



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

	delivery, the function of shielding gas, and the layer-wise build mechanism.				
Q5) (B)	Describe the Selective Laser Sintering (SLS) process. Explain the working sequence step-by-step and illustrate the operation with a neatly labeled diagram.	10	3	3	5
Q6) (A)	Explain the working principle of the Integrated Hardening Process used in modern RP systems. Describe why this technique is needed and how it enhances part strength and overall performance.	10	4	3	6
Q6) (B)	Explain the Reverse Engineering (RE) workflow in detail. Discuss each stage from data acquisition to model reconstruction and list typical hardware/software tools along with its major applications in design improvement and product development.	10	2	3	6
Q7) (A)	Discuss the fabrication of biomedical scaffolds using Rapid Prototyping. Explain the design considerations, material choices, and suitable AM techniques, along with the benefits offered in biomedical engineering applications.	10	3	3	7
Q7) (B)	Explain the use of RP in investment casting. Describe the workflow of creating RP-based patterns, and highlight how the technique enhances accuracy, reduces lead time, and supports complex geometry production.	10	2	3	7



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WP-END SEM/RE-EXAM/Nov2025/JAN2026



Program: BTech Mechanical engg working Prof Duration: 3 hr

Course Code: PE-BTM511

Maximum Points: 100

Course Name: FEM for Mechanical Engineers.

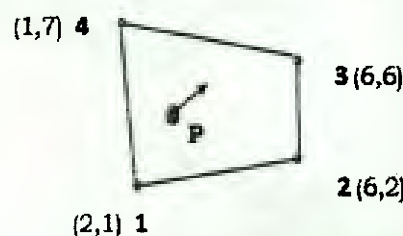
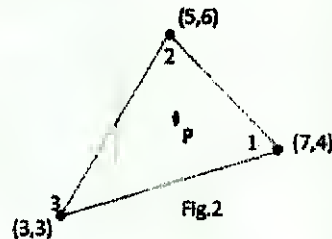
Semester: V

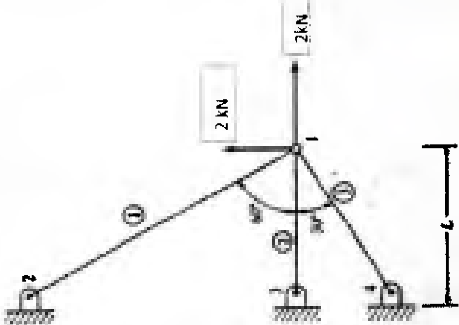
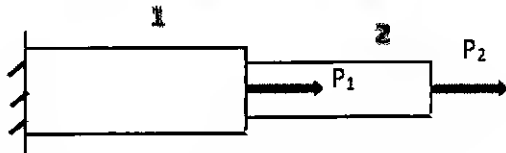
Notes:

1. All questions are compulsory.
2. Answers to each sub-questions are grouped together
3. Use of scientific calculator is allowed
4. Begin answer to each question on new page.
5. Keep some margin on left side of answer paper

24/11/2025

Q.No	Question Description	Pts	CO	BL
1	a) Explain the weighted residual method in detail.	10	1,2	2,3
	b) Discuss the mesh revision methods supporting suitable sketches.	10		
2	a) Discuss in detail the characteristics of the stiffness matrix.	10	1,2	2,3
	b) Explain Choleski factorization technique.	10		
3	a) The pin-fin used for heat dissipation, has 90 mm long and circular c/s area of $81\pi \text{ mm}^2$. At one end of fin temperature is 250°C . (take $k = 100 \text{ watt/cm}^\circ\text{C}$, $h = 10 \text{ watt/cm}^2^\circ\text{C}$. Discretize in 3 linear elements, consider convection from free end also) Find: i) Conductive and convective matrix for each element ii) Final assembled matrix.	15	1,2,3	3,4
	b) What are the advantages and disadvantages of FEM?	5		
4	a) Obtain the shape functions for element shown in fig.2	10	1,2	3,4
	b) For the element shown in fig.2, calculate temperature at point P(6,5). Given the nodal temperatures $T_1 = 50^\circ\text{C}$, $T_2 = 45^\circ\text{C}$, $T_3 = 60^\circ\text{C}$.	5		
	c) List the steps involved FE analysis.	5		
5	a) The element shown in Fig., P (4, 4) is the point on which the load of 20kN in the directions of 45 degrees with horizontal is applied. Determine its nodal equivalent forces.	10	2,3	2,3
	b) Obtain the Jacobian matrix for the element.	10		



