Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	PLANT ENERGY EFFICIENCY
COURSE CODE	:	BNL 40303
PROGRAMME CODE	:	BNL
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) What is cooling tower?

(3 marks)

(b) Give **SEVEN (7)** components of cooling tower and its function.

(7 marks)

(c) According to the **Table Q1 (c)**, show the cooling tower data properties in Maju Bina Sdn Bhd's building of the year 2019. This cooling tower is under consideration for replacement if the efficiency (<60%) and tons of refrigeration (TR) (<100). As an executive in Maju Bina Sdn Bhd, you are trusted to analyze either the cooling tower should be replaced or not.

(i) Calculate the cooling tower efficiency

(3 marks)

(ii) Calculate the tons of refrigeration (TR)

(3 marks)

(iii) Determine either the cooling tower should be replaced or not.

(4 marks)

Q2 (a) Analogue and digital circuits are used to transmit and process the information like sound, light from an environment to generate continuous variable signals. To obtain the outputs, analog circuits can directly give the signals while a digital circuit has to change the information back to an analog signal. Distinguish **SEVEN (7)** differences between analogue and digital circuit.

(7 marks)

(b) A single-phase transformer with a 1.8 kVA rating has a 415V primary, and a 240V secondary.

(i) Calculate the primary full-load currents of the transformer.

(ii) Calculate the secondary full-load currents of the transformer.

(3 marks)

(c) There is significant variation in the load requirements that must be met at different times. Thus, the power plant generating capacity utilization is subjected to continual change. Given:

(i) A power plant has an average load of 300 MW and peak load of 420 MW over 24 hours period. Define the load factor of power plant during the 24 hours period.

(ii) A power plant has an average load of 75 MW and an output capacity of 125 MW. Define the capacity factor of the power plant.

(5 marks)

(d) A hall in commercial buildings is 20m x 40m. It will use 100 fluorescent lighting units that draw 4.5 amperes each. Also, 30-ampere branch circuit will be used. The power factor of the units is 0.85. The operating voltage is 240 volts.

(i) Calculate the total current drawn by the lights.

(ii) Calculate the total power.

(5 marks)

Q3 (a) Give **FIVE (5)** main components of air compressor and its function.

(5 marks)

(b) In a small medium industry, one compressor of rated capacity of 1200 cfm is operated to evaluate the leakage quantity in the plant during a holiday when no equipment was using compressed air. Free air delivery (FAD) test was also carried out before conducting leakage test and found that the compressor is delivering an output of 85% of rated capacity. The observations of leaking test were observed by compressor on load for 10 minutes, unloaded for 40 minutes, and lastly the compressor was consuming 171 kW input power.

(i) Evaluate the FAD operating capacity.

(ii) Evaluate the specific power consumption.

(iii) Evaluate the leakage percentage (%) in compressed air system.

(iv) Evaluate the leakage quantity.

(v) Evaluate the power lost due to leakage.

(10 marks)

(c) According to the **Table Q3 (c)**, the air compressor data properties in Aris Moto Workshop's building of the year 2019. Evaluate the FAD operating capacity of the air compressor.

(5 marks)

Q4 (a) The refrigeration cycle is also known as vapor compression cycle. The cycle operates at two pressures which are high and low, to produces a continuous cooling effects.

(i) Sketch and label the refrigeration cycle.

(4 marks)

(ii) Express the **FOUR (4)** main component's function in the refrigeration cycle.

(4 marks)

(b) A machine working on a Carnot cycle operates between thermal reservoir at 55°C and 560 °C.

(i) Calculate the thermal efficiency, if it is a power cycle.

(ii) The coefficient of performance, if it is a refrigerator.

(iii) The coefficient of performance, if it is a heat pump.

(6 marks)

(c) Evaluate the time needed to cool down 5 watermelons by using refrigerator systems at given operating conditions as in **Table Q4 (c)**.

(3 marks)

(d) A house is heated by a 1200kWh electric resistance heater during a winter month. The owner had studied the potential of a heat pump in order to replace the electric resistance heater usage. If the coefficient of performance (COP) of heat pump is 2.4 and electricity rate of 0.085 $/kWh. Please define the amount of money that would be saved if heat pump is chosen.

(3 marks)

Q5 (a) The integration of substantial amounts of renewable energy, supplying efficient and energy via cogeneration had shown potential future energy saving and utilization.

(i) Define the cogeneration.

(2 marks)

(ii) List down **FOUR (4)** cogeneration technologies.

