



SARDAR PATEL COLLEGE OF ENGINEERING

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



END SEM/RE-EXAM EXAMINATION MAY/ JULY 2026

Program: Final Year B.Tech (M/E) *Sem VIII*

Duration: 03 Hrs.

Course Code: OE-BTM712

Maximum Points: 100

Course Name: Introduction to Research Methodology

Semester: VIII

Notes:

1. Attempt any FIVE questions.
2. Each question carries equal marks.
3. Answers to all sub questions must be grouped together.
4. Assume suitable data wherever necessary and justify the same.
5. Use of Statistical Charts are permitted.

Q.No.	Questions	Points	CO	BL	Module No.
1	a) A mechanical engineer collects vibration data from 150 industrial machines using condition monitoring sensors and applies statistical analysis to evaluate the average machine health and failure trends. Identify the appropriate research approach.	10			
	b) A civil engineering student is carrying out a project on reducing structural vibrations in high-rise buildings using an innovative damping system. Explain why this study can be classified as technical research and discuss the major components that must be included in the research work.	10	1,2	3	1
2	a) A smart manufacturing industry has appointed graduate trainees from mechanical, electrical, and industrial engineering streams to work on automated production and maintenance systems. The organization intends to create a comprehensive training module to improve technical expertise, teamwork, and operational management capabilities. • Formulate a suitable research problem for the above case. • State the research objectives necessary for developing an effective industrial training program.	10			
	b) A final-year student selects a research topic solely because simulation software is easily available. Critically comment on the suitability of such selection criteria.	10	1,2	2,3	2
3	a) A team of researchers intends to carry out a review of published studies on energy-efficient thermal management systems used in electric vehicles. What factors and selection criteria should be considered to ensure that the literature review includes reliable, high-quality, and technically relevant research articles?	10			
	b) Before designing an automated fault detection system for industrial machines, a researcher must study earlier research related to condition monitoring, sensors, and machine learning techniques. Explain the systematic steps involved in conducting the literature review for this research work.	10	1,2	3	3



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4	a) A researcher must choose suitable data collection methods for the following research situations. For each scenario, identify the most appropriate data collection method and briefly justify your choice. (i) A retail company wants to study how customers move through a supermarket, which shelves attract the most attention, and how long shoppers spend in different sections before making purchases. (ii) A psychologist wants to uncover hidden motivations behind why consumers prefer certain luxury brands, even when they may not openly express those reasons. (iii) A government agency wants to collect information on income, education, and family size from people living in remote villages where literacy rates are low. (iv) A researcher wants to conduct an in-depth investigation of how one startup transformed from near bankruptcy into a successful global company, studying its history, decisions, and leadership. (v) A media company wants to monitor how the television viewing preferences of a group of households change over a year after introducing a new streaming platform. b) Critically examine the following statements: (i) Observation method often provides more realistic data than interviews, but may suffer from limitations in interpretation. (ii) The case study method generates rich and detailed information, yet its findings may not always be generalised. (iii) In collecting statistical data, scientific technique is essential, but sound judgment and practical experience are equally important.	10																																																
		10	2.3	3	4																																													
5	a) Assuming a linear relationship exists between distance travelled and fuel cost, fit an appropriate regression model using the method of least squares and determine all regression coefficients. Interpret the coefficients in practical terms. Also, estimate the expected fuel cost when a vehicle travels 280 km in a day. <table><tr><th>Day</th><th>Machine Hours</th><th>Skilled Workers</th><th>Quality Rating</th><th>Output</th></tr><tr><td>1</td><td>6</td><td>4</td><td>7</td><td>82</td></tr><tr><td>2</td><td>8</td><td>5</td><td>8</td><td>97</td></tr><tr><td>3</td><td>7</td><td>6</td><td>7</td><td>95</td></tr><tr><td>4</td><td>9</td><td>5</td><td>9</td><td>108</td></tr><tr><td>5</td><td>5</td><td>4</td><td>6</td><td>74</td></tr><tr><td>6</td><td>10</td><td>7</td><td>8</td><td>121</td></tr><tr><td>7</td><td>6</td><td>5</td><td>7</td><td>88</td></tr><tr><td>8</td><td>8</td><td>6</td><td>9</td><td>105</td></tr></table>	Day	Machine Hours	Skilled Workers	Quality Rating	Output	1	6	4	7	82	2	8	5	8	97	3	7	6	7	95	4	9	5	9	108	5	5	4	6	74	6	10	7	8	121	7	6	5	7	88	8	8	6	9	105	10			
Day	Machine Hours	Skilled Workers	Quality Rating	Output																																														
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		9	7	5	8	94				
		10	9	7	9	118				
		Assuming that daily output is linearly related to these three factors through a multiple regression model, determine all regression coefficients using the method of least squares and obtain the fitted regression equation. Interpret the meaning of the estimated coefficients in the context of the problem. b) After data have been collected and processed, a researcher must analyze them to draw meaningful conclusions. Different types of analysis are used depending on the nature of the study and the objectives of the research. Explain the major types of data analysis used in research, including descriptive, inferential, diagnostic, and predictive analyses. Discuss the purpose and significance of each type and illustrate how they help researchers interpret data and support decision-making. Also, comment on the situations in which each type of analysis may be most appropriate.					10			
6		a) A precision engineering firm is comparing the consistency of two CNC machines used to manufacture high-tolerance shafts. While both machines have similar average dimensions, management is concerned about variability, since lower variation means greater precision and less rejection. Two random samples of shaft diameter deviations (in microns) were collected from the two machines: Machine A: 8, 11, 10, 12, 9, 13, 10, 11 Machine B: 7, 5, 8, 6, 9, 5, 7, 6 Using a 2% level of significance, test whether the variability of the two machines differs significantly. Perform the test, interpret the result, and state what conclusion management should draw regarding machine consistency and process capability. b) A research team is investigating the relationship between remote work, employee productivity, and psychological well-being in technology firms. During proposal discussions, five researchers made the following statements about what constitutes a good hypothesis: "A hypothesis should be broad enough to cover every possible explanation." "A good hypothesis must be capable of empirical verification." "A hypothesis should be simple, specific, and logically consistent with known facts." "A useful hypothesis should be testable and capable of falsification." "A hypothesis is valuable even if it cannot be measured"					10	2,3	4	6