6	For the truss shown in fig. , solve for the horizontal and vertical components of displacement at node 1. Also determine the stress in elements 1 and 2. Let $A = 625 \text{ sq mm}$, $L = 2500 \text{ mm}$, $E = 210 \text{ Gpa}$. 	20	1,2,3	2,3
7	a) For the stepped bar shown in figure, obtain the following using FEM procedure: • Obtain element level and assembled stiffness matrix. • Calculate nodal displacement. • Stress in each element. Take $P_1 = 90 \text{ kN}$, $P_2 = 60 \text{ kN}$, $E_1 = 200 \text{ GPa}$, $E_2 = 100 \text{ GPa}$, $L_1 = 1.2 \text{ m}$, $L_2 = 0.8 \text{ m}$, $d_1 = 32 \text{ mm}$, $d_2 = 20 \text{ mm}$ 	8 6 6	1,2,3	2,3



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END SEMESTER November 2025 / RE-EXAM January 2026

Program: B.Tech (Working Professionals) Third year

Duration: 3 hrs

Course Code: PC-BTM503

Maximum Points:100

Course Name: CAD/CAM/CIM

Semester: V

Note:- All questions are compulsory.

26/11/2025

Q.No.	Questions	Points	CO	BL	Module No.
Q1) (A)	Describe the six major phases involved in the design process. Provide suitable examples and explain how each stage supports the overall success of product development.	10	1	3	1
Q1) (B)	Explain the importance of engineering analysis within CAD/CAE systems. Discuss how Finite Element Analysis (FEA) improves the evaluation and refinement of product designs.	10	1	4	1
Q2) (A)	Write a program to draw a straight line between two specified points using Bresenham's line drawing approach for a gentle slope ($0 < m < 1$). Clearly explain how the decision parameter is initialized, updated, and how the pixel coordinates are modified at each step.	10	3,4	3	2
Q2) (B)	Develop a program to compute and display a cubic B-spline curve for a user-defined set of control points (minimum four). Show how the uniform cubic B-spline basis functions are evaluated and used to calculate the coordinates of the points on the curve.	10	3,4	4	2
Q3) (A)	Describe the "Part Families → Coding → Machine Cells" workflow used in Group Technology. Explain the objectives, tools, and methods applied at each stage, and show how this sequence leads to cellular manufacturing with lower setup time, reduced material handling, and minimized work-in-progress.	10	1	3	3
Q3) (B)	Compare Variant, Generative, and Hybrid CAPP systems. Discuss the basis of planning, the source of process plans, level of human involvement, implementation difficulty, consistency, and flexibility. Provide suitable examples of commercially used CAPP systems.	10	1	2	3
Q4) (A)	Compare NC, CNC, and DNC machines in terms of architecture, data storage, control strategy, and feedback mechanism. Discuss how DNC supports centralized data management and contributes to improved productivity in Flexible Manufacturing Systems (FMS).	10	2	3	4



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Q4) (B)	Define manufacturing flexibility and describe the various types such as machine, material-handling, process, routing, product, volume, and expansion flexibility. Explain how each type enables industries to respond effectively to changing market demands.	10	1	3	4
Q5) (A)	Describe the concept of a Relational Database used in design applications. Explain how design information is organized using tables, primary keys, foreign keys, and relationships, using a simple illustrative example.	10	1	3	5
Q5) (B)	Explain the idea of Object-Oriented Database Management Systems (OODBMS). Discuss key features such as objects, classes, inheritance, and their role in storing complex engineering design data.	10	1,4	2	5
Q6) (A)	Explain the importance of automation in modern manufacturing, OR discuss different robot configurations with neat sketches. Describe robot anatomy and explain the concept of degrees of freedom (DOF) in industrial robots.	10	1	3	6
Q6) (B)	Identify the key barriers that hinder the effective implementation of CIM. Discuss the socio-technical and economic issues involved, and explain how advanced CIM systems can address these challenges in the future.	10	1	4	6
Q7) (A)	Discuss the contribution of Artificial Intelligence and Machine Learning (AIML) in design and manufacturing. Explain how AIML supports product development, process optimization, predictive maintenance, and informed decision-making.	10	1	3	7
Q7) (B)	Explain the concept of Design for Assembly (DFA). Describe its key principles and methodology, and discuss how DFA leads to reduced cost, better manufacturability, and improved product quality with suitable industrial examples.	10	1	3	7



