

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai - 400058



Re-Exam/End Sem MAY 2025/JUNE 2025

Program: Mechanical

Course Code: PE-BTM 733

Course Name: Industrial Robotics

Notes: Solve any **five** questions

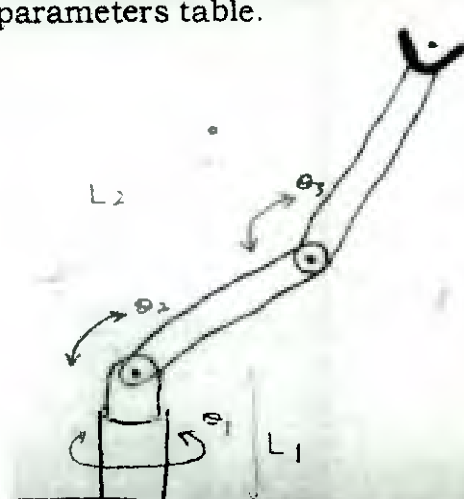
Assume Suitable data

Duration: 3 Hrs

Maximum Points: 100

Semester: VIII

25/6/25

Q.No.	Questions	Points	CO	BL	PI
1	a) Discuss the Work Space Envelope in details b) Discuss different types of drives in Robotics c) Define Robot and discuss Robotic Manipulator d) Discuss the three laws of the Robots	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



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~~Re-Exam/End Sem~~ ~~MAY 2025~~ / June 2025

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	Discuss the Robotics applications in Manufacturing such as: Material transfer, Material loading and unloading, Assembly and inspection	10	3	VI	1.6.1
6a	Discuss the Social issues and Economics of Robots. Name the different types of Industrial Robots use commonly use.	10	3	IV	5.4.1
6b	Explain the different types of sensors used in the Industrial Robots and Discuss the steps involved in the design of the Industrial Robots	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

A



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Program: Mechanical

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Course Name: Industrial Robotics

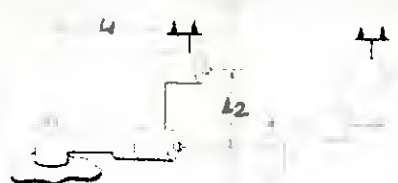
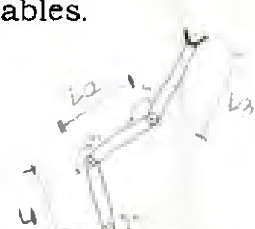
Notes: Solve any **five** questions

Duration: 3 Hrs

Maximum Points: 100

Semester: VIII

2015/25

Q.No.	Questions	Points	CO	BL	PI
1	a) Discuss the Automation in details b) Discuss the AI and Role of AI in Robotics c) Define Robot and enlist types of grippers d) Discuss the Classification of the Robots	20	1,2	I,III,V	1.5.1
2a	For the shown no-planar 3R manipulator, demonstrate the non-uniqueness of frame assignments and corresponding DH parameters for the two possible choices of Z_2 -axis direction and two possible choices of X_1 -axis direction. 	10	2	I	1.6.1
2b	Assign frames {0} to {4} for the shown planar 3R (RRR) robotic manipulator, then find the DH parameters tables. 	10	2	VI	5.4.1
3a	Explain X-Y-Z Fixed Angles, Z-Y-X Euler Angles and the Equivalent Single-Axis Representation with suitable examples.	10	1	III	1.6.1



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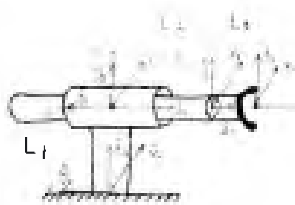
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~~22-EXAM~~ / End Sem - MAY 2025 / ~~JUNE 2025~~

3b	Explain the Forward kinematics and obtain the total transformation matrix from frame {0} to frame {n}. Obtain for the shown RPR robotics manipulator the DH parameters and calculate the transformation matrices 0T_1, 1T_2, 2T_3, 3T_4 and find 0T_4. 	10	2	V	5.4.1
4a	Discuss the Inverse Kinematics and explain the solvability of the inverse kinematics problems with suitable examples.	10	3	VI	1.6.1
4b	Explain the Robot Intelligence, Problem Solving, Robot Learning and Task Planning in brief.	10	3	III	5.4.1
5a	Explain the Jacobian and Discuss the Jacobian using Velocity Propagation Method with suitable example.	10	3	II	1.6.1
5b	Discuss the Robotics applications in Manufacturing such as: Material transfer, Material loading and unloading, Assembly and inspection	10	3	VI	1.6.1
6a	Develop 2R Robot, find the Jacobian matrix using Direct Differentiation Method relative to frame {0} to frame {3}	10	3	IV	5.4.1
6b	Explain the specification of the Robot and different drives used in the Robots	10	3	III	5.4.1
7a	Explain the different types of sensors used in the Industrial Robots and Discuss the steps involved in the design of the Industrial Robots	10	4	III	5.1.2
7b	Discuss the Social issues and Economics of Robots. Name the different types of Industrial Robots use commonly.	10	4	III	5.1.2

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**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025**

Program: MECHANICAL ENGINEERING

Duration: 03 Hrs

Course Code: PE-BTM735

Maximum Points: 100

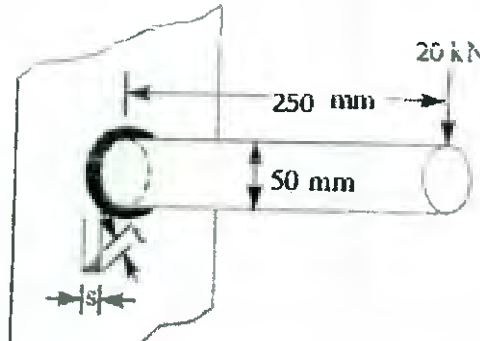
Course Name: Welding Process And Welding Technology

Semester: VIII

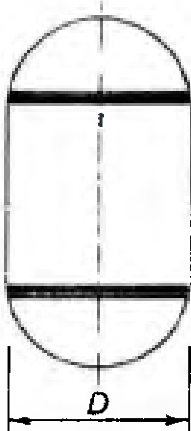
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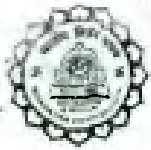
1. Question no 1 is compulsory
2. Attempt any four questions from the remaining six questions.
3. If necessary assume suitable data with justification
4. Draw neatly labeled sketches wherever required.

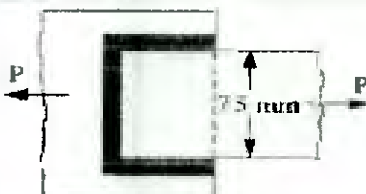
23/6/25

Q. No.	Questions	Points	CO	BL	Module No
Q1	A. A 50 mm diameter solid shaft is welded to a flat plate as shown in Figure. If the size of the weld is 15 mm, find the maximum normal and shear stress in the weld. 	10	2	3	2
	B. An arc welding DC power source has a linear power source characteristic with open circuit voltage $V_0=80$ Volts and $I_s=1150$amps. The voltage length characteristic of the arc has given by $V=40+5L$ 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 0.86 and welding speed is 7mm/sec.	10	1,4	4	5
2	A. Analyze and Evaluate the most suitable welding process for reducing fuel consumption in lightweight aircraft, automotive, and	06	1,4	5	4

**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025**

	shipbuilding applications where filler materials are not required, providing justification for its selection, and examine the criteria for tool pin design necessary for achieving optimal weld quality.				
	B. Considering MIG welding, analyze the role of shielding gases such as Argon, CO ₂ , Helium, and their mixtures. How do these gases influence arc stability, metal transfer mode, heat input, and overall weld quality for different base metals?	06	4	3	3
	C. A gas tank consists of a cylindrical shell of 185cm inner radius. It is enclosed by hemispherical shells by means of butt welded joint as shown in Figure. The thickness of the cylindrical shell as well as the hemispherical cover is 1.4 cm. Determine the allowable internal pressure (MPa) to which the tank may be subjected, if the permissible tensile stress in the weld is 105 N/mm ² . Assume efficiency of the welded joint as 0.82.	08	2,3	4	2
					
