Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	BNJ 10703
PROGRAMME	:	BNG/BNL/BNM/BNK
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) (i) State the 1st law of thermodynamics.

(2 marks)

(ii) Explain the condition of heat that transferred from a cooler region to a hotter based on 1st law of thermodynamics.

(3 marks)

(b) "A compressed liquid water temperature is at 20°C".

(i) Define the state postulate.

(2 marks)

(ii) Based on the given statement, explain whether this information enough to postulate the specific volume of the water.

(3 marks)

(c) A steam heating system for a building 175 m high is supplied from a boiler 20 m below ground level. Dry saturated steam is supplied from the boiler at 300 kPa, which reaches the top of the building at 250 kPa. Heat losses from the supply line to the surroundings are 50 kJ/kg.

(i) Determine the quality of steam at the 175 m elevation. Neglect any change in kinetic energy; and

(9 marks)

(ii) Compare the answer in (i) if the change in potential energy was neglected in the analysis.

(6 marks)

Q2 Determine the missing properties and the phase described in the following Table 1: Water properties and show each of the states on *T*-*v* and *P*-*v* diagrams.

Table 1: Water properties

State	*P*, bar	*T*, °C	*x*	*v*, m^3/kg	*u*, kJ/kg	*h*, kJ/kg	*s*, kJ/kg.K	Phase description
1	2				504.50			
2		200	0.5					
3	10	150						
4		300				3075.8		
5	9						4.5273	

(25 marks)

Q3 An adiabatic air compressor is to be powered by a direct-coupled adiabatic steam turbine. A piston–cylinder device initially contains air at 100 kPa and 25°C. In this state, the piston is resting on a pair of stops, as shown in Figure **Q3** and the enclosed volume is 500 L. The mass of the piston is such that a 400 kPa pressure is required to move it. The air is now heated until its volume has doubled. Determine:

(i) The final temperature;

(5 marks)

(ii) The work done by the air;

(5 marks)

(iii) The total heat transferred to the air; and

(10 marks)

(iv) Sketch a *P-V* diagram of the process.

(5 marks)

Q4 (a) Air enters an adiabatic diffuser steadily at 100 kPa, 200°C, and 180 m/s and leaves at 320 kPa and 30 m/s. If the inlet area of the diffuser is 80 cm^2, determine:

(i) The mass flow rate;

(6 marks)

(ii) The exit temperature of the air; and

(6 marks)

(iii) The ratio area of entrance to exit.

(3 marks)

(b) An insulated tank at Figure **Q4(b)** with a volume of 0.5 m^3 contains air at 100 kPa and 25°C. The tank is connected through a valve to a large compressed air line. The air in the line is maintained at 700 kPa and 120°C. The valve is then opened and air is allowed to flow into the tank until the tank pressure becomes 500 kPa. At that point the valve is closed. Determine:

(i) The mass of the air that enters the tank; and

(8 marks)

(ii) The final temperature of the air in the tank.

Take $\gamma = 1.4$ and $R = 0.287$ kJ/kg K

(2 marks)

Q5 Consider two Carnot heat engines operating in series at Figure **Q5**. The first engine receives Q_H amount of heat from a hot reservoir and operates with twice the thermal efficiency than the second engine. The second engine receives the heat Q from the first engine and rejects the waste heat Q_L to another reservoir. Determine:

(i) Q_L in terms of Q and Q_H;

(9 marks)

(ii) Q_L, if Q_H=100 kJ and net work output of the first engine is 30 kJ;

(6 marks)

(iii) The net work output of the second engine; and

(3 marks)

(iv) The thermal efficiency of the system.

(7 marks)

Q6 (a) During an irreversible process air is compressed from state 1 to state 2. Pressure and the piston-cylinder device allows air to expand from 6 MPa to 1.2 MPa. The initial volume and temperature are 500 cm^3 and 800°C. If the expansion process is isothermal, determine:

(i) The heat transfer; and

(8 marks)

(ii) The change of entropy.

(5 marks)

(b) An air compressor was used to supply the compressed air with a rate of 0.35 kg/s at pressure 5 bars and temperature 70°C. The atmospheric air was stated at pressure 1 bar and temperature 29°C. If the requirement of compressor power is 27 kW, determine:

(i) The change of entropy;

(4 marks)

(ii) The rate of heat transfer; and

(4 marks)

(iii) The rate of entropy generation.

Take C_{pair} = 1.005 kJ/kg.K and R = 0.287 kJ/kg.K

(4 marks)

- END OF QUESTION –

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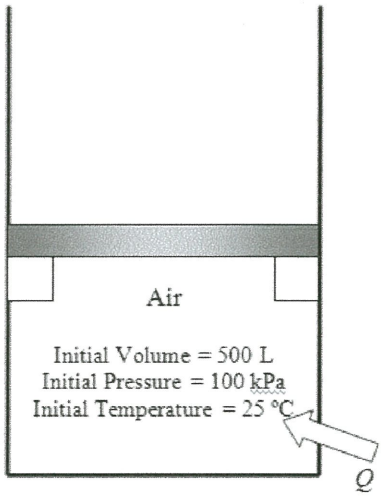

Figure Q3

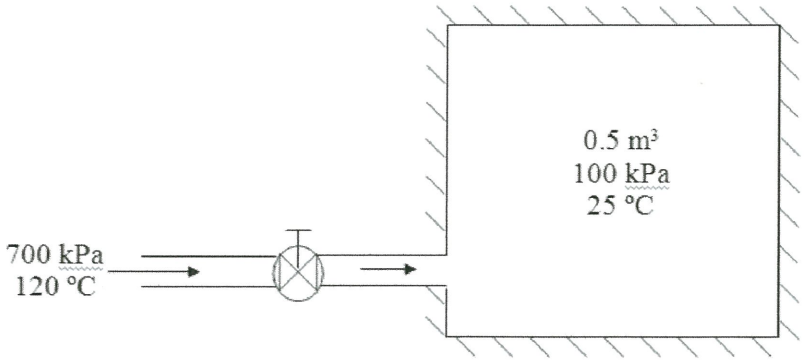

Figure Q4 (b)

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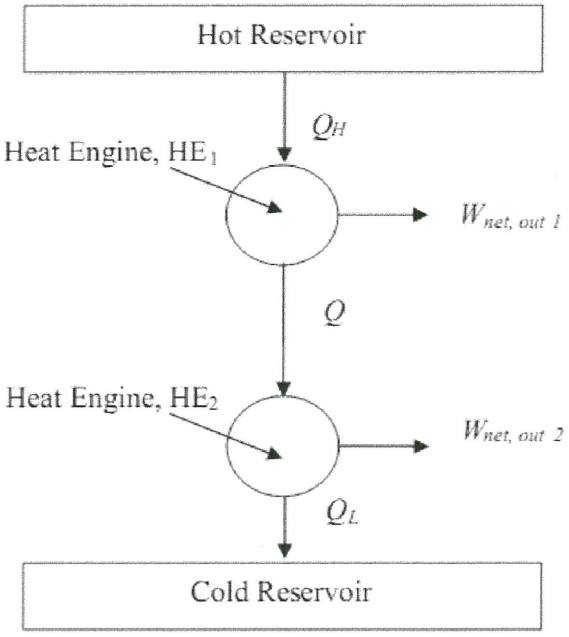

Figure Q5