Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 400058

END SEMESTER November-2025 ~~RE-EXAM~~ January-2026

Program: T Y. B. Tech Mechanical Engineering Sem V
Course Code: PC-BTM501
Course Name: Heat and Mass Transfer

Duration: 3 hours
Maximum Points: 100
Semester: V

21/11/25

Important Instructions:

1. Solve **any five** questions.
2. Use of **Reference Data** for **Properties of fluids, Convective heat transfer correlations Heisler Charts and heat exchanger data** charts duly approved by examiner is permitted.
3. Assume suitable data and state the same if required.
4. Draw **neat sketches** wherever necessary.
5. Answers to theory questions should be **specific** and in **legible** handwriting.

Q.No.	Questions	Points	CO	BL	Module No.
1(a)	(i) Write and explain Fourier's law of heat conduction. (ii) Define thermal conductivity of a material. (iii) What is thermal resistance? How electrical analogy can be used to compute thermal resistance in the heat transfer. Explain with neat sketch. (iv) Explain heat transfer by convection and coefficient of convective heat transfer h with neat sketch. (v) Explain the Stefan-Boltzmann law with neat sketch.	10	01	1,2	01
1(b)	The interior of a refrigerator having inside dimensions of 0.5 m x 0.5 m base area and 1 m height, is to be maintained at 6°C. The walls of the refrigerator are constructed of two mild steel sheets of 3 mm thick (k = 46.5 W/m°C) with 50 mm of glass wool insulation (k = 0.046 W/m°C) between them. If the average heat transfer coefficients at the outer and inner surfaces are 11.6 W/m^2°C and 14.5 W/m^2°C respectively. Estimate the followings: (i) The rate at which heat must be removed from the interior to maintain the specified temperature in the kitchen at 25°C. (ii) The temperature on the outer surface of the metal sheet.	10	1,2	3,4	02
2(a)	A 240 mm steam main pipeline which is 210 meters long, covered with 50 mm of high temperature insulation (k = 0.092 W/m°C) and 40 mm of low temperature insulation (k = 0.062 W/m°C). The inner and outer surface temperatures as measured are 390°C and 40°C respectively. Evaluate:	10	1,2	3,4	02

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	(i) The total heat loss per hour (ii) The heat loss per m^2 of pipe surface (iii)The total heat loss per m^2 of outer surface, and (iv)The temperature between two layers of insulation. Neglect heat conduction through pipe material				
2(b)	An aluminium pipe carries steam at 110°C. The pipe (k = 185 W/m°C) has an inner diameter of 100 mm and outer diameter of 120 mm. The pipe is located in a room where the ambient air temperature is 30°C and the convective heat transfer coefficient between the pipe and air is 15 W/m^2°C. Determine the heat transfer rate per unit length of pipe. To reduce the heat loss from a pipe, it is covered with a 50 mm thick layer of insulation (k = 0.20 W/m°C). Determine the heat transfer rate per unit length from the insulated pipe. Assume that the convective resistance of the steam is negligible.	**10**	1,2	3, 4	02
3(a)	A 6 mm thick stainless steel plate (ρ = 7800 kg/m^3, c = 460 J/kg°C, k = 55 W/m°C) is used to form the nose section of missile. It is held initially at a uniform temperature for 30°C. When the missile enters the denser layers of the atmosphere at a very high velocity the effective temperature of air surrounding the nose region attains the value 2150°C; the surface convective heat transfer coefficient is estimated as 3393 W/m^2°C. If the maximum metal temperature is not to exceed 1100°C, determine; (i) Maximum permissible time in these surroundings. (ii) Inside surface temperature under these conditions.	**10**	1,2	3,4	03
3(b)	Derive an expression for the LMTD of a counter-flow arrangement of the heat exchanger.	**10**	2	2,3	6
4(a)	Air at 20°C and at atmospheric pressure flows at a velocity of 4.5 m/s past a flat plate with a sharp leading edge. The entire plate surface is maintained at a temperature of 60°C. Assuming that the transition occurs at a critical Reynolds number of 5×10^5, find the distance from the leading edge at which the flow in the boundary layer changes from laminar to turbulent. At the location, calculate the followings: (i) Thickness of hydrodynamic boundary layer, (ii) Thickness of thermal boundary layer, (iii) Local and average convective heat transfer coefficients, (iv) Heat transfer rate from both sides for, unit width of the plate, (v) The skin friction coefficient. Assume cubic velocity profile and approximate method.	**10**	4	3,4	4

	The thermos-physical properties of air at mean film temperature (60+20)/2 = 40°C are: $\rho = 1.128$ kg/m^3, $\nu = 16.96 \times 10^{-6}$, $k = 0.02755$, $Pr = 0.699$. [For cubic velocity profile $\delta = \frac{4.64\,x}{\sqrt{Re_x}}$, $C_{fx} = \frac{0.646}{\sqrt{Re_x}}$]				
4(b)	Explain: Significance of Grashoff's number. A vertical cylinder 1.5m high and 180 mm in diameter is maintained at 100°C in an atmosphere environment of 20°C. Calculate heat loss by free convection from the surface of the cylinder. Assume properties of air at the mean temperature as $\rho = 1.06$ kg/m^3, $\nu = 18.97 \times 10^{-6}$ m^2/s, $C_p = 1.004$ kJ/kg°C and $k = 0.1042$ kJ/mh°C Select appropriate relation from followings for Vertical Plates and Cylinders Laminar flow: $Nu = 0.59\,(Gr.\,Pr)^{1/4}$ for $(10^4 < Gr.\,Pr < 10^9)$ Turbulent flow: $Nu = 0.10\,(Gr.\,Pr)^{1/3}$ for $(10^9 < Gr.\,Pr < 10^{12})$	**10**	4	3,4	4
5(a)	In a counter-flow double pipe heat exchanger, water is heated from 25°C to 65°C by an oil with a specific heat of 1.45 kJ/kg K and mass flow rate of 0.9 kg/s. The oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 W/m^2°C, calculate the followings: (i) Draw neat sketch of temperature distribution for parallel flow heat exchanger showing temperatures, (ii) The rate of heat transfer, (iii) The mass flow rate of water and (iv) The surface area of the heat exchanger.	**10**	4	3,4	6
5(b)	A counter-flow heat exchanger is employed to cool 0.55 kg/s ($c_p = 2.45$ kJ/kg °C) of oil from 115°C to 40°C by the use of water. The inlet and outlet temperatures of cooling water are 15°C and 75°C, respectively. The overall heat transfer coefficient is expected to be 1450 W/m^2 °C. Using NTU method, estimate the followings: (i) The mass flow rate of water, (ii) The effectiveness of the heat exchanger, (iii) The surface area required.	**10**	4	3,4	6
6(a)	What is black body? State: The following laws of radiation and Express: Mathematical equation/s for each of them. i) Stefan-Boltzmann Law ii) Kirchoff's Law iii) Wien's Displacement Law iv) Lambert's Cosine Law	**10**	3	1,2	5
6(b)	For an industrial furnace in the form of a black body emitting radiations at *2500°C*, Evaluate: i) Monochromatic emissive power at *1.2 μm.* ii) Wavelength at which emission is maximum iii) Maximum emissive	**10**	3	3,4	5

	power iv) Total emissive power v) Total emissive power of the fumace if it is assumed as a real surface with emissivity equal to 0.8. Where : $\sigma = 5.67 \times 10^{-8}$ W/m^2 K^4, $C_1 = 0.3742 \times 10^{-15}$ W.m^4/m^2 and $C_2 = 1.4388 \times 10^{-2}$ mK (The symbols have their usual meaning.)					
7	(i)	State the examples of mass transfer in day-to-day life and industrial applications. What are the various mechanisms of mass transfer?	**05**	1	1,2	7
	(ii)	State Fick's law of diffusion. Define the various symbols used and give their units.	**05**	1	1,2	7
	(iii)	Give formulation and significance of Prandtl number (*Pr*) and Nusselt number (*Nu*).	**05**	1	1,2	4
	(iv)	What do you mean by Characteristics length or Equivalent diameter?	**05**	3	1,2	4

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6/1/26

Program: T Y. B. Tech Mechanical Engineering Sem V
Course Code: PC-BTM501
Course Name: Heat and Mass Transfer

Duration: 3 hours
Maximum Points:100
Semester: V

Important Instructions:

1. Solve **any five** questions.
2. Use of **Reference Data** for **Properties of fluids, Convective heat transfer correlations Heisler Charts and heat exchanger data** charts duly approved by examiner is permitted.
3. Use of steam table is permitted.
4. Assume suitable data and state the same if required.
5. Draw **neat sketches** wherever necessary.
6. Answers to theory questions should be **specific** and in **legible** handwriting.

Q.No.	Questions	Points	CO	BL	Module No.
1(a)	A surface of area $3m^2$ and at 200°C exchanges heat with another surface at 30°C by radiation. If value of factor due to the geometric location and emissivity is 0.60, **determine**: (i) The rate of heat transfer (ii) The value of thermal resistance, and (iii) The equivalent convection coefficient.	05	1	1	1
1(b)	Explain the thermal conductivity of the material and explain the thermal resistance of the material to the heat transfer. Show how electrical analogy can be applied to show the thermal resistance to heat transfer by conduction.	05	1	1	1
1(c)	A cold storage room has walls made of 220 mm of brick on the outside, 90 mm of plastic foam, and finally 16 mm of wood on the inside. The outside and inside air temperatures are 25°C and -3°C respectively. If the inside and outside heat transfer coefficients are respectively 30 and 11 $W/m^2°C$, and the thermal conductivities of brick, foam and wood are 0.99, 0.022 and 0.17 W/m°C respectively, then **Estimate:** (i) The rate of heat removed by refrigeration if the total wall area is 100 m^2. (ii) The temperature of the inside surface of the brick.	10	1,2	3,4	2
2(a)	A steam pipe (inner diameter = 150 mm and outer diameter = 160 mm) with a thermal conductivity of 58 W/m°C is covered with two layers of insulation, each with a thickness of 30 mm and 50 mm, respectively, and thermal conductivities of 0.18 W/m°C and 0.09 W/m°C, respectively. The temperature of the inner surface of the steam pipe is 320°C, and that of the outer surface of the insulation layers is 40°C.	10	1,2	3,4	2

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	(i) Determine the quantity of heat lost per meter length of steam and layer contact temperature, and (ii) If the condition of the steam is dry saturated, find the quality of steam coming out of one meter pipe assuming the quantity of steam flowing is 0.32 kg/min.				
2(b)	A 150 mm steam pipe has inside diameter of 120 mm and outside diameter of 160 mm. It is insulated at the outside with asbestos. The steam temperature is 150°C and the air temperature is 20°C. h (steam side) = 100 W/m^2°C, h (air side) = 30 W/m^2°C, k (asbestos) = 0.8 W/m°C and k (steel) = 42 W/m°C. How thick should the asbestos insulation be provided in order to limit the heat losses to 2.1 kW/m^2?	**10**	1,2	3,4	2
3(a)	A 60 mm thick large steel plate (k = 42.6 W/m °C, α = 0.043 m^2/h), initially at 440°C is suddenly exposed on both sides to an environment with convective heat transfer coefficient 235 W/m^2 °C and temperature 50°C. Determine the center line temperature, and temperature inside the plate 15 mm from the mid-plane after 4.3 minutes	**10**	1,2	3,4	3
3(b)	Derive an expression for the LMTD of a parallel-flow arrangement of the heat exchanger.	**10**	2	2,3	6
4(a)	Air at 1 bar pressure and 20°C is flowing over a flat plate at a velocity of 3 m/s. if the plate is 280 mm wide and at 56°C, calculate the following quantities at x = 280 mm, given that properties of air at the bulk mean temperature [(20+56)/2 = 38°C] are: ρ =1.1374 kg/m^3; k = 0.02732 W/m°C; c_p =1.005 kJ/kgK; ν=16.768 × 10^{-6} m^2/s; Pr = 0.7. (i) Boundary layer thickness (δ) (ii) Local and average friction coefficient (C_{fx} and $\overline{C_{fx}}$) (iii) Thickness of thermal boundary layer (δ_{th}) (iv) Local and average convective heat transfer coefficient (h_x and $\bar{h}$) (v) Rate of Convective heat transfer by plate, Q_{conv} Select appropriate correlation: $Nu_x = 0.332\ (Re)^{1/2} \times (Pr)^{1/3}$ for laminar flow $\overline{Nu} = 0.664\ (Re)^{1/2} \times (Pr)^{1/3}$ for laminar flow $Nu_x = 0.036\ [(Re_x)^{0.8} - 850] * (Pr)^{1/3}$ for Turbulent Flow	**10**	**4**	3,4	**4**
4(b)	A hot plate of 1m height and 0.5 m wide at 130°C is kept vertically in still air at 20°C. Calculate heat loss by free convection from the surface of the cylinder. Assume properties of air at mean temperature as, ρ =1.06 kg/m^3; ν=18.97 × 10^{-6} m^2/s; c_p =1.004 kJ/kg°C ; k = 0.1042 kJ/mh°C; Use suitable correlation from the following: $Nu_L = 0.59(Gr \cdot Pr)^{1/4}$ for $10^4 < Gr \cdot Pr < 10^9$. $Nu_L = 0.10(Gr \cdot Pr)^{1/3}$ for $10^9 < Gr \cdot Pr < 10^{12}$.	**10**	4	3	4