3	A. Describe electrode polarities in GTAW using AC and DC power sources. Discuss their influence on penetration, heat distribution, and cleaning action. Recommend appropriate polarities for welding stainless steel and aluminum.	8	4,1	3,4	3
	B. Analyze the advantages and limitations of the Electron Beam Welding (EBW) process compared to other fusion welding methods. How do beam parameters and vacuum conditions influence penetration depth, heat-affected zone, and weld quality?	06	3	4	4
	C. Draw a graph showing the relationship between different welding processes and the corresponding tensile strength in increasing order, and analyze why some welding processes result in higher tensile strength than others by applying your understanding of welding parameters such	06	4	3	1

**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025**

	as heat input, power density, cooling rate, and associated metallurgical changes affecting weld quality.														
4	A. Compare and contrast the chemical composition and functional behavior of welding electrode coatings for the following types: 1. Iron oxide-sodium 2. Cellulose-sodium 3. Low hydrogen-sodium 4. Rutile-iron powder. Apply your understanding to evaluate how each type influences arc stability, penetration, and weld quality under varying welding conditions	10	1,3,4	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 82 MPa and 62 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading.  Table: Stress concentration factor for welded joints. <table><tr><th>Type of joint</th><th>Stress concentration factor</th></tr><tr><td>1. Reinforced butt welds</td><td>1.2</td></tr><tr><td>2. Toe of transverse fillet welds</td><td>1.5</td></tr><tr><td>3. End of parallel fillet weld</td><td>2.7</td></tr><tr><td>4. T-butt joint with sharp corner</td><td>2.0</td></tr></table>	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	10	2	6	2
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														
5	A. During a steady gas metal arc welding with direct current electrode positive polarity, the welding current, voltage and weld speed are 150 A, 30 V and 6 m/min respectively. A metallic wire electrode of diameter 1.2 mm is being fed at a constant rate of 12 m/min. The density, specific heat and melting temp of the wire electrode are 7000 kg/m³, 500 J/kg and 1530°C respectively. Assume the ambient temp to be 30°C and neglect the latent heat of melting. Further consider that 2/3rd of the total electrical power is	10	2,4	4	5										

**END SEM/RE EXAM EXAMINATION MAY / JUNE 2025**

	available for melting of the wire electrode. Find melting efficiency (in percentage) of the wire electrode.				
	B. Explain following NDT of welded joints with schematic diagram. I. Magnetic particle test II. Ultrasonic reflection approach.	10	4	2	7
6	A. Analyze the structural and functional differences among the following types of electrodes: 1. Bare Electrodes 2. Light Coated Electrodes 3. Shielded Arc or Heavy Coated Electrodes.	08	1,4	3	6
	B. Why SAW considered more efficient compared to other arc welding processes? Additionally, explain how the following process parameters affect weld quality when all other process parameters are kept at their optimum values in SAW: i) Discuss the impact of high and low welding currents on weld quality. ii) Elaborate on the effects of a long arc length and a short arc length on weld quality. Support your answers with relevant examples or reasons for the observed effects.	06	3,4	4	3
	C. Examine the role of welding in manufacturing processes and compare it with other common joining methods such as brazing, soldering, and adhesive bonding in terms of strength, temperature requirements, and applications; further, explain the concepts of autogenous and heterogeneous welds, and analyze the conditions under which each type is preferred to achieve optimum weld quality.	06	1	3,4	1
7	A. Identify and analyze five common weld defects encountered in different welding processes. For each defect, provide a detailed explanation of its causes, illustrate with clear schematic diagrams, and recommend practical remedies. Justify the effectiveness of each remedy and explain how it aids in minimizing or eliminating the occurrence of these defects in future welds	10	1,4	6	7
	B. Volt ampere characteristic is given by $I^2 = -550(V - 60)$. Arc characteristic is given as $I_a = 20(V - 16)$. Here, I is in Amperes and V is in Volts. Find the power of the stable arc in kW.	05	2	5	5

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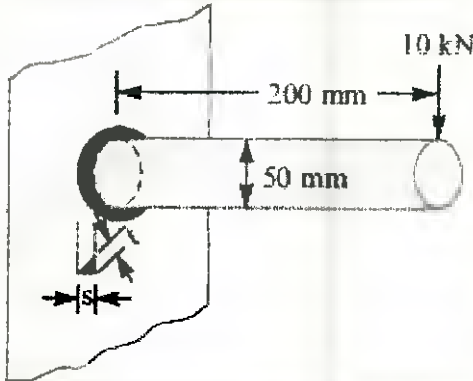
**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025**

	C. Explain the generation of the laser in a laser welding machine, incorporating a schematic diagram to illustrate the process. Furthermore, discuss the various types of modes associated with the generated laser, considering their characteristics and applications.	05	1,4	3	4
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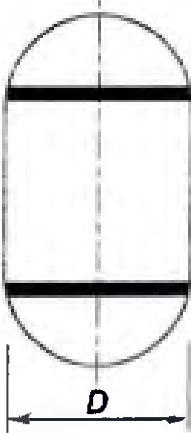
**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025****Program:** MECHANICAL ENGINEERING**Duration:** 03 Hrs**Course Code:** PE-BTM735**Maximum Points:** 100**Course Name:** Welding Process And Welding Technology**Semester:** VIII**Notes:**

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.

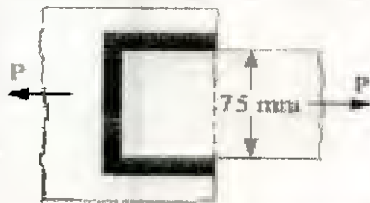
14/5/25

Q. No.	Questions	Points	CO	BL	Module No
Q1	A. A 50 mm diameter solid shaft is welded to a flat plate as shown in Figure. If the size of the weld is 15 mm, find the maximum normal and shear stress in the weld. 	10	2	3	2
	B. An arc welding DC power source has a linear power source characteristic with open circuit voltage $V_0 = 85$ Volts and $I_s = 1250$ amps. The voltage length characteristic of the arc has given by $V = 40 + 5L$ 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 0.86 and welding speed is 7 mm/sec.	10	1,4	4	5
2	A. Analyze and Evaluate the most suitable welding process for reducing fuel consumption in lightweight aircraft, automotive, and shipbuilding applications where filler materials are not required, providing justification for its selection, and examine	06	1,4	5	4

**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025**

	the criteria for tool pin design necessary for achieving optimal weld quality.				
	B. Analyze the effect of electrode extension on welding current by drawing a graph for different electrode diameters (1.2 mm and 1.8 mm) at electrode extensions of 10 mm and 18 mm. Explain how the welding current is characterized for each case in the MIG welding process, considering the influence of electrode extension and diameter.	06	4	3	3
	C. A gas tank consists of a cylindrical shell of 185cm inner radius. It is enclosed by hemispherical shells by means of butt welded joint as shown in Figure. The thickness of the cylindrical shell as well as the hemispherical cover is 1.4 cm. Determine the allowable internal pressure (MPa) to which the tank may be subjected, if the permissible tensile stress in the weld is 105 N/mm ² . Assume efficiency of the welded joint as 0.82. 	08	2,3	4	2
3	A. Explain the types of electrode polarity used in GTAW with DC and AC power. How do they affect weld penetration, oxide cleaning, and heat concentration? Suggest suitable polarity for welding aluminum and stainless steel	8	4,1	3,4	3
	B. With a schematic diagram, explain the concept of the Electron Beam Welding (EBW) process. Analyze why the entire welding operation is carried out in a vacuum, and how this affects weld quality and process efficiency.	06	3	4	4

**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025**

	C. Explain the concept of arc blow in arc welding. Analyze the causes of arc blow, and discuss its effects on weld quality. How can arc blow be minimized during welding operations?	06	3,4	4	3										
4	A. Analyze the functional roles and properties of welding electrode ingredients for the following types: 1. Cellulose-sodium 2. Rutile-sodium 3. Low hydrogen-sodium 4. Rutile-iron powder. Explain how these ingredient properties influence electrode performance and welding outcomes in practical applications	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.  <table><caption>Table: Stress concentration factor for welded joints.</caption><thead><tr><th>Type of joint</th><th>Stress concentration factor</th></tr></thead><tbody><tr><td>1. Reinforced butt welds</td><td>1.2</td></tr><tr><td>2. Toe of transverse fillet welds</td><td>1.5</td></tr><tr><td>3. End of parallel fillet weld</td><td>2.7</td></tr><tr><td>4. T-butt joint with sharp corner</td><td>2.0</td></tr></tbody></table>	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	10	2	6	2
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5	A. During a steady gas metal arc welding with direct current electrode positive polarity, the welding current, voltage and weld speed are 150 A, 30 V and 6 m/min respectively. A metallic wire electrode of diameter 1.2 mm is being fed at a constant rate of 12 m/min. The density, specific heat and melting temp of the wire electrode are 7000 kg/m³, 500 J/kg and 1530°C respectively. Assume the ambient temp to be 30°C and neglect the latent heat of melting. Further consider that 2/3rd of the total electrical power is available for melting	10	2,4	4	5										

