CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2017/2018

COURSE NAME	:	THERMODYNAMICS II
COURSE CODE	:	BDA 30403
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2017 / JANUARY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS **ONLY** FROM ALL QUESTIONS.

TERBUKA

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

Q1 **Figure Q1** shows a steam power plant operating on the Rankine cycle. The plant used to supply power to two generators. Water enters the feed water pump in the saturated state at a pressure of 1.3 bar and out at a pressure of 20 bar. Steam has a maximum temperature of 330°C and expanded in high-pressure turbine to 10 bar before expanded in low-pressure turbine to the condenser pressure is reached. Isentropic efficiency of the high pressure turbine and low pressure are respectively 0.90 and 0.85. If the steam mass flow rate is 400kg/h, determine:

(i) the power of the two turbines;
(ii) the ratio of the plant work;
(iii) the thermal efficiency of the plant;
(iv) the specific steam consumption; and
(v) the power of the two plants where mechanical efficiency is 0.8.

(20 marks)

Q2 Air enters the compressor of a gas-turbine engine at 300 K and 100 kPa, where it is compressed to 700 kPa and 580 K. Heat is transferred to air in the amount of 950 kJ/kg before it enters the turbine. For a turbine efficiency of 86%. Determine:

(i) the fraction of turbine work output used to drive the compressor;
(ii) the thermal efficiency.

(20 marks)

Q3 In a single acting, two-stage reciprocating air compressor, 4.5 kg/min of air is compressed from 1.013 bar and 15°C surrounding conditions through a pressure ratio of 9 to 1. Both stages have the same pressure ratio, and the law of compression and expansion in both stages is $PV^{1.3}=C$. The clearance volume of both stages are 5% of their respective swept volumes and it runs at 300 rpm. If inter cooling is complete. Determine:

(i) Indicated power;
(ii) Volumetric efficiency;
(iii) Cylinder swept volumes required.

(20 marks)

Q4 (a) Why is the reversed Carnot cycle executed within the saturation dome not a realistic model for refrigeration cycles?

(2 marks)

(b) A refrigeration uses refrigerant 134-a as the working fluid and operates on an ideal vapor compression refrigeration cycle between 0.12 MPa and 0.7 MPa. The mass flow rate of the refrigerant is 0.05 kg/s. Show the cycle on a T-s diagram with respect to saturation lines. Determine

(i) the rate heat of the removal from the refrigerated space and the power input to the compressor
(ii) the rate of heat rejection to the environment
(iii) the coefficient of performance

(18 marks)

Q5 (a) Draw a schematic diagram of a natural-draft wet cooling tower, and explain how does it work.

(4 marks)

(b) A wet cooling tower (**Figure Q5**) is to cool 60 kg/s of water from 40°C to 26°C. Atmospheric air enters the tower at 1 atm with dry and wet temperatures of 22°C and 16°C, respectively, and leaves at 34°C with a relative humidity of 90%. Using the psychometric chart, determine

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

(16 marks)

Q6 (a) Sketch the P-v diagram for ideal Otto cycle and ideal Diesel cycle.

(3 marks)

(b) An ideal Otto cycle with a specified compression ratio is executed using (a) air, (b) argon and (c) ethane as the working fluid. For which case will the thermal efficiency be the highest? Explain why.

(2 marks)

(c) The compression ratio of an air-standard Otto cycle is 9.5. Prior to the isentropic process, the air is at 100kPa, 35°C, and 600 cm3. The temperature at the end of the isentropic expansion process is 800 K. Using specific heat values at room temperature, determine

(i) the highest temperature and pressure in the cycle
(ii) the amount of heat transferred in, in kJ
(iii) the thermal efficiency
(iv) the mean effective pressure

(20 marks)

