UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESI 2012/2013

COURSE NAME	:	THERMODYNAMICS I / THERMODYNAMICS
COURSE CODE	:	BDA 20202 / BDA 1612
PROGRAMME	:	BDD / BEE
EXAMINATION DATE	:	JUNE 2013
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER ANY FOUR (4) QUESTIONS ONLY FROM SIX (6) QUESTIONS.

THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

Q1 (a) One end of a U-tube manometer in a certain experiment is connected to a reservoir while the other end is connected to a flat zigzag pipe filled with corn cooking oil which has a density (ρ_2 =922 kg/m^3) as shown in **FIGURE Q1**. The zigzag pipe is connected to a round container filled with a liquid A which has a density of (ρ_1 =800 kg/m^3). On top of the reservoir, a channel filled with palm oil (ρ_4 =915 kg/m^3) was set to have an angle of 55° from the vertical line. The absolute pressure at point A is measured to be 102736 Pa.

(i) Determine the density of the working fluid (ρ_3) in the U-tube manometer.

(ii) Suggest the name of the working fluid based on your result in (i).

(15 marks)

(b) Explain the definition of Flow Work with the help of appropriate diagrams if needed.

(4 marks)

(c) Sketch either in P-v or T-v diagram and show the followings in the sketch

(i) T_{sat}

(ii) P_{sat}

(6 marks)

Q2 (a) Explain and differentiate between the 1st, 2nd, and the 0th Law of Thermodynamics with one appropriate example for each law.

(3 marks)

(b) A rigid tank is filled with liquid water and water vapour at 513.15 K and 3347 kPa. The tank is connected to a heating element and the outside of the tank is insulated as shown in **FIGURE Q2**. The mass of the liquid water is equal to the water vapour which is 2 kg. The inside of the tank is then heated until the final temperature is double the initial temperature.

(i) Sketch the whole process in a P-v diagram.
(ii) Specify the condition/phase of the fluid inside the tank at the end of the process.
(iii) Find the volume of the rigid tank.
(iv) Calculate the internal energy per unit mass at the end of the process.

(22 marks)

Q3 (a) How does a turbine function in steam, gas or hydroelectric power plants?

(4 marks)

(b) The power output of an adiabatic steam turbine is 16MW. The inlet steam pressure, temperature and velocity are 2.5MPa, 420°C and 57 m/s respectively. The outlet steam pressure and velocity are given as 15kPa and 186 m/s respectively. The quality of the outlet steam is 89%. The elevation difference between the turbine inlet and outlet is 6.3m.

(i) Find the magnitudes of Δh, Δke and Δpe.
(ii) Determine the work done per unit mass of the steam flowing through the turbine.
(iii) Calculate the mass flow rate of the steam.
(iv) State and justify two typical assumptions that can be made for most engineering devices by comparing Δke and Δpe with respect to Δh.

(21 marks)

Q4 (a) An air conditioner has COP greater than unity and transfer heat from living space to a warmer environment. Is this a violation of the second law of thermodynamics? Explain.

(3 marks)

(b) An engineer parked his car for one hour at noon with all windows closed. When he returns to his parked car, he finds that its interior is at 38°C. He turns on the air conditioner, which cools the air inside the car to 22°C in 4 minutes while keeping all windows shut. If the COP of the air conditioner is 2.5, determine the power drawn by the air conditioner. Assume the entire mass within the car is equivalent to 10 kg of air. Take c_v and c_p values at 27°C.

(10 marks)

(c) Similar to question Q4(b), calculate the required power input for the air condition system to cool the car interior from 38°C to 22°C in 1 minute, 2 minutes, and 3 minutes. From the calculations, sketch a graph of Power Input (y-axis) against Cooling Time (x-axis) ranges from 1 to 4 minutes.

(12 marks)

Q5 A heat pump as shown in **FIGURE Q5** with refrigerant-134a as the working fluid is used to keep a space at 26°C by absorbing heat from geothermal water that enters the evaporator at 60°C at a rate of 0.05 kg/s and leaves at 30°C. Refrigerant enters the evaporator at 22°C with a quality of 20 percent and leaves at the same pressure as saturated vapor. If the compressor consumes 1.5 kW of power, and the phase of geothermal water at the inlet and outlet of evaporator is saturated liquid, determine,

(i) the mass flow rate of the refrigerant,
(ii) the rate of heat supply,
(iii) the actual COP of the heat pump, and
(iv) the maximum COP can be achieved by the heat pump.

(25 marks)

Q6 (a) What is entropy?

(1 marks)

(b) If the entropy of a steady flow turbine increases, how does it affect the isentropic efficiency of the turbine? Support your answer with related equation and diagram.

(4 marks)

(c) An adiabatic compressor shown in **FIGURE Q6** with isentropic efficiency of 85% is used to compress refrigerant-134a. During the operation, the refrigerant enters the compressor as saturated vapor at 160 kPa at the rate of 0.9 m^3/min, and leaving the compressor at pressure of 1.40 MPa.

(i) Determine the temperature of refrigerant at the compressor exit.
(ii) How much is the mass flow rate flowing through the compressor?
(ii) Show the process (inlet and outlet) on a *T*-s diagram with respect to saturation line, and label the temperature, pressure and entropy on the diagram.