**END SEM/RE-EXAM EXAMINATION MAY / JUNE-2025**

	of the wire electrode. find melting efficiency (in percentage) of the wire electrode.				
	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. Explain the generation of the laser in a laser welding machine, incorporating a schematic diagram to illustrate the process. Furthermore, discuss the various types of modes associated with the generated laser, considering their characteristics and applications.	06	1,4	3	4
	C. Examine the role of welding in manufacturing processes and compare it with other common joining methods such as brazing, soldering, and adhesive bonding in terms of strength, temperature requirements, and applications; further, explain the concepts of autogenous and heterogeneous welds, and analyze the conditions under which each type is preferred to achieve optimum weld quality.	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. Volt ampere characteristic is given by $P = -600(V - 60)$. Arc characteristic is given as $I_a = 20(V - 16)$. Here, I is in Amperes and V is in Volts. Find the power of the stable arc in kW.	05	2	5	5
	C. Draw a graph showing the relationship between different welding processes and the corresponding tensile strength in increasing order, and analyze why some welding processes result in higher tensile strength than others by applying your understanding of welding parameters such as heat input, power density, cooling rate, and associated metallurgical changes affecting weld quality.	05	4	3	1



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END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025

Program: Final Year B. Tech.(C/E/M)

sem VIII

Duration: 3 Hours

Course Code: OE-BTM712

Maximum Points: 100

Course Name: Introduction to Research Methodology

Semester: VIII

m 16/3

Notes:

1. Attempt any 5 questions out of the given 7.
2. Each question carries 20 marks (2 sub-questions of 10 marks each).
3. If you choose to attempt Q.1(a), you must also attempt Q.1(b) — sub-questions must be answered in pairs.

Q.No.	Questions	Points	CO	BL	Module No.
Q1(a)	You are part of a research team developing a sustainable energy solution. During your work, you discover your colleague is manipulating data. Discuss how guiding principles of research ethics can help you respond to this situation, and suggest steps to handle it ethically.	10	2	5	1
Q1(b)	Differentiate between the general steps of the research process and the steps in research methodology with suitable engineering examples. Why is it important to understand both when planning a research project?	10	1	4	1
Q2(a)	In a medical device testing study, a researcher concludes a new device is effective when it is actually not. Identify this type of error, and explain the consequences of Type I and Type II errors using engineering research examples.	10	1	4	1
Q2(b)	Explain with engineering examples how dependent and independent variables are identified in an experimental study.	10	3	3	2
Q3(a)	You are assigned a research project in your domain (Civil/Mechanical/Electrical). Justify the need for conducting a thorough literature survey before beginning experimental work. Support your answer with examples.				3
Q3(b)	You are tasked with writing both a review paper and a research paper on a technological advancement (e.g., AI in Smart Grids for Electrical Engineering, AI in Construction Management for Civil Engineering, or AI in Manufacturing for Mechanical Engineering). Discuss the differences in structure, purpose, and literature review approach between the two types of papers. How	10	4	4	3



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	would these differences apply to the topic in your specific engineering domain?																										
Q4(a)	Compare and contrast primary and secondary data sources in research. Provide engineering-related examples of each and discuss when each would be preferable in conducting a study on a new product development in your field.	10	2	4	4																						
Q4(b)	Imagine you are conducting a study on consumer behavior toward electric vehicles. What would be the key differences in using the interview method, telephonic method, structured vs. unstructured interviews, and questionnaires for data collection? Choose the most appropriate method for this research and justify your selection.																										
Q5(a)	Compute the rank correlation coefficient for the following data: <table><tr><td>X</td><td>56</td><td>75</td><td>45</td><td>71</td><td>62</td><td>64</td><td>58</td><td>80</td><td>76</td><td>61</td></tr><tr><td>Y</td><td>66</td><td>70</td><td>40</td><td>75</td><td>65</td><td>56</td><td>59</td><td>77</td><td>67</td><td>63</td></tr></table>	X	56	75	45	71	62	64	58	80	76	61	Y	66	70	40	75	65	56	59	77	67	63	10	1	4	5
X	56	75	45	71	62	64	58	80	76	61																	
Y	66	70	40	75	65	56	59	77	67	63																	
Q5(b)	The following data provides information on military expenditure (X) in crores of rupees and the corresponding war casualties (Y) in thousands during various phases of the India-Pakistan War of 1965: <table><tr><th>Military Expenditure (X) (Rs. in crores)</th><th>War Casualties (Y) (in thousands)</th></tr><tr><td>100</td><td>15</td></tr><tr><td>150</td><td>18</td></tr><tr><td>200</td><td>22</td></tr><tr><td>250</td><td>28</td></tr><tr><td>300</td><td>32</td></tr><tr><td>350</td><td>40</td></tr><tr><td>400</td><td>45</td></tr><tr><td>450</td><td>50</td></tr></table>	Military Expenditure (X) (Rs. in crores)	War Casualties (Y) (in thousands)	100	15	150	18	200	22	250	28	300	32	350	40	400	45	450	50	10	1	4	5				
Military Expenditure (X) (Rs. in crores)	War Casualties (Y) (in thousands)																										
100	15																										
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450	50																										



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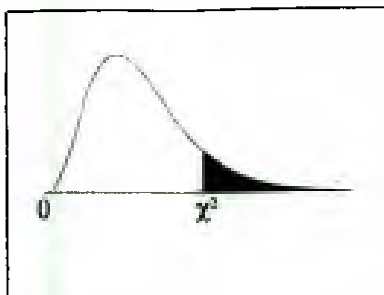
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Munshi Nagar, Andhori (W) Mumbai - 400058



END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025

	Using the above data: (i) Find the regression line of Y on X, i.e., estimate the number of casualties based on military expenditure. (ii) Find the regression line of X on Y, i.e., estimate the military expenditure based on the number of casualties.																
Q6(a)	The following mistakes per page were observed in a book. <table><tr><td>Mistakes per Page</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>No. of Page</td><td>211</td><td>90</td><td>19</td><td>5</td><td>0</td></tr></table> Assuming that the number of mistakes per page follows a Poisson distribution, fit a Poisson distribution to the data and test the goodness of fit using the Chi-square test.	Mistakes per Page	0	1	2	3	4	No. of Page	211	90	19	5	0	10	1	4	6
Mistakes per Page	0	1	2	3	4												
No. of Page	211	90	19	5	0												
Q6(b)	The tensile strength (in MPa) of a newly developed carbon fiber material was measured on a sample of 10 specimens. The observed values were: 812, 805, 798, 790, 803, 800, 799, 801, 825, 818 Using a t-test, test whether the average tensile strength of the carbon fiber material can be assumed to be 805 MPa at the 5% significance level.	10	1	4	6												
Q7(a)	Why is it important to identify the limitations in a research report? How does acknowledging these limitations improve the credibility of the research, and what role do they play in suggesting areas for future research?	10	4	5	7												
Q7(b)	Evaluate the process of identifying the future scope in a research report. Why is it essential to outline future research directions, and how can these suggestions benefit both the academic and professional communities?	10	4	5	7												

Chi-Square Distribution Table



The shaded area is equal to α for $\chi^2 = \chi^2_{\alpha}$.

