UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	BDA1612
PROGRAMME	:	BEE
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	**PART A:** ANSWER **THREE (3)** QUESTIONS ONLY **PART B:** ANSWER **ALL** QUESTIONS

THIS PAPER CONTAINS SIX (6) PAGES

PART A

Q1 (a) What is the 1st law of thermodynamics? If heat is said to be transferred from a cooler region to a hotter region, is the 1st law is being **violated**? Please give an explanation.

(5 marks)

(b) For an ideal gas in a closed system during an isothermal process, **derive** the following volume,**V** and pressure, ***P*** relation: $\frac{V_2}{V_1} = \frac{P_1}{P_2}$

(5 marks)

(c) A steam heating system for a building 175 m high is supplied from a boiler which is located 20 m below ground level (Figure Q1(c)). Steam at saturated vapor is supplied from the boiler at 350 kPa, and reaches the top of the building at 300 kPa. Heat losses from the supply line to the surroundings are 50 kJ/kg. Determine:

(i) The quality of steam at the 175 m elevation (by neglecting any change in kinetic energy); and

(ii) How would the answer change **if** the change in potential energy was neglected in the analysis?

(15 marks)

Q2 (a) Explain the term of "**electrical work**". Why do this work is not categorized as heat?

(3 marks)

(b) Air is heated electrically at a constant pressure of 50 bars. At initial state, the air has volume of 0.0015 m^3 with temperature of 300 K. At final state, the temperature of air reaches 500 K. During the process, 3 kJ of electrical energy is supplied to the air through a heater. Based on energy balance with **enthalpy change**, determine the **heat transfer** in kJ.

(12 marks)

(c) Verify that the solution in Q2(b) is agrees to solution using **internal energy change**.

(10 marks)

Q3 (a) What are the different **transfer mechanisms** for transferring energy **to** or **from** a control volume? Give one example of the **process** (energy transfer) comprise at least two of the transfer **mechanisms**.

(5 marks)

(b) Steam flows steadily through an adiabatic turbine (Figure 3(b)), with mass flow rate of 15 kg/s. At inlet point, the steam pressure is 20 MPa, temperature is 450°C, and it flows at 120 m/s of speed. At turbine exit point, the steam pressure and velocity dropped to 10 kPa and 60 m/s, respectively. Steam enthalpy at exit point has changed to 2000 kJ/kg. Determine:

(i) the **change** in kinetic energy in kJ/kg;
(ii) the **power** output in kW; and
(iii) the turbine inlet **area**.

(20 marks)

Q4 (a) Consider two heat engines operate in a series as shown in Figure Q4(a). The first heat engine receives $\boldsymbol{Q_H}$ amount of heat from hot reservoir and operates with **triple** the thermal efficiency of the second heat engine. The second heat engine receives $\boldsymbol{Q}$ amount of heat from the first engine and release $\boldsymbol{Q_L}$ amount of waste heat to the cold reservoir. With assumption that there is **no heat loss** occurs during heat transfer from first to second engine, determine:

(i) Q_L in terms of Q and Q_H;
(ii) the value of Q_L, if Q_H is 300 kJ and net work output of **first** heat engine is 50 kJ ;
(iii) the net work out of **second** heat engine ; and
(iv) the thermal efficiency of the **whole** system.

(20 marks)

(b) Does the **actual** exit state of an adiabatic turbine have to be on **right-hand side** of the **isentropic** exit state on the temperature versus entropy (T-s) diagram? Why?

(5 marks)

PART B

Q5 Refrigerant-134a enters an adiabatic compressor as **saturated vapor** at 200 kPa at the rate of 0.3 m^3/min, and exit the compressor at 1 MPa of pressure. The **isentropic** efficiency of the compressor is 80% as shown in Figure Q5.

(i) Determine the temperature of refrigerant at the compressor exit.

(ii) Show the process (inlet and outlet) on a *T-s* diagram with respect to saturation line, including the temperature, pressure and entropy labeled on the diagram.

(25 marks)

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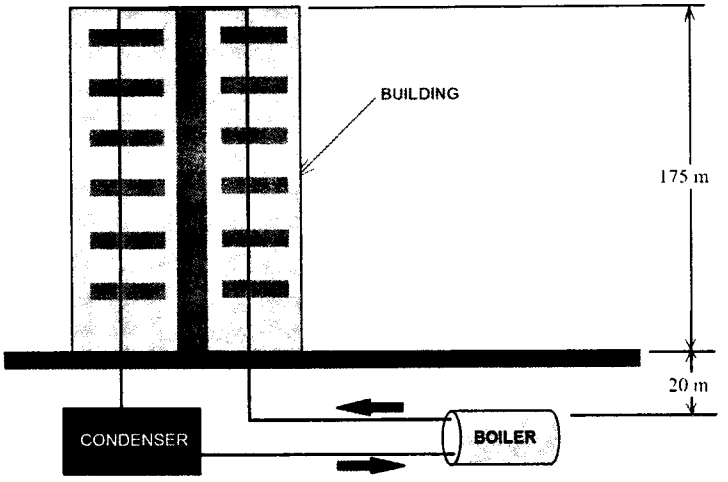

Figure Q1(c)

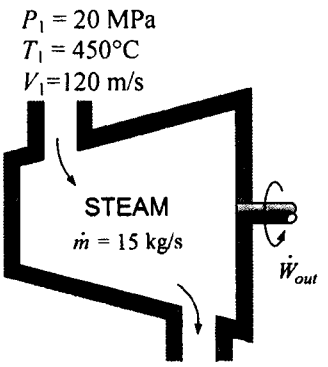

Figure Q3(b)

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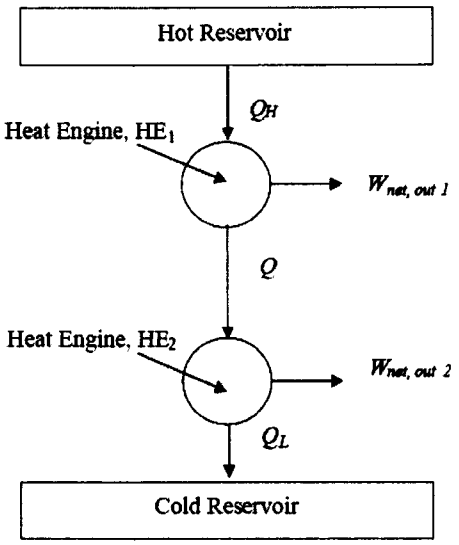

Figure Q4(a)

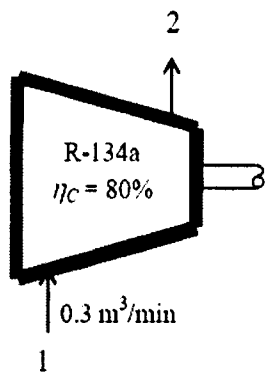

Figure Q5