UNIVERSITY OF RUHUNA

Faculty of Engineering

End - Semester 8 Examination in Engineering: November 2017

Module Number: ME 8312 **Module Name: Energy Management**

[Three Hours]

[Answer **all questions**, each question carries **10** marks]

Note: Clearly state any assumptions you made in answering the questions.

Q1. a) State six opportunities for reducing the electrical energy consumption of a given manufacturing plant.

[3.0 Marks]

b) Briefly describe the "Ten-Step" method followed in a detailed energy audit.

[3.0 Marks]

c) Assume that you have been newly appointed as the energy manager of a manufacturing plant. Briefly explain how you will implement an effective energy management culture in the organisation and ensure its long term sustainability.

[4.0 Marks]

Q2. For a given factory, lighting is provided by 100 Compact Fluorescent lamps (CFLs), each having a power rating of 18 W, a luminous efficacy of 50 lm/W and a lifetime of 10,000 hrs. In the factory, the lights remain switched on for the whole day (24 hrs) and 330 days per year. In an upcoming renovation of the lighting system of the factory, all the existing CFLs are planned to be replaced with the new ones. However, the management has requested from you (the energy manager of the company), to study the possibility of introducing LED panel lights having a power rating of 12 W, a luminous efficacy of 150 lm/W and a life time of 50,000 hrs, without altering the original lighting level within the factory. Based on this case, answer the following questions.

(a) If the unit cost of electricity is Rs.12 per kWh, calculate the annual energy cost for lighting, if CFLs are continued to be used.

[2.0 Marks]

(b) With the same tariff given in Q2(a), calculate the annual energy cost for lighting if the CFLs are replaced with LED panel lights.

[4.0 Marks]

(c) The retail price of a CFL and a LED panel light is Rs. 450/= and Rs. 600/=, respectively. If LED based lighting to be used instead of CFL based lighting, calculate the simple payback period.

[2.0 Marks]

(d) Would you recommend the proposal to use LED lighting in the factory? Justify your answer.

[2.0 Marks]

Q3. a) In an energy audit of a coal-fired industrial boiler, below data have been recorded. Calculate the boiler efficiency using the direct method.

Quantity of steam generated = 12.0 ton/hr
Pressure of steam = 12.0 bar g
Temperature of steam = 220.0 °C
Temperature of feed water = 65.0 °C
Specific enthalpy of feed water at 65.0 °C = 272.1 kJ/kg
Specific enthalpy of superheated steam at 12.0 bar g and 220.0 °C = 2860.6 kJ/kg
Rate of coal consumption = 2.2 ton/hr
Gross calorific value of coal = 20,000.0 kJ/kg

[5.0 Marks]

b) Comment on the limitations of using the direct method to calculate the efficiency of a boiler compared with the indirect method.

[2.0 Marks]

c) State different measurements and related measuring equipment that can be applicable for collection of data to calculate the efficiency of a boiler using the **indirect method.**

[3.0 Marks]

Q4. a) Briefly explain the variation in total cost with Pinch temperature difference.

[1.0 Mark]

b) The heat flow capacities and temperatures of four streams are shown in the table below. The minimum allowable temperature difference between the streams is 20 K.

Table Q4. Heat flow capacities and temperatures

Stream No.	Type	Thermal capacity rate (kW/K)	Initial Temperature (°C)	Final Temperature (°C)
1	Hot	2	200	60
2	Hot	4	170	70
3	Cold	3.5	40	175
4	Cold	4.5	100	150

(i) Draw the hot and cold stream composite curves.

[1.0 Mark]

(ii) Calculate the minimum external heating and cooling requirements using "Tabular Method".

[3.0 Marks]

(iii) What are the Hot and Cold Pinch Temperatures?

[2.0 Marks]

(iv) Match the heat loads of hot and cold streams and draw the corresponding Heat Exchanger Network.

[3.0 Marks]

Q5. a) In a manufacturing plant, a boiler feeds 15 bar g steam to the main steam line, which provides steam for the use of the whole plant. One particular heating oven operates at 10 bar g, using the steam obtained from a branch line connected to the main steam line. In the heating oven, steam flows in side of a heating element composed of a copper coil. The condensate produced at the coil is directed to a condensate collection pipe line. Considering this setup, draw a schematic diagram of the steam distribution network, covering all the elements mentioned above. In the diagram, make sure to include essential standard steam circuit components and name them clearly.

[7 Marks]

b) State six different ways of minimising energy wastage in steam distribution networks.

[3 Marks]