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END SEMESTER EXAMINATION MAY 2026 / RE - EXAM JULY 2026

Program: Mechanical Engineering

Duration: 03 Hr

Course Code: OE-BTM715

Maximum Points: 100

Course Name: Solar and wind technology

Semester: 8

Q.No.	Questions	Points	CO	BL	Module No.
1a	Write a short note on the basic components of a wind energy conversion system with a neat sketch.	10	1	1	5
1b	Write a short note on vertical-axis wind turbine. State any two applications of the turbine and explain them briefly.	10	1	1	6
2a	Briefly discuss the following: 1) Number of blades of wind turbine 2) Yaw control and pitch control 3) Wind speed variation	10	1	1	6
2b	State the site selection criteria for wind mills. Define torque coefficient, power coefficient and tip speed ratio, and write their relation.	10	1	2	7
3a	Explain the working principle of a P-N type solar cell with a neat sketch. Discuss the fill factor of a solar cell. A solar multimeter records open circuit voltage = 0.2 V, maximum voltage = 0.125 V, short circuit current = 5.5 mA and maximum current = 3 mA. Determine the fill factor.	10	1	2	3
3b	Write a short note on pyranometer and pyrhelimeter with suitable sketches.	10	1	1	3
4a	(a) Calculate the angle between beam radiation and the normal to a flat-plate collector on May 1 at 0900 h (local apparent time). The collector is located in New Delhi (28°35' N, 77°12' E), tilted at 36° to the horizontal and facing due south. (b) Repeat the calculation for 1200 h (local apparent time).	10	1	2	4
4b	Derive the expression for the angle of incidence of solar radiation on an inclined plate with respect to the earth surface using a sketch. Define monthly average daily global radiation and state its significance.	10	2	1	4