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5(a)	The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s, respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C, respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 W/m^2°C, calculate the area of the heat exchanger.	**10**	4	3,4	5
5(b)	Calculate the surface area required for a heat exchanger that is required to cool 3200 kg/h of benzene (Cp = 1.74 kJ/kg°C) from 72°C to 42°C. The cooling water (Cp = 4.18 kJ/kg°C) at 15°C has a flow rate of 2200 kg/h. (i) Single pass counter-flow, (ii) 1-4 heat exchanger (one-shell pass and four-tube passes), and Cross flow single pass with both water and benzene mixed	**10**	4	3,4	5
6(a)	What is black body? State: The following laws of radiation and Express: Mathematical equation/s for each of them. i) Stefan-Boltzmann Law ii) Kirchoff's Law iii) Wien's Displacement Law iv) Lambert's Cosine Law	**10**	3	1,2	5
6(b)	For an industrial furnace in the form of a black body emitting radiations at *3000°C*, Evaluate: i) Monochromatic emissive power at *1.2 μm*. ii) Wavelength at which emission is maximum iii) Maximum emissive power iv) Total emissive power v) Total emissive power of the furnace if it is assumed as a real surface with emissivity equal to 0.8. Where : $\sigma = 5.67 \times 10^{-8}$ W/m^2 K^4, $C_1 = 0.3742 \times 10^{-15}$ W.m^4/m^2 and $C_2 = 1.4388 \times 10^{-2}$ mK (The symbols have their usual meaning.)	**10**	3	3,4	5
7	(a) State five examples of mass transfer in day-to-day life and industrial applications. (b) State Fick's law of diffusion. Define the various symbols used and give their units. (c) Give formulation and definition of followings: Reynolds number (*Re*), Prandtl number (*Pr*), Nusselt number (*Nu*), Stanton number (*St*) and Grashoff number (*Gr*)	**05** **05** **10**	1 1 1	1,2 1,2 1,2	7 7 4

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END SEMESTER November 2025 / ~~RE - EXAM~~ January 2026

Program: Third Year B.Tech in Mechanical Engineering **Duration: 03 Hrs.**

Course Code: PC BTM 502 **Maximum Points: 100**

Course Name: Design of Machine Elements **Semester: V**

Notes:

1. Attempt any **FIVE** questions.
2. Use of Machine Design Data Book by V. B. Bhandari is permitted.
3. Assume suitable data wherever necessary and justify the same.
4. All sub questions must be grouped together.

Q.No.	Questions	Points	CO	BL	Module No.
1	(a) Aircraft landing gears experience repeated impact and cyclic loading. Discuss why specific strength, fatigue resistance, and toughness are critical properties for landing gear materials. Recommend suitable alloys and explain how heat treatment can improve their mechanical performance. (b) Explain how theories of failure assist in predicting failure in mechanical components like crankshafts or connecting rods under combined axial and bending stresses. (c) Describe how draft angles, fillet radii, and uniform section thickness affect ease of manufacture and quality of cast products. Give suitable examples. (d) Describe the procedure for selection of tolerance and fit for a driveshaft and bearing assembly in an automobile. Justify your choice based on operating conditions and type of motion.	05 05 05 05	3	2	1
2 (a)	In a railway bogie suspension system, two steel connecting rods are joined using a cotter joint to transmit axial forces between the axle housing and the suspension link. The rods are made of plain carbon steel 40C8 (S_{yt} = 380 N/mm²), each having a diameter of 50 mm. The cotter is made from a steel plate of 15 mm thickness. Assume that: 1. The yield strength in compression is twice the tensile yield strength, 2. The yield strength in shear is 50% of the tensile yield strength, and 3. A factor of safety of 6 is applied in the design. (i) Design the socket end of the cotter joint and determine all its principal dimensions.	15	1	5	2

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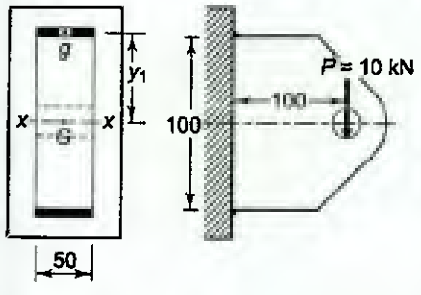
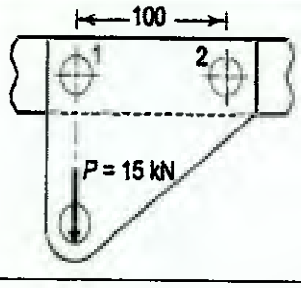
	(ii) Explain how such cotter joints are used in railway bogie linkages or suspension connecting rods for transmitting motion and load. (iii) Comment on how material selection and joint geometry influence the durability and safety of bogie assemblies.				
2 (b)	A mechanical screw jack is used to lift a car weighing 12 kN. The screw has a mean diameter of 40 mm, a pitch of 6 mm, and the coefficient of friction between threads is 0.15. (a) Determine whether the screw jack is self-locking. (b) If not, suggest a design modification (e.g. change in pitch or lubrication condition) to make it self-locking.	05	1	2	2
3 (a)	Differentiate between repeated and fluctuating stresses with suitable mechanical system examples from industries such as power plants or manufacturing.	10	1	4	3
3 (b)	Compare the Soderberg, Goodman, and Gerber criteria for fatigue failure. Which of these is preferred for ductile materials and why? Give examples of industrial components where each criterion is best suited.	10	1	3	3
4 (a)	A rotating shaft, 40 mm in diameter, is made of steel FeE 580 (Syt = 580 N/mm^2). It is subjected to a steady torsional moment of 250 N-m and bending moment of 1250 N-m. Calculate the factor of safety based on, (i) maximum principal stress theory; and (ii) maximum shear stress theory.	15	2	4,5	4
4 (b)	Explain the construction and working of a muff (sleeve) coupling with a neat labeled sketch.	05	2	3	4
5 (a)	A semi-elliptic leaf spring used for automobile suspension consists of three extra full-length leaves and 15 graduated-length leaves, including the master leaf. The centre-to-centre distance between two eyes of the spring is 1 m. The maximum force that can act on the spring is 75 kN. For each leaf, the ratio of width to thickness is 9:1. The modulus of elasticity of the leaf material is 207 000 N/mm^2. The leaves are pre-stressed in such a way that when the force is maximum, the stresses induced in all leaves are same and equal to 450 N/mm^2. Determine (i) the width and thickness of the leaves; (ii) the initial nip; and (iii) the initial pre-load required to close the gap C between extra full-length leaves and graduated-length leaves.	12	2	4,5	5
5 (b)	Derive the expression for stress and deflection in helical compression spring.	08	2	3	5
6 (a)	It is required to select a flat-belt drive for a fan running at 360 rpm which is driven by a 10 kW, 1440 rpm motor. The belt drive is open-type and space is available for a centre distance of 2 m approximately. The belt velocity should be between 17.8 to 22.9 m/s. The power transmitting capacity of the belt per mm width per ply at 180° arc of contact and at a	15	2	4,5	6

	belt velocity of 5.08 m/s is 0.0118 kW. The load correction factor can be taken as 1.2. Suggest preferred diameters for motor and fan pulleys and give complete specifications of belting.				
6 (b)	A sugar mill uses long conveyor chains that frequently jam due to sticky sugar dust. Explain how improper lubrication contributes to this problem and suggest an appropriate lubrication method.	05	2	3	6
7 (a)	During routine plant maintenance in a manufacturing facility, a technician reports that a horizontal equipment-support bracket welded to a vertical steel column shows signs of increased vibration under load. The bracket is attached using two continuous fillet welds, as illustrated in Figure. To ensure reliable operation, the welds must be checked and redesigned if necessary. Given that the bracket supports a static load acting at an offset from the weld line—producing both direct shear and secondary shear due to the resulting moment—determine the required size (leg length) of the fillet welds. The allowable shear stress for the weld material is 70 N/mm² under static conditions. 	10	2	4,5	7
7 (b)	A riveted joint, consisting of two identical rivets, is subjected to an eccentric force of 15 kN as shown in Figure. Determine the diameter of rivets, if the permissible shear stress is 60 N/mm². 	10	2	4,5	7

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~~END SEMESTER November 2025~~ / RE - EXAM January 2026

Program: Third Year B.Tech in Mechanical Engineering Sem V **Duration: 03 Hrs.** 7/1/26

Course Code: PC BTM 502 **Maximum Points: 100**

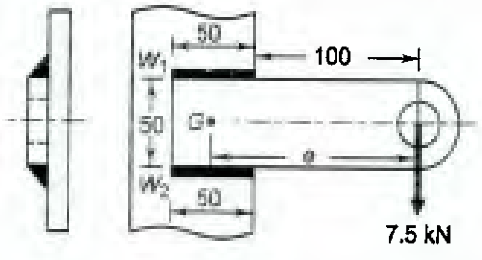
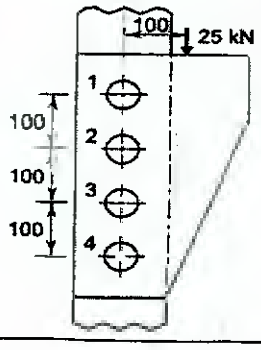
Course Name: Design of Machine Elements **Semester: V**

Notes:

1. Attempt any **FIVE** questions.
2. Use of Machine Design Data Book by V. B. Bhandari is permitted.
3. Assume suitable data wherever necessary and justify the same.
4. All sub questions must be grouped together.