<i>df</i>	$\chi^2_{.995}$	$\chi^2_{.990}$	$\chi^2_{.975}$	$\chi^2_{.950}$	$\chi^2_{.900}$	$\chi^2_{.100}$	$\chi^2_{.050}$	$\chi^2_{.025}$	$\chi^2_{.010}$	$\chi^2_{.005}$
1	0.000	0.000	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
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13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

Critical Values for Student's t-Distribution.



df	Upper Tail Probability: $\Pr(T > t)$									
	0.2	0.1	0.05	0.04	0.03	0.025	0.02	0.01	0.005	0.0005
1	1.376	3.078	6.314	7.916	10.579	12.706	15.895	31.821	63.657	636.619
2	1.061	1.886	2.920	3.320	3.896	4.303	4.849	6.965	9.925	31.599
3	0.978	1.638	2.353	2.605	2.951	3.182	3.482	4.541	5.841	12.924
4	0.941	1.533	2.132	2.333	2.601	2.776	2.999	3.747	4.604	8.610
5	0.920	1.476	2.015	2.191	2.422	2.571	2.757	3.365	4.032	6.869
6	0.906	1.440	1.943	2.104	2.313	2.447	2.612	3.143	3.707	5.959
7	0.896	1.415	1.895	2.046	2.241	2.365	2.517	2.998	3.499	5.408
8	0.889	1.397	1.860	2.004	2.189	2.306	2.449	2.896	3.355	5.041
9	0.883	1.383	1.833	1.973	2.150	2.262	2.398	2.821	3.250	4.781
10	0.879	1.372	1.812	1.948	2.120	2.228	2.359	2.764	3.169	4.587
11	0.876	1.363	1.796	1.928	2.096	2.201	2.328	2.718	3.106	4.437
12	0.873	1.356	1.782	1.912	2.076	2.179	2.303	2.681	3.055	4.318
13	0.870	1.350	1.771	1.899	2.060	2.160	2.282	2.650	3.012	4.221
14	0.868	1.345	1.761	1.887	2.046	2.145	2.264	2.624	2.977	4.140
15	0.866	1.341	1.753	1.878	2.034	2.131	2.249	2.602	2.947	4.073
16	0.865	1.337	1.746	1.869	2.024	2.120	2.235	2.583	2.921	4.015
17	0.863	1.333	1.740	1.862	2.015	2.110	2.224	2.567	2.898	3.965
18	0.862	1.330	1.734	1.855	2.007	2.101	2.214	2.552	2.878	3.922
19	0.861	1.328	1.729	1.850	2.000	2.093	2.205	2.539	2.861	3.883
20	0.860	1.325	1.725	1.844	1.994	2.086	2.197	2.528	2.845	3.850
21	0.859	1.323	1.721	1.840	1.988	2.080	2.189	2.518	2.831	3.819
22	0.858	1.321	1.717	1.835	1.983	2.074	2.183	2.508	2.819	3.792
23	0.858	1.319	1.714	1.832	1.978	2.069	2.177	2.500	2.807	3.768
24	0.857	1.318	1.711	1.828	1.974	2.064	2.172	2.492	2.797	3.745
25	0.856	1.316	1.708	1.825	1.970	2.060	2.167	2.485	2.787	3.725
26	0.856	1.315	1.706	1.822	1.967	2.056	2.162	2.479	2.779	3.707
27	0.855	1.314	1.703	1.819	1.963	2.052	2.158	2.473	2.771	3.690
28	0.855	1.313	1.701	1.817	1.960	2.048	2.154	2.467	2.763	3.674
29	0.854	1.311	1.699	1.814	1.957	2.045	2.150	2.462	2.756	3.659
30	0.854	1.310	1.697	1.812	1.955	2.042	2.147	2.457	2.750	3.646
31	0.853	1.309	1.696	1.810	1.952	2.040	2.144	2.453	2.744	3.633
32	0.853	1.309	1.694	1.808	1.950	2.037	2.141	2.449	2.738	3.622
33	0.853	1.308	1.692	1.806	1.948	2.035	2.138	2.445	2.733	3.611
34	0.852	1.307	1.691	1.805	1.946	2.032	2.136	2.441	2.728	3.601
35	0.852	1.306	1.690	1.803	1.944	2.030	2.133	2.438	2.724	3.591
36	0.852	1.306	1.688	1.802	1.942	2.028	2.131	2.434	2.719	3.582
37	0.851	1.305	1.687	1.800	1.940	2.026	2.129	2.431	2.715	3.574
38	0.851	1.304	1.686	1.799	1.939	2.024	2.127	2.429	2.712	3.566
39	0.851	1.304	1.685	1.798	1.937	2.023	2.125	2.426	2.708	3.558
40	0.851	1.303	1.684	1.796	1.936	2.021	2.123	2.423	2.704	3.551
41	0.850	1.303	1.683	1.795	1.934	2.020	2.121	2.421	2.701	3.544
42	0.850	1.302	1.682	1.794	1.933	2.018	2.120	2.418	2.698	3.538
43	0.850	1.302	1.681	1.793	1.932	2.017	2.118	2.416	2.695	3.532
44	0.850	1.301	1.680	1.792	1.931	2.015	2.116	2.414	2.692	3.526
45	0.850	1.301	1.679	1.791	1.929	2.014	2.115	2.412	2.690	3.520
46	0.850	1.300	1.679	1.790	1.928	2.013	2.114	2.410	2.687	3.515
47	0.849	1.300	1.678	1.789	1.927	2.012	2.112	2.408	2.685	3.510
48	0.849	1.299	1.677	1.789	1.926	2.011	2.111	2.407	2.682	3.505
49	0.849	1.299	1.677	1.788	1.925	2.010	2.110	2.405	2.680	3.500
50	0.849	1.299	1.676	1.787	1.924	2.009	2.109	2.403	2.678	3.496
60	0.848	1.296	1.671	1.781	1.917	2.000	2.099	2.390	2.660	3.460
70	0.847	1.294	1.667	1.776	1.912	1.994	2.093	2.381	2.648	3.435
80	0.846	1.292	1.664	1.773	1.908	1.990	2.088	2.374	2.639	3.416
90	0.846	1.291	1.662	1.771	1.905	1.987	2.084	2.368	2.632	3.402
100	0.845	1.290	1.660	1.769	1.902	1.984	2.081	2.364	2.626	3.390
120	0.845	1.289	1.658	1.766	1.899	1.980	2.076	2.358	2.617	3.373
140	0.844	1.288	1.656	1.763	1.896	1.977	2.073	2.353	2.611	3.361
180	0.844	1.286	1.653	1.761	1.893	1.973	2.069	2.347	2.603	3.345
200	0.843	1.286	1.653	1.760	1.892	1.972	2.067	2.345	2.601	3.340
500	0.842	1.283	1.648	1.754	1.885	1.965	2.059	2.334	2.586	3.310
1000	0.842	1.282	1.646	1.752	1.883	1.962	2.056	2.330	2.581	3.300
∞	0.842	1.282	1.645	1.751	1.881	1.960	2.054	2.326	2.576	3.291
	60%	80%	90%	92%	94%	95%	96%	98%	99%	99.9%
	Confidence Level									

Note: $t(\infty)_{\alpha/2} = Z_{\alpha/2}$ in our notation.



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END SEM/~~RE-EXAM~~ EXAMINATION MAY / JUNE 2025

Program: Final Year B. Tech.(C/E/M)

Sem VIII

Duration: 3 Hours

Course Code: OE-BTM712

Maximum Points: 100

Course Name: Introduction to Research Methodology

Semester: VIII

Notes:

1. Attempt any 5 questions out of the given 7.
2. Each question carries 20 marks (2 sub-questions of 10 marks each).
3. If you choose to attempt Q.1(a), you must also attempt Q.1(b) — sub-questions must be answered in pairs.

