Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

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

21/11/25

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

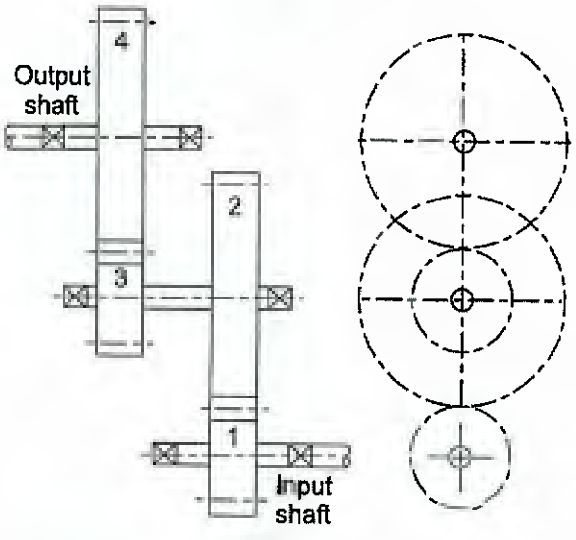
Program: Final Year B.Tech in Mechanical Engineering Sem VII **Duration: 03 Hrs.**

Course Code: PC BTM 711 **Maximum Points: 100**

Course Name: Design of Machines and Mechanical Systems **Semester: VII**

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)	A train of spur gears is shown in Fig. Gear 1 is the driving gear and transmits 5 kW power at 720 rpm. The number of teeth on gears 1, 2, 3 and 4 are 20, 50, 30 and 60 respectively. The module for all gears is 4 mm. The gears have a 20° full-depth involute profile. Calculate the tangential and radial components of the tooth force between (i) Gears 1 and 2 and (ii) Gears 3 and 4 	12	1,4	5	1
1 (b)	Derive the expression for Beam strength of Bevel Gear.	08	1,4	3	1
2 (a)	A cylindrical roller bearing with bore diameter of 40 mm is subjected to a radial force of 25 kN. The coefficient of friction is 0.0012 and the speed of rotation is 1440 rpm. Calculate the power lost in friction.	10	1,4	4	2
2 (b)	Explain the common causes of bearing failures in rolling contact bearings. Discuss how factors such as improper lubrication, contamination,	10	1,4	4	2

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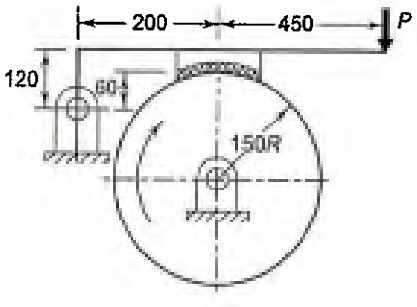
	misalignment, and overloading influence failure modes, and outline typical preventive measures used in industry.				
3 (a)	A 360° hydrodynamic journal bearing supports a radial load of 3.2 kN and operates at 1490 rpm with a journal diameter of 50 mm, bearing length of 50 mm, radial clearance of 0.05 mm, and a lubricant viscosity of 25 cP. Assuming that all the heat generated by friction is removed by the lubricant flow, Determine: (i) Coefficient of friction, (ii) Power loss due to friction, (iii) Minimum oil film thickness, (iv) Required lubricant flow rate in litres per minute, and (v) Resulting temperature rise of the lubricant.	15	1,4	4	3
3 (b)	Explain the materials commonly used for hydrodynamic and rolling contact bearings, emphasizing key properties such as embeddability, conformability, wear resistance, and fatigue strength. Discuss how contaminated operating environments influence the selection of bearing materials. Support your explanation with the case of conveyor systems, which often operate under dusty and abrasive industrial conditions.	05	1,4	2	3
4 (a)	A multi-disk clutch consists of two steel disks with one bronze disk. The inner and outer diameters of the contacting surfaces are 200 and 250 mm respectively. The coefficient of friction is 0.1 and the maximum pressure between the contacting surfaces is limited to 0.4 N/mm^2. Assuming uniform wear theory, calculate the required force to engage the clutch and the power transmitting capacity at 720 rpm.	10	1,4	4	4
4 (b)	A single block brake with a torque capacity of 15 N-m is shown in Figure. The coefficient of friction is 0.3 and the maximum pressure on the brake lining is 1 N/mm^2. The width of the block is equal to its length. Calculate (i) the actuating force; (ii) the dimensions of the block; (iii) the resultant hinge-pin reaction; and (iv) the rate of heat generated, if the brake drum rotates at 50 rpm. 	10	1,4	4	4
5	i. A hydraulic motor rotates at a speed of 450 rpm with a nominal displacement of 4 cm^3/rev. The pressure differential across the hydraulic motor is 75 bar. The overall efficiency is 80% and the volumetric efficiency is 90%. Calculate the following: a) Theoritical flow rate. b) Actual flow rate c) Power input d) Shaft power and e) Shaft torque.	10	2	3	5

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	ii. With the schematic diagram discuss the essential relation of cylinders connected to the pump such as Q_A (actual flow rate), P_{In} (Input power), Q_T (theoritical flow rate), Q_S (Slippage), Thrust force, Pull force and P_{out} (Power output).	10			
6	An Electric Overhead Travelling (EOT) crane is required for heavy-duty foundry service. The crane has a safe working load (SWL) of 100 kN and a height of lift of 10 m. The hoisting mechanism employs four falls of wire rope, and the system operates under heavy-duty service conditions for approximately 3500 hours per year. The hoisting velocity is 10 m/min, while the trolley travels at a speed of 25 m/min. During braking, the hoist is designed to stop within a distance of 90 mm. Based on the above specifications, design the essential components of the hoisting system. Specifically, (i) Select and design a suitable wire rope, determining its type, construction, and diameter in accordance with the service and loading requirements, and (ii) Design the snatch block (hook block), specifying the main dimensions of the sheave, pin, and hook considering the given number of rope falls. Assume any missing data wherever necessary and state all assumptions clearly. Apply relevant design standards and principles, and support your design with neat, labeled sketches of the rope arrangement and snatch block assembly.	20	3,4	5	6
7	A centrifugal pump is to be designed for an agricultural irrigation system supplying water from an underground reservoir to distribution pipelines in a farm. The pump must handle clean water under the following operating conditions: Parameter: Specification Application: Agricultural irrigation(water lifting and distribution) Total Head: 35 m Discharge: 80 m^3/hr Working Fluid: Water at 30°C Type of Drive: Pump directly coupled to an electric motor Operating Duty: Continuous operation during irrigation season The pump should deliver water efficiently with minimal power consumption and high reliability under field conditions. Select suitable motor for pump and design impeller shaft, impeller and casing with volute profile.	20	3,4	5	7

Annexure 1

(All symbols indicate their conventional meaning)

EOT Crane Design

- Rope area, $A = \frac{F}{\frac{\sigma_u}{n} - \frac{d}{D_{min}}\frac{d_{wire}}{d}E'}$

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- $n = (FOS\ from\ DDB) \times Impact\ factor$
- $\frac{d_{wire}}{d} = \frac{1}{1.5\sqrt{i}}$; i = total number of wires
- E' = corrected Young's modulus of wire = 76,000 MPa for 6x37 rope
- D_{min}/D as a function of number of bends in system

No. of bends	1	2	3	4	5	6
D_{min}/d	16	20	23	25	26.5	28

- Factors for permissible stress calculations
  - C_{df} = duty/impact factor from DDB
  - C_{bf} = basic stress factor = 3.15 for normal loading
  - C_{sf} = safety factor = 1.12 for mild steel
- Rope drum
  - Length of rope drum = $\left(\frac{2H \times i}{\pi D} + 12\right) s + l_1$
  - Crushing stress below rope groove of drum = $\frac{F_T'}{w \times s}$
  - Standard diameters of rope drum at the bottom of groove: 200, 250, 315, 400, 500, 630, 710, 800, 900, 1000, 1250 mm.

Some useful relationships for design of centrifugal pump:

$n_q = \frac{n\sqrt{Q}}{H^{3/4}}$; Suction pipe diameter, $D_s = \sqrt{\frac{4Q'}{\pi V_s} + {d_n}^2}$

where Q' = (leakage factor) × Q, $V_s = V_0 = V\epsilon$, $V = \sqrt{2gH}$, $\epsilon = 0.023\sqrt{n_q}$

Inlet vane width, $b_1 = \frac{Q'}{\pi D_1 V_0}$

Outlet vane width, $b_2 = \frac{Q'}{\pi D_2 V_{m3}}$ where $V_{m3} = (0.8\ to\ 0.9) \times V_0$

Number of vanes, $z = 13\frac{r_m}{e}\sin\beta_m$

$$\tan\beta_1 = \frac{1.25V_0}{u_1},\quad u_1 = \frac{\pi n D_1}{60}$$

Radius of curvature of vane profile (approx.) = $\frac{R_2^2 - R_1^2}{2(R_2\cos\beta_2 - R_1\cos\beta_1)}$

Volute radius $\rho_\theta = \frac{\theta^o}{C} + \sqrt{2r_3\frac{\theta^o}{C}}$, $C = \frac{2\times360°\times\pi g H_{th}}{wQ'}$

Deflection of shaft, $Y = \frac{L^3}{EI}\left(\frac{P_1}{3} + \frac{P_2}{8}\right)$; Whirling speed = $\omega_{cr} = \sqrt{\frac{3EI}{mL^2L_1}}$

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6/1/26

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4. All sub questions must be grouped together.