Q.No.	Questions	Points	CO	BL	Module No.
1	(a) In an automobile chassis, a structural steel frame must withstand impact loads during a collision. Explain how tensile strength, yield strength, and toughness influence material selection for the chassis. Suggest a suitable material and justify your answer based on its stress–strain characteristics. (b) A gear tooth is subjected to both bending stress and contact compressive stress. Discuss how suitable failure criteria can be applied to ensure safe operation under these combined stresses. (c) A marine propeller is made by casting, while a crankshaft is made by forging. Explain the design logic and property requirements that justify these choices. (d) A shaft of nominal diameter 50 mm is to be fitted into a bearing. Suggest suitable fit types for: (a) a sliding bearing, (b) a press-fit coupling. Justify your selection.	05 05 05 05	3	1,2	1
2 (a)	In an industrial power transmission system, two steel connecting rods are joined using a cotter joint to transmit axial force in a valve mechanism of a steam engine. The rods are made of plain carbon steel 40C8 (S_{yt} = 380 N/mm²), each having a diameter of 50 mm. The cotter is manufactured from a steel plate of 15 mm thickness. Assuming that: 1. The yield strength in compression is twice the tensile yield strength, and 2. The yield strength in shear is 50% of the tensile yield strength, 3. A factor of safety of 6 is used in design, Design the socket end of the cotter joint and determine its main dimensions. Also, discuss briefly how such cotter joints are applied in	15	1	5	2

	steam engine valve mechanisms, automotive linkages, or mechanical coupling systems in industry.				
2 (b)	In a lathe machine, the lead screw is used to move the carriage during threading and turning operations. If the lead screw has a single-start square thread, determine whether the screw will be self-locking under static conditions when the screw is used to hold the tool carriage in position without power. Given: • Lead = 6 mm, • Mean diameter = 36 mm, • Coefficient of friction between threads = 0.12. a) Determine whether the screw is self-locking. b) Explain the significance of self-locking in maintaining tool position during machining.	05	1	4,5	2
3 (a)	Discuss the industrial significance of understanding reversed and fluctuating stresses in the design of rotating machinery components like turbines and compressors.	10	1	2	3
3 (b)	Write short notes on the following: (a) Modified Goodman diagram (b) Endurance limit modifying factors used with Soderberg and Goodman criteria	10	I	2	3
4 (a)	A centrifugal pump is driven by 10 kW power 1440 rpm electric motor. There is a reduction gearbox between the motor and the pump. The pump shaft rotates at 480 rpm. The design torque is 150% of the rated torque. The motor and pump shafts are made of plain carbon steel 40C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 4. Assume (S_{sy} = 0.5S_{yt}) Calculate: (i) diameter of the motor shaft ;and (ii) diameter of the pump shaft.	12	2	4,5	4
4 (b)	It is required to design a square key for fixing a gear on a shaft of 25 mm diameter. The shaft is transmitting 15 kW power at 720 rpm to the gear. The key is made of steel 50C4 (S_{yt} = 460 N/mm^2) and the factor of safety is 3. For key material, the yield strength in compression can be assumed to be equal to the yield strength in tension. Determine the dimensions of the key.	08	2	4,5	4
5 (a)	A concentric spring consists of two helical compression springs one inside the other. The free length of the outer spring is 15 mm greater than that of the inner spring. The wire diameter and mean coil diameter of the inner spring are 5 and 30 mm respectively. Also, the wire diameter and mean coil diameter of the outer spring are 6 and 36 mm respectively. The number of active coils in the inner and outer springs are 8 and 10 respectively. Assume same material for two springs and the modulus of rigidity of spring material is 81370 N/mm^2. The composite spring is	12	2	4,5	5

	subjected to a maximum axial force of 1000 N. Calculate: (i) the compression of each spring; (ii) the force transmitted by each spring; and (iii) the maximum torsional shear stress induced in each spring.				
5 (b)	Derive the expression for stress and deflection in helical compression spring.	08	2	3	5
6 (a)	It is required to select a flat-belt drive to connect two transmission shafts rotating at 800 and 400 rpm respectively. The centre to centre distance between the shafts is approximately 3 m and the belt drive is open type. The power transmitted by the belt is 30 kW and the load correction factor is 1.3. The belt should operate at a velocity between 17.8 to 22.9 m/s. The power transmitting capacity of the belt per mm width per ply at 180° arc of contact and at a belt velocity of 5.08 m/s is 0.0147 kW. Select preferred pulley diameters and specify the belt.	15	2	4,5	6
6 (b)	A motorcycle chain drive experiences noticeable jerks during acceleration. Explain how polygonal action contributes and how it can be minimized?	05	2	3	6
7 (a)	A welded bracket connection, similar to the configuration shown in Figure, is subjected to an eccentric load of 7.5 kN acting at a known offset from the weld group. The welds are to be designed to safely resist the combined effect of direct shear and torsional shear induced by the eccentricity.  Given that the allowable shear stress for the weld material is 100 N/mm² under static loading conditions, determine the required weld size (leg length) for the connection.	10	2	4,5	7
7 (b)	A bracket, attached to a vertical column by means of four identical rivets, is subjected to an eccentric force of 25 kN as shown in Figure. Determine the diameter of rivets, if the permissible shear stress is 60 N/mm². 	10	2	4,5	7

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END SEM/~~RE-EXAM EXAMINATION~~ NOV / DEC 2025

T.Y.

Program: BTECH (MECHANICAL ENGG.) Sem V

Duration: 3hrs

Course Code: PC-BTM606

Maximum Points: 100

Course Name: CAD/CAM/CIM

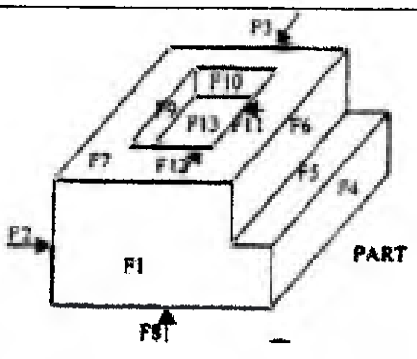
Semester: V

Important Notes:

- Solve any five questions out of seven
- Figures to the right indicates full marks
- Assume suitable data wherever necessary

26/11/25

Q.No.	Questions	Points	CO	BL	PI
Q.1 (a)	1. A quadrilateral ABCD has vertices A(1, 2), B(4, 3), C(5, 6), and D(2, 5). Reflect the object about the x- axis and find the transformed coordinates. Plot both original and reflected shapes. **2.** A triangle XYZ has vertices X(1, 3), Y(4, 5), and Z(6, 1). Reflect the triangle about the line y = 2. Compute the new coordinates and show the before-and-after transformation graphically.	[10]	1	1	3.2.1
(b)	Explain the role of AIML in automating and enhancing 3D modeling tasks in modern CAD systems?	[04]	2,4	3	5.2.1
(c)	Explain Z buffer Algorithm with figure.	[06]	3	3	5.2.1
Q.2 (a)	A cube defined by 8 vertices A (0, 0, 0) B (2, 0, 0) C (2, 2, 0) D (0, 2, 0) E (0, 0, 2) F (2, 0, 2) G (2, 2, 2) H (0, 2, 2). Find the final coordinates after it is rotated by 45^0 around a line joining the points (2, 0, 0) and (0, 2, 2)	[10]	2	3	3.2.1
(b)	Construct a B-spline curve for open uniform vectors with n=5(i.e., 6 control points) and K=4 (cubic B-spline) with polygon vertices: $Q_0(0, 1)$, $Q_1(2, 3)$, $Q_2(4, 6)$, $Q_3(6, 5)$, $Q_4(7, 2)$, $Q_5(8, 0)$	[10]	1	1	3.2.1
Q.3 (a)	Explain the concept of Adaptive Control (AC) in CNC machining. Discuss the various sources of process variability affecting AC systems and describe how Adaptive Control Optimization (ACO) and Adaptive Control Constraint (ACC) strategies respond to these	[10]	3	3	5.2.1

	variations. Illustrate your answer with neat block diagrams and indicate how modern sensors and AI-based feedback improve adaptive performance.				
(b)	Explain Generative CAPP & CAQC with neat sketches?	[10]	2,3,4	1	3.2
Q.4 (a)	What are canned cycles? What is their significance in CNC programming? Explain G81, G82, G82, G84, G85 canned cycles along with examples and their syntax/format?	[10]	4	3	5.2
(d)	Explain G86, G87, G88, G89 canned cycles with examples and their syntax/format? What is the difference between G86, G87, G88, G89 canned cycles?	[10]	4	3	5.2
Q.5 (a)	Explain the complete Design for Assembly (DFA) guidelines along with neat figures?	[10]	3	3	5.2
(c)	 **Fig.E** For the object shown above in Fig.E use the graph based feature recognition approach to achieve the following • Develop the AAG of the given object • Give the matrix representation of the AAG • Recognize the features in this object	[10]	3	3	5.2
Q.6	Write a C++ program for line with following 2D transformations using class & object • Translation • Scaling • Rotation • Reflection • Shearing Insert comments wherever necessary.	[20]	2,4	3	5.2

Q.7	Write Short Notes on (Any Three) • Graphics Standards • Computer Integrated Manufacturing (CIM) • Mixed Reality • Virtual Manufacturing • Structured Query Language (SQL) • AIML in design & Mfg.	[20]	3,4	2	5.2.1 3.2.1

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~~END SEM~~/RE-EXAM EXAMINATION ~~NOV / DEC 2025~~ 2026

T.Y.B.Tech Sem V

Program: BTECH (MECHANICAL ENGG.) **Duration:** 3hrs

Course Code: PC-BTM606 **Maximum Points:** 100

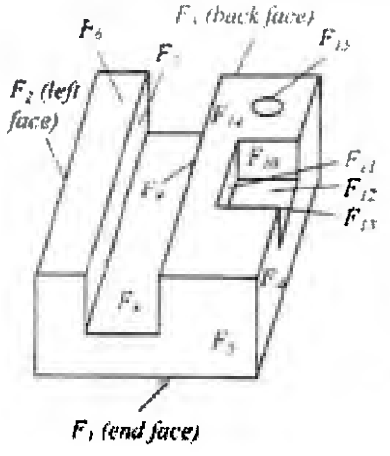
Course Name: CAD/CAM/CIM **Semester:** V

8/1/26

Important Notes:

- Solve any five questions out of seven
- Figures to the right indicates full marks
- Assume suitable data/dimensions wherever necessary

Q.No.	Questions	Points	CO	BL	PI
Q.1 (a)	1. Triangle XYZ has vertices at X(0,0),Y(2,3),Z(4,1). Reflect the triangle through the line y = x+1. Find the coordinates of the reflected triangle and show the result graphically. **2.** Triangle ABC has vertices at A(1,3),B(5,5),C(3,7). It is desired to reflect through the line y= − x + 4y. Calculate the new vertices of the triangle and show the results graphically.	[10]	1	1	3.2.1
(b)	Explain the role of AIML in 3D modeling?	[04]	2,4	3	5.2.1
(c)	Explain Gouraud Shading Algorithm with figure.	[06]	3	3	5.2.1
Q.2 (a)	Explain the sequence of steps involved in performing a rotation of an object about an arbitrary axis in 3D transformations. Derive the rotation matrix for rotation by an angle θ & alpha about an arbitrary axis passing through the origin, defined by the direction cosines	[10]	2	3	3.2.1
(b)	Construct a B-spline curve for open uniform vectors with n=3(i.e., 4 control points) and K=2(linear B-spline) with polygon vertices: $R_0(1, 1)$, $R_1(2, 4)$, $R_2(4, 2)$, $R_3(5, 0)$	[10]	1	1	3.2.1
Q.3 (a)	Explain the concept of Adaptive Control (AC) in CNC machining. Discuss the various sources of process variability affecting AC systems and describe how Adaptive Control Optimization (ACO) and Adaptive Control Constraint (ACC) strategies respond to these variations. Illustrate your answer	[10]	3	3	5.2.1

	with neat block diagrams and indicate how modern sensors and AI-based feedback improve adaptive performance.				
(b)	Explain Generative CAPP & CAQC with neat sketches?	[10]	2,3,4	1	3.2.1
Q.4 (a)	Explain Tool Length Compensation (TLC) and Cutter Radius Compensation (CRC) in CNC machining. Discuss their need, working principles, and implementation through appropriate G-codes. Support your answer with illustrative example & neat sketches showing their effect on tool path control.	[10]	4	3	5.2.1
(c)	Describe the working of a CNC servomechanism system incorporating displacement and velocity feedback loops. Explain how photoelectric transducers are used to measure linear and angular feedback to the controller. Support your answer with neat block diagrams.	[10]	3	3	5.2.1
Q.5 (a)	What is Rapid Prototyping (RPT)? explain any two methods of RPT?	[10]	3	3	5.2.1
(b)	 **Fig.E** For the object shown above in Fig.E use the graph based feature recognition approach to achieve the following • Develop the AAG of the given object • Give the matrix representation of the AAG • Recognize the features in this object	[10]	3	3	5.2.1

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Q.6	Write a C++ program for line with following 2D transformations using class & object • Translation • Scaling • Rotation • Reflection • Shearing Insert comments wherever necessary.	[20]	2,4	3	5.2.1
Q.7	Write Short Notes on (Any Three) • Graphics Standards • Computer Integrated Manufacturing (CIM) • Augmented Reality • Digital Twin • Structured Query Language (SQL) • AIML in Design & Manufacturing Pls provide necessary figures, sketches, block diagrams etc. wherever required for above short notes	[20]	3,4	2	5.2.1 3.2.1

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PREVIOUS SEMESTER EXAMINATION JANUARY 2026

8/1/26

T. Y. B. Tech Sem V

Program: B.Tech Mechanical **Duration: 3 hrs.**

Course Code: PC-BTM515 **Maximum Points: 100.**

Course Name: Computer Aided Machine Drawing **Semester: V**

Important Notes:

1. Question 1 is compulsory.
2. Attempt any three out of remaining five questions.
3. Create a new folder and rename it to <Reg. No._CAMD_PSE>
4. Create separate .dwg file for each question and save in the above created folder only. File name should be <Q1_Reg. no._PSE>.
5. Answers to free hand sketches should be drawn on given A4 answer sheet and submit is back.
6. Students to carry only Admit Card, Pen, Pencil, eraser and sharpener in Exam Hall. Use of scale and any geometric instrument is prohibited in Exam Hall.
7. At the end of exam, your folder with autocad and pdf files will be uploaded by the authorized person. Before leaving the exam seat, student have to confirm that his/her folder is uploaded by the authorized person.
8. Assume suitable data wherever only if necessary.
9. **Save your Work** in AutoCad Regularly.