16/5/25

Q.No.	Questions	Points	CO	BL	Module No.
Q1(a)	As a graduating engineer, you are assigned to work on a rural infrastructure project. Discuss how your role as a researcher can contribute to solving societal challenges in such a project. Provide examples to justify your viewpoint.	10	1	4	1
Q1(b)	Consider a project aimed at analyzing the performance of electric vehicles. How would an objective approach differ from a subjective approach in conducting this research? Discuss with suitable technical examples.	10	3	4	1
Q2(a)	You are asked to investigate the causes of frequent delays in a metro rail project. Describe how you would define a research problem for this situation, outlining the specific steps involved. Justify why each step is important.	10	1	3	1
Q2(b)	Explain with engineering examples how dependent and independent variables are identified in an experimental study.	10	3	3	2
Q3(a)	You are assigned a research project in your domain (Civil/Mechanical/Electrical). Justify the need for conducting a thorough literature survey before beginning experimental work. Support your answer with examples.	10	1	3	3
Q3(b)	You are tasked with writing both a review paper and a research paper on a technological advancement (e.g., AI in Smart Grids for Electrical Engineering, AI in Construction Management for Civil Engineering, or AI in Manufacturing for Mechanical Engineering). Discuss the differences in structure, purpose, and literature review approach between the two types of papers.	10	4	4	3



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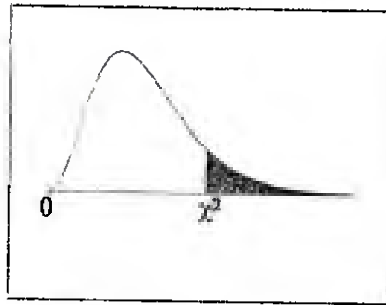
END SEM/RE-EXAM EXAMINATION MAY / ~~JUNE~~ 2025

	How would these differences apply to the topic in your specific engineering domain?																										
Q4(a)	In your research, you need to decide on a data collection method. Explain the importance of selecting the appropriate method and how it impacts the accuracy and reliability of your research results. Discuss examples from an engineering context.	10	3	3	4																						
Q4(b)	Imagine you are conducting a study on consumer behavior toward electric vehicles. What would be the key differences in using the interview method, telephonic method, structured vs. unstructured interviews, and questionnaires for data collection? Choose the most appropriate method for this research and justify your selection.				4																						
Q5(a)	A factory recorded the age (in years) of 8 machines and the corresponding annual maintenance cost (in ₹ thousands). Calculate Karl Pearson's coefficient of correlation and interpret the result. <table><tr><td>X</td><td>56</td><td>75</td><td>45</td><td>71</td><td>62</td><td>64</td><td>58</td><td>80</td><td>76</td><td>61</td></tr><tr><td>Y</td><td>66</td><td>70</td><td>40</td><td>75</td><td>65</td><td>56</td><td>59</td><td>77</td><td>67</td><td>63</td></tr></table>	X	56	75	45	71	62	64	58	80	76	61	Y	66	70	40	75	65	56	59	77	67	63	10	1	4	5
X	56	75	45	71	62	64	58	80	76	61																	
Y	66	70	40	75	65	56	59	77	67	63																	
Q5(b)	A research firm is studying the relationship between temperature (in degrees Celsius) and electricity consumption (in kilowatt-hours) in a city during summer. The data for five months of the year 2022 is as follows: <table><tr><td>Month</td><td>Temperature (X) (°C)</td><td>Electricity Consumption (Y) (kWh)</td></tr><tr><td>June</td><td>30</td><td>200</td></tr><tr><td>July</td><td>32</td><td>220</td></tr><tr><td>August</td><td>34</td><td>240</td></tr><tr><td>September</td><td>35</td><td>260</td></tr><tr><td>October</td><td>33</td><td>230</td></tr></table>	Month	Temperature (X) (°C)	Electricity Consumption (Y) (kWh)	June	30	200	July	32	220	August	34	240	September	35	260	October	33	230	10	1	4	5				
Month	Temperature (X) (°C)	Electricity Consumption (Y) (kWh)																									
June	30	200																									
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October	33	230																									

**END SEM/RE-EXAM EXAMINATION MAY / JUNE 2025**

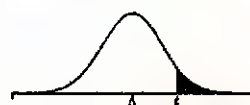
	i) Fit a linear regression equation of Y on X (Electricity Consumption on Temperature). ii) Estimate the electricity consumption for the month of November, where the temperature is expected to be 31°C.																
(a)	The following mistakes per page were observed in a book. <table border="1"> <tr> <td>Mistakes per Page</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr> <tr> <td>No. of Page</td><td>211</td><td>90</td><td>19</td><td>5</td><td>0</td></tr> </table> Assuming that the number of mistakes per page follows a Poisson distribution, fit a Poisson distribution to the data and test the goodness of fit using the Chi-square test.	Mistakes per Page	0	1	2	3	4	No. of Page	211	90	19	5	0	10	1	4	6
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Q6(b)	The tensile strength (in MPa) of a newly developed carbon fiber material was measured on a sample of 10 specimens. The observed values were: 812, 805, 798, 790, 803, 800, 799, 801, 825, 818 Using a t-test, test whether the average tensile strength of the carbon fiber material can be assumed to be 805 MPa at the 5% significance level.	10	1	4	6												
Q7(a)	Explain the key components of a research report. How do these components work together to effectively convey the findings and conclusions of the research to the audience?	10	4	4	7												
Q7(b)	Discuss the importance of the conclusion section in a research report. What should be included in this section to ensure that the research findings are clearly summarized and communicated effectively to the reader?	10	4	4	7												

Chi-Square Distribution Table



The shaded area is equal to α for $\chi^2 = \chi^2_{\alpha}$.

df	$\chi^2_{.995}$	$\chi^2_{.990}$	$\chi^2_{.975}$	$\chi^2_{.950}$	$\chi^2_{.900}$	$\chi^2_{.100}$	$\chi^2_{.050}$	$\chi^2_{.025}$	$\chi^2_{.010}$	$\chi^2_{.005}$
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2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
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8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
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12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

Critical Values for Student's t -Distribution.