Q.No.	Questions	Points	CO	BL	Module No.
1 (a)	A pair of parallel helical gears consists of 18 teeth pinion meshing with a 63 teeth gear. The normal module is 3 mm. The helix angle is 23° while the normal pressure angle is 20°. Calculate (i) the transverse module; (ii) the transverse pressure angle; and (iii) the axial pitch.	12	1,4	5	1
1 (b)	Derive the expression for Wear strength of Bevel Gear.	08	3	4	1
2 (a)	A ball bearing is subjected to a radial force of 2500 N and an axial force of 1000 N. The dynamic load carrying capacity of the bearing is 7350 N. The values of X and Y factors are 0.56 and 1.6 respectively. The shaft is rotating at 720 rpm. Calculate the life of the bearing.	10	1	2	2
2 (b)	Explain the construction and working of a needle roller bearing. Discuss its load-carrying characteristics, typical applications, and the limitations that must be considered while selecting a needle bearing for a compact mechanical system.	10	1,4	5	2
3 (a)	A full hydrodynamic journal bearing in an electric motor is subjected to a radial load of 1200 N and operates at 1440 rpm with a journal diameter of 50 mm. The static load on the bearing is 350 N. The surface roughness (CLA) of the journal and the bearing are 2 μm and 1 μm respectively. The minimum oil film thickness is specified as five times the combined surface roughness of the journal and bearing. Determine: (i) the required bearing length, (ii) the radial clearance, (iii) the minimum oil film thickness, (iv) the viscosity of the lubricant, and (v) the lubricant flow rate. Select a suitable lubricant for an operating temperature of 65°C.	15	1,4	4 & 5	3
3 (b)	Explain the materials commonly used for hydrodynamic and rolling contact bearings, emphasizing essential properties such as	05	1,4	2	3

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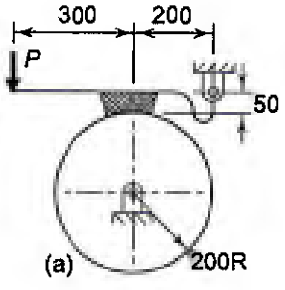
	embeddability, conformability, wear resistance, corrosion resistance, and fatigue strength. Discuss how contaminated operating environments influence the selection of bearing materials. Support your explanation with the case of marine deck machinery, where bearings are routinely exposed to saltwater, moisture, and debris.				
4 (a)	An automotive single plate clutch consists of two pairs of contacting surfaces. The outer diameter of the friction disk is 270 mm. The coefficient of friction is 0.3 and the maximum intensity of pressure is 0.3 N/mm^2. The clutch is transmitting a torque of 531 N-m. Assuming uniform wear theory, calculate: (i) the inner diameter of the friction disk; and (ii) spring force required to keep the clutch engaged.	12	1,4	4	4
4 (b)	A single block brake with a torque capacity of 250 N-m is shown in Figure. The brake drum rotates at 100 rpm and the coefficient of friction is 0.35. Calculate (i) the actuating force and the hinge-pin reaction for clockwise rotation of the drum; (ii) the actuating force and hinge-pin reaction for anticlockwise rotation of the drum; (iii) the rate of heat generated during the braking action; and (iv) the dimensions of the block, if the intensity of pressure between the block and brake drum is 1 N/mm^2. The length of the block is twice its width. State whether the brake is self-locking. 	08	1,4	4 & 5	4
5	i. With the schematic diagram discuss the essential relation of hydraulic pump connected to the motor and tank and to the system such as Q_T (theoritical flow rate), Q_A (actual flow rate), Q_S (slippage), T_T (theoritical torque), T_A (Actual torque), P_{in} (Input power), P_{out} (Output power), Mechanical efficiency η_m, Volumetric efficiency η_v and Overall efficiency η_o. ii. Determine the inner pipe diameter to create a flow velocity of 5 m/s with a flow rate of 100 lpm. A fluid with a density of 820 kg/m^3 and a absolute viscosity of 0.32 Ns/m^2 is flowing through the pipe. Is the flow laminar/ turbulent? Also calculate the frictional pressure loss having length 5m if the kinematic viscosity of the fluid is 0.001 m^2/s.	10 10	3	4 & 5	5

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<table>
<tr><td>6</td><td>An Electric Overhead Travelling (EOT) crane is used for heavy-duty foundry service. The crane is designed for the following specifications:
• Safe Working Load (SWL): 100 kN
• Height of Lift: 10 m
• Number of Rope Falls: 4
• Hours of Service: 3500 hours per year
• Hoisting Velocity: 10 m/min
• Braking Distance for Hoist: 90 mm
• Trolley Travelling Speed: 25 m/min
The crane operates under continuous heavy-duty conditions, and reliability and safety of the hoisting mechanism are of prime importance.
a) Design a suitable wire rope for the above hoisting system. Select an appropriate type and construction of wire rope considering the nature of service. Determine the diameter of the rope, design load, and factor of safety. Check the rope for endurance and repeated loading conditions. State all assumptions clearly and justify your selection using standard design data.
b) Design the snatch block for the same system, taking into account the number of rope falls. Determine the principal dimensions of the sheave, pin, and hook, and ensure that the stresses are within safe limits. Provide a neat, labeled sketch showing the arrangement of the snatch block and rope system. Assume any suitable data wherever required and mention the design procedure followed.</td><td>20</td><td>3,4</td><td>4 & 5</td><td>6</td></tr>
<tr><td>7</td><td>A centrifugal pump is to be designed for use in an industrial water circulation system of a cooling plant. The pump is required to deliver water continuously under the following operating conditions:
<table><tr><td>Parameter</td><td>Specification</td></tr><tr><td>Application</td><td>Cooling water circulation in an industrial plant</td></tr><tr><td>Total Head</td><td>50 m</td></tr><tr><td>Discharge</td><td>100 m³/hr</td></tr><tr><td>Working Fluid</td><td>Water at 25°C</td></tr><tr><td>Type of Drive</td><td>Pump directly coupled to electric motor</td></tr><tr><td>Operating Duty</td><td>Continuous service</td></tr></table>The pump is expected to operate efficiently and reliably for long-duration service with minimal maintenance requirements. Select suitable motor for pump and design impeller shaft, impeller and casing with volute profile.</td><td>20</td><td>3,4</td><td>4 & 5</td><td>7</td></tr>
</table>

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Volute radius $\rho_\theta = \frac{\theta^o}{C} + \sqrt{2r_3 \frac{\theta^o}{C}}$, $C = \frac{2\times360^\circ\times\pi g H_{th}}{wQ'}$

Deflection of shaft, $Y = \frac{L^3}{EI}\left(\frac{P_1}{3} + \frac{P_2}{8}\right)$; Whirling speed = $\omega_{cr} = \sqrt{\frac{3EI}{mL^2L_1}}$

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(An Autonomous Institution Affiliated to University of Mumbai)

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

- **Class: BTech Mech,** Sem VII
- **Course IEPM Course,**
- **Duration 3 hrs,**

Sem VII
Code PEC-BTM 705
Points 100

- **Solve any 5 out of 7 Questions**
- **Figures to right indicate the full points**
- **Assume Suitable data wherever needed.**
- **ND table are permitted.**

Que. No.	Question Statement	Points	Module	BL	CO
Q1A	Construct a detailed comparative table illustrating the major causes of reduced productivity and the corresponding techniques—operational, technological, managerial, and human-factor based—that can effectively enhance overall organizational productivity.	10	1	3	CO1
Q1B	David Upton is President of Upton Manufacturing, a producer of Go-Kart tires. Upton makes 1000 tires per day with the following resources: Labor: 400 hours @ $12.50 per hour Raw material: 20,000 pounds per day @ $1 per pound Energy: $5,000 per day Capital: $10,000 per day (a) What is the labor productivity for these tires at Upton Manufacturing? (b) What is the multifactor productivity for these tires at Upton Manufacturing? (c) What is the percent change in multi-factor productivity if Upton can reduce the energy bill by $1,000 without cutting production or changing any other inputs?	10	1	3	CO1
Q2A	**Investigate how a Man–Machine Chart can reveal operator idle time and machine utilisation in a multi-machine handling scenario like** One operator managing three injection moulding machines.	10	2	4	CO2

<table>
<tr><td>Q2B</td><td>What do you understand by Work Sampling, and how can it be effectively used to estimate machine utilization, operator productivity, or delays in real industrial environments?
Numerical: The elemental timings are given in table to produce a component. Compute the standard time. Assume rest and personal allowance as 12% and contingency allowance 2 %. Compute no of units to be produced in 1 day containing 3 shifts of 8 hours. All work elements are manual elements.
<table>
<tr><th>Element</th><th>Observed time</th><th>Rating</th><th>Remark</th></tr>
<tr><td>A.</td><td>0.25</td><td>95</td><td>-</td></tr>
<tr><td>B.</td><td>0.05</td><td>85</td><td>-</td></tr>
<tr><td>C.</td><td>0.03</td><td>90</td><td>-</td></tr>
<tr><td>D.</td><td>0.78</td><td>95</td><td>-</td></tr>
<tr><td>E.</td><td>0.06</td><td>105</td><td>-</td></tr>
<tr><td>F.</td><td>0.05</td><td>110</td><td>-</td></tr>
<tr><td>G.</td><td>0.02</td><td>95</td><td>Once in 20 pieces</td></tr>
<tr><td>H.</td><td>0.06</td><td>85</td><td></td></tr>
<tr><td>I.</td><td>0.10</td><td>95</td><td></td></tr>
<tr><td>J.</td><td>0.04</td><td>95</td><td>Once in 5 pieces</td></tr>
</table>
Explain Different types of allowances used in computation of standard time.</td><td>10</td><td>2</td><td>4</td><td>CO3</td></tr>
<tr><td>Q3A</td><td>State and explain the ergonomic considerations for the following products
➢ Car seats
➢ Steering wheels
➢ Dashboard layouts
➢ Control pedals
➢ Motorcycle handlebars
➢ Public transport seating
➢ Helmets
➢ Vehicle infotainment systems
➢ Seat Belt
➢ Headrest</td><td>10</td><td>3</td><td>4</td><td>CO3</td></tr>
<tr><td>Q3B</td><td>What are the key principles of DFA, and how do they help in reducing assembly time and complexity? Justify your answer with suitable example and sketches.</td><td>10</td><td>3</td><td>4</td><td>CO3</td></tr>
<tr><td>Q4A</td><td>How can SPCE leverage the full spectrum of Industry 4.0 technologies—such as IoT, Big Data Analytics, Cyber-Physical Systems, AI/ML, Cloud Computing, Additive Manufacturing, Robotics, AR/VR, Blockchain, and Autonomous Systems—to plan, execute, and enhance a Cultural Festival. What measurable benefits can be achieved in terms of time, cost, quality, delivery, efficiency, and participant experience and how they can be achieved?</td><td>10</td><td>3</td><td>5</td><td>CO2, CO3</td></tr>
</table>

