all attachments to conduct shear, bending , compression and tensile test	01
02	Ansys software		20 user
03	Desktop Computer	Latest configuration	10 nos