UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	THERMODYNAMICS II
COURSE CODE	:	BDA 30403
PROGRAMME	:	BDD
EXAMINATION DATE	:	JANUARY/FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	**PART A**: ANSWER **TWO (2)** QUESTIONS **ONLY** FROM **THREE (3)** QUESTIONS. **PART B**: ANSWER **ALL** QUESTIONS.

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

PART A: ANSWER TWO (2) QUESTIONS ONLY FROM THREE (3) QUESTIONS.

Q1 (a) With the help of T-s diagram, differentiate between the Carnot cycle and the Rankine cycle.

(4 marks)

(b) Consider a coal-fired steam power plant that produces 300 MW of electric power. Steam at 4 MPa, 300°C leaves the boiler and enters the high pressure turbine and is expanded to 400kPa. The steam then reheated to 300°C and expanded in low pressure turbine to 10 kPa. Show the cycle on a T-s diagram with respect to saturation lines, and determine;

(i) the thermal efficiency of the cycle;

(ii) the mass flow rate of the steam; and

(iii) the temperature rises of the cooling water if the steam is cooled in the condenser by running cooling water from a lake through the tubes of the condenser at a rate of 2000 kg/s.

(16 marks)

Q2 (a) Explain the four processes make up the simple ideal Brayton cycle.

(4 marks)

(b) The 7FA gas turbine manufactured by General Electric operates on an ideal regenerative Brayton cycle with air as the working fluid. Air enters the compressor at 95 kPa and 290 K and the turbine at 760 kPa and 1100 K. Heat is transferred to air from an external source at a rate of 75,000 kJ/s. If the effectiveness of the regenerator is 90 percent. By assuming constant specific heats for air at room temperature, determine;

(i) the net work output;

(ii) the thermal efficiency of the cycle; and

(iii) the power delivered by this plant.

(iv) If the effectiveness of the regenerator is 100 percent, determine the power delivered and compare with (iii).

(16 marks)

Q3 (a) A single stage reciprocating compressor takes 1 m^3 of air per minutes at 1 013 bar and 15°C and delivers it at 7 bar. Assuming that the law of compression is $pV^{1.35}$=constant, and that clearance is negligible, calculate the indicated power in kW.

(8 marks)

(b) Another single stage single acting reciprocating air compressor is required to manipulate 30 m^3 of free air per hour measured at 1 013 bar. The required output pressure is 6.5 bar at operating speed 450 rpm. Allowing volumetric efficiency of 75%; an isothermal efficiency of 76% and mechanical efficiency of 80%; calculate the indicated mean effective pressure and the power required by the compressor.

(12 marks)

PART B: ANSWER ALL QUESTIONS.

Q4 (a) Describe the term isentropic compressor.

(2 marks)

(b) Consider a two-stage cascade refrigeration system as in **Figure Q4(b)** operating between the pressure limits of 1.4 MPa and 160 kPa with refrigerant 134a as the working fluid. Heat rejection from the lower cycle to the upper cycle takes place in an adiabatic counterflow heat exchanger where the pressure in the upper and lower cycles are 0.4 and 0.5 MPa, respectively. In both cycles, the refrigerant is a saturated liquid at the condenser exit and a saturated vapor at the compressor inlet,

and the isentropic efficiency of the compressor is 80 percent. If the mass flow rate of the refrigerant through the lower cycle is 0.11 kg/s, determine;

(i) the mass flow rate of the refrigerant through the upper cycle;

(ii) the rate of heat removal from the refrigerated space; and

(iii) determine the COP of this refrigerator.

(18 marks)

Q5 (a) Sketch the Diesel Cycle and the theoretical Dual Cycle. Indicate the main differences between the two cycles and explain why Dual Cycle is considered to be better than both Diesel and Otto Cycles.

(6 marks)

(b) A spark ignition (S.I.), 4-stroke engine, of a 57 mm bore and 58.7 mm stroke, with a compression ratio of 10.4:1 was installed on a 120 kg motorcycle chassis. During cruising at 90 km/h, this motorcycle can achieve 2.6 litres/100 km 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 engine's clearance volume;

ii) the motorcycle potential acceleration, if the total mass of the motorcycle and its rider is given at 180 kg and the rider took 13 seconds to reach 60 km/h; and

iii) the amount of energy loss due to the loss in the volumetric efficiency.

(14 marks)

Q6 (a) Moist air is passed through a cooling section where it is cooled and dehumidified. Explain how (i) the specific humidity and (ii) the relative humidity of air change during this process.

(4 marks)

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

(i) the volume flow rate of air into the cooling tower, and

(ii) the mass flow rate of the required makeup water.

(16 marks)

– END OF QUESTION –

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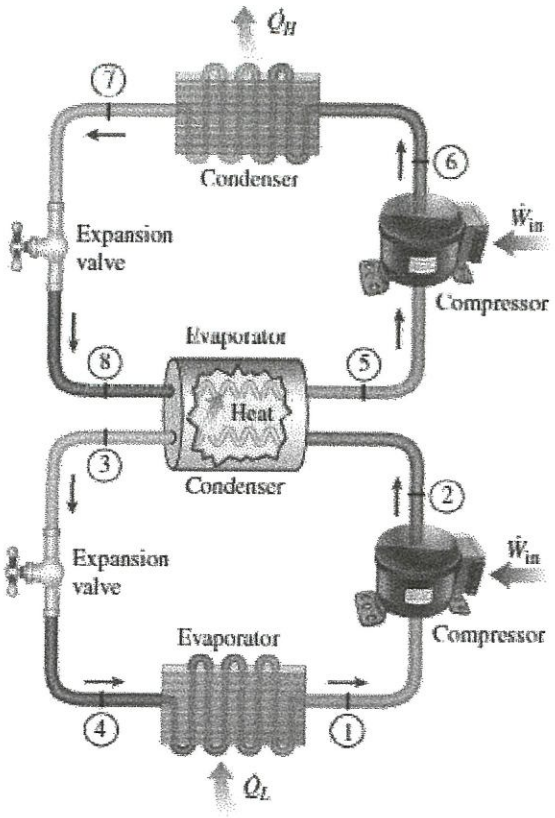

Figure Q4(b)

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