<table>
<tr><td>Q4B</td><td>Prepare a List of industry4.0 Technologies. State the purpose of implementing each technology. Show how it will help to implement the following lean principles in manufacturing industry.
Map the Value Stream
Eliminate All Forms of Waste (Muda)
Reduce Variability (Mura)
Prevent Overburden (Muri)
Create Continuous, Smooth Flow
Pull Systems (Kanban / JIT)
Build Quality into the Process (Jidoka)
Visual Management
Kaizen
Pokayoke</td><td>10</td><td>4</td><td>4</td><td>CO2, CO3</td></tr>
<tr><td>Q5A</td><td>Carry out the stakeholder analysis for the following project. Consider the project of establishment of Nidhi Prayas Lab in workshop of SPCE. What are the requirements of stakeholders. How can the requirement be fulfilled. State the Inputs tools Techniques of stakeholder management.</td><td>10</td><td>5</td><td>5</td><td>CO1, CO4</td></tr>
<tr><td>Q5B</td><td>The time estimates for the activities of a PERT network is given below.
<table>
<tr><th>Activity</th><th>t_o</th><th>t_m</th><th>t_p</th></tr>
<tr><td>1-2</td><td>2</td><td>5</td><td>9</td></tr>
<tr><td>1-3</td><td>3</td><td>5</td><td>10</td></tr>
<tr><td>1-4</td><td>2</td><td>6</td><td>9</td></tr>
<tr><td>2-3</td><td>Dummy</td><td>Dummy</td><td>Dummy</td></tr>
<tr><td>2-5</td><td>3</td><td>7</td><td>11</td></tr>
<tr><td>3-6</td><td>2</td><td>7</td><td>13</td></tr>
<tr><td>4-6</td><td>3</td><td>8</td><td>11</td></tr>
<tr><td>5-6</td><td>5</td><td>8</td><td>14</td></tr>
<tr><td>6-7</td><td>6</td><td>9</td><td>11</td></tr>
</table>
1.Draw the project network and identify all paths through it. 2.Find project duration and CP. 3.Compute standard deviation and variance of project length. 4. What is probability that the project will be completed at least 4 weeks earlier than expected? Show the method only.</td><td>10</td><td>6</td><td>5</td><td>CO1, CO3 CO4</td></tr>
<tr><td>Q6A</td><td>A small project has the details as given below. Find Normal duration and Minimum Duration. What is the percentage increase in cost to complete the project in 2days lesser than Normal duration?
<table>
<tr><th>Activity</th><th>Dependence</th><th>Normal duration</th><th>Crash Duration</th><th>Normal cost</th><th>Crash Cost</th></tr>
<tr><td>A</td><td>--</td><td>11</td><td>7</td><td>900</td><td>1300</td></tr>
<tr><td>B</td><td>A</td><td>12</td><td>8</td><td>400</td><td>800</td></tr>
<tr><td>C</td><td>A</td><td>14</td><td>7</td><td>600</td><td>1200</td></tr>
<tr><td>D</td><td>A</td><td>16</td><td>12</td><td>600</td><td>1000</td></tr>
<tr><td>E</td><td>B,C</td><td>14</td><td>8</td><td>500</td><td>1100</td></tr>
<tr><td>F</td><td>C,D</td><td>15</td><td>10</td><td>600</td><td>1100</td></tr>
<tr><td>G</td><td>E,F</td><td>12</td><td>6</td><td>600</td><td>900</td></tr>
</table></td><td>10</td><td>6,7</td><td></td><td>CO3, CO4</td></tr>
<tr><td>Q6B</td><td>What do you mean by Project Resource Management -PRM? Prepare Ishikawa diagram showing causes that lead to ineffective PRM.</td><td>10</td><td>6,7</td><td></td><td>CO3 CO4</td></tr>
</table>

<table>
<tr><td>Q7A</td><td>Develop Higher level depiction of key potential areas of improvement in Project Procurement Management. Explain in it detail.</td><td>10</td><td>M 6 M 7</td><td>5</td><td>CO1 CO4</td></tr>
<tr><td>Q7B</td><td>Prepare the Project Network for the following project data. Find Critical Path and Project duration. Find E and L for each event.
If the activities 3-6, 4-8, 6-9 require a piece of equipment one at a time, Will it affect the project? Find the schedule.
<table>
<tr><th>Activity</th><th>Time in days</th></tr>
<tr><td>1-2</td><td>5</td></tr>
<tr><td>1-4</td><td>11</td></tr>
<tr><td>1-7</td><td>8</td></tr>
<tr><td>2-3</td><td>12</td></tr>
<tr><td>3-6</td><td>9</td></tr>
<tr><td>4-5</td><td>6</td></tr>
<tr><td>4-8</td><td>9</td></tr>
<tr><td>5-6</td><td>12</td></tr>
<tr><td>6-9</td><td>6</td></tr>
<tr><td>7-8</td><td>9</td></tr>
<tr><td>8-9</td><td>3</td></tr>
</table></td><td>10</td><td>M 6, M 7</td><td></td><td>CO2 CO3</td></tr>
</table>

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

26/11/25

Program: BTech Mechanical Sem VII **Duration: 3hr**

Course Code: PE-BTM734 **Maximum Points: 100 Course**

Name: Supply Chain Management **Semester: ~~VIII~~ VII**

Note: Solve any 5 questions out seven

Q.No.	Questions	Points	CO	BL	Module
Q1A	Numerical on Simulation- Demand Pattern Analysis and Inventory Rule: A auto component manufacturing company wish to find level of stock it should carry for the items in its range. Demand is uncertain and there is lead time for stock replenishment. For an item A following information is available. Beginning inventory is 20 units. Explore the demand pattern and closing stock for 10 days . Inventory rule is order 15 units when present inventory plus any outstanding order falls below 15 units. Use Random Number in an array 0,9,1,1, 5,1,8,6,3,5,7,1,2,9 . Calculation should include total cost of operating this inventory rule for 10 days.	10	CO1	3	1
Q1B	Prepare list of at least 5 subsystems/components of Water Cooler. Prepare a Block Diagram to show Supply Chain of above and explain it. Show all flows through above SCM and Explain them.	10	CO1, CO4	5	1
Q2A	Numerical on Location of Facility :An organization has following three options for selection of location for the business	10	CO3	6	2

Demand units/day	3	4	5	6	7
Probability	0.10	0.20	0.30	0.30	0.10
Carrying cost per unit/day	Rs2				
Ordering cost per order	Rs50				
Lead time for replenishment	3 days				

Assumptions: Order are placed at the end of the day and received on 3rd day at the end of the day, Back orders are accumulated in case of short supply and supplied when stock is available

City	Fixed Cost in $	Varaible Cost

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

		in $
Athens	30000	75
Brussels	60000	45
Lisbon	110,000	25

If Selling price = $120, Expected volume = 2,000 units

- Plot the cost for each location
- Select location with lowest total cost for expected production volume
- Find the range of volume of sale to achieve the lowest cost for the following three different cities

Q2B	Numerical on Forecasting : A multi-hospital system (MHS) owns 12 hospitals. Revenues (x, or the independent variable) and profits (y, or the dependent variable) for each hospital are given below. Obtain a regression line for the data and predict profits for a hospital with $30 million in revenues. All figures are in millions of dollars.	10	CO2	5	2

Multi Hospital System Revenues and Profits Data		
Hospital	Revenue (x)	Profit (y)
1	8	0.17
2	3	0.12
3	7	0.15
4	5	0.14
5	12	0.20
6	13	0.24
7	17	0.25
8	19	0.26
9	14	0.24
10	20	0.27
11	21	0.28
12	23	0.31

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

<table>
<tr><td>Q3A</td><td>Numerical on Inventory with multiple price breaks: A company need 50000 units per year which costs Rs10 per unit. Ordering cost is estimated to be 100 per order carrying cost are 15% per annum of average inventory. The supplier is ready to give 2 % discount in price of the original value if the company purchases 10000 units or more but less than 20000 lot size. A further of 1 % in price of original value is available on the order of 20000 or more units. Find the economical lot size and min total cost.
Explore factors affecting WIP inventory cost</td><td>10</td><td>CO2</td><td>5</td><td>3</td></tr>
<tr><td>Q3B</td><td>Numerical on Vendor Evaluation : An organization has 4 suppliers 1,2,3,4 for the material. Their performance details are given in following table. Find the best supplier using the criteria and their weightage.
<table>
<tr><th>Subject / item</th><th>Supplier 1</th><th>Supplier 2</th><th>Supplier 3</th><th>Supplier 4</th></tr>
<tr><td>Units Supplied</td><td>82</td><td>95</td><td>94</td><td>95</td></tr>
<tr><td>Units accepted</td><td>78</td><td>88</td><td>86</td><td>86</td></tr>
<tr><td>Delivery Promised in days</td><td>20</td><td>20</td><td>20</td><td>20</td></tr>
<tr><td>Actual Delivery</td><td>21</td><td>22</td><td>22</td><td>21</td></tr>
<tr><td>Price</td><td>30</td><td>33</td><td>32</td><td>32.5</td></tr>
<tr><td>Suggestions given - (Responsiveness)</td><td>10</td><td>10</td><td>10</td><td>10</td></tr>
<tr><td>Suggestions implemented - (Responsiveness)</td><td>9</td><td>10</td><td>9</td><td>9</td></tr>
<tr><td>Innovation Practices</td><td>10</td><td>10</td><td>9</td><td>9</td></tr>
</table>
Evaluation Criteria
<table>
<tr><th>Criteria</th><th>Weightage</th></tr>
<tr><td>Quality</td><td>25</td></tr>
<tr><td>Delivery Performance</td><td>20</td></tr>
<tr><td>Price</td><td>20</td></tr>
<tr><td>Responsiveness</td><td>10</td></tr>
<tr><td>Innovation Practices</td><td>15</td></tr>
<tr><td>Sustainable Practices</td><td>10</td></tr>
</table></td><td>10</td><td>CO2</td><td>5</td><td>3</td></tr>
<tr><td>Q4A</td><td>Explore the factors affecting the Logistics Cost. Develop the strategies to prioritise the factors affecting the logistic cost.</td><td>10</td><td>CO1, CO3</td><td>5</td><td>4</td></tr>
<tr><td>Q4B</td><td>Compare the forward Logistics and reverse Logistics in detail and explain them. Draw the Reverse Logistics Process for a News Prints and Explain it in detail.</td><td>10</td><td>CO2,CO3</td><td>5</td><td>4</td></tr>
</table>