df	Upper Tail Probability: $\Pr(T > t)$									
	0.2	0.1	0.05	0.04	0.03	0.025	0.02	0.01	0.005	0.0005
1	1.376	3.078	6.314	7.916	10.579	12.706	15.895	31.821	63.657	636.619
2	1.061	1.886	2.920	3.320	3.896	4.303	4.849	6.965	9.925	31.599
3	0.978	1.638	2.353	2.605	2.951	3.182	3.482	4.541	5.841	12.924
4	0.941	1.533	2.132	2.333	2.601	2.776	2.999	3.747	4.604	8.610
5	0.920	1.476	2.015	2.191	2.422	2.571	2.757	3.365	4.032	6.869
6	0.906	1.440	1.943	2.104	2.313	2.447	2.612	3.143	3.707	5.959
7	0.896	1.415	1.895	2.046	2.241	2.365	2.517	2.998	3.499	5.408
8	0.889	1.397	1.860	2.004	2.189	2.306	2.449	2.896	3.355	5.041
9	0.883	1.383	1.833	1.973	2.150	2.262	2.398	2.821	3.250	4.781
10	0.879	1.372	1.812	1.948	2.120	2.228	2.359	2.764	3.169	4.587
11	0.876	1.363	1.796	1.928	2.096	2.201	2.328	2.718	3.106	4.437
12	0.873	1.356	1.782	1.912	2.076	2.179	2.303	2.681	3.055	4.318
13	0.870	1.350	1.771	1.899	2.060	2.160	2.282	2.650	3.012	4.221
14	0.868	1.345	1.761	1.887	2.046	2.145	2.264	2.624	2.977	4.140
15	0.866	1.341	1.753	1.878	2.034	2.131	2.249	2.602	2.947	4.073
16	0.865	1.337	1.746	1.869	2.024	2.120	2.235	2.583	2.921	4.015
17	0.863	1.333	1.740	1.862	2.015	2.110	2.224	2.567	2.898	3.965
18	0.862	1.330	1.734	1.855	2.007	2.101	2.214	2.552	2.878	3.922
19	0.861	1.328	1.729	1.850	2.000	2.093	2.205	2.539	2.861	3.883
20	0.860	1.325	1.725	1.844	1.994	2.086	2.197	2.528	2.845	3.850
21	0.859	1.323	1.721	1.840	1.988	2.080	2.189	2.518	2.831	3.819
22	0.858	1.321	1.717	1.835	1.983	2.074	2.183	2.508	2.819	3.792
23	0.858	1.319	1.714	1.832	1.978	2.069	2.177	2.500	2.807	3.768
24	0.857	1.318	1.711	1.828	1.974	2.064	2.172	2.492	2.797	3.745
25	0.856	1.316	1.708	1.825	1.970	2.060	2.167	2.485	2.787	3.725
26	0.856	1.315	1.706	1.822	1.967	2.056	2.162	2.479	2.779	3.707
27	0.855	1.314	1.703	1.819	1.963	2.052	2.158	2.473	2.771	3.690
28	0.855	1.313	1.701	1.817	1.960	2.048	2.154	2.467	2.763	3.674
29	0.854	1.311	1.699	1.814	1.957	2.045	2.150	2.462	2.756	3.659
30	0.854	1.310	1.697	1.812	1.955	2.042	2.147	2.457	2.750	3.646
31	0.853	1.309	1.696	1.810	1.952	2.040	2.144	2.453	2.744	3.633
32	0.853	1.309	1.694	1.808	1.950	2.037	2.141	2.449	2.738	3.622
33	0.853	1.308	1.692	1.806	1.948	2.035	2.138	2.445	2.733	3.611
34	0.852	1.307	1.691	1.805	1.946	2.032	2.136	2.441	2.728	3.601
35	0.852	1.306	1.690	1.803	1.944	2.030	2.133	2.438	2.724	3.591
36	0.852	1.306	1.688	1.802	1.942	2.028	2.131	2.434	2.719	3.582
37	0.851	1.305	1.687	1.800	1.940	2.026	2.129	2.431	2.715	3.574
38	0.851	1.304	1.686	1.799	1.939	2.024	2.127	2.429	2.712	3.566
39	0.851	1.304	1.685	1.798	1.937	2.023	2.125	2.426	2.708	3.558
40	0.851	1.303	1.684	1.796	1.936	2.021	2.123	2.423	2.704	3.551
41	0.850	1.303	1.683	1.795	1.934	2.020	2.121	2.421	2.701	3.544
42	0.850	1.302	1.682	1.794	1.933	2.018	2.120	2.418	2.698	3.538
43	0.850	1.302	1.681	1.793	1.932	2.017	2.118	2.416	2.695	3.532
44	0.850	1.301	1.680	1.792	1.931	2.015	2.116	2.414	2.692	3.526
45	0.850	1.301	1.679	1.791	1.929	2.014	2.115	2.412	2.690	3.520
46	0.850	1.300	1.679	1.790	1.928	2.013	2.114	2.410	2.687	3.515
47	0.849	1.300	1.678	1.789	1.927	2.012	2.112	2.408	2.685	3.510
48	0.849	1.299	1.677	1.789	1.926	2.011	2.111	2.407	2.682	3.505
49	0.849	1.299	1.677	1.788	1.925	2.010	2.110	2.405	2.680	3.500
50	0.849	1.299	1.676	1.787	1.924	2.009	2.109	2.403	2.678	3.496
60	0.848	1.296	1.671	1.781	1.917	2.000	2.099	2.390	2.660	3.460
70	0.847	1.294	1.667	1.776	1.912	1.994	2.093	2.381	2.648	3.435
80	0.846	1.292	1.664	1.773	1.908	1.990	2.088	2.374	2.639	3.416
90	0.846	1.291	1.662	1.771	1.905	1.987	2.084	2.368	2.632	3.402
100	0.845	1.290	1.660	1.769	1.902	1.984	2.081	2.364	2.626	3.390
120	0.845	1.289	1.658	1.766	1.899	1.980	2.076	2.358	2.617	3.373
140	0.844	1.288	1.656	1.763	1.896	1.977	2.073	2.353	2.611	3.361
180	0.844	1.286	1.653	1.761	1.893	1.973	2.069	2.347	2.603	3.345
200	0.843	1.286	1.653	1.760	1.892	1.972	2.067	2.345	2.601	3.340
500	0.842	1.283	1.648	1.754	1.885	1.965	2.059	2.334	2.586	3.310
1000	0.842	1.282	1.646	1.752	1.883	1.962	2.056	2.330	2.581	3.300
∞	0.842	1.282	1.645	1.751	1.881	1.960	2.054	2.326	2.576	3.291
	60%	80%	90%	92%	94%	95%	96%	98%	99%	99.9%
	Confidence Level									

Note: $t(\infty)_{\alpha/2} = Z_{\alpha/2}$ in our notation.

**END SEM / RE-EXAMINATION - MAY 2025**

Program: BTech Mechanical

Scm VIII

Duration: 3hr

Course Code: PE-BTM734

Maximum Points:100

Course Name: Supply Chain Management

Semester: VIII

Note: Solve any 5 questions out seven

14/5/25

Q.No.	Questions	Points	CO	BL	Module																		
Q1A	- Prepare a Schematic Diagram to represent the definition of SCM and explain it. - Prepare a Block Diagram to show Detergent Supply Chain and explain it. - Prepare Diagram to show flows through SCM and Explain it.	10	CO1	3	1																		
Q1B	- Prepare list of at least 5 subsystems/components of an Electric Car. - 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	- Prepare the list of Barriers under “people category” to adopt the Digitization of Supply Chain. - Develop the strategy to overcome them in detail. - Show Steps to building a digital roadmap of Supply Chain	10	CO3	6	1,6																		
Q2B	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 \$10 million in revenues. All figures are in millions of dollars. <table><tr><th colspan="3">Multi Hospital System Revenues and Profits Data</th></tr><tr><th>Hospital</th><th>Revenue (x)</th><th>Profit (y)</th></tr><tr><td>1</td><td>7</td><td>0.15</td></tr><tr><td>2</td><td>2</td><td>0.10</td></tr><tr><td>3</td><td>6</td><td>0.13</td></tr><tr><td>4</td><td>4</td><td>0.15</td></tr></table>	Multi Hospital System Revenues and Profits Data			Hospital	Revenue (x)	Profit (y)	1	7	0.15	2	2	0.10	3	6	0.13	4	4	0.15	10	2	5	2
Multi Hospital System Revenues and Profits Data																							
Hospital	Revenue (x)	Profit (y)																					
1	7	0.15																					
2	2	0.10																					
3	6	0.13																					
4	4	0.15																					



Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

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



END SEM / RE-EXAMINATION - MAY 2025

END SEM / RE EXAMINATION																																																			
	5	14	0.25																																																
	6	15	0.27																																																
	7	16	0.24																																																
	8	12	0.20																																																
	9	14	0.27																																																
	10	20	0.44																																																
	11	15	0.34																																																
	12	7	0.17																																																
Q3A	What are the various techniques of Inventory Management? Prepare the ABC analysis of the following data . <table><tr><td>Item</td><td>Annual Units</td><td>Usage</td><td>Unit Cost (Rs)</td></tr><tr><td>a</td><td>30,000</td><td></td><td>0.01</td></tr><tr><td>b</td><td>2800</td><td></td><td>1.5</td></tr><tr><td>c</td><td>300</td><td></td><td>0.10</td></tr><tr><td>d</td><td>1100</td><td></td><td>0.05</td></tr><tr><td>e</td><td>400</td><td></td><td>0.05</td></tr><tr><td>f</td><td>2200</td><td></td><td>1.00</td></tr><tr><td>g</td><td>1500</td><td></td><td>0.05</td></tr><tr><td>h</td><td>8000</td><td></td><td>0.05</td></tr><tr><td>i</td><td>3000</td><td></td><td>0.30</td></tr><tr><td>j</td><td>800</td><td></td><td>0.10</td></tr></table>			Item	Annual Units	Usage	Unit Cost (Rs)	a	30,000		0.01	b	2800		1.5	c	300		0.10	d	1100		0.05	e	400		0.05	f	2200		1.00	g	1500		0.05	h	8000		0.05	i	3000		0.30	j	800		0.10	10	CO2	5	3
Item	Annual Units	Usage	Unit Cost (Rs)																																																
a	30,000		0.01																																																
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c	300		0.10																																																
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h	8000		0.05																																																
i	3000		0.30																																																
j	800		0.10																																																
Q3B	Draw the KPIV-KPOV based Green Supplier Development Process Model . Prepare Stagegate based Green Supplier Development Process Model.			10	CO2	5	3																																												
Q4A	Draw a schematic diagram to show Components of a Customer Order Cycle. Prepare a Table showing Strategic, Tactical, and Operational Decision Making. The table should include following columns Decision area of Supply Chain / Strategic/ Tactical / Operational.			10	CO1, CO3	4	4																																												
Q4B	- Prepare a Table to showcase comparison of modal capabilities of Transportation in SCM . The table should contain Mode of transportation / Strengths / Limitations /Primary role / primary product characteristics / Example Products - Explain it in detail.			10	CO2,CO3	5	5																																												

