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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

TERBUKA

COURSE NAME	:	THERMODYNAMICS I
COURSE CODE	:	BDA 20703
PROGRAMME	:	BDD
EXAMINATION DATE	:	DISEMBER 2016 / JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	**PART A**: ANSWER **FOUR (4)** QUESTIONS **ONLY** FROM **FIVE (5)** QUESTIONS. **PART B**: ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

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PART A

Q1 (a) The absolute pressure of manometer shown in **Figure Q1(a)** is 270 kPa. If the specific gravity of oil is 0.82 and specific gravity of kerosene is 0.75. Determine the local atmospheric pressure in bar.

(10 marks)

(b) Water is pumped from a lake to a storage tank 20 m above the lake surface at a rate of 70 L/s while consuming 20.4 kW of electric power. Disregarding any frictional losses in the pipes and any changes in kinetic energy, determine:

(i) the overall efficiency of the pump-motor unit; and

(ii) the pressure difference between the inlet and the exit of the pump.

(10 marks)

Q2 (a) Referring to the constant-pressure phase-change process that is illustrated in **Figure Q2(a)** and assuming that the working fluid is water, answer the following questions:

(i) Why is that the condition between 1 and 2 is called 'Compressed Liquid' even though the pressure is constant at 1 atm?

(ii) What will happen to the saturation temperature if the pressure was doubled?

(iii) Why is quality only applicable between point 2 and 4, and not beyond that?

(iv) Is it true that it takes more energy to vaporize 1 kg of saturated liquid water at 100 °C than it would at 120 °C? Explain to support your answer.

(v) Is it possible to have water vapor at –10 °C? Explain to support your answer.

(10 marks)

(b) Find the correct value for each blank cell shown in **Table Q2(b)**. Provide details of the working steps on how you derived each value.

(10 marks)

Q3 Consider the following closed systems:

(a) Isobaric process is a process where the pressure is remains constant. While, quasi-equilibrium process means the process happen slowly enough for the system to remain in internal equilibrium.

(i) Please show that the energy balance for a constant pressure expansion process for quasi equilibrium is $Q - W_{other} = H_2 - H_1$

(5 marks)

(ii) A piston cylinder device contains of saturated water vapour that is maintained at a constant pressure of 300 kPa. A resistance heater within the cylinder is turned on and passes a current of 0.2 A for 5 minutes from 120 volt source. At the same time a heat loss of 3.7 kJ occurred. Calculate ΔH for this process.

(5 marks)

(b) Air at 300 K and 200 kPa is heated at constant pressure to 600 K. Determine the change in internal energy of air per unit mass, using

(i) the functional form of the specific heat; and

(7 marks)

(ii) the average specific heat value.

(3 marks)

Q4 (a) (i) What is the different between turbine and compressor? You can include the sketches of both devices together with parameters and energies involved during operation according to the 1st law of Thermodynamics.

(4 marks)

(ii) Helium is to be compressed from 120 kPa and 300 K to 600 kPa and x K as shown as in **Figure Q4(a)**. A heat loss of 20 kJ/kg and power input 900 kW occurs during the compression process. Neglecting kinetic energy changes, determine the temperature output for a mass flow rate of 50 kg/min. Take the constant pressure specific heat of helium is c_p = 5.1926 kJ/kg.K.

(6 marks)

(b) Steam flows steadily through an adiabatic turbine as shown as in **Figure Q4(b)**. The inlet conditions of the steam are 3 MPa, 400 °C, and 90 m/s and the exit condition is 25 kPa. The mass flow rate of the steam is 10 kg/s, the change in kinetic energy is –2 kJ/kg and the power output is 13 MW. Determine:

(i) the outlet velocity, in m/s; and

(ii) the dryness fraction, *x*.

(10 marks)

Q5 (a) (i) A 600 MW steam power plant, which is cooled by a nearby river has a thermal efficiency of 40 percent. Determine the rate of heat transfer to the river water.

(3 marks)

(ii) Draw a *P-V* diagram of the Carnot cycle, and label the four processes that involved in the cycle.

(2 marks)

(iii) An inventor claims to have devised a cyclical engine for the use in space vehicles that operates with a nuclear-fuel-generated energy source whose temperature is 550 K and a sink at 300 K that radiates waste heat to deep space. He also claims that this engine produces 5 kW while rejecting heat at a rate of 15,000 kJ/h. Is this claim valid? Please prove your answer with calculation.

(5 marks)

(b) (i) Please write down the Kelvin-Planck statement.

(1 marks)

(ii) Please draw a schematic diagram of a refrigeration system with its four basic components. Include the flow direction of its work, heat and working fluid together with the appropriate labels.

(3 marks)

(iii) Refrigerant-134a enters the condenser of a residential heat pump at 800 kPa and 35°C at a rate of 0.018 kg/s and leaves at 800 kPa as a saturated liquid. If the compressor consumes 1.2 kW of power, determine the COP of the heat pump and the rate of heat absorption from the outside air.

(6 marks)

PART B

Q6 (a) (i) Consider a thermodynamic system that undergoes an irreversible process from state 1 to state 2. According to Clausius inequality, the entropy change of the system (ΔS_{sys}) will be influenced by the presence of entropy generation (S_{gen}) during the irreversible process. State and describe the governing relationship for this condition.

