CONFIDENTIAL

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2018/2019

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|---|---|---|
| COURSE NAME | : | THERMODYNAMICS II |
| COURSE CODE | : | BDA 30403 |
| PROGRAMME | : | 3 BDD |
| EXAMINATION DATE | : | DECEMBER 2018/JANUARY 2019 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **FIVE (5)** QUESTIONS ONLY |

TERBUKA

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

**Q1** (a) Discuss how to increase the thermal efficiency of a steam power plant working on Rankine cycle.

(3 marks)

(b) In a a small steam power plant, the maximum steam temperature is limited to 400°C anf the pressure of 5 MPa. The steam from the turbine is exhausted to a condenser at 10 kPa. Assuming ideal processes. If the steam is superheated to 550°C, evaluate the changes in thermal efficiency and the quality of the steam.

(17 marks)

**Q2** (a) List and sketch the 4 processes of an ideal Brayton cycle.

(5 marks)

(b) Consider a simple ideal Brayton cycle with air as the working fluid. The pressure ratio of the cycle is 6, and the minimum and maximum temperatures are 300 K and 1300 K, respectively. Now the pressure ratio is doubled without changing the minimum and the maximum temperatures in the cycle. Assuming variable specific heats for air,

(i) show the initial process and process change in a T-s diagram;
(ii) calculate the change in the net work output per unit mass; and
(iii) determine the change in thermal efficiency of the cycle.

(15 marks)

**Q3** (a) Explain briefly why clearance is necessary in a compressor.

(3 marks)

(b) In a single-acting two-stage reciprocating air compressor 4.5 kg of air per minute are compressed from 1.013 bar and 15°C through a pressure ratio of 9 to 1. Both stages have the same pressure ratio, and the law of compression and expansion in bot stages is $pV^{1.3}$ =constant. If intercooling is complete, calculate the indicated power and the cylinder swept volumes required. Assume that the clearance volume of both stages are 5% of their respective swept volumes and the compressor runs at 300 rev/min.

(17 marks)

**Q4** Refrigerant-134a enters the compressor of a refrigerator as superheated vapor at 0.20 MPa and -5°C at a rate of 0.07 kg/s and leaves at 1.2 MPa and 70°C. The refrigerant is cooled in the condenser to 44 °C and 1.15 MPa, and it is throttled to 0.21 MPa.

(i) Show the cycle on a T-s diagram with respect to saturation lines;
(ii) Determine rate of heat removal from the refrigerated space and power input to the compressor;
(iii) Calculate isentropic efficiency of the compressor;
(iv) Estimate COP of the refrigerator.

(20 marks)

**Q5** (a) Discuss what is the difference between the specific humidity and the relative humidity.

(3 marks)

(b) A wet cooling tower is to cool 25 kg/s of cooling tower from 40 to 30°C at a location where the atmospheric pressure is 96 kPa. Atmospheric air enters the tower at 20°C and 70% relative humidity at 35°C. Neglecting power input to the fan, determine

(i) the volume flow rate of air into the cooling tower;
(ii) the mass flow rate of the required makeup water.

(17 marks)

**Q6** (a) State the differences between Otto Cycle and Diesel Cycle

(4 marks)

(b) A spark ignition (S.I.), 4-stroke engine, of a 50mm bore and 55mm stroke, with a compression ratio of 9.1:1 was installed on a 93kg motorcycle chassis. During cruising at 90km/hr, this motorcycle can achieve 55km/liter fuel economy with an average volumetric efficiency of 75%. Using appropriate assumptions, sketch the P-v diagram of the engine's operating cycle and calculate:

(i) the capacity of the engine;
(ii) the engine's clearance volume;
(iii) the mass of air used for combustion;

(iv) the motorcycle potential acceleration, if the total mass of the motorcycle and its rider is given at 155kg and the rider took 13 seconds to reach 60 km/hr; and

(v) the amount of energy loss due to the loss in the volumetric efficieny.

(16 marks)

**- END OF QUESTION –**

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List of Formula

$$bwr = \frac{w_{pump}}{w_{turbine}}$$

$$\eta_P = \frac{w_s}{w_a}$$

$$\eta_T = \frac{w_a}{w_s}$$

$$\eta_{th} = \frac{w_{net}}{q_{in}}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{(k-1)}{k}} = \left(\frac{P_3}{P_4}\right)^{\frac{(k-1)}{k}} = \frac{T_3}{T_4}$$

$$\epsilon = \frac{q_{regen_{actual}}}{q_{regen_{maximum}}}$$

$$IP = \frac{n}{n-1}\dot{m}R(T_2 - T_1)$$

$$Isothermal\,Power = \dot{m}RT \ln\frac{P_2}{P_1}$$

$$V_{in} = V_a - V_d$$

$$\eta_v = \frac{V_a - V_d}{V_s}$$

$$V_s = V_a - V_c$$

$$\frac{V_s}{V_c} = \left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}$$

$$COP_R = \frac{q_L}{w_{net,in}}$$

$$P = P_a + P_v$$

$$h_{dry\ air} = C_p T$$

$$\phi = \frac{\omega P}{(0.622 + \omega)P_g}$$

$$h = h_a + \omega h_g$$

$$\dot{Q}_{in} = \dot{m}_a(h_2 - h_1)$$

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$$\dot{Q}_{out} = \dot{m}_a(h_1 - h_2) - \dot{m}_w h_w$$