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

<table>
<tr><td>Q5A</td><td>Numerical on Transportation Decisions
• Mr X flies quite often from town A to Town B.
• He can use the Airport Bus which cost Rs25 But if he takes it there is a 0.08 Chance that he will miss the flight .
• The stay in hotel costs Rs270 with a 0.96 chance of being in time for the flight.
• For Rs 350 he can use taxi which will make 99 percent chance of being on time for the flight.
• If Mr X catches the plane on time he will conclude the business transaction that will produce the profit of Rs 10000/-, otherwise he will lose it . Which mode of transport should Mr X use ?
• State the Guidelines to reduce fleet management costs</td><td>10</td><td>CO1
CO2,
CO3</td><td>5</td><td>5</td></tr>
<tr><td>Q5B</td><td>Prepare the following detailed table and explain it.
Name of industry4.0 technology / Potentials / Limitations / Application in Transportation</td><td>10</td><td>CO1,CO2</td><td>5</td><td>5</td></tr>
<tr><td>Q6A</td><td>Prepare the list of technologies in industry 4.0 Basket. Identify their potential features. Consider the supply chain of Onion. Draw the Supply Chain Model of the Onion. Recommend the use of the above technologies in various phases of the Onion Supply Chain.</td><td>10</td><td>CO1,
CO2,
CO3</td><td>5</td><td>5</td></tr>
<tr><td>Q6B</td><td>Explain Digital Supply Chain From Design to Operate based on following points: 1Design 2.Plan 3Procure 4 Manufacture sub assemblies 5 Sale manufacture final product 6 Deliver 7.Operation</td><td>10</td><td>CO1,
CO4,
CO3</td><td>5</td><td>6</td></tr>
<tr><td>Q7A</td><td>• A retailer purchase cherries every morning at Rs50 a case and sells them for Rs80 per case.
• Any case remain unsold at the end of the day can be disposed of the next day at a salvage value of Rs 20 per case.
• Past sales have ranged from 15 to 18 cases per day.
• The following is the record of sales for the past 120 days.
• Find how many cases retailer should purchase everyday to miximise the profit.
<table><tr><td>Cases sold</td><td>15</td><td>16</td><td>17</td><td>18</td></tr><tr><td>Number of days</td><td>12</td><td>24</td><td>48</td><td>36</td></tr></table>OR
Consider a company struggling with order fulfillment and customer service. How can SCOR's 'Make' and 'Deliver' processes be re-engineered to improve performance?</td><td>10</td><td>CO1,
CO2,
CO3</td><td>5</td><td>7</td></tr>
<tr><td>Q7B</td><td>A company wants to reduce its distribution cost by 12%. Using the concept of Total Distribution Cost-TDC, identify and justify the cost elements where savings can be targeted.</td><td>10</td><td>CO1,
CO2,
CO3</td><td>5</td><td>7</td></tr>
</table>

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26/11/2025

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

Program: B.Tech. Mechanical Sem VII — **Duration: 3 Hour**

Course Code: PEC-BTM753 — **Maximum Points: 100**

Course Name: Introduction to Cryogenics — **Semester: VII**

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. **List:** Various significant events in the history of cryogenics. **Describe:** Any two significant achievements of India in the space programs.	10	I	I, II, IV	1
	b) Explain: i) Meissener Effect. **Draw:** Neat sketch, ii) Transition temperature (T_0), ii) Critical field (H_c) and iii) Critical current (I_c) for 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) Explain:** The effect of variation of temperature from 300 K to 4 K on the following properties of materials: i) Yield strength ii) Thermal conductivity. **Justify:** Reasons for the same. **Evaluate:** Strength to conductivity ratio (S_y/k) for SS-304 and k-Monel as the material of inner vessel shell of a dewar storing LH_2 at 1 atm and **Coclude:** about the choice of material.	10	2	VI	2
	b) Evaluate: Percentage contribution of electronic specific heat ($c_{v,e}$) and lattice specific heat ($c_{v,l}$) in the total specific heat (c_v) for Aluminum at i) 200 K and ii) 2 K. $\bar{R}$ = 8.31434 J/mol and Relative Molecular Mass (RMM) of Aluminum = 27 g/mol, **Conclude:** about variation of electronic and lattice specific heat of metals with temperature.	10	2	II, VI	2

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

3.	**a) Explain:** Salient features, operation and advantages of a Pre-cooled Linde-Hampson system of liquefaction. **Draw:** i) neat system diagram and ii) T-s diagram. **Derive:** Expression for the liquid yield (y) for the system.	**10**	4	II, III IV	3
	b) Evaluate: i) Liquid yield, ii) Net work per unit mass of the gas compressed, and iii) Figure of Merit (FoM) of a basic Claude system for Nitrogen liquefaction operating between 1 atm, 300 K to 50 atm. The expander flow rate ratio (x) is 0.6 and the expander work is utilized to aid the compression of gas. The condition of gas at the inlet to the expander is 270 K and 50 atm. **Draw:** Neat system diagram and T-s diagram.	**10**	4	III, VI	3
4.	**a) Explain:** Salient features and Operation of Collin's system for liquefaction of Helium. **Draw:** i) neat system diagram and ii) T-s diagram. **Derive:** Expression for the liquid yield (y) for the system.	**10**	4	II, III, IV	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.	**a) 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) Discuss: Practical difficulty in liquefaction and storage of LH_2 with reasons and significance. **Explain:** Remedial methods using catalyst. **Draw:** Neat schematic diagrams.	**10**	4	II, III	2,4
6.	**a) Justify:** Necessity of vacuum and insulation in cryogenic applications. **Explain:** With the illustrative example of cryogen storage vessel. **Draw:** neat schematic diagram.	**10**	3	II, III, VI	5,6
	b) List : Various insulations used in cryogenic systems and **State:** One example of each type. **Justify:** Preferred use of Multilayer Insulation (MLI) in cryogenic systems based on its properties and advantages compared with other types of insulations.	**10**	3	I, VI	5

7.	**a) State:** Types of flow regimes in vacuum and types vacuum pumps with their respective ranges. **Explain:** Working of diffusion pump. **Draw:** neat schematic diagram.	**10**	3	I, II, III	6
	b) Discuss: i) Various Health hazards associated with cryogenic systems, ii) Measures for personal safety in cryogenic plants.	**10**	3	II	7

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END SEMESTER EXAMINATION NOVEMBER 2025

Program: Mechanical Engineering
Course Code: PE-BTM755
Course Name: **Automobile Engineering**

Duration: 3 Hours
Maximum Points: 100
Semester: 7

INSTRUCTIONS:

1. Question no 1 is compulsory and attempt any four questions out of remaining six questions.
2. Draw neat schematic diagrams wherever is necessary, highlight important points of answer.

Q. No	Questions	Point	CO	BL	Module
Q1 A	Derive final expression for thermal efficiency of Diesel air standard cycle with the help of necessary P-V and T-S diagram?	10	2	3	1
Q1 B	Explain necessary requirements so that window will function according to its design intent? Which is best system to operate automobile side windows safest and quit mode, explain it using sketch? Using Sketch explain how odometer and speedometer works?	10	4	1	5
Q2 A	Why disk brake performance more reliable compared to drum brake performance? Explain it with the help of sketch? Write short note on traction limit, friction ellipse and draw graph between friction coefficient and wheel slip ratio, give its significance?	10	2	3	4
Q2 B	Draw the typical passenger body design and label all its elements and components? Give any 5 functional requirements of any typical automobile body?	10	1	1	7
Q3 A	Give working principle of motor vehicle horn system with the help of neat sketch? Explain using the sketch Control of wipers using the following 1) Regenerative braking, 2) self-switching action?	10	2	1	5
Q3 B	Enlist the elements involved in the starting system of an automobile. Explain their work using a block diagram / sketch? Discuss about construction features and elements of battery? Discuss construction features and elements of battery?	10	3	2	6

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END SEMESTER EXAMINATION NOVEMBER 2025

Q4 A	Write short note on Independent suspension system with neat sketch?? Draw free body diagram of Quarter car model having 2 degree of freedom suspension system and obtain basic equations for both bodies?	10	3	1	3
Q4 B	When an automobile is steered using steering mechanism, then obtain expression for side slip angle (β) and radius of turn (R) using "kinetics of Bicycle model"?	10	2	3	2
Q5 A	Obtain expression for optimized gear ratio (including gear box and differential) of automobile at which automobile can be accelerated 'f' to 'f_{max}'? (consider resistance, inertia of slow and fast moving parts)	10	2	3	1
Q5 B	List down basic functions to be performed by brake system for satisfactory performance? What is Ideal brake force distribution and give its formula with all terminology?	10	3	1	4
Q6 A	Obtain expression for maximum tractive effort available in case of rear wheel drive (During transmission system design)?	10	2	2	3
Q6 B	Explain the following Wheel alignment parameters? 1) Caster, 2) Camber and 3) Toe. Give significance of these parameters along with their sketch?	10	4	1	2
Q7 A	Give different types of ignition system and explain any one of them using complete sketch and its working?	10	2	1	6
Q7 B	What are different types of chassis frames? Explain each type with 3 points?	10	1	1	7

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END SEMESTER November 2025 ~~RE-EXAM~~ January 2026 26/11/25

Program: B. Tech Mechanical Sem VII

Duration: 3 Hour

Course Code: PE-BTM756

Maximum Points: 100

Course Name: Renewable Energy Sources and Utilization

Semester: VII

Notes:

1) **Solve any five questions out of seven.**
2) Use of steam table, refrigeration properties table and Gamma function table is permitted.
3) Draw neat sketches wherever required.
4) Assume suitable data and justify the same.