**END SEM / RE-EXAMINATION - MAY 2025**

Q5A	Explain the Term Numerical on Buffer Stock - Compute the following. • Avg Lead Time • Avg Demand Rate • Avg Lead Time Demand • Maximum Lead time Demand • Buffer Stock Based on the past records gives the following distribution for the lead time and daily demand during the lead time. <table><tr><th colspan="12">LEAD TIME DISTRIBUTION</th></tr><tr><td>Lead time in days</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr><tr><td>Frequency</td><td>0</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>4</td><td>3</td><td>2</td><td>2</td><td>1</td></tr></table> <table><tr><th colspan="10">DEMAND RATE DISTRIBUTION</th></tr><tr><td>Demand/day units</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Frequency</td><td>3</td><td>5</td><td>4</td><td>5</td><td>2</td><td>3</td><td>2</td><td>1</td></tr></table>	LEAD TIME DISTRIBUTION												Lead time in days	0	1	2	3	4	5	6	7	8	9	10	Frequency	0	0	1	2	3	4	4	3	2	2	1	DEMAND RATE DISTRIBUTION										Demand/day units	0	1	2	3	4	5	6	7	Frequency	3	5	4	5	2	3	2	1	10	CO1 CO2, CO3		3,4, 6
LEAD TIME DISTRIBUTION																																																																					
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Frequency	3	5	4	5	2	3	2	1																																																													
Q5B	Prepare the following detailed table and explain it. Name of industry4.0 technology / Potentials / Limitations / Application in SCM	10	CO1,CO2	5	2,3, 6																																																																
Q6A	Numerical on Transportation Model - A Oxygen production company has Five production plants P1,P2,P3,P4,P5 with production capacity as shown in table in (100') units per day of a product respectively. • These units are expected to be shipped to 5 cities D1,D2,D3,D4,D5, D6 with requirements as shown in table in (100') units per day respectively. • The transportation cost in Rs per unit between factories and cities are given in table. • Use NWCM to find initial basic solution to the transportation problem.	10	CO1, CO2, CO3	5	5																																																																

**END SEM / RE-EXAMINATION - MAY 2025**

- Use LCM to find initial basic solution to the transportation problem. Find percentage reduction in transportation cost.

Production facility Pi/ City demand Di	D1	D2	D3	D4	D5	D6	Supply Capacity
P1	19	24	15	28	19	26	17
P2	13	17	19	13	13	21	13
P3	21	14	24	17	15	25	22
P4	16	23	14	16	17	18	28
P5	22	18	21	19	29	31	15
Oxygen Demand	24	13	17	16	12	13	95

Q6B

Develop the vendor rating system of Supply Chain of your choice. What are the features of SCOR model of SCM?

10

CO1,
CO4,
CO3

5

3, 7

Q7A

The manager of a Flower shop promises its delivery within four hrs on all orders. All flowers are purchased on previous day and delivered to parker by 8.00 am the next day. The daily demand of roses is as follows.

Dozens of Roses	70	80	90	100
Probabilities	0.1	0.2	0.4	0.3

The manager purchases roses for Rs 10 per dozen and sell them for Rs 30 per dozen. All unsold roses are donated to local hospital. How many dozen of roses should be ordered each evening to maximize the profit? What is the expected profit?

10

CO1,
CO2,
CO3

5

3,6,
7

Q7B

State and Explain the barriers in adoption of digitization in Supply Chain Management. Explain IOT based Framework to be implemented in Supply Chain

10

CO1,
CO2,
CO3

5

6



Program: B. Tech Mechanical

Course Code: PE BTM756

Course Name: Renewable Energy Sources and Utilization

Duration: 3 Hour

Maximum Points: 100

Semester: VIII

14/5/25

Notes:

- 1) Question number ONE is compulsory and solve any FOUR out of remaining SIX questions.
 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 the electricity production of India and compare how much the consumption per person is in India as compared to the world's per-person consumption.	20	1,2,4	1,2	1,2,6,7
1(b)	What is geothermal energy? Explain it in short.				
1(c)	Draw a neat sketch of the Deenbandhu model bio-gas plant.				
1(d)	Discuss the effect of tilt angle solar liquid flat plate collector.				
2(a)	Explain the method of manufacturing single crystal silicon solar cell with neat sketch.	10	1	1,2	3
2(b)	A photovoltaic cell has an open circuit voltage of 0.6 V and a short circuit current of 250 A/m^2 at a cell temperature of 40°C . Calculate the voltage and current density that maximizes the power of the cell. What would be the corresponding maximum power output per unit cell area? Given that charge of an electron, $e = 1.602 \times 10^{-19} \text{ J/V}$ and Boltzmann constant, $k = 1.381 \times 10^{-23} \text{ J/K}$	10	2	3	3
3(a)	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 ($L_1 \times L_2$) : $2.9 \text{ m} \times 1.9 \text{ m}$ Spacing between plate and the first glass cover (L) : 4 cm	12	2	3,4	2

**End Semester Examination May-2025**

	Spacing between first and the second glass cover (L) : 4 cm Plate emissivity (ϵ_p) : 0.92 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_i) : 0.05 W/m-K Note: Use correlations and properties of air given on subsequent pages.				
3(b)	Explain with neat sketch the production of biogas by Khadi Village Industrial Corporation (KVIC) model.	08	1	1	7
4(a)	Classify the water turbines. Write in detail about the Kaplan propeller turbine and the Francis propeller turbine with a neat sketch of each.	10	3	1,2	5
4(b)	Calculate the efficiency of a closed-cycle OTEC system using ammonia as the working fluid and installed at a location where the warm and cold sea water streams are at temperatures of 29°C and 8°C , respectively. Make an allowance of about 5°C for the temperature difference required in the evaporator and condenser for transferring heat, and assume that the ammonia is evaporating at 24°C and condensing at 13°C . Take the isentropic efficiencies of the turbine and pump to be 90 and 80 per cent, respectively.	10	3	3,4	5
5(a)	Explain how geothermal energy is renewable energy. Also, explain the closed cycle and open cycle house heating systems with the available geothermal aquifer.	10	4	2	6
5(b)	Draw a neat schematic diagram of a downdraft gasifier and explain the biomass gasification process in detail.	10	4	1,2	7
6(a)	Calculate the actual energy available for the wind machine for which the cut-in speed is 14 kmph, the design speed is 30 kmph, and the cut-out speed is 90 kmph for the following location.	10	2	1,2	3

**End Semester Examination May-2025**

	Location: Kandla Port Month: December Take ρ for air = 1.20 kg/m^3. <table><tr><th>Interval</th><th>Dec</th><th>Interval</th><th>Dec</th><th>Interval</th><th>Dec</th><th>Interval</th><th>Dec</th></tr><tr><td>00</td><td>2.2</td><td>10-12</td><td>7.5</td><td>22-24</td><td>7.8</td><td>34-36</td><td>0.4</td></tr><tr><td>00-02</td><td>2.4</td><td>12-14</td><td>8.4</td><td>24-26</td><td>5.4</td><td>36-38</td><td>0.1</td></tr><tr><td>02-04</td><td>2.7</td><td>14-16</td><td>10.3</td><td>26-28</td><td>3.2</td><td></td><td></td></tr><tr><td>04-06</td><td>3.0</td><td>16-18</td><td>11.2</td><td>28-30</td><td>2.5</td><td></td><td></td></tr><tr><td>06-08</td><td>4.4</td><td>18-20</td><td>11.5</td><td>30-32</td><td>1.2</td><td></td><td></td></tr><tr><td>08-10</td><td>6.5</td><td>20-22</td><td>9.0</td><td>32-34</td><td>0.3</td><td></td><td></td></tr></table>	Interval	Dec	Interval	Dec	Interval	Dec	Interval	Dec	00	2.2	10-12	7.5	22-24	7.8	34-36	0.4	00-02	2.4	12-14	8.4	24-26	5.4	36-38	0.1	02-04	2.7	14-16	10.3	26-28	3.2			04-06	3.0	16-18	11.2	28-30	2.5			06-08	4.4	18-20	11.5	30-32	1.2			08-10	6.5	20-22	9.0	32-34	0.3						
Interval	Dec	Interval	Dec	Interval	Dec	Interval	Dec																																																						
00	2.2	10-12	7.5	22-24	7.8	34-36	0.4																																																						
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02-04	2.7	14-16	10.3	26-28	3.2																																																								
04-06	3.0	16-18	11.2	28-30	2.5																																																								
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08-10	6.5	20-22	9.0	32-34	0.3																																																								
6(b)	Explain the manufacturing process of Copper Indium Gallium Diselenide (CIGS) thin film multi-crystalline solar cell with neat sketch.	10	2	1,2	3																																																								
7(a)	Explain the method of Bio-ethanol and Bio-diesel production in detail.	10	3	3	7																																																								
7(b)	An engine-generator system running on biogas is installed to produce 2 kW of electric power. Estimate the volume of the digester of the biogas plant required, if cow dung is used as the feed material. Take: Calorific value of biogas : $20,000 \text{ kJ/m}^3$ Efficiency of generator : 90.1 per cent Engine efficiency : 30 per cent	10	1	3	4																																																								