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Program: Mechanical Engineering Working Professional

Duration: 3 Hours

Course Code: PC-BTM504

Third year

Maximum Points: 100

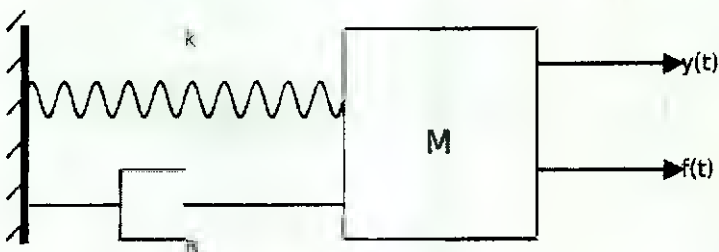
Course Name: Mechatronics & Automation

Semester: V

Notes:

1. Question no 1 is compulsory
2. Attempt **any four** questions from the remaining six questions.
3. If necessary, **assume suitable data** with justification
4. Draw **neatly labeled sketches** wherever required.

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Q.No.	Questions	Points	CO	BL	Module No.
1	A. Explain the role of Oscillator, I/O Ports, and Control Unit in the 8051 block diagram and justify their importance in automation systems.	10	1	3	2
	A. Determine the stability of the characteristic equation using Hurwitz Criterion: $s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$	10	5	3,4	5
2	A. Analyze the role of sensors and actuators in achieving desired performance of a CNC machine tool as a mechatronic system.	10	1,2	4	1
	B. The open loop transfer function of a unity feedback system is $G(s) = k / [s(s+2)(s+4)]$. Sketch the complete root locus and comment on the stability of the system.	10	3	4,5	6
3	A. Critically analyze the mechatronics design process for an industrial robot manipulator, highlighting how integration of mechanics, electronics, and control ensures precision.	10	1	4	1
	B. Obtain a state model for the mechanical system shown below 	10	4	3,4	7

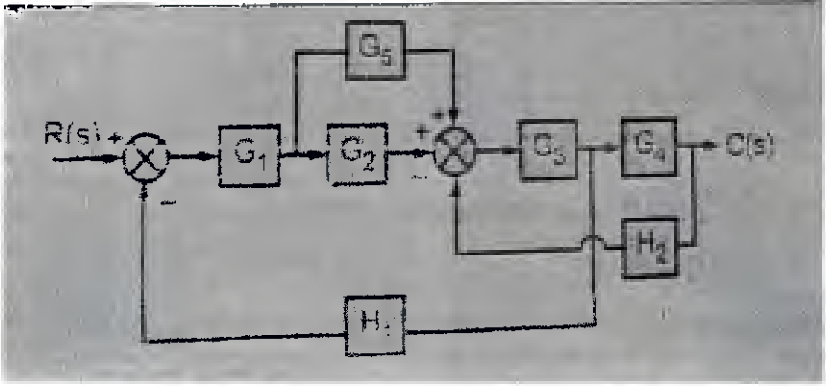


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4	A. Draw and explain the internal RAM organization of the 8051 and show how data is accessed through direct and indirect addressing modes.	10	1,2	3	2
	B. Determine C(s)/R(s) for the block diagram shown using block diagram reduction. 	10	2,3	3,4	4
5	A. For a hydraulic system requiring high pressure, low flow rate and precise metering, justify with reasons which of the three pumps (gear, lobe, gerotor) you would select. Support your answer with at least three application-based arguments.	10	2	3	3
	B. Determine the stability using Routh's Criterion and comment on the poles in RHP. The characteristic equation is: $s^4 + 2s^3 + 4s^2 + 6s + 8 = 0$	10	3	4	5
6	A. Draw a sequencing circuit using two double-acting cylinders, a sequencing valve, check valves, and a 4/2 DC valve. Explain step-by-step how the cylinders complete one full operating cycle in the correct sequence	10	2	4,3	3
	B. A system is represented by the following state and output equations $\dot{x} = \begin{bmatrix} -3 & -2 \\ -1 & -2 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t) \quad y = [1 \quad 2]x$ Find the poles of the system	10	4	4	7
7	A. Describe how P, I, and D actions work together in a PID controller to improve system performance.	10	1	2	4
	B. If $G(s)H(s) = 10 / [s(1 + 0.4s)(1 + 0.1s)]$, construct the Bode plot and calculate the gain crossover frequency, phase crossover frequency, gain margin, and phase margin, and comment on the stability of the system.	10	3	4	6



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Working Professionals

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:

01/12/2025

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.	Question	Points	CO	BL	Module No.
1	(a) Select an automobile component (such as a steering wheel, gear lever, or car seat) and propose design improvements based on aesthetic appeal and ergonomic comfort.	05	3	2	1
	(b) Explain the importance of applying factor of safety in conjunction with theories of failure during the design of industrial lifting hooks or crane components.	05			
	(c) Compare forged crankshafts and cast crankshafts in terms of strength, grain structure, and fatigue resistance. Explain how design supports these properties.	05			
	(d) Explain how the type of fit affects the assembly and function of components such as gears, pulleys, and bearings.	05			
2 (a)	In a hydraulic valve control system of an industrial press, two steel connecting rods are required to transmit an axial tensile force of 50 kN. The rods are of equal diameter and are connected using a cotter joint to allow easy dismantling during maintenance and alignment. Design a cotter joint suitable for this application and specify all main dimensions of its components, ensuring safe operation under the given load.	10	1	4,5	2
2 (b)	A lifting platform in a factory uses a power screw to raise and lower equipment. Explain, with calculations, how you would ensure that the screw does not rotate backward when power is cut off. Given: Weight lifted = 20 kN, Mean diameter = 60 mm, Pitch = 8 mm,	10	2	4,5	2



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Working Professionals

	$\mu = 0.14$. a) Check if the design is self-locking. b) Suggest how using multiple starts or lubrication might affect the self-locking property.				
3 (a)	How do manufacturing defects and residual stresses affect the fatigue performance of components subjected to fluctuating stresses in industrial systems?	10	1	2	3
3 (b)	A 40 mm diameter shaft is made of steel 50C4 ($S_{ut} = 660 \text{ N/mm}^2$) and has a machined surface. The expected reliability is 99%. The theoretical stress concentration factor for the shape of the shaft is 1.6 and the notch sensitivity factor is 0.9. Determine the endurance limit of the shaft.	10	2	4,5	3
4 (a)	A transmission shaft is supported between two bearings, which are 750 mm apart. Power is supplied to the shaft through a coupling, which is located to the left of the left-hand bearing. Power is transmitted from the shaft by means of a belt pulley, 450 mm in diameter, which is located at a distance of 200 mm to the right of the left-hand bearing. The weight of the pulley is 300 N and the ratio of the belt tension of tight and slack sides is 2:1. The belt tensions act in vertically downward direction. The shaft is made of steel FeE 300 ($S_{yt} = 300 \text{ N/mm}^2$) and the factor of safety is 3. Determine the shaft diameter, if it transmits 12.5 kW power at 300 rpm from the coupling to the pulley. Assume ($S_{sy} = 0.5S_{yt}$).	15	2	4,5	4
4 (b)	Describe the construction and principle of operation of a clamp (split muff) coupling with a neat sketch.	05	2	2	4
5 (a)	A semi-elliptic spring used for automobile suspension, consists of two extra full-length leaves and eight graduated-length leaves, including the master leaf. The centre-to-centre distance between the two eyes is 1 m. The leaves are made of steel 55Si2Mo90 ($S_{yt} = 1500 \text{ N/mm}^2$ and $E = 207\,000 \text{ N/mm}^2$) and the factor of safety is 2. The maximum spring load is 30 kN. The leaves are pre-stressed so as to equalize stresses in all leaves under maximum load. Determine the dimensions of the cross-section of the leaves and the deflection at the end of the spring.	12	2	4,5	5
5 (b)	Derive the expression for stress and deflection in helical compression spring.	08	2	3	5
6 (a)	What are different types of chains? Explain, with neat sketches, the power transmission chains.	10	2	2	6
6 (b)	A V-belt drive is required for a 15-kW, 1440 rpm electric motor, which drives a centrifugal pump running at 360 rpm for a service of 24 hours per day. From space considerations, the centre distance should be approximately 1 m. Determine (i) belt specifications; (ii) number of belts; and correct centre distance.	10	2	4,5	6



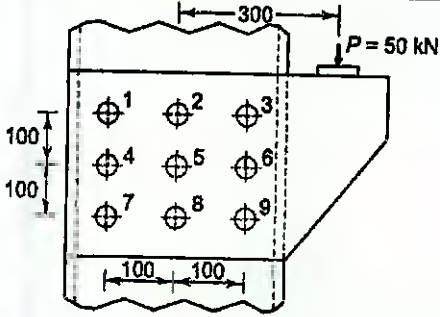
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Working Professionals