Q.No.	Questions	Points	CO	BL	Module Number
1(a)	Discuss India's production and reserves of commercial energy sources via (i) Fossil Fuels (ii) Hydro power (iii) Nuclear Power and (iv) Other sources of energy.	10	1	1	1
1(b)	It is proposed to set up a wind farm at a promising location in the Konkan region, for which long-term data on wind speed is not available. To assess wind potential and select suitable wind turbines, a large number of discrete measurements of hourly wind speed are taken over some representative days for a couple of years. The measurements yield the following values of the average wind speed and standard deviation: $\bar{V} = 5.8$ m/s $\sigma = 3.5$ m/s Plot the annual wind speed-frequency distribution under the assumption that it is a Weibull distribution.	10	2	3,4	4
2(a)	Draw a block diagram of the manufacturing process for a single-crystal silicon solar cell from semiconductor-grade silicon. Explain the method of production in detail.	08	2	1,2	3
2(b)	Calculate the overall loss coefficient for a flat-plate collector with two glass covers by calculation. (Without using empirical formula) Given the following data: Size of the absorber plate ($L_1 \times L_2$) :1.90 m × 0.9m Spacing between plate and the first glass cover (L) : 4 cm Spacing between first and the second glass cover (L) : 4 cm Plate emissivity (ε_p) : 0.92	12	2	2,3	2

	Glass cover emissivity (ε_c) : 0.88 Collector tilt (β) : 20° Mean Plate temperature (T_{pm}) : 70°C Ambient air temperature (T_a) : 24°C Wind speed (V_∞) : 2.5 m/s Back insulation thickness (δ_b) : 8 cm Side insulation thickness (δ_s) : 4 cm Thermal conductivity of insulation (k_l) : 1.0 W/m-K				
3(a)	Explain the manufacturing process of Copper Indium Gallium Diselenide (CIGS) a thin film multi-crystalline solar cell with neat sketch.	10	2	1,2	3
3(b)	A photovoltaic cell has an open-circuit voltage of 0.6 V and a short-circuit current of 250 A/m² at a cell temperature of 40°C. Calculate the voltage and current density that maximises the power of the cell. What would be the corresponding maximum power output per unit cell area? Given that charge of an electron, $e = 1.602 \times 10^{-19}$ J/V and Boltzmann constant, $k = 1.381 \times 10^{-23}$ J/K	10	2	3	3
4(a)	Write the effects of following parameters on the performance of liquid flat plate collectors: (i) Selective surfaces (ii) Number of covers (iii) Spacing between the absorber plate and the first cover or between two covers (iv) Collector tilt	10	2	1,2	2
4(b)	Calculate the energy content in the wind for data given below. Also calculate the actual energy available for wind machine for which the cut in speed is 14 kmph, the design speed is 36 kmph and the cut-out speed is 90 kmph for following location. Location : November Month : May Take ρ for air = 1.20 kg/m³.	10	2	2,3	4

Interval	Nov.	Interval	Nov.	Interval	Nov.	Interval	Nov.
00	6.9	10-12	6.2	22-24	4.5	34-36	0.3
00-02	5.9	12-14	7.9	24-26	2.9	36-38	0.1
02-04	4.1	14-16	10.4	26-28	1.5		

	04-06	4.5	16-18	13.6	28-30	1.1						
	06-08	4.7	18-20	12.9	30-32	0.7						
	08-10	1.7	20-22	9.7	32-34	0.4						
5(a)	Explain the mechanism of producing electricity by using geothermal energy. Also explain dry steam power plant using geothermal energy with neat sketch.								10	4	1,2	6
5(b)	A propeller wind machine has a rotor diameter of 60 m. It is operating at a location having a wind speed of 35 kmph and rotating at 20 rpm. Calculate theoretically, the power which the machine can extract from the wind if (a) only wake rotation is considered (b) both wake rotation and the effect of drag are considered. For part (b) assume that value of ε=0.012.								10	2	2,3	4
6(a)	Draw a neat schematic diagram of downdraft gasifier and explain the biomass gasification process in detail.								10	3,4	1,2	7
6(b)	Draw a neat sketch of the "closed cycle" OTEC system, and explain its working.								10	3,4	1,2	5
7(a)	Draw a neat sketch of the KVIC biogas plant and explain its working in detail.								10	3,4	1,2	7
7(b)	Explain the method of Bio-ethanol and Bio-diesel production in detail.								10	3,4	1,2	7

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

Data Sheet and Properties of Air

1.Relationship between Nusselt and Rayleigh numbers.

$$Nu_L = 1 \; ; \; Ra_L \cos\beta < 1708$$

$$Nu_L = 1 + 1.446\left(1 - \frac{1708}{Ra_L \cos\beta}\right); \; 1708 < Ra_L \cos\beta < 5900$$

$$Nu_L = 0.229\,(Ra_L \cos\beta)^{0.252}; \quad 5900 < Ra_L \cos\beta < 9.23 \times 10^4$$

$$Nu_L = 0.157\,(Ra_L \cos\beta)^{0.285}; \quad 9.23 \times 10^4 < Ra_L \cos\beta < 10^6$$

$$h_w = 8.55 + 2.56\,V_\infty$$

Table A 4.2 *Properties of dry air at atmospheric pressure*

T °C	ρ kg/m³	C_p kJ/kg-K	$\mu \times 10^6$ N-s/m²	k W/m-K	Pr	$\nu \times 10^6$ m²/s
0	1.293	1.005	17.2	0.0244	0.707	13.28
10	1.247	1.005	17.7	0.0251	0.705	14.16
20	1.205	1.005	18.1	0.0259	0.703	15.06
30	1.165	1.005	18.6	0.0267	0.701	16.00
40	1.128	1.005	19.1	0.0276	0.699	16.96
50	1.093	1.005	19.6	0.0283	0.698	17.95
60	1.060	1.005	20.1	0.0290	0.696	18.97
70	1.029	1.009	20.6	0.0297	0.694	20.02
80	1.000	1.009	21.1	0.0305	0.692	21.09
90	0.972	1.009	21.5	0.0313	0.690	22.10
100	0.946	1.009	21.9	0.0321	0.688	23.13
120	0.898	1.009	22.9	0.0334	0.686	25.45
140	0.854	1.013	23.7	0.0349	0.684	27.80
160	0.815	1.017	24.5	0.0364	0.682	30.09
180	0.779	1.022	25.3	0.0378	0.681	32.49
200	0.746	1.026	26.0	0.0393	0.680	34.85
250	0.674	1.038	27.4	0.0427	0.677	40.61
300	0.615	1.047	29.7	0.0461	0.674	48.33
350	0.566	1.059	31.4	0.0491	0.676	55.46
400	0.524	1.068	33.0	0.0521	0.678	63.09
500	0.456	1.093	36.2	0.0575	0.687	79.38
600	0.404	1.114	39.1	0.0622	0.699	96.89
700	0.362	1.135	41.8	0.0671	0.706	115.4
800	0.329	1.156	44.3	0.0718	0.713	134.8
900	0.301	1.172	46.7	0.0763	0.717	155.1
1000	0.277	1.185	49.0	0.0807	0.719	177.1

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

Gamma Function for Γ(x)

x	1	2	3	4	5	6	7	8	9	10
0	1	1	2	6	24	120	720	5040	40320	362880
0.05	0.97	1.02	2.1	6.39	25.88	130.72	790.83	5575.35	44881.53	406177.83
0.1	0.95	1.05	2.2	6.81	27.93	142.45	868.96	6159.59	49973.71	454760.75
0.15	0.93	1.07	2.31	7.27	30.16	155.31	955.16	6829.42	55659.8	509287.17
0.2	0.92	1.1	2.42	7.76	32.58	169.41	1050.32	7562.29	62010.76	570499.03
0.25	0.91	1.13	2.55	8.29	35.21	184.86	1155.38	8376.51	69106.23	639232.6
0.3	0.9	1.17	2.68	8.86	38.08	201.81	1271.42	9281.39	77035.56	716430.69
0.35	0.89	1.2	2.83	9.47	41.2	220.41	1399.63	10287.32	85899.08	803156.43
0.4	0.89	1.24	2.98	10.14	44.6	240.83	1541.34	11405.89	95809.46	900608.9
0.45	0.89	1.28	3.15	10.85	48.3	263.26	1698	12650.08	106893.21	1010140.79
0.5	0.89	1.33	3.32	11.63	52.34	287.89	1871.25	14034.41	119292.46	1133278.39
0.55	0.89	1.38	3.51	12.47	56.75	314.95	2062.92	15575.08	133166.94	1271744.28
0.6	0.89	1.43	3.72	13.38	61.55	344.7	2275.03	17290.25	148696.14	1427482.93
0.65	0.9	1.49	3.94	14.37	66.8	377.42	2509.83	19200.21	166081.84	1602689.78
0.7	0.91	1.54	4.17	15.43	72.53	413.41	2769.83	21327.69	185550.94	1799844.13
0.75	0.92	1.61	4.42	16.59	78.78	453.01	3057.82	23698.13	207358.61	2021746.44
0.8	0.93	1.68	4.69	17.84	85.62	496.61	3376.92	26339.99	231791.89	2271560.56
0.85	0.95	1.75	4.99	19.2	93.1	544.61	3730.6	29285.17	259173.77	2552861.66
0.9	0.96	1.83	5.3	20.67	101.27	597.49	4122.71	32569.41	289867.73	2869690.49
0.95	0.98	1.91	5.64	22.27	110.21	655.77	4557.58	36232.73	324282.91	3226614.98