**End Semester Examination May-2025****Data Sheet and Properties of Air****1. Relationship between Nusselt and Rayleigh numbers.**

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

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

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

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

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

Table A.4.2 Properties of dry air at atmospheric pressure

T °C	ρ kg/m ³	C_p kJ/kg·K	$\mu \times 10^6$ N·s/m ²	k W/m·K	Pr	$\nu \times 10^6$ m ² /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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Program: B. Tech. Mechanical *sem VIII*
Course Code: PEC-BTM 754
Course Name: Power Plant Engineering

Duration: 3 Hours
Maximum Points: 100
Semester: VIII

Notes:

- 1) Solve: Any FIVE Questions.
- 2) Answers must be **SPECIFIC** and in **legible** handwriting.
- 3) Draw neat, labelled system and process diagrams wherever asked or necessary.
- 4) Illustrate your answers with suitable examples wherever asked or necessary.
- 5) Use separate Graph papers for drawing load curve and load duration curve in Q.1.
- 6) Use separate Graph papers for drawing Hydrograph and Flow duration curve in Q.2.
- 7) Assume suitable data wherever necessary and state the same.

Q. No.	Question	Points	CO	BL	Module												
1.	a) Explain with significance: i) Load factor ii) Capacity factor iii) Reserve factor iv) Use factor for a power plant. b) A power station supplies load for 24 hours as shown in the table below. <table border="1"> <tr> <td>Time (Hours)</td><td>0-6</td><td>6-12</td><td>12-14</td><td>14-18</td><td>18-24</td></tr> <tr> <td>Load (MW)</td><td>45</td><td>135</td><td>90</td><td>150</td><td>75</td></tr> </table> Construct: i) Load curve and ii) load duration curve for the above data. Evaluate: i) Load factor and ii) Capacity factor.	Time (Hours)	0-6	6-12	12-14	14-18	18-24	Load (MW)	45	135	90	150	75	8 12	1 1 4	II V, VI	1 1
Time (Hours)	0-6	6-12	12-14	14-18	18-24												
Load (MW)	45	135	90	150	75												
2.	a) Explain with significance: i) Run-off ii) Hydrograph iii) Flow duration curve and iv) Mass curve b) The run-off data of a river at a particular site for a hydroelectric power plant at a site for 12 months is given in table. The water head available is 80 m, turbine efficiency = 90% and generator efficiency = 95%. Construct: i) Hydrograph and ii) Flow duration curve for the given data.	8 12	2 2 4	II V, VI	2 2												



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RE-EXAMINATION, TERM-II, A.Y. 2024-25

Month	Discharge Q (million m ³)	Month	Discharge Q (million m ³)
January	40	July	75
February	25	August	100
March	20	September	110
April	10	October	60
May	0	November	50
June	50	December	40

Evaluate: i) Capacity of the reservoir required, iii) Power available for distribution to customer. **Recommend:** Suitable hydraulic turbine. **Assume:** each month of 30 days.

3.	a) Explain: Principle of working of Fluidized Bed Combustion (FBC) system. Draw: Neat sketch of basic FBC system. b) State: Modifications in the simple gas turbine plant for improving the efficiency. In a gas turbine power plant, the compressor with a pressure ratio 4 and isentropic efficiency 82%, takes in the air at 15°C. The air is then passed through a regenerator with 78% effectiveness. The maximum temperature after the constant pressure combustion is 600°C. Turbine efficiency is 70%. Neglecting all other losses except those stated and assuming air as the work fluid in the cycle, Evaluate: Thermal efficiency of cycle. Draw: Neat system diagram and T-s diagram. Assume: Specific heat capacity and adiabatic constant for air as $c_{pa} = 1.005 \text{ kJ/kg. K}$ and $\gamma_a = 1.4$ respectively.	8	2	II, III	3
4.	a) Describe: Essential elements of a nuclear reactor with their functions and features. Draw: Neat system diagram. b) Explain: Working of CANDU reactor, its advantages and disadvantages. Draw: Neat system diagram.	10	2	I, III, VI	5
5.	a) Explain: Working of simple Closed Cycle Gas Turbine Plant (CCGT). Draw: A neat system diagram and T-s diagram. Compare: Advantages and disadvantages of OCGT and CCGT plants.	10	2	II, III, IV	4
		8	2	II, III, IV	5



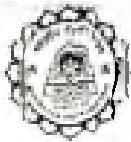
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	b) Explain: i) Work ratio and ii) Air rate for a gas turbine plant. The following data refers to a gas turbine plant using a reheater between the two turbines. Power developed = 5 MW, Inlet pressure and temperature to the compressor = 1 bar, 30°C, Pressure ratio = 5, Isentropic efficiency of compressor = 80%, Isentropic efficiency of each turbine = 85%, Intermediate pressure for reheating = 2.24 bar, specific heat capacity for air and gas are $c_{pa} = 1$ kJ/kg. K and $c_{pg} = 1.15$ kJ/kg. K respectively, the adiabatic constant for air and gases are $\gamma_a = 1.4$ and $\gamma_g = 1.33$ respectively. Evaluate: i) Mass flow rate of air and ii) Thermal efficiency of the cycle. Neglect: The mass of fuel. Draw: Neat system diagram and T-s diagram.	12	2, 4	II, III, VI	5																		
6.	a) Describe: Simple Gas Turbine cycle combined with Single Pressure Steam Turbine cycle (SGT1ST). Draw: Neat system diagram and T-s Diagram. b) Compare: Favorable and adverse features of hydroelectric plant and steam power plant for its use as a base load and peak load plant. It is proposed to supply a maximum demand of 500 MW with load factor of 70%. Choice is to be made between a hydroelectric and steam power plant. Evaluate: The overall cost per kWh of energy generated for each plant from scheme of cost elements shown in the table. Assume the maximum demand equal to the plant capacity. State: Choice of power plant and Justify: your recommendation. <table><tr><th>Element of cost</th><th>Steam power plant</th><th>Hydroelectric power plant</th></tr><tr><td>Capital cost per MW installed</td><td>Rs. 3 Crore</td><td>Rs. 4 Crore</td></tr><tr><td>Interest on capital</td><td>6 %</td><td>5 %</td></tr><tr><td>Depreciation</td><td>6 %</td><td>4 %</td></tr><tr><td>Operating cost per kWh(including fuel)</td><td>Rs. 0.30</td><td>Rs. 0.05</td></tr><tr><td>Transmission and distribution cost per kWh</td><td>Rs. 0.02</td><td>Rs. 0.03</td></tr></table>	Element of cost	Steam power plant	Hydroelectric power plant	Capital cost per MW installed	Rs. 3 Crore	Rs. 4 Crore	Interest on capital	6 %	5 %	Depreciation	6 %	4 %	Operating cost per kWh(including fuel)	Rs. 0.30	Rs. 0.05	Transmission and distribution cost per kWh	Rs. 0.02	Rs. 0.03	8	2	I, II	6
Element of cost	Steam power plant	Hydroelectric power plant																					
Capital cost per MW installed	Rs. 3 Crore	Rs. 4 Crore																					
Interest on capital	6 %	5 %																					
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Transmission and distribution cost per kWh	Rs. 0.02	Rs. 0.03																					
		12	1, 2, 4	IV, V	1,6																		



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7.	a) Explain: Nuclear waste from a nuclear power plant. Discuss: its Environmental impact in terms of hazards.	6	3	II, III	4,7
	b) Explain: Methods of disposal of various nuclear wastes. Draw: Neat sketches of systems involved.	6			
	c) State: Various methods of controlling SO ₂ emission from thermal power plants. Explain: Working of a wet scrubber for the same. Draw: Neat schematic diagram of the system.	8	3	I, II, III	7