7 (a)	A bracket is attached to a steel channel by means of nine identical rivets as shown in Figure. Determine the diameter of rivets, if the permissible shear stress is 60 N/mm^2. 	10	2	4,5	7
7 (b)	Explain: a) Plasma-arc (or plasma-torch) welding process for welding of stainless steel and nickel alloy tubes b) Explosion welding Missile casing parts used for Military applications	10	2	2	7



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Program: T. Y. B.Tech (Mechanical) (WP)

Duration: 3 Hours

Course Code: PC-BTM501

Maximum Points: 100

Course Name: Heat and Mass Transfer

Semester: V

Important Instructions:

03/12/2025

1. Notes: 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 ($k = 46.5 \text{ W/m}^\circ\text{C}$) with 50 mm of glass wool insulation ($k = 0.046 \text{ W/m}^\circ\text{C}$) between them. If the average heat transfer coefficients at the outer and inner surfaces are $11.6 \text{ W/m}^2\text{C}$ and $14.5 \text{ W/m}^2\text{C}$ 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 steam pipe (inner diameter = 150 mm and outer diameter = 160 mm) with a thermal conductivity of $58 \text{ W/m}^\circ\text{C}$ is covered with two layers of insulation, each with a thickness of 30 mm and 50 mm, respectively, and thermal conductivities of $0.18 \text{ W/m}^\circ\text{C}$ and $0.09 \text{ W/m}^\circ\text{C}$, 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)	Hot air at a temperature of 65°C is flowing through a steel pipe of 120 mm diameter. The pipe is covered with two layers of different insulating materials of thickness 60 mm and 40 mm, and their corresponding thermal conductivities are 0.24 and 0.4 W/m°C. The inside and outside heat transfer coefficients are 60 W/m ² °C and 12 W/m ² °C respectively. The atmosphere is at 20°C. Find the rate of heat loss from 60 m length of pipe.	10	1,2	3,4	2
3(a)	A 60 mm thick large steel plate ($k = 42.6 \text{ W/m } ^\circ\text{C}$, $\alpha = 0.043 \text{ m}^2/\text{h}$), 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 midplane 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)	In a certain glass making process, a square plate of glass 1 m ² area and 3 mm thick heated uniformly 90°C is cooled by air at 20°C flowing over both sides parallel to the plate at 2 m/s. Calculate the initial rate of cooling the plate (Δt). Neglect temperature gradient in the glass plate and consider only forced convection. Take for glass: $\rho = 2500 \text{ kg/m}^3$ and $c_p = 0.67 \text{ kJ/kg K}$ Take the following properties of air: $\rho = 1.076 \text{ kg/m}^3$; $c_p = 1008 \text{ J/kg K}$, $k = 0.0286 \text{ W/m } ^\circ\text{C}$ and $\mu = 19.8 \times 10^{-6} \text{ N-s/m}^2$. Use relation for average Nusselt number as $\overline{Nu} = 0.664 (Re)^{1/2} \times (Pr)^{1/3}$ for laminar flow	10	1,2	3,4	4
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 $\rho = 1.06 \text{ kg/m}^3$, $\nu = 18.97 \times 10^{-6} \text{ m}^2/\text{s}$, $C_p = 1.004 \text{ kJ/kg } ^\circ\text{C}$ and $k = 0.1042 \text{ kJ/mh } ^\circ\text{C}$	10	4	3,4	4



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	Select appropriate relation from followings for Vertical Plates and Cylinders Laminar flow: $Nu = 0.59 (Gr \cdot Pr)^{1/4}$ for $(10^4 < Gr \cdot Pr < 10^9)$ Turbulent flow: $Nu = 0.10 (Gr \cdot Pr)^{1/3}$ for $(10^9 < Gr \cdot Pr < 10^{12})$				
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 ($C_p = 1.74$ kJ/kg°C) from 72°C to 42°C. The cooling water ($C_p = 4.18$ 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 (iii) Cross flow single pass with water and benzene unmixed	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 2500°C, Evaluate: i) Monochromatic emissive power at $1.2 \mu m$. 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



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7	(i)	State four examples of mass transfer in day-to-day life and industrial applications. What are the various mechanisms of mass transfer?	08	1	1,2	7
	(ii)	State Fick's law of diffusion. Define the various symbols used and give their units.	06	1	1,2	7
	(iii)	Give formulation and significance of Prandtl number (Pr) and Nusselt number (Nu).	06	1	1,2	4