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5a	Derive the expression for Betz coefficient (CP) for a horizontal-axis wind mill and state its significance.	10	2	3	5
5b	Explain the construction of a solar PV module with a sketch. State the construction parameters that directly affect module performance.	10	1	1	2
6a	Explain the mechanisms of absorption and scattering. List all radiation components reaching the earth surface with a neat sketch.	10	1	1	1
6b	A PV system powers a DC motor delivering 2 hp shaft power. The motor efficiency is 85%. Each module has 36 Si solar cells arranged in a 9×4 matrix. Each cell size is $125 \text{ mm} \times 125 \text{ mm}$ and cell efficiency is 12%. Determine the number of PV modules required. Assume average global radiation normally incident on the panels is 900 W/m^2 .	10	2	3	2
7a	Define air mass index and state its significance with a sketch. For Mumbai ($19^\circ 07' \text{ N}$, $72^\circ 51' \text{ E}$), calculate the sunrise and sunset hour angles on June 21 and December 21 for a due south ($\gamma = 0^\circ$) surface inclined at 10° .	10	2	1	1
7b	Derive the expressions for forces acting on turbine blades for: a) general case b) ideal case	10	2	1	7

Notes:



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END SEMESTER EXAMINATION MAY 2026 / RE - EXAM JULY 2026

Program: Mechanical Engineering

Course Code: OE-BTM719

Course Name: Value Engineering

Duration: 03 Hours.

Maximum Points: 100

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.

Q. No.	Questions	Points	CO	BL	Module No.																								
1A	A factory plans to install an automated conveyor system. Three alternatives are available: <table><tr><th>Parameter</th><th>Alt A</th><th>Alt B</th><th>Alt C</th></tr><tr><td>Initial Cost (₹)</td><td>15,00,000</td><td>18,00,000</td><td>20,00,000</td></tr><tr><td>Annual Savings (₹)</td><td>4,00,000</td><td>5,00,000</td><td>5,50,000</td></tr><tr><td>Implementation Risk</td><td>Medium</td><td>Low</td><td>High</td></tr><tr><td>Failure Probability</td><td>0.20</td><td>0.10</td><td>0.30</td></tr><tr><td>Failure Cost (₹)</td><td>3,00,000</td><td>2,00,000</td><td>5,00,000</td></tr></table> Task: 1. Calculate Expected Risk Cost = Probability × Failure Cost 2. Adjust annual savings considering risk 3. Compare alternatives based on net benefit	Parameter	Alt A	Alt B	Alt C	Initial Cost (₹)	15,00,000	18,00,000	20,00,000	Annual Savings (₹)	4,00,000	5,00,000	5,50,000	Implementation Risk	Medium	Low	High	Failure Probability	0.20	0.10	0.30	Failure Cost (₹)	3,00,000	2,00,000	5,00,000	10	3,2	4	5
Parameter	Alt A	Alt B	Alt C																										
Initial Cost (₹)	15,00,000	18,00,000	20,00,000																										
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	Select best alternative and justify considering both cost and risk.				
1B	Analyze the characteristics of an effective VE team and evaluate how each characteristic contributes to successful implementation of value engineering proposals.	10	1,2,4	3,4	4
2A	Apply the Value Equation to explain how value can be improved in Value Engineering. Describe any four acceptable strategies for improving value with suitable examples. Also explain why reducing both function and cost is not considered an acceptable strategy in Value Engineering.	10	2,3	4,5	1
2B	Consider any suitable engineering product or system. Construct a simple morphological matrix by identifying minimum three design parameters and listing three possible alternatives for each parameter. Analyze the alternatives based on cost, function, and suitability. Select one optimal combination from the matrix and justify why it is the most appropriate design solution.	10	4	3,4	4
3A	Analyze the decision of an institute planning to install an energy-efficient LED lighting system in its workshop and classrooms. The system requires a higher initial investment compared to conventional lighting, but it reduces electricity consumption and maintenance cost over time. Explain the concept of Life Cycle Costing and discuss its importance in Value Engineering decisions. Apply the Payback Period method to evaluate the investment, considering an initial cost of ₹8 lakh and annual savings of ₹1.6 lakh. Also analyze how Use Value and Cost Value influence the decision to adopt the energy-efficient lighting system.	10	2,4	4	1
3B	Consider an automatic fire sprinkler system used in a building to detect fire and discharge water for fire control. Perform a FAST analysis for the system by identifying the higher-order function representing the customer objective, defining the basic function using the Verb-Noun rule, identifying at least five secondary functions required to achieve the basic function, and constructing a properly labelled FAST diagram using HOW-WHY logic to show the functional hierarchy. Also clearly indicate the left and right scope lines in the FAST diagram	10	3,2	4,5	3
4A	An industrial valve system has the following FCW data.	10	3,4	4	3



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Function	Type	Cost (₹)	Worth (₹)
Control Flow	B	1600	1500
Seal Fluid	S	900	350
Reduce Leakage	S	600	300
Protect Surface	S	400	250

Tasks:

- Calculate the Value Index (Worth / Cost) for each function.
- Based on the calculated value, determine the priority level for Value Engineering improvement using the following guideline:
 - Value ≥ 0.90 → Low priority
 - $0.70 \leq \text{Value} < 0.90$ → Medium priority
 - Value < 0.70 → High priority
- Identify the functions where Value Engineering improvement is required and provide appropriate remarks.