Q. No.		Points	MO/ CO	BL	PI
Q.1	Given in the figure is the details of Sleeve and Cotter Joint. Complete the following tasks:		03/–	03	5.1.2
	a) Draw detail drawing of each part in **2d.**	06	01		
	b) Make one copy of each part and assemble the parts at their functional positions where u can see **Sectional Front View** of Assembly in **2d.**	07	03		
	c) Create a Bill of Material and plot a pdf file of the assembly with given template layout.	04	04		
	d) Draw Free Hand Sketches of the following:		02/	01	1.4.1
	i. Metric Thread.	04	02		
	ii. Buttress Thread	04			

PREVIOUS SEMESTER EXAMINATION JANUARY 2026

Q.2	A vertical Cone, Diameter 90 mm side and axis 100 mm is resting on its base on the H.P. A horizontal cylinder, diameter 40 mm, having its axis parallel to both the V.P. and H.P. penetrates the cone. The axis of the solids intersects each other at right angle and cylinder axis is 35 mm above the prism base. a) Create 3d models of the cone and cylinder. b) Create a copy of 3d models of the cone- cylinder and assemble them as given in problem. c) plot the projections of the assembly in F.V., T.V., and S.V. showing curves of intersections in the given layout template.	06 04 07	01/-- 01 03 04	03	5.1.2
	d) Draw Free Hand Sketches of the following: 1. Flange Nut. 2. Hook Bolt	04 04	02/ 02	01	1.4.1
Q.3	Given in the figure is the Details of Protected Flange Coupling. Complete the following tasks. a) Create the Parts drawing in **2d** space. b) Make one copy of each part and assemble the parts at their functional positions where u can see **Sectional Front View and Side View** of Assembly in **2d.** c) Create a Bill of Material and plot a pdf file of the assembly within given template layout.	07 08 05	04/-- 01 03 04	03	5.1.2
	d) Draw Free Hand Sketches of the following: 1. Flat Saddle Key 2. Taper Rectangular Key	05	04/ 02	01	1.4.1

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Q.4	Given in the figure is the Details of V-Belt Pulley. Complete the following tasks.		05/--	03	5.1.2
	a) Create the part model of all parts in **3d** space.	8	01		
	b) Make one copy of each part and assemble the parts at their functional positions. Plot **Sectional Front View and Side View** of Assembly in **2d** layout with template.	6	03		
	c) Create a Bill of Material and plot a pdf file of the assembly.	6	04		
	d) Calculate the limits for Ø45 H7, f8	5	02/ 02	01	1.4.1
Q.5	Given in the figure is the Expansion Valve Assembly.		06/--	03	5.1.2
	a) Plot the **2d** detail drawing for:				
	Body: i) Sectional Front View	7	01		
	ii) Side View	7	01		
	b) Create the **3d** part model of **Gland Bush.**	6	03		
	c) Plot the **Sectional Front View** of **3d** model of **Gland Bush** in 2d layout.	5	04		
Q.6	Given in the figure is the Drill Jig Assembly.		07/--	03	5.1.2
	a) Create 3d part model of Latch Washer	08	03		
	b) Plot the **Sectional Front View and Top View of 3d model** in **2d layout** with given template.	10	04		
	c) Create a **3d** model for Base Plate.	07	03		

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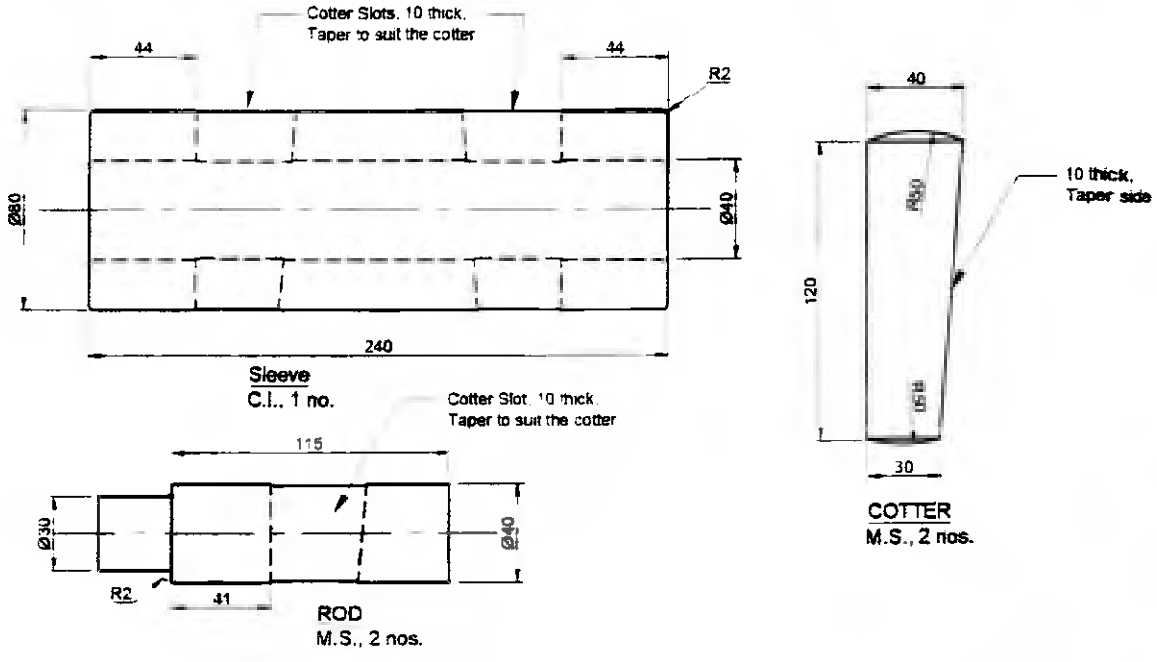
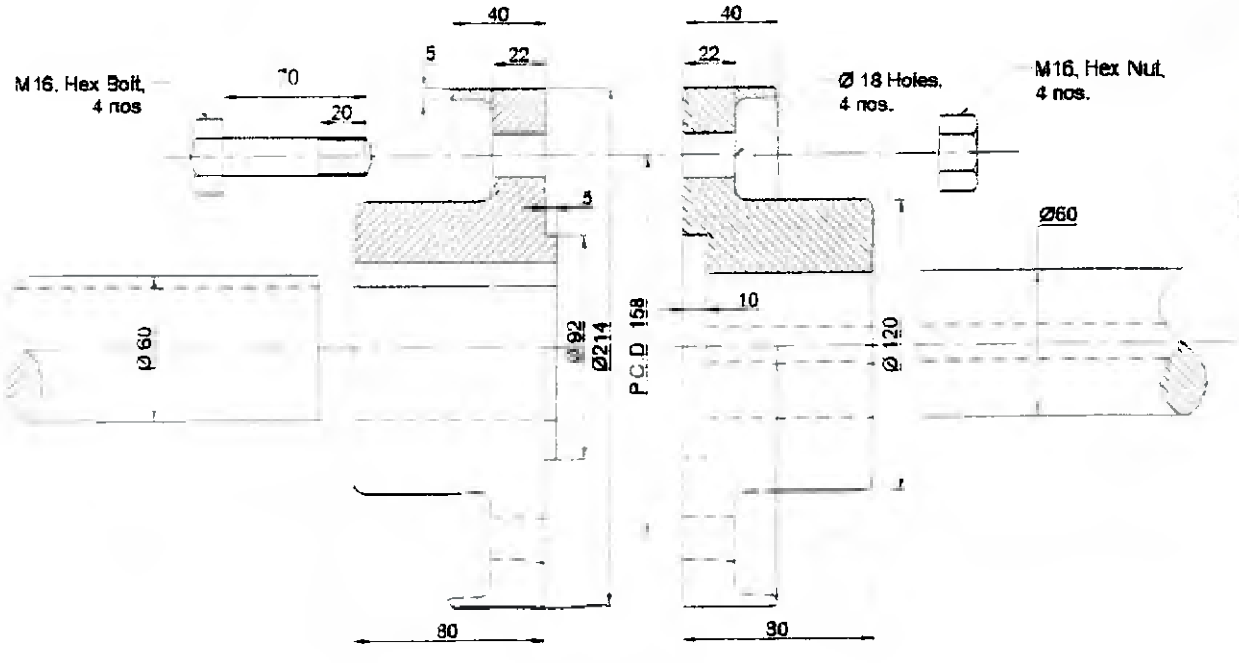


Q.1. Sleeve and Cotter Joint



Q.3. Protected Flange Coupling

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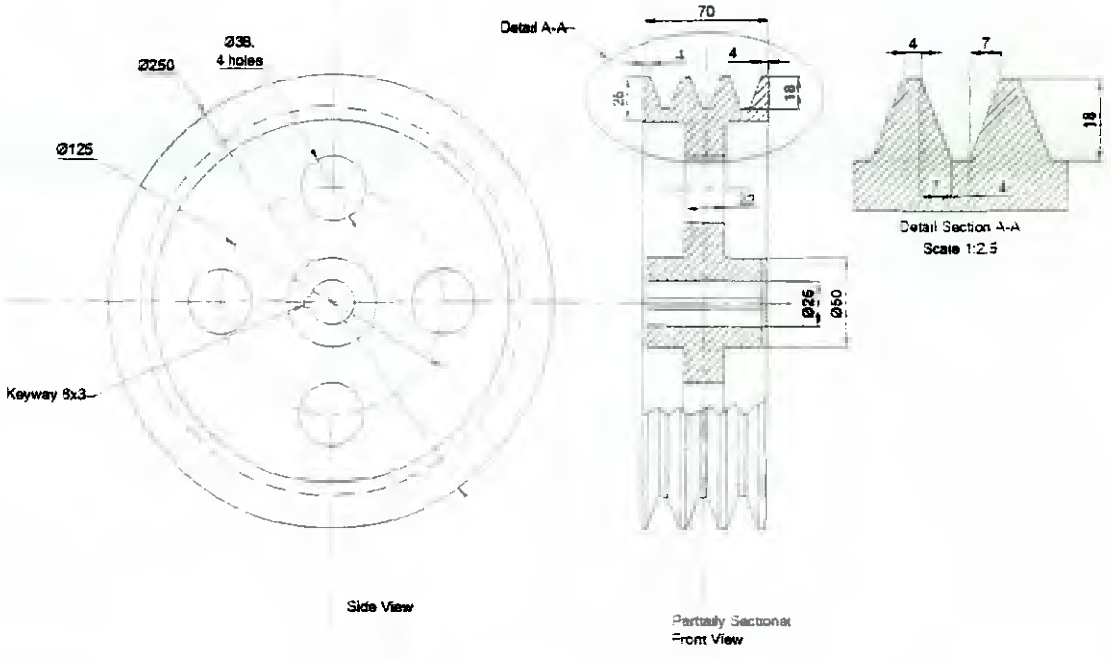