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

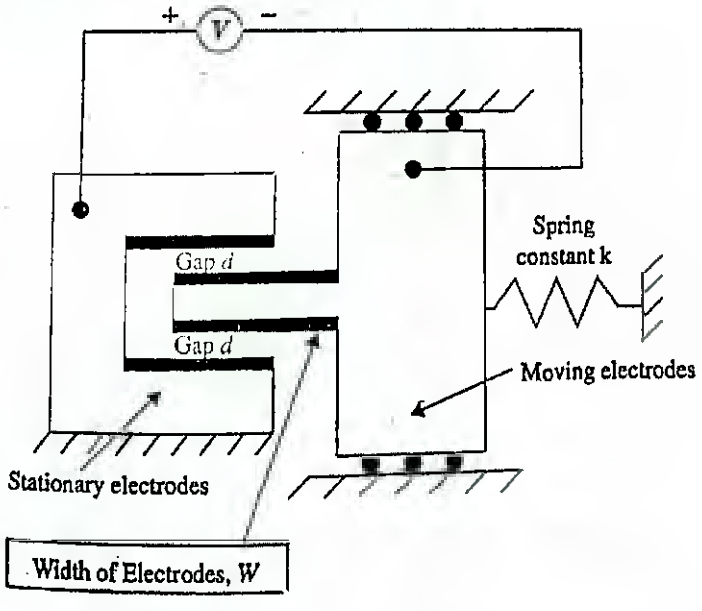
Program: B. Tech. mech Sem VII

Duration: 3 Hrs **Semester: VII**

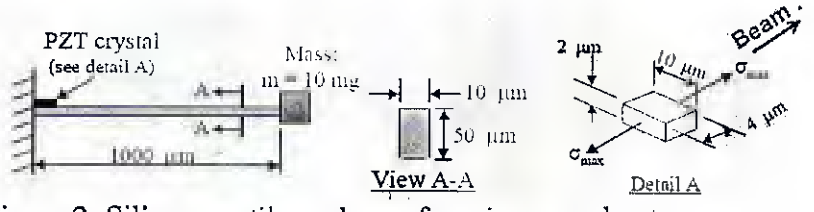
Course Code: OE-BTM 714 **Maximum Points: 100**

Course Name: Open Elective Course II "Introduction to MEMS" 28/11/25

Notes: 1. Question number 1 is compulsory, 2. Solve any four questions from Q. No. 2 to 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 (a)	For the comb-driven actuator shown in Figure 1, determine the voltage supply required to pull the moving electrode 10 microns from the unstretched position of the spring. The spring constant k is 0.05 N/m. The comb drive is operated in air. The gap d between the electrodes and the width W of the electrodes are 2 microns and 5 microns respectively. The e_r=1.0 for air as dielectric material and e_0=8.85 Pf/m  Figure 1 Comb drive actuator	10	3,4	4	3
1 (b)	Differentiate between Micro electromechanical Systems (MEMS) and Micro-electronics	10	1	4	1
2	Explain working principles of the followings with neat labeled sketches: (i) Optical Lithography (ii) Electrophoresis System	20	3	3	3,4,5

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

	(iii) Chemical Sensor (iv) Micro Pump				
3	Explain working principles of the followings with neat labeled sketches: (i) Micro Valve (ii) Micro Pressure Sensor (iii) Atomic Force Microscope (AFM) (iv) Dual-axis Motion Sensor	20	3	3	2,3,6,7
4 (a)	Explain Laser Beam Propagation in photopolymer resin system using non linear Shrodinger equation and polymerization modeling.	10	4	4	6,7
4 (b)	A thin piezoelectric crystal film, PZT is used to transduce the signal in a micro accelerometer involving a cantilever beam made of silicon. The accelerometer is design for maximum acceleration/deceleration of 10 g. The PZT transducer is located at the support of the cantilever beam where the maximum strain exists (near the support) during the bending of the beam as illustrated below in Figure 2. Determine the electrical voltage output from the PZT film at a maximum acceleration/deceleration of 10 g. Take E for silicon beam as 1.9×10^{11} Pa. Piezoelectric coefficient d = 480×10^{-12} m/V  Figure 2: Silicon cantilever beam for micro-accelerator	10	2 to 4	6	4,5
5 (a)	Describe the LIGA fabrication process. State the features that enable high aspect ratio structures.	10	4	4	6
5 (b)	Explain Smart Microsystems. Discuss sensing, actuation, embedded computation, and feedback features.	10	3	3	3
6 (a)	Explain Reactive Ion Etching (RIE) and Chemical Etching with neat sketches.	10	3	3	6
6(b)	Explain all 10 steps of lithography with neat labeled sketches	10	4	4	4
7 (a)	Explain Micro accelerometer with neat sketch	10	2, 3	4	3
7 (b)	Explain Laser Doppler Vibrometer with neat labelled sketches	10	3	3	7

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End Semester/~~Re-exam Examination~~ – NOV/DEC 2025 Examinations

Program: BTECH (MECH.ENGG.) Sem VII

Course Code: OE-BTM717

Course Name: Digital Twin

Duration: 3 hrs.

Maximum Points: 100

Semester: VII

28/11/25

- Solve any 5 questions out of seven
- Figures to the right indicate full marks
- Draw neat sketches & figures wherever required

Q.No.	Questions	Points	CO	BL	PI
Q.1 (a)	Explain the working of a Smart Sensor with the help of a neat diagram, and discuss three important features such as (i) self-calibration, (ii) edge/AI-based processing, and (iii) wireless communication capability.	[10]	1,2,3	2	3.2.1
(b)	The construction industry is increasingly adopting Digital Twin (DT) technology to meet sustainability goals related to material efficiency, carbon reduction, energy optimization, and lifecycle performance. Digital Twins allow real-time monitoring, simulation, and predictive analysis of buildings and infrastructure from design to demolition. In this regard -With a neat diagram Explain the concept of Digital Twin in Sustainable Construction, highlighting how DT enhances environmental performance across the building lifecycle (design, construction, operation, maintenance, and end-of-life).	[10]	1,2,3	2	3.2.1
Q.2 (a)	Explain how predictive maintenance can enhance decision-making in Smart Factories. What role do Digital Twins play in implementing predictive maintenance strategies? Explain with neat sketches. Also	[10]	1,2,3	2	5.4.1

	explain the predictive maintenance/analytics algorithm pipeline				
(b)	Explain how the integration of Digital Twin with PLM can create a feedback loop that improves product design and lifecycle management.	[10]	1,2	2	5.4.1
Q.3 (a)	A manufacturing company plans to use a Digital Twin for predictive maintenance. Analyze how Big Data Analytics and Machine Learning can process and interpret data to optimize maintenance schedules. Provide necessary framework with good figures.	[20]	2,3	3	5.5.1
Q.4 (a)	Propose a framework for integrating IIoT with Digital Twin technology for monitoring a smart manufacturing system (such as a CNC line, assembly line, machining cell, or robotic workstation). With a neat diagram, explain how IIoT sensors, gateways, and cloud platforms connect to the Digital Twin model. Highlight the role of data analytics and AI in optimizing key performance metrics such as machine utilization, cycle time, energy consumption, and predictive maintenance.	[10]	2,3	3	5.5.1
(b)	Explain BIM with neat sketch? Also explain advantages of BIM & Machine Learning integration	[10]	1,2,3	2	5.5.1
Q.5 (a)	With a neat diagram, illustrate the architecture of a Smart Home Digital Twin, showing IoT devices, edge gateway, cloud analytics, simulation engine, and user interface/control dashboard.	[10]	3,4	3	5.5.1
(b)	Digital Twin technology is emerging as a powerful tool for insurance and warranty service providers by enabling real-time risk assessment, fault prediction, asset performance monitoring, and usage-based service models. By creating virtual replicas of vehicles, industrial machines, home appliances, or infrastructure assets, insurers and warranty companies can move from traditional reactive claims processing to predictive, data-driven, and personalized coverage models. In this regard,	[10]	2,3	3	5.1.2

	Discuss how Digital Twins can be leveraged to create innovative business and revenue models in the Insurance and Warranty domains. In your answer, highlight applications such as predictive warranty management, usage-based insurance, real-time claims validation, failure risk scoring, preventive maintenance recommendations, and customer-specific premium pricing. Support your answer with suitable examples.				
Q.6	Q. Modern organizations are shifting from traditional on-premise CRM systems to Cloud-based CRM platforms to enhance scalability, mobility, and real-time customer engagement. With the emergence of Industry 4.0 technologies, Digital Twin concepts are now being applied to improve service operations, product performance monitoring, and customer support workflows within CRM ecosystems. (a) Compare Traditional CRM and Cloud CRM in terms of architecture, accessibility, cost, scalability, analytics capability, and integration with other business systems. (b) With a neat diagram, illustrate how Cloud CRM can integrate with a Digital Twin of a product, device, or service environment—showing real-time IoT sensor data flowing into cloud analytics and CRM service modules (ticketing, alerts, customer support).	[10] [10]	3,4	3	5.5.1
Q.7	Write Short notes on (any three)	[20]	2,3,4	3	5.4.1, 5.5.1
	• Digital Twin in Material Science • DT in Smart Containers • DT in Product Development • DT in Construction Management • DT in Construction Industry • Data Visualization tools • DT in Asset Maintenance				
********** All the Best **********					