(2 marks)

(b) According to **Figure Q5 (b)**, a dairy plant, milk at 4°C is pasteurized continuously at 72°C at a rate of 20 L/s for 24 hours a day and 365 days a year. The milk is heated to the pasteurizing temperature by hot water heated in a natural-gas-fired boiler that has an efficiency of 90 %. The pasteurized milk is then cooled by cold water at 18°C before it is finally refrigerated back to 4°C. In order to save energy and money, the plant installs a regenerator that has an effectiveness of 82 %. If the cost of natural gas is RM 1.10/therm (1 therm = 105,00 kJ) and given the milk average density is 1 kg/L and the specific heat is 3.79 kJ/kg.°C, evaluate how much energy and money the regenerator will save the company per year.

(8 marks)

(c) According to **Figure Q5 (c),** the hot water needs of a household are met by a 60 L electric water heater whose heaters are rated at 1.6 kW. The hot water tank is initially full with hot water at 80°C. Somebody takes a shower by mixing a constant flow of hot water from the tank with cold water at 20°C at a rate of 0.06kg/s. After a shower period of 8 minutes, the water temperature in the tank is measured to drop to 60°C. The heater remained ON during the shower and hot water withdrawn from the tank is replaced by cold water at the same flow rate. Given the water average density is 1000 kg/m^3 and the specific heat is 4.18 kJ/kg.°C. Evaluate the mass flow rate of hot water withdrawn from the tank during the shower and the average temperature of mixed water used for the shower.

(8 marks)

- END OF QUESTIONS -

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Table Q1 (c) : Cooling tower(CT) data properties in 2019

Properties	Data
Water flow rate through CT	150 m^3/h
Specific heat of water	1 kCal/kg.°C
Inlet water temperature	45 °C
Outlet water temperature	32 °C
Ambient wet bulb temperature	29 °C
1 ton refrigeration	3026 kCal/h

Table Q3 (c) : Air compressor data properties

Properties	Data
Receiver capacity	0.45 m^3
Atmospheric pressure	1.03323
Initial pressure	2 kg/cm^2 (g)
Final pressure	17 kg/cm^2 (g)
Initial temperature	25 °C
Final temperature	49 °C
Additional holdup volume	0.07 m^3
Compressor pump up time	7.5 minutes

Table Q4 (c) : Refrigerator systems

Properties	Data
Mass of watermelon (1pcs)	10kg
Initial temperature	20 °C
Final temperature	8 °C
Specific heat of watermelon	4.2 kJ/kg.°C
Refrigerator power input	450 Watt
Refrigerator COP	2.5

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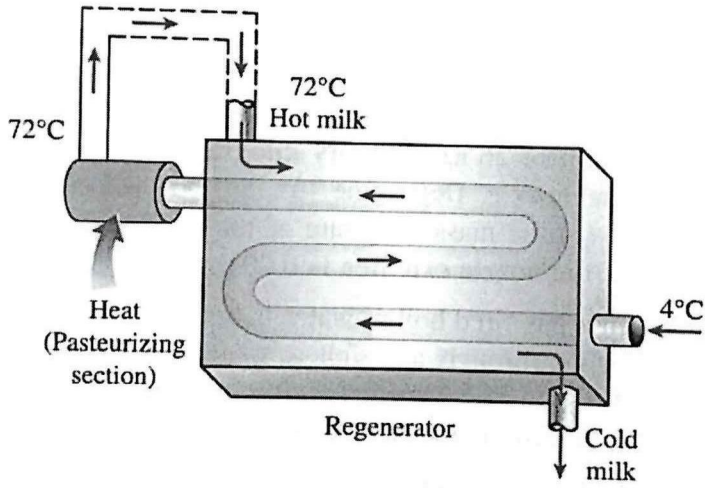

Figure Q5 (b) : Dairy plant regenarator

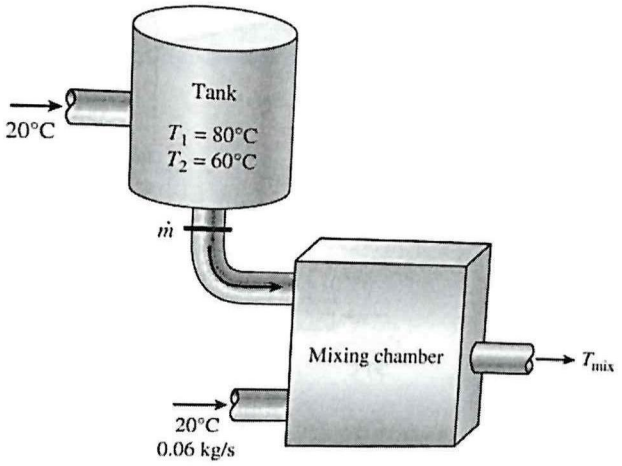

Figure Q5 (c) : Water heater systems