Q.4. V-Belt Pulley

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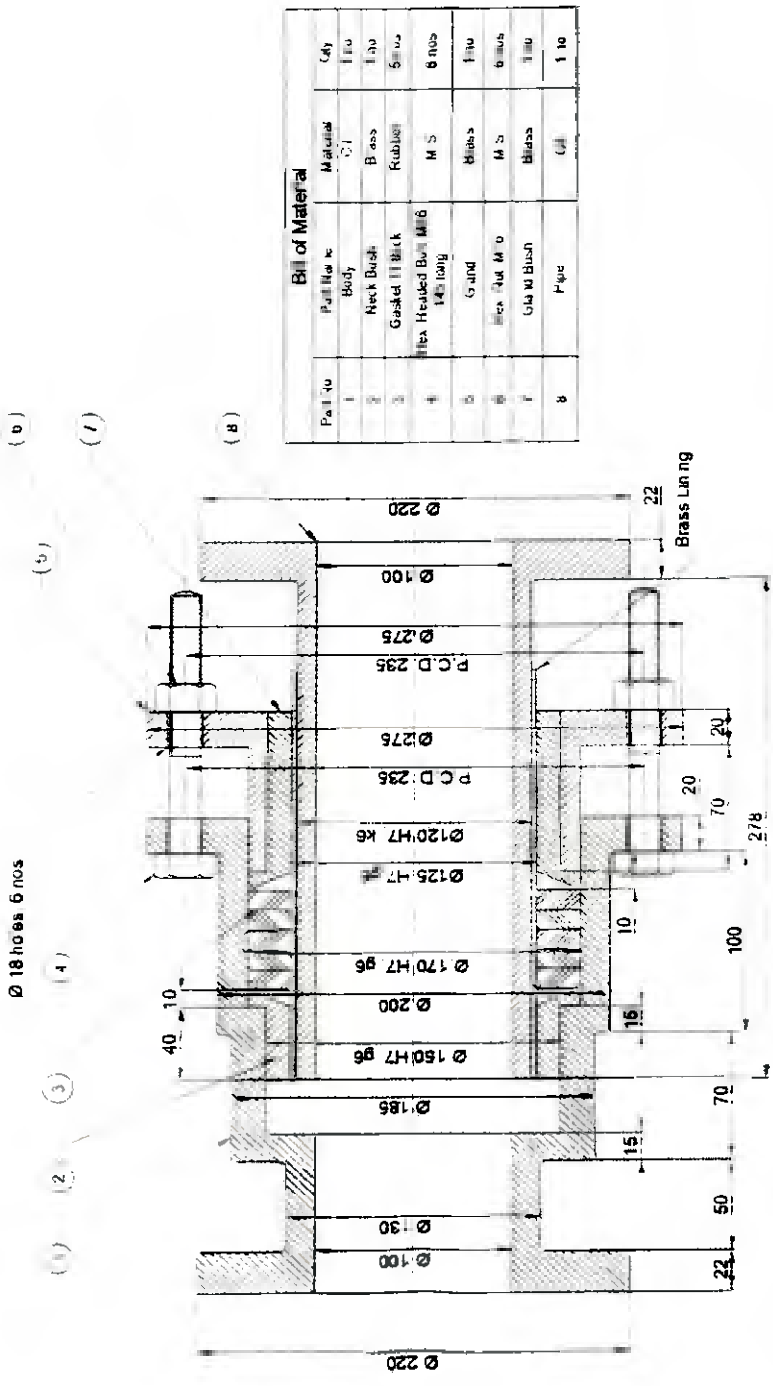
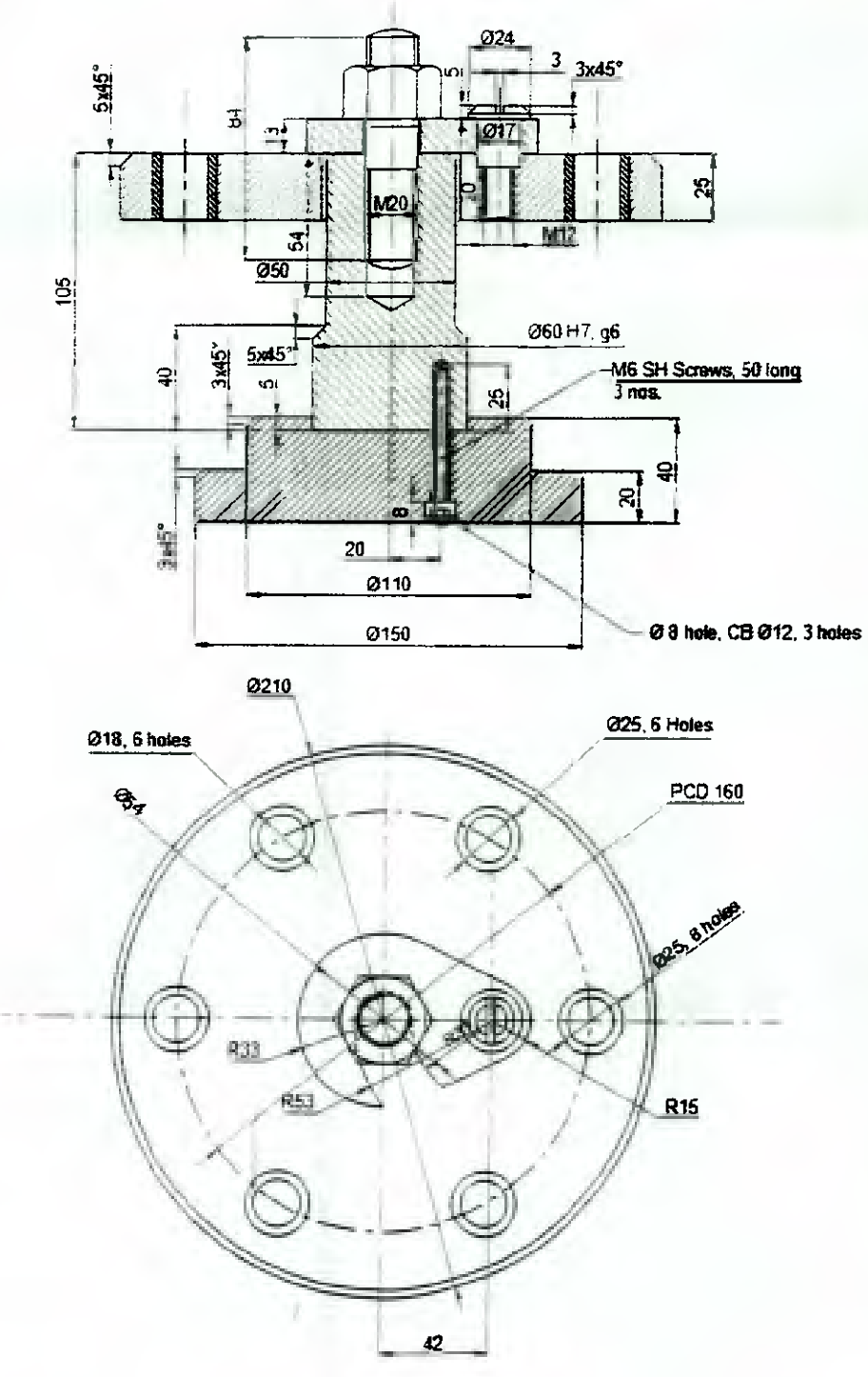


Q.5. Exapnsion Joint

PREVIOUS SEMESTER EXAMINATION JANUARY 2026



Q.6. Drill Jig Assembly

PREVIOUS SEMESTER EXAMINATION JANUARY 2026

Limits, Tolerance Tables

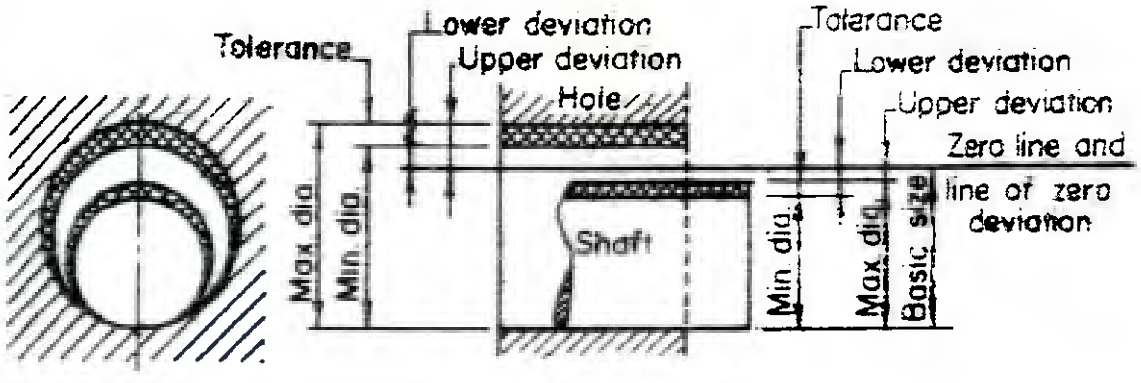


Table 1 Recommended diameter steps upto 500 mm (13 steps)

Over	-	3	6	10	18	30	50	80	120	180	250	315	400
Upto	3	6	10	18	30	50	80	120	180	250	315	400	500

Table 2 Equations to calculate fundamental deviation of shaft size up to 500 mm (D = Geometrical mean dia. in mm)

Symbol	Fundamental deviation in microns	Symbol	Fundamental deviation in microns
d	$-16D^{0.44}$	js	$\pm(IT/2)$
e	$-11D^{0.41}$	k4 to k7	$+0.63D^{1/2}$
f	$-5.5D^{0.41}$	m	+ (IT7 – IT6)
g	$-2.5D^{0.34}$	n	$+5D^{0.34}$
h	0	p	+ (IT7 + 0 to 5)

Table 3 Fundamental Tolerance for IT grades in terms of i.

IT Grade	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16
Tolerance in Microns	7i	10i	16i	25i	40i	64i	100i	160i	250i	400i	640i	1000i

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End Sem. / [redacted]m - Dec 2025

Program: Mechanical

Duration: 3 Hrs

Course Code: PC-BTM504

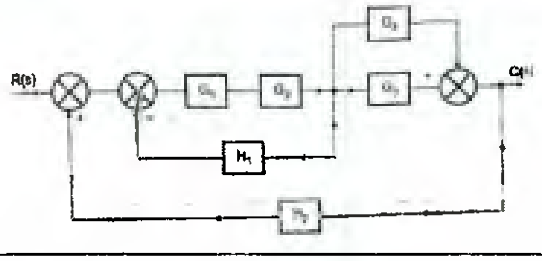
Maximum Points: 100

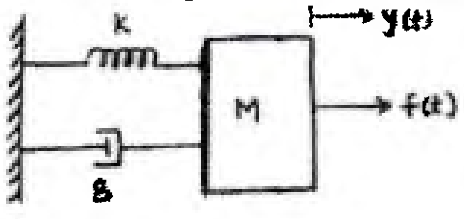
Course Name: Mechatronics and Automation

Semester: V

Notes: Question **No.1 is compulsory**

Solve any **Four** questions out of **SIX**

Q.No.	Questions	Points	CO	BL	PI
1	**a) Discuss** Mechatronics applications in various field such as Home, Industry and office **b) Discuss** the various application of Fluid power **c) Draw** and **Explain** Piston pump **d) Explain** the standard test inputs in detail **e) Drive** the steady state error	20	1to4	I,III,V	1.5.1
2a	**Develop** following circuit i) Meter-in and Meter- out circuit and ii) Hydraulic Robotic arm with clamping	10	2	I	1.6.1
2b	**Draw** the architecture of 8085 and **explain** the pin diagram 8051	10	2	VI	5.4.1
3a	**Draw** and **explain** i) Gear Pump ii) Lobe pump iii) unbalanced vane pump iv) Gerotor pump	10	1	III	1.6.1
3b	**Explain** the concept of stability in detail with suitable example.	10	2	V	5.4.1
4a	**Develop** a schematic and functional block diagram of liquid level control. Justify your answer.	10	3	VI	1.6.1
4b	**Reduce** the Block diagram and **obtain** the transfer function 	10	3	III	5.4.1
5a	**Explain** the Herwitz Criteria and Routh's stability with suitable example	10	3	II	1.6.1