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End Sem. / [redacted] - Dec 2025

Program: Mechanical
Course Code: OE-BTM718
Course Name: Fundamental of AI & ML
Notes: Solve any **Five** questions out of **Seven**

Assume suitable Data whenever needed

Duration: 3 Hrs
Maximum Points: 100
Semester: VII

Q.No.	Questions	Points	CO	BL	PI
1a	Explain the knowledge representation in AI with propositional logic and predicate logic with suitable example	05	1	I,III,V	1.5.1
1b	Explain what is meant by an "Uninformed search" in artificial intelligence. Discuss its main characteristics advantages and disadvantages.	05	1	III	1.6.1
1c	Compare and contrast the two basic uninformed search method: Breadth –first search (BFS) and Depth first search (DFS).Highlight their strategies, weakness and typical use cases.	05	1	II	5.4.1
1d	Define a heuristic search. Explain the meaning of a heuristic function in search algorithm and state the properties.	05	1	III	1.6.1
2a	Explain the Regularization in ML with L1 and L2 regularization with suitable example.	05	2	I	1.6.1
2b	Discuss the geometric intuition of principal component analysis (PCA).	05	2	VI	5.4.1
2c	Given the data in Table, reduce the dimensions from 2 to 1 using the Principal Component Analysis (PCA) algorithm X: 2.5, 0.5, 2.2, 1.9, 3.1, 2.3, 2, 1, 1.8, 1.1 Y: 2.4, 0.7, 2.9, 2.2, 3.0, 2.7, 1.6, 1.1, 1.6, 0.9	10	1	III	1.6.1
3a	Discuss the support vector machine, linear SVM, Non-linear SVM with suitable example.	05	2	V	5.4.1
3b	For the given data using support vector machine. Draw an optimal hyper plane. +ve class: (4,1), (4,-1), (6,0) -ve class: (1,0), (0,1), (0,-1)	05	3	VI	1.6.1

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End Sem. /[redacted] - Dec 2025

3c	Discuss the Logistic Regression with its algorithm and obtain the logistic cost function	10	3	III	5.4.1
4a	Explain Naïve Bayes ML algorithm with suitable example	05	3	II	1.6.1
4b	Discus the K-nearest neighbor (KNN) classifier with suitable example	05	3	VI	1.6.1
4c	Explain the decision tree with suitable example and geometric intuition.	05	3	II	1.6.1
4d	Explain the geometric intuition of the Perceptron with suitable example	05	3	III	5.4.1
5a	Discuss the back propagation in detail	10	4	IV	5.4.1
5b	Discuss the deep learning in detail	05	4	III	5.4.1
5c	Discuss the K-means in detail with suitable example	05	3	II	5.1.2
6a	**Obtain** the multiple regression for the following data: X_1 Product 1 Sales: 1, 2, 3, 4 X_2 Product 1 Sales: 4, 5, 8, 2 Y Weekly Sales: 1, 6, 8, 12	10	4	III	5.1.2
6b	**Obtain** the linear regression using least square method for the given data X: 1, 2, 3, 4, 5 Y: 3, 6, 7, 9, 10	10	4	III	5.1.2

7a	Explain the concept of collaborative filtering based recommendations	05			5.1.2
7b	Explain the Reinforced learning in detail with suitable example	05		II	5.1.2
7c	Obtain the multiple regression for the following data X_1 | X_2 | Y 1 | 2 | 3 2 | 9 | 7 3 | 16 | 9 4 | 27 | 15	10		IV	1.6.1

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End Sem. /~~Re-Exam~~ – Dec. 2025

Program: Mechanical

Course Code: PE-BTM 733

Course Name: Industrial Robotics

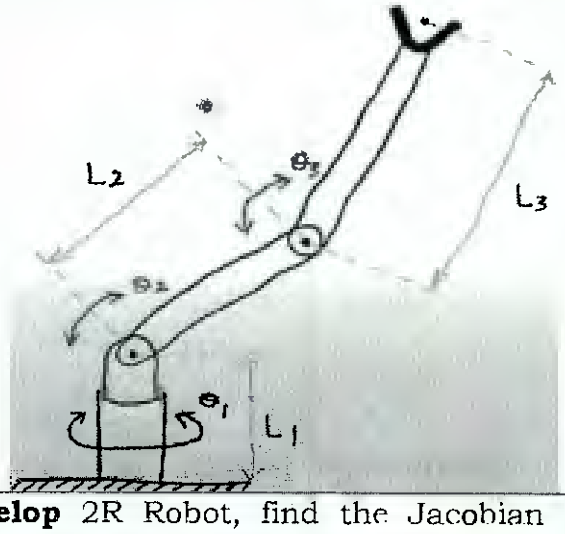
Notes: Solve any **five** questions

Assume Suitable data

Duration: 3 Hrs

Maximum Points: 100

Semester: ~~VIII~~

Q.No.	Questions	Points	CO	BL	PI
1	a) Classify robots based on configuration and control. b) Describe any two types of robot drives with suitable diagrams. c) Define forward and inverse kinematics. d) Define robot intelligence. How is it implemented in modern systems?	20	1,2	I,III,V	1.5.1
2a	**Assign** frames {0} to {4} for the shown non planar 3R robotic manipulator, then find the DH parameters table. 	10	2	I	1.6.1
2b	**Develop** 2R Robot, find the Jacobian matrix using Direct Differtiation Method relative to frame {0} to frame {3}	10	2	VI	5.4.1

3a	**Explain** Equivalent Single-Axis Representation matrix and Z-Y-X Euler angles with suitable examples.	10	1	III	1.6.1
3b	**Explain** the Forward kinematics and obtain the total transformation matrix from frame {0} to frame {n}. Obtain for the DH parameters and calculate the transformation matrices with suitable example	10	2	V	5.4.1
4a	**Discuss** the Inverse Kinematics and explain the existence of solution of the inverse kinematics problems with suitable examples.	10	3	VI	1.6.1
4b	**Explain** the Robot Learning and Task Planning and the Robot Intelligence, Problem Solving in brief.	10	3	III	5.4.1
5a	**Discuss** the Velocity Propagation Method with suitable example.	10	3	II	1.6.1
5b	Explain robotic machine loading and unloading operations and discuss the role of robots in assembly and inspection.	10	3	VI	1.6.1
6a	Discuss the social impact of robotics on employment and describe ethical issues associated with large-scale robot deployment.	10	3	IV	5.4.1
6b	Describe robot learning and its applications and explain any one suitable robot programming language.	10	3	III	5.4.1
7a	**Explain** different drives used in the Robots and the classification based on types of motion control	10	4	III	5.1.2
7b	Explain the Robot Anatomy and discuss the factors which determine Work space Envelope.	10	4	III	5.1.2

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

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

11/12/25

B.Tech Sem VII

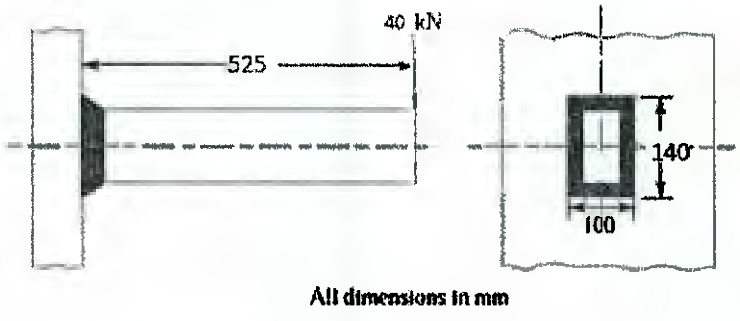
Program: MECHANICAL ENGINEERING **Duration: 03 Hours**

Course Code: PE-BTM735 **Maximum Points: 100**

Course Name: Welding Process and Welding Technology **Semester: VII**

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.

Q. No.	Questions	Points	CO	BL	Module No
Q1	A. rectangular cross-section bar is welded to a support by means of fillet welds as shown in Fig. Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 MPa.  All dimensions in mm	10	2	3	2
	B. An arc welding DC power source has a linear power source characteristic with open circuit voltage V_0=90 Volts and Is=1250amps.The voltage length characteristic of the arc has given by V=45+5L Volt where L is the arc length in mm. Calculate the optimum length of arc for obtaining max. arc power at welding. What voltage and current setting should be done on the power source for max.arc power. Also calculate net heat input for process if the arc heat transfer efficiency is 0.88 and welding speed is 7mm/sec.	10	1,4	4	5

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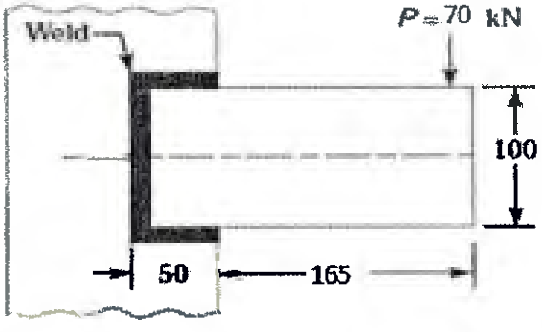
END SEMESTER November 2025 / ~~RE - EXAM January~~ 2026