(3 marks)

(ii) A Carnot engine delivers 130 kW of power by operating between temperature reservoirs at 100 °C and 1200 °C. Calculate the entropy change of each reservoir and the net entropy change of the two reservoirs after 30 minutes of operation.

(7 marks)

(b) Steam enters an adiabatic steady flow nozzle with low velocity as saturated vapor at 6 MPa and expands as it exits the nozzle at 1.2 MPa with much higher velocity.

(i) Determine the exit velocity, in m/s.

(ii) Sketch the *T-s* diagram with respect to the saturation line for this process.

(10 marks)

– END OF QUESTION –

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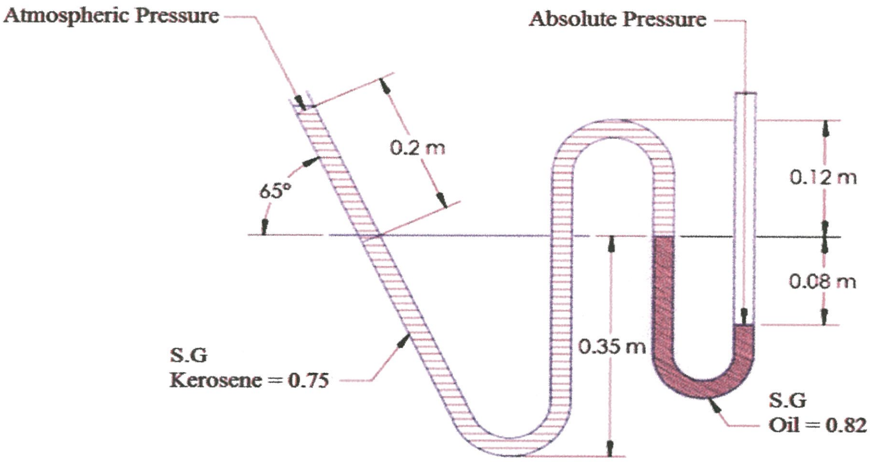

Figure Q1(a)

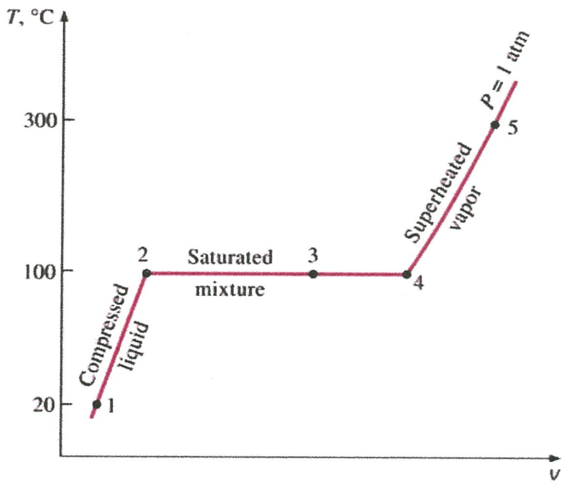

Figure Q2(a)

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Table Q2(b)

Case No.	Fluid Type	*P* (kPa)	*T* (°C)	*v* (m^3/kg)	*u* (kJ/kg)	Phase	Quality, *x* (-)
1	Water	200	30				
2	Water	270.28	130				0.68
3	R-134a		40	0.017794			
4	R-134a	200			249		

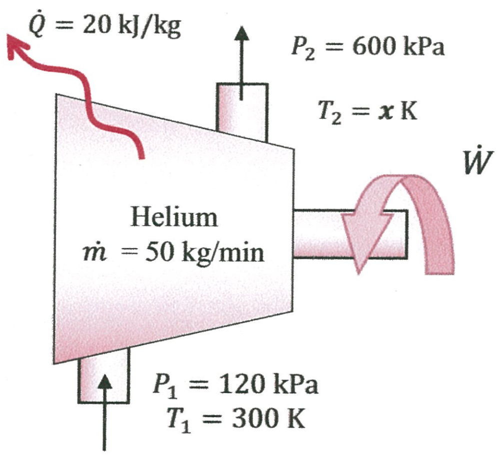

Figure Q4(a)

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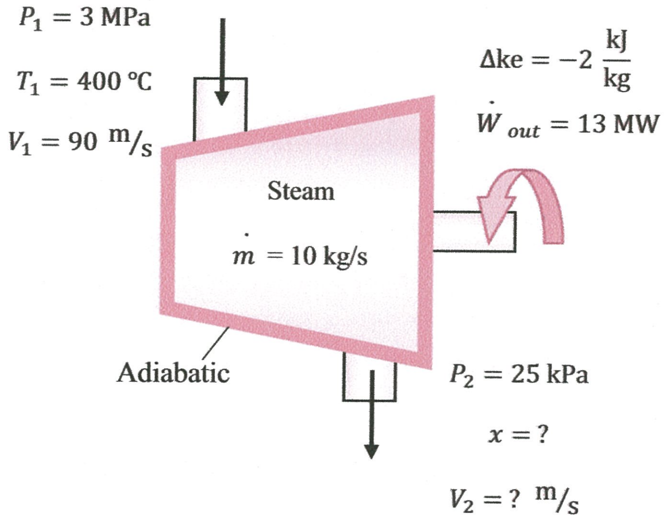

Figure Q4(b)