- END OF QUESTIONS -

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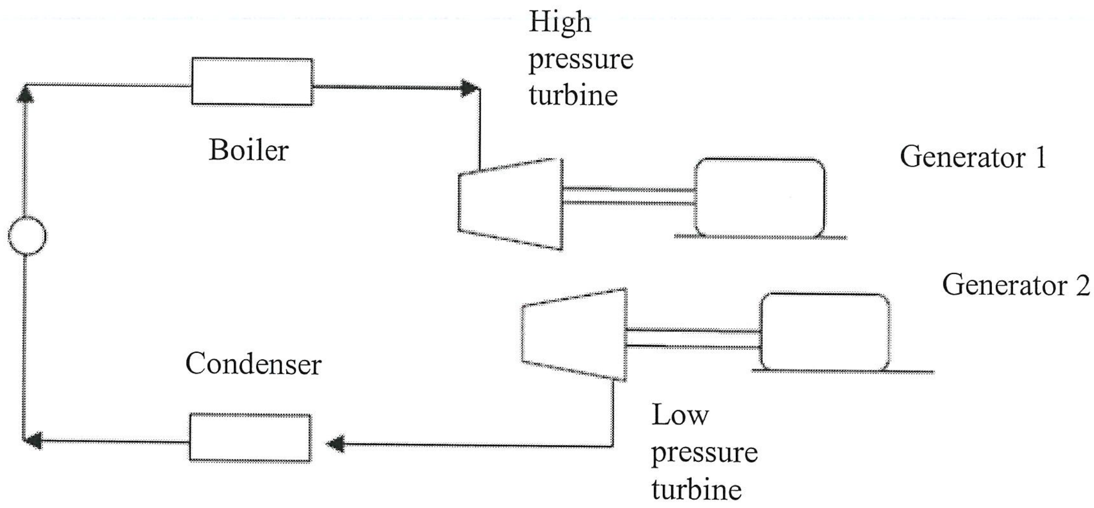

Figure Q1

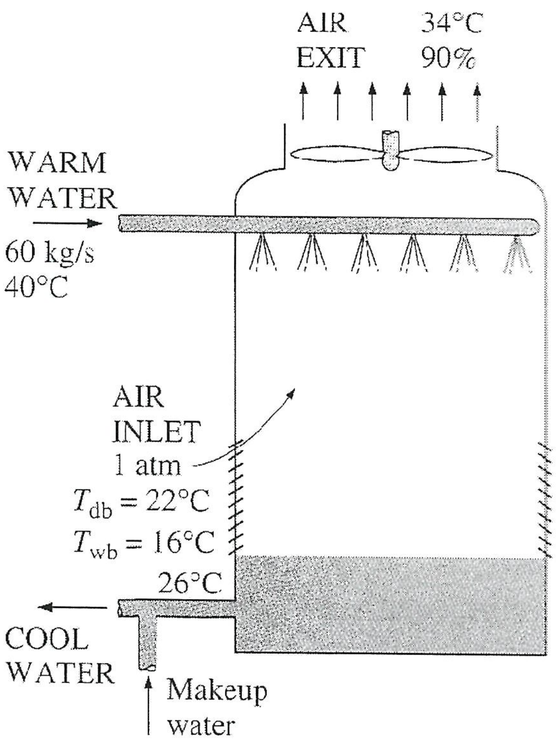

Figure Q5

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Formula

1. *Isentropic relationship and thermal efficiency of Brayton cycle under cold-air-standard assumptions :*

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(k-1)/k} , \qquad \eta_{th,Brayton} = 1 - \frac{1}{r_p^{(k-1)/k}}$$

2. *Compressor work per cycle:*

$$w_{poly} = \frac{n}{n-1} R T_1 \left(\frac{T_2}{T_1} - 1\right) , \qquad w_{isen} = \frac{k}{k-1} R T_1 \left(\frac{T_2}{T_1} - 1\right) , \qquad w_{iso} = R T_1 \ln \frac{P_2}{P_1}$$

3. *Free Air Delivery (FAD) :* $\text{FAD} = V_a = V_{in} \dfrac{T_a p_1}{T_1 p_a}$

4. *Volumetric efficiency:* $\eta_v = \dfrac{V_{in}}{V_{swept}}$ *or* $\eta_v = 1 - \dfrac{V_c}{V_s}\left(\left(\dfrac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right)$

5. *Indicated Power for z-Stages Compressor :* $\dot{W} = z * \dfrac{n-1}{n} \dot{m} R T_1 \left(\left(\dfrac{P_2}{P_1}\right)^{(n-1)/zn} - 1\right)$

6. *The atmospheric air pressure :* $P = P_a + P_v$

7. *The enthalpy of water vapor in air :* $h_g(T) \cong 2500.9 + 1.82T$ (T in °C)

8. *The enthalpy of dry air :* $h_a = C_p T$

9. *The enthalpy of atmospheric air :* $h = h_a + \omega h_g$

10. *Specific humidity :* $\omega = \dfrac{m_v}{m_a} = 0.622 \dfrac{P_v}{P_a}$ (kg H_2O/ kg dry air)

11. *Relative humidity :* $\phi = \dfrac{m_v}{m_g} = \dfrac{P_v}{P_g}$

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