5b	**Draw and explain** 4/2 poppet type valves and spool valves.	10	3	VI	1.6.1
6a	For unity feedback system, $G(s)H(s) = \frac{K}{s(s^2+2s+2)}$, **sketch** the nature of the root locus showing all details on it. **Comment** on stability of the system.	10	3	IV	5.4.1
6b	**Obtain** the transfer function for a system having state model $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} * \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$, $y = [1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$	10	3	III	5.4
7a	**Obtain** the state model for the mechanical system 	10	4	III	5.1.2
7b	Explain the Bode Plot with various factors with suitable example.	10	4	III	5.1.2

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~~End Sem.~~/Re Exam - Dec 2025

T. Y. B. Tech (Mech) Sem V

9/1/26

Program: Mechanical
Duration: 3 Hrs

Course Code: PC-BTM504
Maximum Points: 100

Course Name: Mechatronics and Automation
Semester: V

Notes: Question **No.1** is compulsory

Solve any **Four** questions out of **SIX**

Q.No.	Questions	Points	CO	BL	PI
1	**a) Discuss** Mechatronics design process with suitable example **b) Discuss** the various components of hydraulics circuit **c) Draw** and **Explain** vane pump balanced and unbalanced **d) Explain** the Open loop and Close loop system with suitable application in detail **e) Explain** the Time response analysis in detail	20	1to4	I,III,V	1.5.1
2a	**Draw** and **explain** i) Sequencing Circuit, and ii) Clamping circuit with accumulator	10	2	I	1.6.1
2b	**Draw** the architecture of 8051 and **explain** the memory organization of 8051 in detail	10	2	VI	5.4.1
3a	**Derive** the steady state error and obtain the effect of all standard test inputs on steady state error and static error coefficients *Kp, Kv* and *Ka.*	10	1	III	1.6.1
3b	**Develop** a schematic and functional block diagram of Ship stabilization. In this system a roll sensor is used as a feedback element. The desired roll position is selected as Theta r, while actual roll position is theta c, which is compared with theta r to generate control signal. This activates the fin actuator in proper way to stabilize the ship.	10	2	V	5.4.1
4a	**Develop** a schematic and functional block diagram of liquid level control. Justify your answer.	10	3	VI	1.6.1
4b	**Reduce** the Block diagram and **obtain** the transfer function	10	3	III	5.4.1

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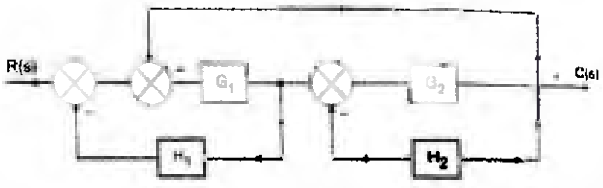
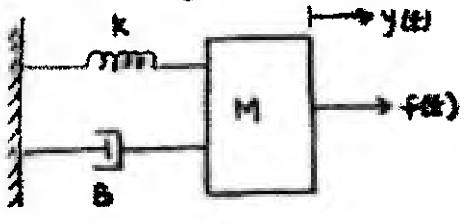
~~End Sem~~./Re Exam - Dec 2025

					
5a	**Explain** the effect of input R(s) and G(s)H(s) on steady state error with suitable example.	10	3	II	1.6.1
5b	**Explain** the Routh's Stability Criteria. Obtain $S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$ Routh's Stability	10	3	VI	1.6.1
6a	**Obtain** the Root Locus for $G(s)H(s) = \frac{K}{S(S+2)}$ and $G(s)H(s) = \frac{K(s+1)}{S(S+5)}$. Comment on stability.	10	3	IV	5.4.1
6b	**Obtain** the transfer function for a system having state model $\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix} * \begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix} u$, $y = [1 \quad 0]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$	10	3	III	5.4.1
7a	**Obtain** the state model for the mechanical system 	10	4	III	5.1.2
7b	A unity feedback control system has $G(s) = \frac{20}{s(1+0.1s)}$, **Draw the Bode Plot.**	10	4	III	5.1.2

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END SEM/~~RE/ EXAMINATIONS~~ November 2025/Jan 2026

Program : **BTech Mechanical engg** **Duration** :**3 hr**

Course Code : **PE-BTM511** **Maximum Points** :**100**

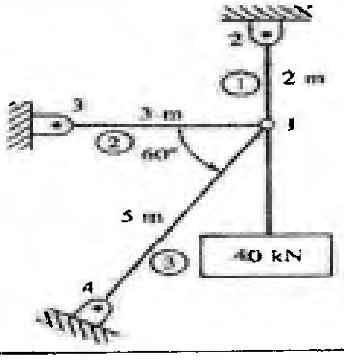
Course Name: Finite Element Methods for Mechanical Engineers.

Semester : **V**

Instruction : Refer below

1. Question No. 1 is compulsory
2. Solve any four out of remaining six.
3. Answers to each sub-questions must be grouped together
4. Use of scientific calculator is allowed
5. Begin answer to each question on new page.
6. Keep some margin on left side of answer paper
7. **Candidates should write the answer legibly**

Q. no.	Description	Points	CO	BL
1	Answer the following: a) List and elaborate steps involved in FE analysis b) Develop the weak formulation for simply supported beam with udl.	10x2	1,2, 3	2,3
2	For an isoparametric quadrilateral element the nodal cartesian co-ordinates are 1(2,2); 2(5,3); 3(7,5) and 4(1,6) determine:- a) Jacobian matrix, b) At point '*P*'(3,4) within the element if the load of 10 kN at 30 degrees with horizontal in ccw direction is applied; find equivalent nodal forces.	10x2	2,3	2,3
3	a) A CST element having nodal co-ordinates (2,0); (6, 0); (4, 4) for node 1, 2 add 3 respectively and thickness 2.0 mm; upon loading the nodal deflections in microns found to be (2,1); (3,2) and (5,3) at nodes 1, 2 and 3 respectively. Find the displacement at P(4,2) and strain displacement relation {B} matrix. b) List the characteristics of the stiffness matrix.	15 05	1,2	3,4
4	The pin-fin used for heat dissipation, has 60 mm long and circular c/s area of 100π mm^2. At one end of fin temperature is 250^{0}C. (take k = 100 watt/cm ^{0}C, h = 10 watt/cm^2 ^{0}C, surrounding temperature 30^{0}C, use 3 linear elements, (consider convection from free end also). Find: a) Conductive and convective matrix for each element b) Final assembled matrix c) Temperature at various nodes.	10 4 6	1,2, 3	3,4

5	A taper bar having $50mm^2$ and $20mm^2$ as cross-sectional area at fixed end and free end respectively, is subjected to point load of 1.8 kN at free end. Take total length of taper bar as 1.2 m and E = 210 GPa. Find the displacement at each node and stress in each element. (discretize bar in 3 element)	20	2,3	3,4
6	a) Evaluate $\iint(3y^2 + 2x)dxdy$ using 2X2 gauss quadrature, take limits of integration as 0 to 2 for both x and y. b) Derive expression of stiffness matrix for arbitrary oriented bar element. (truss element).	10 10	2,3	3,4
7	For the truss shown in fig. obtain: a) Elements stiffness matrix and assembled stiffness matrix. b) Displacement of node 1 c) Stress in each element E = 200 GPa, A = 375 mm^2 	10 4 6	2,3	2,3

$$N_1 = \frac{1}{L^3}(2x^3 - 3x^2L + L^3) \qquad N_2 = \frac{1}{L^3}(x^3L - 2x^2L^2 + xL^3)$$

$$N_3 = \frac{1}{L^3}(-2x^3 + 3x^2L) \qquad N_4 = \frac{1}{L^3}(x^3L - x^2L^2)$$

$$\frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & 6L \\ 6L & 4L^2 & -6L & 2L^2 \\ -12 & -6L & 12 & -6L \\ 6L & 2L^2 & -6L & 4L^2 \end{bmatrix}$$

$$N_1 = 1 - \frac{3x}{\ell} + \frac{2x^2}{\ell^2}, \qquad N_2 = \frac{-x}{\ell} + \frac{2x^2}{\ell^2}, \qquad N_3 = \frac{4x}{\ell} - \frac{4x^2}{\ell^2}$$

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END SEM / ~~RE-EXAMINATION~~ –NOV DEC 2025

11/11/25

T.Y. Sem V

Program: BTech Mechanical Engineering **Duration:03 Hour**

Course Code: PE-BTM512 **Max.Points:100**

Course Name: Lean and Green Manufacturing **Semester:V**

11/11/25

Que 1 is compulsory.

Solve any 4 questions from remaining.

Figures to the right indicate full marks.

Assume any suitable data if necessary

Q.No.	Questions	Points	CO	BL	Module No.
Q1A	Draw a detailed Value Stream Mapping (VSM) for the Internship received. Consider the traditional/manual feedback collection approach and identify non-value-added activities.	10	CO3	4	2
Q1B	Explore the essential Characteristics of Environment friendly product. Explore and explain Barriers for Green Product Development.	10	CO4	5	6
Q2A	State and explain the major risks involved in the implementation of Just-In-Time (JIT) manufacturing. Develop a detailed Fishbone (Ishikawa) Diagram to illustrate the various supply-related risks associated with JIT implementation	10	CO1	3	3
Q2B	Explore and explain Barriers for Green Product Development.	10	CO4	5	6
Q3A	Draw the Kano model. Explain it in detail.	10	CO1	5	6
Q3B	Explain the key guidelines for designing an environmentally friendly product (Design for Environment – DfE). Discuss how these guidelines help in reducing environmental impact across the product life cycle. Illustrate your answer with suitable examples. .	10	CO4	4	4
Q4A	Develop the strategies to reduce the wastes in state transport in Maharashtra.	10	CO2	6	2
Q4B	Explore and explain the key guidelines for Human Development required to achieve sustainable Lean implementation. Discuss how employee skills, mindset, motivation, leadership involvement, and organisational culture contribute to long-term Lean success. Support your answer with suitable examples.	10	CO2	5	5,6
Q5A	Prepare the table to showcase Human Resource Barriers for Lean Implementation, Strategies and action plan.	10	CO1 CO2	6	5
Q5B	Discuss the concepts and benefits of 5S. State the principles adopted in 5S. Prepare the 5S audit checksheet.	10	CO3	4	5,6
Q6A	Prepare Green Supplier Development Process Model and Explain it in detail	10	CO4	5	7

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END SEM / ~~RE-EXAMINATION~~ – NOV DEC 2025

Q6B	Explain 11 principles used in Lean Construction practices	10	CO2	3	6,7
Q7A	What do you mean by error proofing? What are the root causes of generation of error.	10	CO3	3	3
Q7B	What are 3 M's as per Lean Manufacturing? Identify the wastes in the agriculture or healthcare sector. State the reasons for each waste. Develop the strategies to eliminate the wastes	10	CO2	5	1

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END SEMSTER EXAM. NOVEMBER-2025 / ~~RE-EXAMINATION~~ JANUARY-2026

Program: B.Tech. Mechanical T.Y. B.Tech. Sem V

Duration: 3 Hour

Course Code: PEC-BTM513

Maximum Points: 100

Course Name: Introduction to Cryogenics

Semester: V

11/12/25

Notes:

1) **Solve: Any FIVE Questions.**
2) Answers must be **SPECIFIC** and in **legible** handwriting.
3) Draw **neat system diagram/s and T-s diagram/s** wherever necessary.
4) **Use of charts / tables for material properties and T-s chart for cryogens provided by Examination Section is permitted.**
5) **Assume suitable data wherever necessary and state the same.**

