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THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
MASTER OF TECHNOLOGY IN INDUSTRIAL ENGINEERING – LEVEL07
FINAL EXAMINATION – 2009/2010
MEX 7125 – ENERGY MANAGEMENT IN INDUSTRIES
DATE : 01 April 2010
TIME : 1400 -1700 hrs
DURATION : *Three (03) hours*

This paper consists of Six (06) questions. Answer only five (05) Questions. Question No 01 is compulsory.

Instructions

1. Read the questions carefully before answering.
2. Please note that you should write your registration number and your index number in each pages of your answer book. Do not write your name.
3. In case of doubt, please consult the supervisor or an invigilator conducting the examination.
4. Answer only five (05) questions.

Q1. CASE STUDY *(Compulsory Question)*

"Smart Rubber" is a leading rubber goods manufacturing industry in Sri Lanka for over 10 years. It operates on a two shift work programme. One shift operates from 06.00hrs to 14.00hrs and the second shift from 14.00hrs to 22.00hrs. The company operates 5 days a week and Saturday and Sunday are non-working days. The average monthly electricity consumption of the factory is 25,400 kWh and the maximum demand is 125kVA. The current contract on supply of electricity is on normal industrial tariff. The company has a standby generator of 125kVA to supply power when the grid fails. There are two critical production machines. Once started these two machines cannot be stopped half way, but must continue to operate until their job is completed. One machine, of capacity 20kW operates from 12.00hrs to 20.00hrs daily. And the other machine, of capacity 12kW and power factor 0.8, operates from 09.00hrs to 17.00hrs daily.

Due to the increase in cost of energy in the production process, the company commissioned an energy consultant to study and report on ways and means of reducing electricity cost in the factory. One of the main expectations of the company was to know whether there would be any cost advantage accruable by changing over to Time of the Day Tariff.

The consultant collected the following data to analyse the situation.

- The tariffs applicable to the industry.

	Normal Tariff	**Time of Day Tariff**
Energy Charge	Rs. 9.30/kWh	Peak - Rs. 24.60/kWh Off peak - Rs. 8.40/kWh
Max. Demand (kVA) charge	Rs. 675/kVA	- Rs. 650/kVA
Peak period	----------	18.30hrs to 22.30hrs
Fixed charge	Rs. 3000	- Rs. 3000

- Average monthly electricity consumption during peak period = 940 kWh
- Cost of electricity generated by the standby generator (including operation and maintenance) = Rs. 18.00/kWh
- Peak demand occurs during the period when both critical production machines are in operation.
- Operating power factor of 20kW machine was 0.85, and that of 12kW machine was 0.8.
- Cost of change over to Time of the Day Tariff is Rs. 25,000.

Answer the following questions.

1. Analyse the system and find out whether it is profitable to change over to the Time of Day tariff without making any changes to the present system. Justify your answer.

2. Do you recommend running the generator during peak hours? If so what additional cost advantages would be accruable?

3. If a water pump (a time flexible load) of capacity 5 kW and 0.8 power factor has been operating daily for two hours from 18.00 hrs to 20.00 hrs, what recommendations would you give to further minimize the electricity cost when TOD tariff is applicable? Justify your answer by calculating the benefits accruable.

4. What other actions would you recommend to reduce the cost of electricity?

(32 marks)

Q2. Write short notes on four (04) of the following.

a. Energy labelling
b. Energy conservation
c. Comfort zone in air conditioning
d. Excess air in fuel combustion
e. Specific energy consumption

(17 marks)

Q3. Discuss in detail the environmental implications of consumption of fossil fuels. In what way this could undermine the competitive advantage of manufacturing businesses in global business setting?

(17 marks)

Q4. "Attitudinal changes of people towards energy consumption can make a big improvement in overall energy efficiency of a country". Discuss this statement critically. Use a few practical examples of attitudinal behaviours of people that have positive impact on energy efficiency, in support of your answer.

(17 marks)

Q5. What are the important environmental parameters that are controlled in space air conditioning for human comfort? Discuss how these parameters influence the comfort level of people. In a typical air conditioned office space, say in Colombo, what steps would you take to reduce the air conditioning load and improve the energy efficiency of air conditioning, thereby to reduce the electricity bill?

(17 marks)

Q6. (i) Measurements taken on the operation of a 15 kW, 3 phase (name plate data) Induction Motor has given the followings readings.

- Power consumption = 12.5 kW
- Power factor = 0.84

Find out the following.

a) Operating kVA of the motor
b) If power factor to be improved to 0.99, what is the value of kVar (capacitance) that should be connected to the motor?
c) When the power factor is improved to 0.99 what would be the reduction in kVA expected?

(ii) An energy efficiency improvement exercise was carried out in a Garment factory in Sri Lanka. The study done on the lighting system on the production floor provided the following data.

No of lamps	Type of lamp	Wattage per lamp	Operating hrs per day
200	Fluorescent Tube with magnetic ballast	40W	8 hrs

Energy consumption of the magnetic ballast = 12W
It is also, observed that lighting consumption has a direct bearing on the maximum demand.

Electricity tariff applicable to the industry is

Unit charge = Rs. 9.30 per kWh
kVA charge = Rs. 675 per kVA

The factory operates 5days a week, Saturday and Sunday being holidays.

The Garment Factory is considering whether to replace the magnetic ballasts with energy efficient electronic ballast, the energy consumption of which is only 2W. The replacement cost of magnetic ballasts with Energy Efficient Electronic Ballasts is Rs. 450 per unit (including labour cost).

Calculate,

a) The current annual energy consumption and cost of electricity for lighting in the production floor.

b) If all magnetic ballasts are replaced by electronic ballasts calculate the expected annual energy consumption and cost of electricity for lighting in the production floor.

c) Calculate the simple payback of the investment.

(17 marks)

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