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SJC INSTITUTE OF TECHNOLOGY

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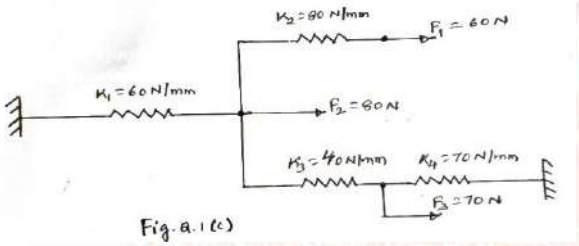
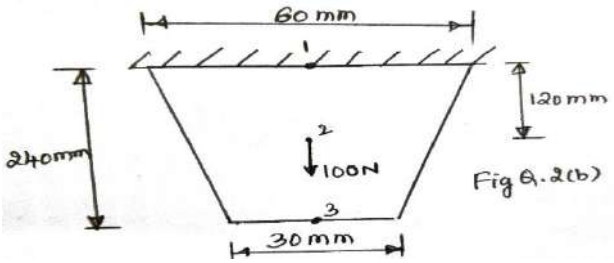
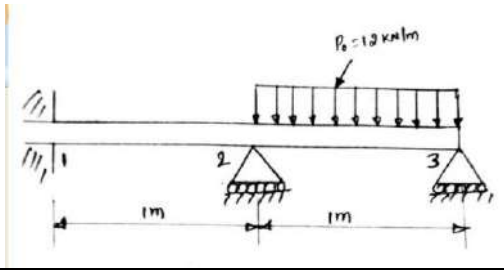
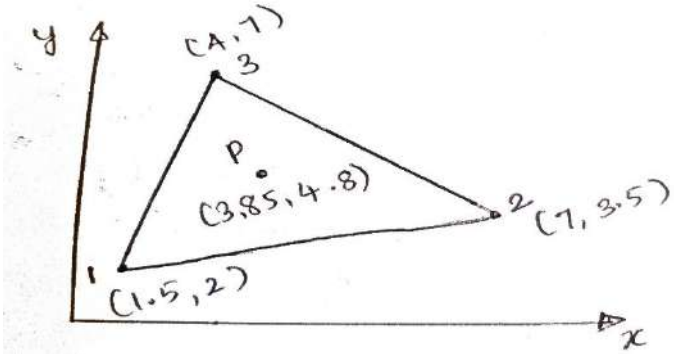
FIRST/SECOND SEMESTER M.TECH DEGREE SEMESTER END EXAMINATIONS

SEPTEMBER 2025

Course:	**ADVANCED FINITE ELEMENT METHODS AND APPLICATIONS**		
Course Code:	**MME201**	**Program:**	**M.Tech in Machine Design**
Max Marks:	**100**	**Duration:**	**03 Hours**

Note:
1. Answer ONE question from each MODULE and Question 1 & 2 is compulsory.
2. Any missing Data can be suitably assumed.

Q. No.		**Module - 1**	**Marks**	**CO**	**RBTL**
Q1	**a**	State Principle of virtual work and principle of minimum potential energy.	**6**	**1**	**L1**
	b	Derive potential energy functional for a simple Spring mass system with load at free end.	**6**	**1**	**L2**
	c	Using principle of Minimum Potential energy, Determine the Nodal displacements for the system shown in Fig.Q.1.c  Fig. Q.1 (c)	**8**	**1**	**L3**
		Module – 2			
Q2	**a**	List the Properties of Stiffness Matrix and Derive the Stiffness Matrix for 1-D bar Element.	**10**	**2**	**L2**
	b	Fig Q.2 (b) Shows a thin plate of uniform thickness of 1mm, weight density= 76.6. X10^{-6} N/mm^3 and subjected to a point load of 100N at its Midpoint. Take E=200GPa, Evaluate Nodal Displacements, stresses and reactions. Use elimination Method  Fig Q.2(b)	**10**	**2**	**L4**
		Module – 3			
Q3	**a**	Derive Shape functions for beam element.	**10**	**3**	**L2**