Q.	Question	Points	CO	BL	Module
1.	a) **Define:** Cryogenics. **Differentiate:** between refrigertaion and cryogenics. **Describe:** Any one application of cryogenics in space and medical sciences each.	10	1	I, II, IV	1
	b) **Explain:** Meissener Effect. **Draw:** Neat sketch. **Differentiate:** Between Type-I and Type-II superconductors. **Evaluate:** Critical current for a Type-I superconductor Gallium wire of 2.9 mm diameter at 0.6 K. Assume parabolic rule holds true.	10	1, 2	II, III, VI	1,2
2.	a) **Compare:** Mechanical and thermal properties of SS-304 and Titanium and **Justify:** Why SS-304 is preferred for most of the cryogenic applications?	05	2	VI	2
	b) **Explain:** Phases of Helium-4 with significance of Lambda point and super fluidity. **Draw:** Neat sketch.	05	2	II, III	2,4
	c) **Evaluate:** Percentage contribution of electronic specific heat ($c_{v,e}$) in the total specific heat (c_v) for Copper at i) 30 K and ii) 3 K. $\bar{R}$ = 8.31434 J/mol and Relative Molecular Mass of Copper, RMM = 63.54 g/mol, **Conclude:** about variation of electronic and lattice specific heat of metals with temperature.	10	2	II, VI	2
3.	a) **Derive:** Expression for i) Liquid yield and ii) Work of compression per unit mass of gas compressed for a basic Claude system of liquefaction. **Draw:** neat	10	4	II, IV	3

	system diagram and T-s diagram.				
	b) Evaluate: i) Liquid yield and ii) Figure of Merit (FoM) of a Linde-Dual pressure system for Nitrogen liquefaction operating between 1 atm, 300 K to 200 atm. The intermediate pressure is 50 atm and intermediate pressure flow rate ratio (i) is 0.7. **Draw:** Neat system diagram and T-s diagram.	**10**	4	III, VI	3
4.	**Discuss:** Practical difficulty in liquefaction and storage of LH_2 with reasons and significance. **Explain:** Remedial methods using catalyst. **Draw:** Neat system diagrams.	**10**	4	II, III	4
	b) In a simple Linde-Hampson liquefaction system, Nitrogen gas at 101.3 kPa, 300 K is compressed to 200 atm. The effectiveness of heat exchanger is 0.965. **Evaluate:** i) Liquid yield ii) Work of compression per unit mass of the gas liquefied. **Draw:** neat system diagram and T-s diagram.	**10**	4	I, V	4
5.	**b) Evaluate:** i) Joule-Thomson coefficient (μ_{JT}) and ii) Isentropic expansion coefficient (μ_s) for Nitrogen gas expanding from 20 MPa, 300 K to 10 MPa. **Draw:** Neat T-s diagram. **Compare:** Advantages and disadvantages of expansion of a cryogen gas through a J-T Valve and an Expander.	**10**	4	III, IV	3
	b) Explain: Necessity of insulation in cryogenic systems. **Justify:** Preferred use of Multilayer Insulation (MLI) in cryogenic systems based on its properties and advantages compared with other types of insulations.	**10**	3	II, VI	5
6.	**a)** Justify: Necessity of vacuum in cryogenic applications. **Explain:** Working of diffusion pump. **Draw:** neat sketch.	**10**	3	I, II	6
	b) Discuss: i) Various Health hazards associated with cryogenic systems, ii) Measures for personal safety in cryogenic plants.	**10**	3	II	7
7.	Write short notes on **ANY THREE** of the following:				
	a) Cryogenics for medical applications	20	1	II	1
	b) Isotopes of Hydrogen and their phases		2		2
	c) Inversion curve and Maximum inversion temperature		4		3
	d) Vacuum gauges for cryogenic applications		3		6
	e) Safety considerations for cryogenic plant		3		7

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END SEM./~~RE-EXAMINATION,~~ DECEMBER 2025

T. Y. B. Tech (MM)

B.Tech. (Mechanical Engineering) Semester -V Duration: **Three Hour**

PE BTM 514: **COMPRESSIBLE FLUID FLOW** Maximum Points :**100**

11/12/25

Notes

1. Attempt **any five** questions out of the seven provided.
2. Ensure that the answers to all sub-questions of a particular question are **grouped together** for evaluation.
3. Make suitable assumptions wherever necessary and **justify them clearly**.
4. Use **GAS tables** wherever applicable.
5. The data shown in the **CO** (Course Outcome) and **BL** (Bloom's Taxonomy Level) columns are **only for academic reference**.

1.	**(A)** Explain the characteristic features of compressible flow. Derive the basic governing equations for mass, momentum, and energy for a compressible fluid, and write them in their appropriate mathematical forms.	**[10]**	2,3/4
	(B) Develop an area velocity and pressure relation for an isentropic varying area flow analysis. Analyze and explain the expression with their physical meaning.	**[10]**	2,3/4,5
2.	**(A)** What do you understand by Mach number and the critical (sonic) conditions in compressible flow? Starting from thermodynamic principles, obtain the general expression for the speed of sound in a fluid. Discuss whether the sonic velocity depends on pressure.	**[10]**	1,2/4
	(B) Explain the fundamental differences between the following compressible-flow phenomena. Support each comparison with sketches or practical examples: • Subsonic, transonic, and supersonic flow regimes, • Isentropic flow *vs* Non-isentropic flow, • Choked flow condition *vs* Unchoked flow condition, • Expansion waves *vs* Shock waves	**[10]**	1/1,4
3.	**(A)** Identify the two reference (benchmark) states commonly used to characterize the properties of a compressible flow. Using these reference states, derive the relations for pressure, temperature, and density of a flow having Mach number M. Express each property in terms of both benchmark states.	**[10]**	1/1,2
	(B) Air at Mach number 2 enters the test section of a wind tunnel from a large reservoir maintained at 0.69bar and 310K. A throat of cross sectional area of 1000cm^2 is used in the tunnel. Determine following: (a) P, T and V at throat and test section, (b) test section cross sectional area, (c) mass flow rate (d) maximum velocity (e) force acting on the nozzle wall	**[10]**	3,4/3,4
4.	**(A)** What is Fanno flow? Sketch Fanno line on an appropriate property diagram and explain it. Discuss the effect of Fanno flow on following properties: Pressure, temperature, density, enthalpy and velocity of flow.	**[10]**	1,2/1,2
	(B) A long pipe of 25.4 mm diameter has a mean coefficient of friction of 0.003. Air enters	**[10]**	3,4/3,4

the pipe at a Mach number of 2.5, stagnation temperature 310K and static pressure 0.507 bar. Determine for a section at which the Mach number reaches 1.2

(a) static pressure and temperature
(b) stagnation pressure and temperature
(c) velocity of air
(d) distance of section from the inlet, and
(e) mass flow rate of the air

(Use of Gas Table is permitted)

5. **(A)** A normal shock is formed in a one-dimensional compressible gas flow. Describe how the shock affects each of the following flow properties—does it increase or decrease? Provide justification for every change: **[10]** 3,4/1,2

- Stagnation pressure and stagnation temperature
- Static pressure and static temperature
- Entropy
- Velocity
- Density

(B) A stationary normal shock occurs within a constant-area duct carrying air, which may be treated as an ideal gas. The upstream conditions are: T_1=5°C, p_1=65 (absolute), and flow velocity V_1=668 m/s. Determine all thermodynamic and flow properties immediately downstream of the shock, and calculate the entropy increase across it. Illustrate the shock process on a T–s diagram. **[10]** 4/3,4

(Use Gas Table is permitted)

6. **(A)** Discuss Rayleigh Flow. List down all governing equation required to characterize this flow. Represent it on a Ts diagram and explain its unique feature. **[10]** 1,3/2,4

(B) Air flows isentropically in a channel. At section 1 the Mach number is 0.3, the area is 0.001m^2, and the absolute pressure and the temperature are 650 kPa and 62°C, respectively. At section 2, the Mach number is 0.8. Sketch the channel shape, plot a T-s diagram for the process, and evaluate properties at section 2. **[10]** 3/4,5

7. **(A)** Define choked flow. Under what conditions does it occur? Explain the behavior of isentropic flow through a converging nozzle when the back pressure is varied. Illustrate how the flow properties change along the length of the nozzle. **[10]** 1,3/1,2

(B Define a supersonic wind tunnel and highlight the key features that distinguish it from a subsonic wind tunnel. Describe the various types of supersonic wind tunnels, explain their operating principles, and support your discussion with suitable schematic diagrams. **[10]** 2,3/1,3

2---2---2---2---2

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END SEMESTER EXAM NOVEMBER 2025 (SET 1)

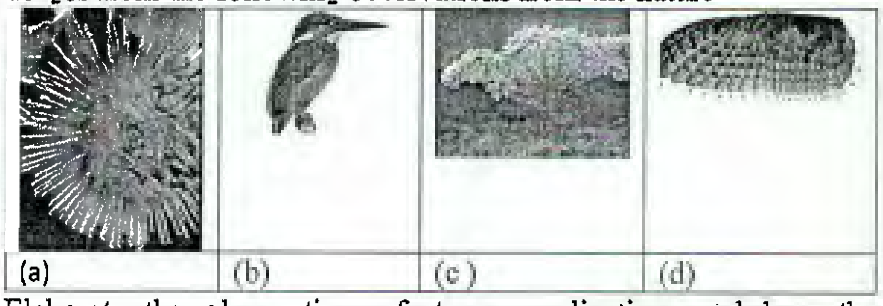
Program: B. Tech. (Mechanical Engineering)

Duration: 3 Hrs **Semester: V**

Course Code: PE-BTM 515 **Maximum Points: 100**

Course Name: Professional Elective-I Nature Inspired Design and Innovation

Notes: 1. Question Number 1 is compulsory, 2. Solve any four question from Q. No. 2 to 7. 3. Assume suitable data if necessary with justification. 4. Provide Schematics and Figures to support the answers

Q. No.	Questions	Points	CO	BL	Module No.
1	Correlate the appropriate nature inspired designs prepared and its usages from the following observations from the nature  Elaborate the observations, features, applications and how the design is conceived for intended application for each of the case.	20	1-4	3,4	2-6
2 (a)	What are the Nature's Design Principles?	10	2	3	2
2 (b)	Draw design spiral and explain significance of each of the steps provided in design spiral.	10	2	3	3
3 (a)	Explain contribution of the Fathers of Modern Biomimetics: Percy Shaw. Explain his observation from nature which turned into product. Explain the science/working principle in his nature inspired product. Draw schematics and figures to explain the answer	10	3	3	1
3 (b)	Draw neat labeled sketch of Eastgate centre mall constructed at Harare Zimbabwe. Discuss (i) Inspiration from nature in designing the Eastgate mall (ii) Underlying physics behind effectiveness of the mall in alignment with the nature's design.	10	4	4	4
4 (a)	Name the inventions inspired from Lotus leaf and Water Droplet interaction effects. Elaborate on the geometrical features of the structure and the physics behind the interaction.	10	4	4	4

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END SEMESTER EXAM NOVEMBER 2025 (SET 1)

4 (b)	What is Swarm Intelligence and ant colony optimization? Provide the phenomenon observed in nature for Swarm Intelligence and ant colony optimization.	10	3,4	5	7
5 (a)	Explain the different important aspects of biological materials and engineering materials. Explain material aspects of pitcher plant.	10	2,3	3	5
5 (b)	Explain the step by step process that mosquito follows in bite. With neat labelled sketches explain the product developed from the observations.	10	3,4	4	6
6 (a)	With neat sketched explain the detailed structure of the wings of the *Morpho* butterfly. Explain science behind colours in nature. How natural colours are advantageous over artificial colours.	10	2,3	4	3
6 (b)	With neat labeled sketch explain the working of burrowing robot based on razor clams.	10	2,3	3	6
7 (a)	Students shall present five different designs observed from various species available in Bhavans Campus, Andheri (West). Student shall explain the design and the location of species found in the campus.	10	1-3	3	1-7
7 (b)	Explain contribution of the Fathers of Modern Biomimetics: George de Mestral. Explain his observation from nature which turned into product. Explain the science/working principle in his nature inspired product. Draw schematics and figures to explain the answer	10	3		1

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END SEMESTER/~~RE-EXAM~~ NOVEMBER/DECEMBER 2025 SET 1

T. Y. B. Tech (OM) Sem V

Program: B. Tech.