2	A. Describe how Friction Stir Welding (FSW) can be utilized in the automotive sector for producing high-strength aluminum components, and apply your understanding of the process to examine the roles of the advancing side, retreating side, and tool pin height in governing material flow and heat distribution. Analyze how these parameters collectively influence weld formation, defect prevention, and mechanical performance of welded automotive structures	06	1,4	5	4
	B. An engineering workshop plans to hard facing worn-out agricultural tiller blades to restore durability and enhance wear resistance. Analyze how MMAW can be effectively applied for this hard facing task, evaluate the suitability of different electrodes and polarity settings for achieving deeper weld penetration, and examine how changes in current settings and travel speed influence the metallurgical quality and performance of the hardfaced layer, using relevant examples to support your analysis.	06	4	3	3
	C. A rectangular steel plate is welded as a cantilever to a vertical column and supports a single concentrated load P, as shown in Fig. Determine the weld size if shear stress in the same is not to exceed 140 MPa  All dimensions in mm.	08	2,3	4	2
3	A. An aerospace company is manufacturing a lightweight aluminum alloy fuel tank for a satellite; justify the selection of GTAW (TIG welding) over other welding processes for this application, and apply your understanding to analyze how the choice of shielding gas argon, helium, or their mixtures affects weld quality, penetration characteristics, and overall performance when welding thin aluminum sheets	8	4,1	3,4	3
	B. Describe the essential process parameters used in plasma arc welding for piping applications, and apply this understanding to evaluate how variations in current, arc voltage, shielding	06	3	4	4

	gas flow, electrode dimensions, and welding speed affect weld penetration and bead quality. Additionally, analyze the functional differences between transferred and non-transferred plasma arc welding modes, and support your explanation with neat schematic diagrams showing the basic arrangement of each setup.				
	C. Describe what arc blow is in arc welding and illustrate how it typically develops during welding. Apply your understanding to explain its impact on weld bead appearance and defect formation, and analyze the underlying factors such as magnetic fields, joint configuration, and current settings that intensify arc blow. Finally, suggest effective techniques to control or reduce arc blow in practical welding situations	06	3,4	4	3
4	A. Compare cellulosic, rutile, and low-hydrogen electrodes in terms of coating chemistry, arc behavior, penetration, and applications. Prepare a brief comparison table of their advantages, limitations, and suitable welding positions, and justify which electrode type is most appropriate for pipeline welding, structural fabrication, and pressure-vessel work.	10	1,3	2	6
	B. A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Figure.The maximum tensile and shear stresses are 70 MPa and 56 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading.	10	2	6	2
5	A. During a Gas Tungsten Arc Welding (GTAW) process, the welding voltage and current are maintained at 25 V and 250 A respectively. The arc efficiency is 0.80, and the welding speed is 7 mm/s. If the filler rod (density = 7850 kg/m3, specific heat = 480 J/kg·°C, melting temperature = 1450 °C, ambient	10	2,4	4	5

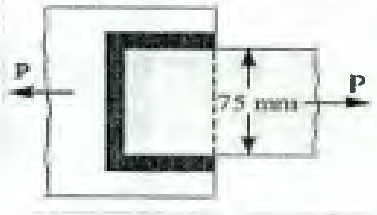


Table:Stress concentration factor for welded joints.

Type of joint	Stress concentration factor
1. Reinforced butt welds	1.2
2. Toe of transverse fillet welds	1.5
3. End of parallel fillet weld	2.7
4. T-butt joint with sharp corner	2.0

	temperature = 30 °C) has a diameter of 1.6 mm and is fed at a rate of 10 mm/s, determine: 1. The net heat input (in J/mm) to the weld. 2. The percentage of available heat actually utilized for melting the filler metal (melting efficiency)				
	B. Explain following NDT of welded joints with schematic diagram. I. Magnetic particle test II. Ultrasonic transmission approach testing.	10	4	2	7
6	A. Apply your understanding of electrode classifications to explain the characteristics and applications of the following types: 1. Bare Electrodes 2. Light Coated Electrodes 3. Shielded Arc or Heavy Coated Electrodes.	08	1,4	3	6
	B. Describe the weld joint configurations that can be employed in laser beam welding and explain the physical principles behind keyhole formation. Additionally, analyze how variations in laser power density, beam focus position, and the metallurgical response of the material influence the keyhole's depth, stability, and resulting weld characteristics.	06	1,4	3	4
	C. Describe zero, positive, and negative manufacturing processes and support each with an appropriate industrial example. Then, apply your understanding of weld design to outline any three practical factors that must be evaluated when choosing a suitable weld joint for a specific service requirement.	06	1	3,4	1
7	A. Examine various types of weld defects in welding. Select five specific defects, elucidate their causes with schematic diagrams, and propose effective remedies for each. Justify the chosen remedies and discuss how they contribute to defect prevention.	10	1,4	6	7
	B. Arc length–voltage characteristic is given by: $V_a = 20 + 4L_a$ Arc length in the welding process changes from 4 mm to 6 mm, and current changes from 550 A to 450 A. Assuming a linear power source characteristic, determine the values of open-circuit voltage (V0) and short-circuit current (Is).	05	2	5	5
	C. Differentiate solid-state welding from fusion welding with respect to thermal damage, residual stress, and metallurgical quality of the joint. Based on this comparison, suggest a suitable welding process for joining heat-sensitive alloys with minimum thermal degradation. Finally, illustrate your answer with a schematic graph showing the variation of tensile strength with heat input for both solid-state and fusion welding processes.	05	4	3	1

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Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester / Re-Examination, DECEMBER 2025

B.Tech. (Mechanical Engineering), Semester-VII

PE-BTM 752: COMPUTATIONAL FLUID DYNAMIC

Max. Marks: 100

Duration: 3 Hours

Instructions:

- Attempt any FIVE questions.
- All sub-parts of a question must be answered together for proper evaluation.
- Make suitable assumptions wherever necessary, providing clear justification.
- Figures in square brackets on the right indicate the maximum marks for each sub-question.
- The figures on the extreme right represent the Course Outcome (CO) and / Bloom's Level (BL) as per the syllabus.

1.	A.	Answer following questions: a) What is alternating direction implicit scheme (ADI)? Where it can be used? b) Mathematically represent ADI scheme applying it to a 2D transient conduction. c) How does it differ from explicit and implicit scheme? d) Where are the advantages of ADI scheme?	[10]	2/2
	B.	A circular fin of inner diameter 20 cm and outer diameter of 26 cm transfers heat from a small motorcycle engine. If the average engine surface temperature is 112°C, determine the temperature distribution along the fin surface. The thermal conductivity of the fin material is 21W/m°C and the convective heat transfer coefficient between the fin and the atmosphere is 120W/m^2 ∘C. Assume an atmospheric temperature of 32°C. Develop a numerical solution using FVM to descretize and to obtain temperature at 5 interior points.	[10]	3/4
2.	A.	For monotonic convergence of one dimensional convection-diffusion problem the stability is limited by $\|Pe\| < 2$ if central difference scheme is used to treat convective terms. How this restrictions can be avoided. Explain any two methods.	[10]	1,2/3
	B.	Explain the following concepts in the context of computational analysis: i) Ill-conditioned and well-conditioned system ii) Numerical Stability iii) Role of mesh size and time-step size in transient analysis	[10]	2/3
3.	A.	Discuss and compare the three major methods of investigating thermal–flow problems: (a) theoretical analysis, (b) experimental analysis, and (c) numerical (computational) analysis.	[10]	1/4
	B.	Compare the solution of following set of equation using Gauss Seidel method and LU decomposition. Show all steps, compare the final solutions, and briefly discuss the relative computational advantages of each method. $4x + 3y - z = 7$ $2x - 5y + 3z = -1$ $-6x + 2y + 8z = 10$	[10]	3/4
4.	A.	Describe and illustrate the following types of computational meshes, giving appropriate examples for each: (i) Orthogonal and non-orthogonal meshes, (ii) Structured and unstructured meshes (iii) Conformal and non-conformal meshes	[10]	1/4

	B.	Discuss the specific numerical and physical reasons that make solving the Navier–Stokes (momentum) equations more challenging than the scalar energy equation. Then develop the 2-D pressure-correction equation (showing algebraic steps) and present a step-by-step algorithm to solve steady incompressible flows.	**[10]**	2/2
5.	**A.**	Describe the essential thermal and fluid-flow boundary conditions, providing appropriate illustrative examples. Further, elaborate on how convective boundary conditions are handled using the **image-point technique** and the **polynomial-fitting** approach in numerical computations.	**[10]**	2/4
	B.	Consider one-dimensional conduction in a plate that is part of a thermal system. The plate is of thickness 3 cm and is initially at a uniform temperature of 1000°C. At time t = 0, the temperature at the two surfaces is dropped to 0°C and maintained at this value. The thermal diffusivity of the material is $\alpha = 5 \times 10^{-6}$ m^2/s. Solve this problem by any finite difference method to obtain the temperature distribution as a function of time.	**[10]**	2/5
6.	**A.**	(i) What is a grid independence study? State its significance in numerical computation. (ii) Develop an energy-balance-based mathematical model to determine the cure temperature of a coated plate exposed to infrared irradiation of 2000 W/m². The coating absorbs 80% of the incident radiation, has an emissivity of 0.50, and exchanges heat with ambient air at 20 °C (with h=15 W/m²K) and large surroundings at 30 °C. Formulate the governing equation in terms of all relevant variables (no numerical solution required) and clearly state all underlying assumptions.	**[10]**	1/1
	B.	Explain the key characteristics of turbulent flow. Discuss the role of Reynolds stresses in turbulence modeling. List various turbulence models and describe any one of them in detail.	**[10]**	4/2
7.	**A.**	Explain how partial differential equations (PDEs) are classified based on their mathematical nature, and provide at least one representative example for each class.	**[05]**	1/2
	B.	A square plate of size 100 cm by 100 cm is subjected to an isothermal boundary condition of 500 ◦C on the top and to a convection environment on all the remaining three sides of 100◦C with a heat transfer coefficient of 10 W/m^2K. The thermal conductivity of the plate is 10 W/m^2K. Assume the thickness of the plate is 1 cm. i. Develop a mathematical model in integral form. ii. Assuming 4 horizontal and 3 vertical mesh, write descretized equation for all cells based FVM. Obtain steady state solution using point by point method with proper initial guess. iii. Calculate the temperature and heat fluxes in the x and y directions at a location (x = 30 cm, y = 30 cm). Assume 2D heat conduction.	**[15]**	4/5

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