NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part Five Examination May 2014

TCE 5217 Industrial Energy Management

Duration of Examination 3 Hours

Instructions to Candidates

1. Answer **Question One** and any other **Three** questions.
2. Show all your steps clearly in your calculation.
3. Start the answers for each question on a new page.

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1. a) Evaluate the statement "Energy Management is not an event but a process". [6]

   b) Interpret the following terms.
      i) active power [1]
      ii) cost intensity [1]
      iii) reactive power [1]
      iv) fuel data [1]

   c) Explain the concept of sustainable energy use. [4]

   d) Design a detailed procedure for carrying out a plant energy survey. [8]

   e) What is the practical significance of energy intensity? [3]

2. a) Power Supply authorities restrict the power factor to a certain level. Justify the position taken by the supply authorities. [5]

b) Validate the statement "Simple changes in people's behaviour can quickly lead to significant energy savings." [5]

c) Calculate the maximum theoretical thermal efficiency of a coal-fired power station that heats steam to 510°C and cools it in a condenser at 30°C? [4]

d) A motor has a power factor of 0.82 and the nameplate information of 100 hp and 94% efficiency. Find the capacitor kVAR needed to raise the power factor to 0.96. [6]

e) Outline how ESGA can effectively promote energy conservation. [5]

3. a) State and explain the 5 rules for monthly energy-performance tracking. [10]

b) A 10hp motor has published efficiencies of: E_{FL} = 0.87 and $E_{0.75}$ = 0.87. Calculate FL 0.75 motor losses at 60% load? [5]

c) Discuss in detail the duties of an energy manager. [5]

d) A room measures 15m x 7m x 3.6m high and the design illumination is 200 lux on the working plane (0.85 metres above the floor). The utilisation factor is 0.5 and the Maintenance factor is 0.8. If the lighting design lumen (LDL) output of each fitting is 2720 lumens, calculate;

i) the number of fittings required.

ii) the fittings layout.

iii) If the spacing/mounting height ratio is 1:1 determine whether the current design is acceptable. [5]

4. a) A consumer in a town centre is charged Rs 0.75 per kWh for his electricity from the national grid. In a rural area, a consumer has a lamp connected to the local micro hydro unit at a cost of Rs 1 per day. Which consumer pays more for his electricity? Assume that

the lamp in the village consumes power of 40 W and that it is switched on for an average of 4 hours per day. [4]

b) Briefly describe the operation of a heat wheel and a heat pump in relation to heat recovery. [4]

c) Given: Synchronous speed in rpm = 1800 Nameplate full load speed = 1750
Measured speed in rpm = 1770 Nameplate rated horsepower = 25 hp. Determine actual output horsepower. [4]

d) A spherical reaction vessel has an outer radius of 1.5m and is covered in lagging 200mm thick. The thermal conductivity of the lagging is 0.1 W/m K. The temperature at the surface of the steel is 340°C and the surface temperature of the lagging is 45°C. Calculate the heat loss? [4]

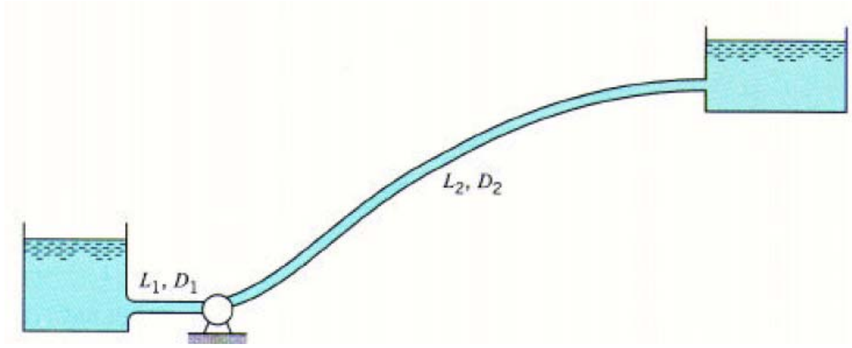
e) Discuss the three categories of energy management opportunities that exist for fans giving relevant examples under each category? [9]

5. a) Over time, the performance of a 175 kW refrigeration system, with an air-cooled, packaged condensing unit, deteriorated. Investigation revealed that the space where the condensing unit was located had been converted to a storage area with stacked materials. Air flow to the condenser was blocked, causing short circuiting of the cooling air stream.
On a day when the ambient temperature was 35°C, the air entering the condenser was 46.1°C. The actual refrigerating was 120 kW. Manufacturer's data for 120 kW cooling indicates that the compressor power is 42.3 kW at 35°C, and 49.76 kW at 46.1°C. The system operates 2,000 hours per year at the elevated temperature. Removal of the stored materials from the condenser vicinity would prevent short circuiting and lower the air temperature entering the condenser to the ambient temperature. Calculate the cost savings given electricity cost is $0.05 /kWh. [4]

b) Justify the need to treat feedwater showing clearly the significance of this process in energy management. [5]

c) Discuss the energy conservation opportunities that exist for compressed air systems. [6]

d) Calculate the power required to pump water from the lower reservoir to the upper one.



Given:

Discharge:	$Q = 2\ m^3/sec$
Friction factor for pipe losses:	$f = 0.014$
Water temperature:	T = 100°C
Pipe lengths:	$L_1 = 100$ m
	$L_2 = 1$ km
Pipe diameters:	$D_1 = 1$ m
	$D_2 = 50$ cm
Elevation of reservoir surfaces:	$z_1 = 150$ m
	$z_2 = 250$ m
Pump elevation:	$z_p = 100$ m
Pump and motor efficiency:	74%

[10]

END OF EXAM