Duration: 3 Hrs **Semester: V**

Course Code: MI-BT022 **Maximum Points: 100**

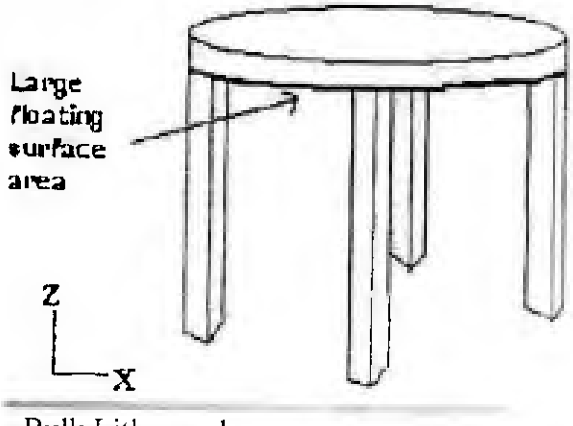
Course Name: Minor Course "Additive Manufacturing"

Notes: 1. Q. No. 1 is compulsory 2. Solve any four questions from Q. No. 2 to Q. No. 7, 3. Assume suitable data if necessary with justification. 3. Provide Schematics and Figures to support the answers

3/12/25

Q. No.	Questions	Points	CO	BL	Module No.
1	Taking Inspiration form United Nations Sustainable Development Goals, the SPCE Hostel Students Committee has proposed the development of an Additive Manufacturing System to 3D print eco-friendly Ganesh idols using natural clay ("Shadu Mati") as a sustainable and ecofriendly material. As a student of Minor Course in Additive Manufacturing, design and sketch the complete system architecture to realize this concept. Your answer should include well-labeled sketches and detailed descriptions of: 1. **Material Handling Systems** – Mechanisms for clay feeding, mixing, and extrusion. 2. **Generating and Pre-processing the CAD Model** – Steps from 3D scanning/design to STL file generation. 3. **Slicing and Scanning Strategy** – Toolpath planning, scanning sequence, and motion control. 4. **Electrical and Electronic Hardware Systems** – Control units, actuators, sensors, microcontroller and interface architecture. 5. **Layer Preparation System** – Layer thickness control, platform movement, and alignment. 6. **Post Processing Systems** – Drying, finishing, and eco-friendly coating/curing methods. Consider following design (Refer Fig. 1) for proposed "Ganesh Idol"	20	1 to 4	6	1 to 7

END SEMESTER/~~RE-EXAM NO~~VEMBER/DECEMBER 2025 SET 1

	 Figure 1: Proposed Ganesh Idol for 3D Printing System				
2	Part shown below is to be develop using following RP processes  (i) Bulk Lithography (ii) Laminated Object Manufacturing (iii) Selective Inhibition Sintering Part is to be developed using compatible material for above mentioned processes. State (i) Compatible materials for the above processes. (ii) Part orientation in developing part with above processes. (iii) Explain process plan with neat labelled schematic diagram of above processes iv) Support process plan with at least three critical sliced sections of part geometry (Note: Answer shall clearly show slicing place, sliced geometry, hatched section etc.).	20	1 to 4	6	1 to 7
3 (a)	Explain .stl and amf file format and its importance.	10	1	3	2
3 (b)	State process of unconstraint depth photopolymerization with the first principles (using nonlinear Shrodinger equation, diffusion and non-linearity due to change of refractive index)	10	3	3	3,4

END SEMESTER/~~RE-EXAM NO~~VEMBER/DECEMBER 2025 SET 1

4 (a)	Describe extrusion based RP systems. Discuss Fused deposition modeling (FDM) process with a neat labeled diagram. Discuss various sub-systems of FDM. In one of the FDM system issues in linear scan speeds is observed due to error in software program. On investigation it is observed that X scan speed is optimum, however the Y scan (in the direction of pitch) is twice the optimum speed. Explain consequences in part fabrication. Further in case if Y scan speed would have been optimum and X scan speed being twice the optimum X scan speed, comment in which case part quality would be worst.	10	3	6	5
4 (b)	Explain Selective Laser Sintering (SLS) process with neat labeled sketches	10	3	4	5
(a)	Explain characteristics of the following materials (i) ABS (ii) Cellulose (iii) Polycarbonate (iv) Thermoplastic Polyester Further with justification provide compatible Additive Manufacturing technologies suitable for the above materials.	10	2,3	4	1,2,3
5 (b)	With neat sketches explain microstereolithography (MSL)? Discuss principle of working and advantages associated with MSL.	10	1	1	3,4
6 (a)	With neat sketch explain design of flexural mechanism for XY scanning system	10	3	2	3
6 (b)	Explain shape deposition modeling process. Take suitable part geometry to explain processes involved in shape deposition manufacturing.	10	2	5	5
7	A startup proposed to develop the machine with additive approach to prepare toast sandwich. The raw material viz tomato, beetroot, and cucumber from the farm along with the slice breads from the bakery will be inputs to the machine. Students shall develop the conceptual design plan depicting the slicing, feeding and locating mechanisms for the input materials for the development of the proposed machine. Design shall be modular, scalable and versatile to have scope for customization and finally the customer delight. Design shall be in the form of labeled drawings and sketches.	20	1 to 4	6	1 to 7

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~~END SEMESTER/RE-EXAM NOVEMBER/DECEMBER 2025~~ **SET 2**

Re exam January 2026 13/1/26

Program: B. Tech.

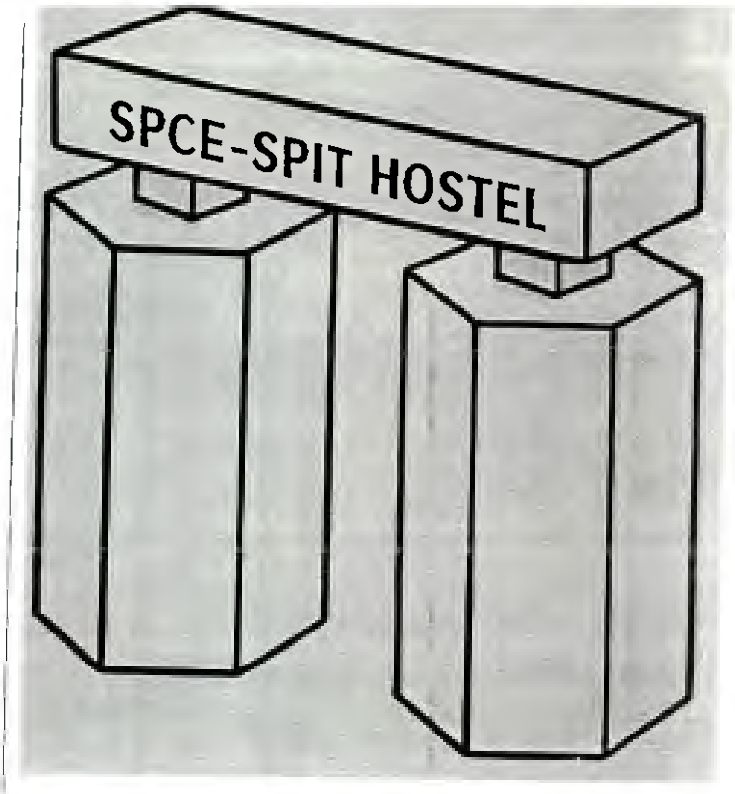
Duration: 3 Hrs T. Y. B. Tech (MI) Sem V **Semester: V**

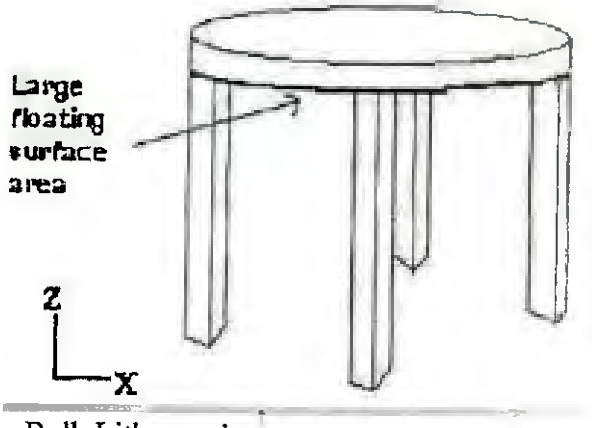
Course Code: MI-BT022 **Maximum Points: 100**

Course Name: Minor Course "Additive Manufacturing"

Notes: 1. Q. No. 1 is compulsory 2. Solve any four questions from Q. No. 2 to Q. No. 7, 3. Assume suitable data if necessary with justification. 3. Provide Schematics and Figures to support the answers

Q. No.	Questions	Points	CO	BL	Module No.
1	The figure below illustrates a conceptual design for the proposed SPCE-SPIT College Hostel building, featuring two hexagonal columns connected by a rib at the top. Assume that the complete hostel building will be constructed using large-scale concrete 3D printing (Additive Manufacturing). Prepare a conceptual framework and a detailed process plan for constructing the proposed SPCE-SPIT Hostel using a concrete 3D printer. Your answer should include: 1. Selection of 3D Printing Technology suitable for concrete structures (e.g., gantry vs robotic arm-based systems). 2. Material specifications, including mix design for printable concrete. 3. Layer-wise deposition strategy for hexagonal columns and the rib structure. 4. Support and reinforcement considerations during and after printing. 5. Curing methods and post-processing requirements. 6. The sensor, microcontroller, feedback system and interfacing	20	1 to 4	6,7	1 to 7



2	Part shown below is to be develop using following RP processes  (i) Bulk Lithography (ii) Laminated Object Manufacturing (iii) Selective Inhibition Sintering Part is to be developed using compatible material for above mentioned processes. State (i) Compatible materials for the above processes. (ii) Part orientation in developing part with above processes. (iii) Explain process plan with neat labelled schematic	20	1 to 4	6	1 to 7

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Recxam January 2026

~~END SEMESTER/RE~~ EXAM NOVEMBER/~~DECEMBER 2025~~ SET 2

	diagram of above processes iv) Support process plan with at least three critical sliced sections of part geometry (Note: Answer shall clearly show slicing place, sliced geometry, hatched section etc.).				
3 (a)	Explain .stl and amf file format and its importance.	10	1	3	2
3 (b)	State process of 3D microfabrication of inverted cone type structure using Bulk Lithography. Provide suitable labelled sketches	10	3	3	3,4
4 (a)	Describe extrusion based RP systems with neat ladled sketches.	10	3	5	5
4 (b)	Explain Selective Laser Sintering (SLS) process with neat labeled sketches	10	3	4	5
5 (a)	Explain characteristics of the following materials (i) Acylic (ii) Cellulose (iii) Nylon (iv) Polycarbonate Further with justification provide compatible Additive Manufacturing technologies suitable for the above materials.	10	2,3	4	1,2,3
5 (b)	With neat sketches explain microstereolithography (MSL)? Discuss principle of working and advantages associated with MSL.	10	1	1	3,4
6 (a)	With neat sketch explain design of flexural mechanism for XY scanning system	10	3	2	3
6 (b)	Explain shape deposition modeling process. Take suitable part geometry to explain processes involved in shape deposition manufacturing.	10	2	5	5
7 (a)	Explain mathematical form of cured depth in ceramic or metal microstereolithograhy along with Mie theory. Explain influence of followings material properties on curing radius and cured depth i) Particle mean size ii) Particle size distribution iii) Refractive index of powder iv) Refractive index of UV curable solution v) Absorption coefficient of powder (Note: Draw rough graphs with curing radius and cured depth taken on y-axis on common graph depicting influence of materials properties. Material properties shall be on x-axis. Justify each of the characteristics).	10	1	4	6
7 (b)	With neat diagram explain Multi-jet modeling process.	10	2	4	5