	b	For the Beam loaded as shown in Fig Q.3(b), Determine the slopes at 2 and 3 and deflection at midpoint of the Distributed load. E=200GPa and I= $4X10^{-6}m^4$. 	**10**	**3**	**L3**
		OR			
Q4	**a**	For the cantilever beam of 1m Span, subjected to a uniformly distributed load of P_o=5kN/m, Determine the nodal displacements and deflection at free end. E=200GPa and I= $4X10^{-6}m^4$.	**10**	**3**	**L3**
	b	Derive stiffness matrix for Beam element.	**10**	**3**	**L3**
		Module – 4			
Q5	**a**	Derive Shape functions for CST element in natural Co-ordinate System.	**10**	**4**	**L3**
	b	Differentiate between plane stress and plane strain problems with examples. Write the stress strain relationship for both.	**10**	**4**	**L2**
		OR			
Q6	**a**	Derive Shape Functions for Quad-4 element using lagrangian method.	**10**	**4**	**L3**
	b	Determine the shape functions N_1, N_2 and N_3 at the interior point "P" for the triangular element and also determine the area coordinates at P (3.85, 4.8). 	**10**	**4**	**L3**
		Module – 5			
Q7	**a**	Integrate the function using Gaussian quadrature technique. $\int_2^5 (x^2 + 2x + 5)dx$	**10**	**5**	**L3**
	b	Derive shape functions for Hexahedral element (Hexa8).	**10**	**5**	**L2**
		OR			
Q8	**a**	Derive Shape functions for TET-4 element	**10**	**3**	**L2**
	b	Derive element stiffness matrix for tetrahedral element.	**10**	**5**	**L4**

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FIRST/SECOND SEMESTER M.TECH DEGREE SEMESTER END EXAMINATIONS

SEPTEMBER 2025

Course:	**MODERN VIBRATION THEORY AND APPLICATION**			
Course Code:	**MME202**	**Program:**	**M.Tech in Machine Design**	
Max Marks:	**100**		**Duration:**	**03 Hours**

Note:

1. Answer ONE question from each MODULE and Question 1 & 2 is compulsory.
2. Any missing Data can be suitably assumed.

Q. No.		**Module - 1**	**Marks**	**CO**	**RBTL**
Q1	**a**	Define the vibration terminologies such as a) Natural Frequency b) Harmonic motion c) Forced Vibration d) Damping ratio e) Resonance	**10**	**1**	**L1**
	b	Add the SHM analytically and verify the solution graphically $X_1 = 2 \text{ Cos } (\omega t + 0.5)$ and $X_2 = 2 \text{ Sin } (\omega t + 1.0)$	**10**	**1**	**L3**
		Module – 2			
Q2	**a**	Define logarithmic decrement and Derive an expression for the ratio of two successive amplitudes in a lightly damped system undergoing free vibration	**10**	**1**	**L3**
	b	Determine the natural frequency of a spring mass system where the mass of the spring is also to be taken into account	**10**	**1**	**L3**
		Module – 3			
Q3	**a**	Derive an expression for a steady state solution spring mass system subjected to harmonic force and also plot Amplitude ratio v/s Frequency ratio for the system.	**10**	**2**	**L3**
	b	A trailer has 1000 kg mass when fully loaded and 250 kg when empty. The spring of the suspension is 350 kN/m. The damping factor is 0.5 when the trailer is fully loaded. The speed is 100 km/hr. The road varies sinusoidally with a wave length of 5 m. Determine the amplitude ratio of the trailer when fully loaded and empty.	**10**	**2**	**L3**
		OR			
Q4	**a**	Discuss different types of vibration measuring instruments used in harmonically excited systems. What are their working principles and applications in industry?	**10**	**3**	**L3**
	b	Determine the limiting frequency for an Accelerometer with 2.5% error having damping factor $\epsilon = 0.7$ and natural frequency 80 Hz	**10**	**3**	**L3**

Module – 4					
Q5	**a**	Obtain the general solution equation for longitudinal vibration of a uniform bar.	**10**	**4**	**L3**
	b	Obtain an expression for general solution of vibration of string. The tension T is large and amplitude of vibration is small.	**10**	**4**	**L3**
OR					
Q6	**a**	Derive the equation of motion for the torsional vibration of a uniform shaft. State the assumptions involved. How do the boundary conditions affect the solution?	**10**	**4**	**L3**
	b	A bar of length L is free at one end and fixed at the other end. It is stretched by an axial force F at the free end. The tensile force is removed suddenly, derive the frequency equation and general solution for free vibration	**10**	**4**	**L3**
Module – 5					
Q7	**a**	List and explain different types of transducers used in Vibrating measuring instruments.	**10**	**5**	**L2**
	b	State the condition of using Vibrometer and Accelerometer and explain them	**10**	**5**	**L2**
OR					
Q8	**a**	Explain the construction and working of mechanical exciters and electrodynamic shakers used for vibration excitation.	**10**	**3**	**L2**
	b	Explain with a neat sketch of Seismic vibration measuring instrument.	**10**	**3**	**L2**

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FIRST/SECOND SEMESTER M.TECH DEGREE SEMESTER END EXAMINATIONS
SEPTEMBER 2025