Determine the total value gap (Cost - Worth) of the system and explain what it indicates regarding cost reduction opportunities.

4B	A hospital with 400 beds is facing delay in patient discharge due to multiple process steps. The revenue loss is ₹3000 per bed per day. The discharge process before improvement includes doctor order 15 minutes, nurse summary 50 minutes, billing 70 minutes, pharmacy 45 minutes, waiting time 80 minutes, and final process 25 minutes. After Value Engineering improvement, nurse summary is reduced to 15 minutes, billing to 25 minutes, pharmacy to 20 minutes, and waiting time to 15 minutes, while doctor order and final process remain unchanged. Analyze the discharge process by calculating the total discharge time before and after improvement, time saved per patient, additional bed availability per day, and possible annual revenue gain. Evaluate how process simplification and time reduction improve service value and operational efficiency in the hospital.	10	2,3	4	7
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5A	Analyze an engineering component such as a mechanical coupling, electrical transformer, or reinforced concrete beam, based on your engineering branch. Apply the Two Word Rule to define its basic function in verb noun format. Identify any two secondary functions of the selected component. Also analyze why correct function definition is important before generating alternative design solutions in Value Engineering.	10	1,2	2,3	2												
5B	A water pumping station operates three pumps of 60 kW each for 14 hours per day. The electricity cost is ₹9/kWh, current pump efficiency is 62%, design efficiency is 82%, annual maintenance cost is ₹65 lakh, motor burnout cost is ₹10 lakh per year, and annual energy cost contributes 50% of the total annual cost of ₹2.8 crore. Analyze the system from a Value Engineering perspective by calculating the annual energy consumption, annual energy cost, energy loss due to inefficiency, and unnecessary cost due to the efficiency gap. Suggest any two suitable Value Engineering solutions such as VFD installation, pump replacement, preventive maintenance, or motor upgrade, and evaluate their expected impact on cost saving and system performance.	10	2,4	3,4	7												
6A	Two pump systems are available: <table><tr><th>Option</th><th>Initial Cost (₹)</th><th>Annual O&M (₹)</th><th>Life (years)</th></tr><tr><td>A</td><td>5,00,000</td><td>1,20,000</td><td>5</td></tr><tr><td>B</td><td>7,00,000</td><td>60,000</td><td>5</td></tr></table> Task: • Apply LCC calculation • Compare both alternatives • Analyze why a higher initial cost option may be preferable • Relate your conclusion to value engineering principles	Option	Initial Cost (₹)	Annual O&M (₹)	Life (years)	A	5,00,000	1,20,000	5	B	7,00,000	60,000	5	10	2,4	4	5
Option	Initial Cost (₹)	Annual O&M (₹)	Life (years)														
A	5,00,000	1,20,000	5														
B	7,00,000	60,000	5														



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6B	Evaluate an engineering project by generating at least five innovative ideas for value improvement, such as design modification, material substitution, process improvement, energy efficiency enhancement, or simplification of components. Compare these ideas based on cost, feasibility, performance, and ease of implementation, and justify the most suitable alternative for improving the value of the project.	10	2,4	3	6
7A	Consider any suitable engineering product or application. Distinguish between Work Functions and Sell Functions in Value Engineering. Explain their importance in engineering product analysis and discuss how both functions influence product performance, customer acceptance, and design improvement decisions.	10	2	4,5	2
7B	Consider your final year project or internship project and perform Value Engineering analysis of the same. Describe the project objective, problem statement, expected outcomes, and primary function. Break the project into major components or subsystems, define the function of each component using the verb-noun rule, classify the functions into basic and secondary functions, and construct a suitable FAST diagram showing the functional relationship among the components. Also analyze how this functional analysis helps in improving the value of the project.	10	2,3, 4	4	6