ADDITIONAL CONTROLLER OF EXAMINATIONS
AU
CHENNAI
600 025

Roll No.

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B.Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, NOV / DEC 2024

MECHANICAL ENGINEERING
VII
ME5010 – Energy Conservation in Industries
(Regulation2019)

Time:**3hrs** Max.Marks: **100**

CO1	Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
CO2	Analyze factors behind energy billing and apply the concept of demand side management for lowering energy costs
CO3	Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
CO4	Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
CO5	Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A (10x2=20Marks)

(Answer all Questions)

Q.No.	Questions	Marks	CO	BL
1	Write a short note on energy balancing in industries	**2**	1	2
2	Why energy conservation should be given high priority	**2**	1	2
3	Write a short note on the electricity tariff structure for domestic consumers as followed by TNEB.	**2**	2	2
4	Define power factor and its role on electricity tariff structure	**2**	2	2
5	What are the losses associated with incomplete combustion	**2**	3	2
6	What are the commonly used waste heat systems in industries for energy efficiency	**2**	3	1
7	How variable frequency drive motor helps in energy conservation	**2**	4	2
8	List any four general energy saving opportunities in lighting system	**2**	4	1
9	What is the purpose of energy labeling in appliances, and how does it help in energy conservation?	**2**	5	2
10	What are the differences between discounting and non-discounting techniques in energy economics? Provide one example of each.	**2**	5	2

PART- B (5x 13=65Marks)

Q.No.	Questions	Marks	CO	BL
11 (a)	What are the typical instruments, devices, or sensors used by energy auditors? Provide an explanation for each.	**13**	**1**	**1**
	OR			
11 (b)	Explain in detail the steps involved in energy auditing	**13**	**1**	**1**

<table>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>12 (a)</td><td>Discuss in detail the energy conservation measures in transformers</td><td>13</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>12 (b)</td><td>Calculate the capacitor size for an inductive load of 50 kW with a power factor of 0.78 for achieving a target power factor of 0.96 Calculate the efficiency of transfer for following loading conditions. Take the rated capacity of transformer to be 500 kVA. Assume no load loss (iron loss) = 3.5 kW and Full Load Loss = 4.5 kW
<table>
<tr><th>No. of operating hours</th><th>Load (kW)</th><th>Power Factor</th></tr>
<tr><td>6</td><td>400</td><td>0 .8</td></tr>
<tr><td>10</td><td>300</td><td>0 .75</td></tr>
<tr><td>4</td><td>100</td><td>0 .8</td></tr>
<tr><td>4</td><td>0</td><td>0</td></tr>
</table></td><td>13</td><td>2</td><td>2</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>13 (a)</td><td>List the performance enhancement measurement measures in industrial furnaces with the help of a fish bone diagram</td><td>13</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>13 (b)</td><td>Calculate the economic insulation thickness for the following data
<table>
<tr><th>Description</th><th>Unit</th><th>1"</th><th>2"</th><th>3"</th></tr>
<tr><td>Length of pipe, L</td><td>m</td><td>50</td><td>50</td><td>50</td></tr>
<tr><td>Bare Pipe outer diameter, d1</td><td>mm</td><td>168</td><td>168</td><td>168</td></tr>
<tr><td>Bare pipe surface area, A</td><td>m²</td><td>26.38</td><td>26.38</td><td>26.38</td></tr>
<tr><td>Ambient Temperature, Ta</td><td>°C</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>Bare Pipe Wall Temperature, Th</td><td>°C</td><td>160</td><td>160</td><td>160</td></tr>
<tr><td>Desired Wall Temperature With Insulation, Tc</td><td>°C</td><td>62</td><td>48</td><td>43</td></tr>
<tr><td>Material of Insulation</td><td colspan="4">Mineral Wool</td></tr>
<tr><td>Mean Temperature of Insulation, Tm = (Th + Tc)/2</td><td>°C</td><td>111</td><td>104</td><td>101.5</td></tr>
<tr><td>Sp. Conductivity of Insulation Material, k</td><td>W/m°C</td><td>0.044</td><td>0.042</td><td>0.04</td></tr>
<tr><td>Surface Emissivity of bare pipe</td><td>-</td><td>0.95</td><td>0.95</td><td>0.95</td></tr>
</table></td><td>13</td><td>3</td><td>2</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>14 (a)</td><td>Briefly discuss the factors affecting energy efficiency of electrical motors and methods for minimizing motor losses in operation</td><td>13</td><td>4</td><td>2</td></tr>
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<table>
<tr><td colspan="5">OR</td></tr>
<tr><td>14 (b)</td><td>List the factors that affect the performance and energy efficiency of refrigeration plants, and briefly explain any three of these factors</td><td>13</td><td>4</td><td>2</td></tr>
<tr><td>15 (a)</td><td>Explain the concept of Monitoring & Targeting in energy management. Discuss its key elements and describe how the CUSUM technique can be applied to identify energy savings opportunities in an industrial setup.</td><td>13</td><td>5</td><td>2</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>15 (b)</td><td>A company is considering purchasing a new energy-efficient machine to replace an older, less efficient model. The details of the two machines are as follows:
<table>
<tr><th>Details</th><th>Existing Machine</th><th>New Machine</th></tr>
<tr><td>Initial Cost (₹)</td><td>1,00,000</td><td>2,50,000</td></tr>
<tr><td>Annual Operating Cost (₹)</td><td>40,000</td><td>15,000</td></tr>
<tr><td>Life Span (years)</td><td>5</td><td>10</td></tr>
<tr><td>Salvage Value (₹)</td><td>10,000</td><td>20,000</td></tr>
<tr><td>Discount Rate (%)</td><td>10</td><td>10</td></tr>
</table>
i. Calculate the Life Cycle Cost (LCC) for both machines using the discounting technique.
ii. Based on the results, analyze which machine is more cost-effective over its life span and justify your answer.</td><td>13</td><td>5</td><td>2</td></tr>
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PART- C (1x 15=15Marks)

(Q.No.16 is compulsory)

Q.No.	Questions	Marks	CO	BL
16.	Calculate the boiler efficiency for the following data • Boiler reference: 20 TPH • Steam pressure: 66 kg/cm^2 **Flue gas:** • O_2 in flue gas = 9 % • CO in flue gas = 800 ppm • CO_2 in flue gas = 10.67% • Average flue gas temperature = 180°C • Atmospheric air: • Ambient temperature = 29.3°C • Humidity in ambient air = 0.01977 kg / kg dry air **Fuel analysis:** • Carbon = 53.65 % • Hydrogen = 3.25 % • Nitrogen = 1.11 % • Oxygen = 8.68 % • Sulphur = 0.54 % • Moisture = 14.48 % • Ash content = 18.54 % • GCV of Coal = 4291 kcal/kg **Ash analysis:** • Unburnts in bottom ash = 0.11 % • Unburnts in fly ash = 4.89 % • GCV of Bottom ash = 889 kcal/kg • GCV of fly ash = 393 kcal/kg	15	3	3