Course:	**ADVANCED MACHINE DESIGN**			
Course Code:	**MME203**	**Program:**	**M.Tech in Machine Design**	
Max Marks:	**100**		**Duration:**	**03 Hours**

Note:

1. Answer ONE question from each MODULE and Question 1 & 2 is compulsory.
2. Any missing Data can be suitably assumed.

Q. No.		**Module - 1**	**Marks**	**CO**	**RBTL**
Q1	**a**	Differentiate between impact loads and gradually applied loads.	**6**	**1**	**L2**
	b	Explain iterative process concept with reference to the major phases involved in the mechanical design cycle.	**8**	**1**	**L2**
	c	How do tolerances affect manufacturing feasibility, cost, and assembly performance?	**6**	**1**	**L2**
		Module – 2			
Q2	**a**	List and explain different types of mechanical loading with simple examples.	**6**	**2**	**L2**
	b	Draw and Explain a Free Body Diagram (FBD) of a simply supported beam with a central point load and label all forces.	**8**	**2**	**L3**
	c	What happens when a sudden impact load acts on a beam?	**6**	**2**	**L1**
		Module – 3			
Q3	**a**	What do you mean by plane stress and principal stress conditions?	**8**	**3**	**L2**
	b	What is the difference between normal stress and shear stress?	**8**	**3**	**L2**
	c	A rod is subjected to an axial tensile force of 20 kN. If the cross-sectional area is 500 mm^2, Calculate the normal stress.	**4**	**3**	**L3**
		OR			
Q4	**a**	Why is the plane strain condition used for modeling long underground tunnels?	**8**	**3**	**L2**
	b	Explain the role of orientation angle (θ) when using Mohr's Circle to analyze plane stress.	**8**	**3**	**L2**
	c	Explain the difference between applied stress and principal stress, Which one is used in failure analysis?	**4**	**3**	**L3**
		Module – 4			
Q5	**a**	Differentiate between thin walled and thick walled cylinder stress states.	**6**	**4**	**L2**
	b	For a thin-walled cylinder of radius 200 mm and thickness 5 mm under internal pressure of 2 MPa. Calculate the hoop and longitudinal stresses.	**8**	**4**	**L2**

	c	Design a leaf spring for a vehicle suspension to carry a static load of 4 kN with a maximum deflection of 50 mm. Specify material, dimensions, and number of leaves.	**6**	**4**	**L3**
		OR			
Q6	**a**	State the relationship between deflection and bending moment for a simple beam.	**6**	**4**	**L2**
	b	What is the difference between bending stress and shear stress in beams?	**8**	**4**	**L2**
	c	What is a stress concentration factor (Kt), and where does it commonly arise? How is the spring rate k of spring defined?	**6**	**4**	**L3**
		Module – 5			
Q7	**a**	State the Maximum Normal Stress (Rankine) criterion and Coulomb–Mohr criterion in terms of principal stresses and tensile/compressive strengths.	**6**	**5**	**L2**
	b	Starting from the distortion-energy concept, derive the von Mises yield condition in terms of principal stresses.	**8**	**5**	**L2**
	c	Write a note on: a) Coulomb Mohr theory b) Modified Mohr theory.	**6**	**5**	**L4**
		OR			
Q8	**a**	Define ductile failure and brittle failure in terms of stress–strain behavior and energy absorption.	**6**	**5**	**L2**
	b	A steel rod (σ_y=300MPa) carries 80 MPa axial tension and 45 MPa torsional shear. (a) Determine if yielding occurs per Tresca. (b) Determine if yielding occurs per von Mises.	**8**	**5**	**L2**
	c	Explain with distortion energy ellipse a) Maximum shear stress theory, b) Maximum normal stress theory.	**6**	**5**	**L3**

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FIRST/SECOND SEMESTER M.TECH DEGREE SEMESTER END EXAMINATIONS

SEPTEMBER 2025

Course:	**SUSTAINABILITY ENGINEERING**			
Course Code:	**MME204C**	**Program:**	**M.Tech in Machine Design**	
Max Marks:	**100**		**Duration:**	**03 Hours**

Note:

1. Answer ONE question from each MODULE and Question 1 & 2 is compulsory.
2. Any missing Data can be suitably assumed.

Q. No.		**Module - 1**	**Marks**	**CO**	**RBTL**
Q1	**a**	Write the Concerns and Ingredients of Good Vision of Sustainable Development.	**6**	**1**	**L1**
	b	Explain the Principles of Sustainable Development.	**6**	**1**	**L2**
	c	How did the concept of sustainability evolve from environmental conservation to include economic and social dimensions?	**8**	**1**	**L3**
		Module – 2			
Q2	**a**	What are the Control measures of water pollution.	**4**	**2**	**L1**
	b	Write a short notes on sources and common effects of common air pollutants.	**8**	**2**	**L2**
	c	Explain how the 3R concept helps in managing solid waste sustainably.	**8**	**2**	**L3**
		Module – 3			
Q3	**a**	Describe the term “Environmental Management System (EMS)” as per ISO 14001:2015.	**10**	**3**	**L1**
	b	Expound Scope and goal of Life Cycle Analysis (LCA).	**10**	**3**	**L3**
		OR			
Q4	**a**	List out and explain various procedures of EIA in India.	**10**	**3**	**L1**
	b	What are the Environmental Management Standards? List out its functions and Frameworks of EMS.	**10**	**3**	**L3**
		Module – 4			
Q5	**a**	What are conventional and Non-conventional energy resources? Give three examples to each.	**6**	**4**	**L1**
	b	Write a short notes on Energy Strategy for the Future.	**6**	**4**	**L2**

	c	Write the advantages, Limitations and applications of Solar and wind energy in the current trend.	**8**	**4**	**L3**
OR					
Q6	**a**	Distinguish between fixed speed system and variable speed system.	**6**	**4**	**L1**
	b	Write a short notes on wind speed prediction.	**6**	**4**	**L2**
	c	Suppose a village has a fast-flowing river nearby. Suggest a suitable non-conventional energy project and justify your choice.	**8**	**4**	**L3**
Module – 5					
Q7	**a**	List the Objectives of national mission on sustainable habitat.	**6**	**5**	**L1**
	b	Write a short notes on Characteristics of green materials	**6**	**5**	**L2**
	c	Explain the concept of Sustainable Transport system.	**8**	**5**	**L4**
OR					
Q8	**a**	What are the Importants (or) benefits of carbon cycle.	**4**	**5**	**L1**
	b	Explain the Principles of Green engineering.	**8**	**5**	**L2**
	c	Apply the concept of usage of Solor cells (or) photovoltaic cells in electronic devices.	**8**	**5**	**L4**

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FIRST/SECOND SEMESTER M.TECH DEGREE SEMESTER END EXAMINATIONS

SEPTEMBER 2025

Course:	**DESIGN FOR MANUFACTURING AND ASSEMBLY**			
Course Code:	**MME205C**	**Program:**	**M.Tech in Machine Design**	
Max Marks:	**100**		**Duration:**	**03 Hours**

Note:

1. Answer ONE question from each MODULE and Question 1 & 2 is compulsory.
2. Any missing Data can be suitably assumed.

Q. No.		Module - 1	Marks	CO	RBTL
Q1	a	What is meant by material and process selection in product design?	4	1	L1
	b	Explain the importance of early material and process selection in product development.	8	1	L2
	c	Select a suitable manufacturing process for producing a high-precision gear and justify your choice.	8	1	L3
		Module – 2			
Q2	a	What are assembly limits in mechanical design? Define datum features in engineering drawing.	4	2	L1
	b	Explain the concept of assembly limits and their importance in component design.	8	2	L2
	c	Apply the principles of datum selection to a given part drawing to determine optimal reference surfaces.	8	2	L3
		Module – 3			
Q3	a	Define parting line in the context of casting.	4	3	L1
	b	What is a pattern in casting? Explain its purpose.	6	3	L2
	c	Draw a sketch showing the ideal placement of a parting line for a symmetrical component.	10	3	L3
		OR			
Q4	a	What are special sand cores used for in casting?	4	3	L1
	b	Differentiate between cast holes and machined holes with examples.	6	3	L2

	c	Explain with a diagram how core prints are integrated into a casting design.	**10**	**3**	**L3**
Module – 4					
Q5	**a**	What are the commonly used materials in injection molding?	**4**	**4**	**L1**
	b	Explain the basic molding cycle in injection molding.	**6**	**4**	**L2**
	c	Calculate the cycle time for an injection molding process with given parameters (cooling time, injection time, etc.).	**10**	**4**	**L3**
OR					
Q6	**a**	List any four general design guidelines for injection molded parts.	**4**	**4**	**L1**
	b	Describe the working of a hot runner system in injection molding.	**6**	**4**	**L2**
	c	Apply design guidelines to reduce warpage in an injection molded plastic part.	**10**	**4**	**L3**
Module – 5					
Q7	**a**	What is meant by interchangeable part manufacture in selective assembly?	**4**	**5**	**L1**
	b	Explain why selective assembly is necessary even when parts are made interchangeable.	**6**	**5**	**L2**
	c	Analyze the impact of unequal group tolerances on final assembly quality.	**10**	**5**	**L4**
OR					
Q8	**a**	How is the number of groups decided in selective assembly of mating parts?	**4**	**5**	**L1**
	b	Why is axial play control important in assemblies?	**6**	**5**	**L2**
	c	Analyze how the introduction of laminated shims simplifies inventory and maintenance.	**10**	**5**	**L4**