(20 marks)

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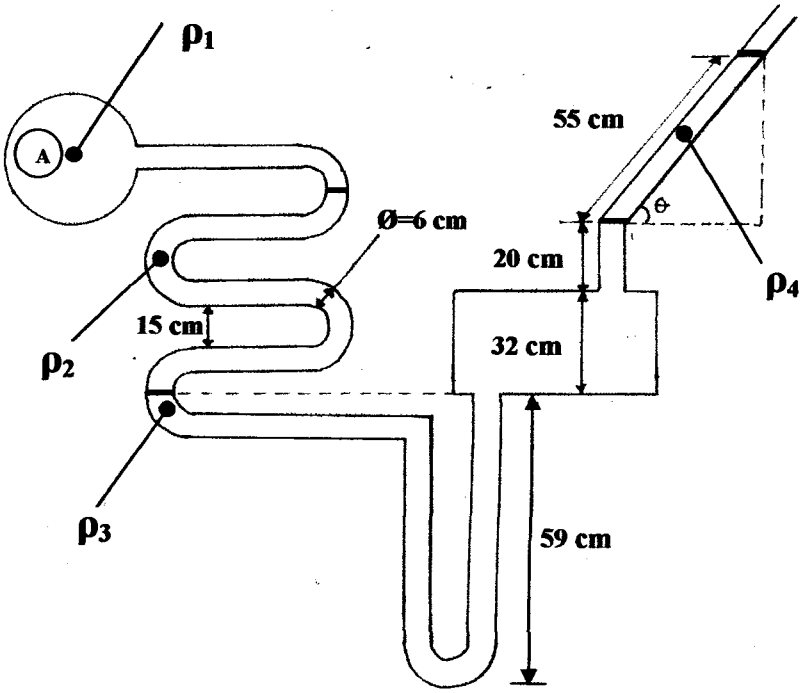

FIGURE Q1

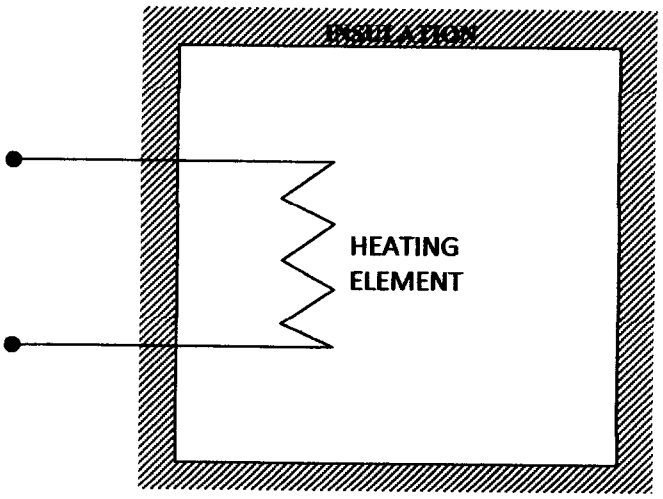

FIGURE Q2

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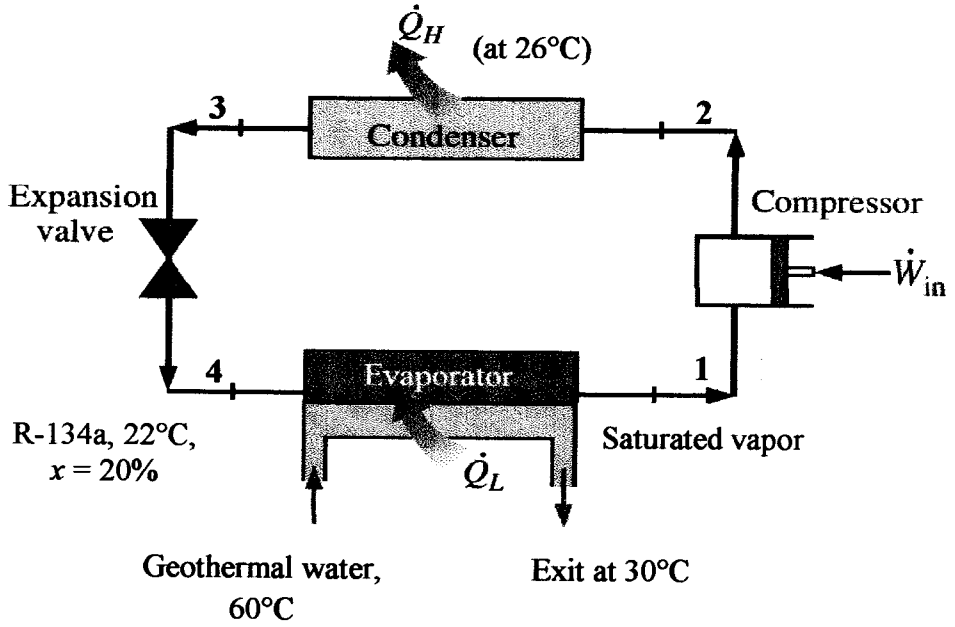

FIGURE Q5

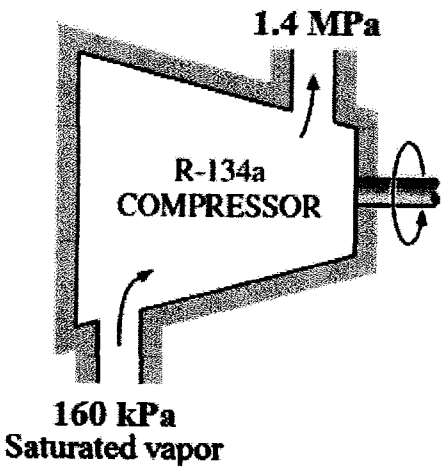

FIGURE Q6

-END OF QUESTION-