$$\dot{m}_{make\ up} = \dot{m}_a(\omega_2 - \omega_1) = \dot{m}_3 - \dot{m}_4$$

$$\dot{m}_3 h_3 = \dot{m}_a(h_2 - h_1) + (\dot{m}_3 - \dot{m}_{make\ up})h_4$$

$$\dot{m}_a = \frac{\dot{m}_3(h_3 - h_4)}{(h_2 - h_1) - (\omega_2 - \omega_1)h_4}$$

$$MEP = \frac{W_{net}}{V_s} = \frac{W_{net}}{V_{max} - V_{min}}$$

$$Q_{in} = mC_v(T_3 - T_2)$$

$$Q_{out} = mC_v(T_4 - T_1)$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{v_1}{v_2} = \left(\frac{P_2}{P_1}\right)^{\frac{1}{k}}$$

$$\frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{k-1}$$

$$r_c = \frac{P_3}{P_2} = \frac{T_3}{T_2} \quad cutoff\ ratio$$

$$r_v = \frac{v_1}{v_2} = \frac{V_1}{V_2}$$

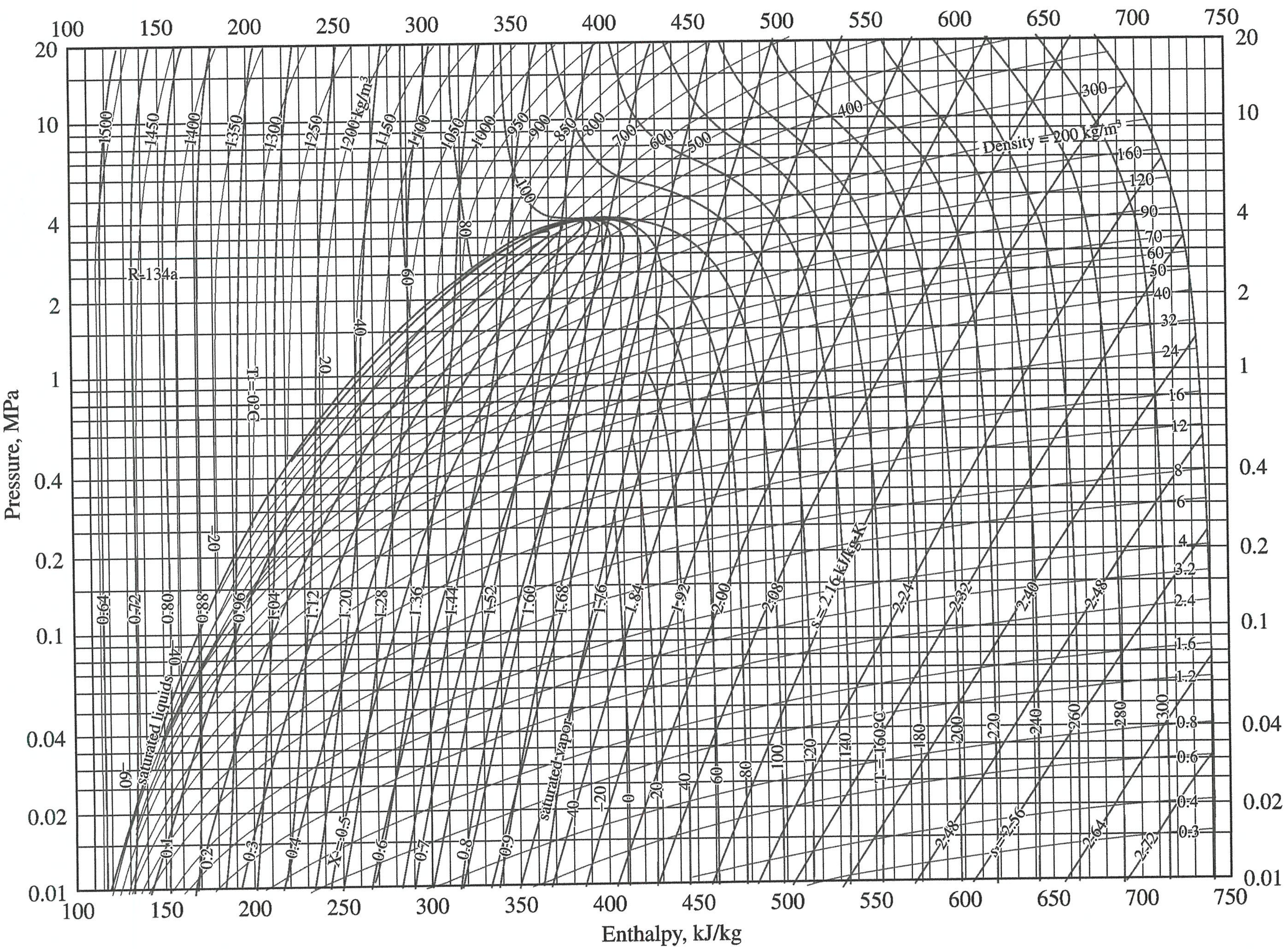
R-134a
Pressure, MPa
Enthalpy, kJ/kg
Density = 200 kg/m³
1200 kg/m³
s = 2.16 kJ/kg·K
T = 0°C
T = 160°C
X = 0.5
saturated liquids
saturated vapor

FIGURE A-14

# PSYCHROMETRIC CHART