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FIRST/SECOND SEMESTER M.TECH DEGREE SEMESTER END EXAMINATIONS

SEPTEMBER 2025

Course:	**MECHANICS OF COMPOSITE MATERIALS**			
Course Code:	**MME206**	**Program:**	**M.Tech in Machine Design**	
Max Marks:	**100**		**Duration:**	**03 Hours**

Note:

1. Answer ONE question from each MODULE and Question 1 & 2 is compulsory.
2. Any missing Data can be suitably assumed.

Q. No.		**Module - 1**	**Marks**	**CO**	**RBTL**
Q1	**a**	List the difference between thermoset and thermoplastic matrices.	**08**	**1**	**L1**
	b	Illustrate with an example the purpose and how corrosion resistance is a key factor in material selection.	**12**	**1**	**L3**
		Module – 2			
Q2	**a**	Discuss in detail the restrictions imposed on elastic constants in composite materials.	**10**	**2**	**L2**
	b	In a unidirectional glass/epoxy lamina with a 70% fiber volume fraction, given that E_f = 85 GPa, v_f = 0.2, E_m = 3.4 GPa and v_m = 0.3. Find the, i) Longitudinal elastic modulus ii) Transverse Young's modulus iii) Ratio of the load taken by the fibers to that of the composite iv) Major and minor Poisson's ratio v) In-plane shear modulus	**10**	**2**	**L4**
		Module – 3			
Q3	**a**	Find the compliance and stiffness matrix for a graphite/epoxy lamina. The material properties are given as E_1 = 181 GPa, E_2 = 10.3 GPa, E_3 = 10.3 GPa, ν_{12} = 0.28, ν_{23} = 0.60, ν_{13} = 0.27, G_{12} = 7.17 GPa, G_{23} = 3.0 GPa, G_{31} = 7.00 GPa	**10**	**2**	**L4**
	b	Derive a stiffness matrix and reduced compliance matrix using Hooke's Law for Specially Orthotropic Material.	**10**	**2**	**L3**
		OR			
Q4	**a**	Derive the relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.	**10**	**2**	**L3**

	b	For a graphite/epoxy unidirectional lamina, the properties of unidirectional graphite/epoxy lamina are E_1 = 181 GPa, E_2 = 10.3 GPa, ν_{12} = 0.28, G_{12} = 7.17 GPa. Find the following i) Compliance matrix ii) Minor Poisson's ratio iii) Reduced stiffness matrix iv) Strains in the 1–2 coordinate system if the applied stresses are σ_1 = 2MPa, σ_2 = -3MPa, τ_{12} = 4MPa	**10**	**2**	**L4**
Module – 4					
Q5	**a**	Discuss in detail the different Strength Failure Theories of Angle Lamina.	**10**	**3**	**L3**
	b	Find the maximum value of S > 0 if a stress of σ_x = 2S, σ_y = –3S, and τ_{xy} = 4S is applied to the 60° lamina of graphite/epoxy. Use maximum stress failure theory and the properties of a unidirectional graphite/epoxy lamina are $(\sigma_1^T)_{ult}$ = 1500MPa, $(\sigma_1^c)_{ult}$ = 1500MPa, $(\sigma_2^T)_{ult}$ = 40MPa, $(\sigma_2^c)_{ult}$ = 246MPa, $(\tau_{12})_{ult}$ = 68MPa.	**10**	**3**	**L4**
OR					
Q6	**a**	Discuss in detail the theory on First Ply Failure and Last Ply Failure in composite materials.	**8**	**3**	**L2**
	b	Determine the failure occurance in a unidirectional lamina subjected to a longitudinal tensile stress, according to the maximum stress criterion.	**12**	**3**	**L4**
Module – 5					
Q7	**a**	Differentiate between pultrusion and filament winding in terms of product geometry, reinforcement alignment, and typical end-use products.	**8**	**3**	**L2**
	b	Discuss how resin flows in Resin Transfer Molding (RTM) and how mold design affects the final part quality.	**12**	**3**	**L3**
OR					
Q8	**a**	Explain with neat sketch the process of vacuum bag molding. List the advantages and applications.	**10**	**3**	**L2**
	b	Analyse the advantages and limitations of Vacuum-Assisted Resin Transfer Molding (VARTM) over traditional RTM	**10**	**3**	**L3**