Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	THERMODYNAMICS II
COURSE CODE	:	BDA 30403
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. **PART A**: ANSWER **THREE (3)** QUESTIONS **ONLY** FROM **FOUR (4)** QUESTIONS. **PART B**: ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

PART A: ANSWER THREE (3) QUESTIONS ONLY FROM FOUR (4) QUESTIONS.

Q1 (a) Discuss briefly the four processes in the Rankine cycle.

(3 marks)

(b) Consider a 45 MW steam power plant that operates on a simple ideal Rankine cycle. Steam enters the turbine at 7 MPa and 500°C and is cooled in the condenser at a pressure of 10 kPa by running cooling water from a lake through the tubes of the condenser at a rate of 2000 kg/s. 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 rise of the boiling water.

(17 marks)

Q2 (a) An aviation machine can use gas turbines as the main propulsion system. Elaborate the advantages of this selection.

(4 marks)

(b) Helium is used as the working fluid in an ideal Brayton cycle. Gas enters the compressor at 27°C and 20 bar and is discharged at 60 bar. The gas is heated to 1000 °C before entering the turbine. The cooler returns the hot turbine exhaust to the temperature of the compressor inlet. Take $C_p = 5.1926$ kJ/kg.K. Determine;

(i) the temperatures at the end of compression and expansion;

(ii) the heat supplied, the heat rejected and the net work per kg of He; and

(iii) the cycle efficiency and the heat rate.

Q3 (a) Discuss the importance of clearance volume.

(2 marks)

(b) A single stage, single-acting compressor delivers 3 m^3/min of air measured at pressure of 1.014 bar and 23°C. During induction, pressure and temperature or air is 0.98 bar and 43°C respectively. Delivery pressure is 6.5 bar and crank speed is 358 rpm. The clearance volume is 5% of swept volume and the compression index is 1.3. Calculate;

i) indicated power; and

ii) volumetric efficiency.

(18 marks)

Q4 (a) Differentiate the actual vapor-compression refrigeration cycle and the two-stage cascade refrigeration cycle. Use appropriate sketches for the explanation.

(4 marks)

(b) Consider a two-stage cascade refrigeration systems operating between the pressure limit of 1.2 MPa and 200 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. Show the cycle on a T-s diagram with respect to saturation lines, and if the mass flow rate of the refrigerant through the lower cycle is 0.15 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) COP of the refrigerator.

(16 marks)

PART B: ANSWER ALL QUESTIONS

Q5 (a) Explain four processes that make up the air-standard diesel cycle by using a P-V diagram.

(3 marks)

(b) A four-cylinder two-stroke 2.0 L diesel engine that operates on an ideal Diesel cycle has a compression ratio of 22 and a cutoff ratio of 1.8. Air is at 70°C and 97 kPa at the beginning of compression process. Using the cold-air standard assumptions, determine how much power the engine will deliver at 2300 rpm.

(17 marks)

Q6 (a) Differentiate between natural-draft and forced-draft cooling tower.

(3 marks)

(b) The cooling water from condenser of the power plant enters a cooling tower at 35°C at the rate of 100 kg/s. The water is cooled to 22°C in the cooling tower by air that enters the tower at 1 atm, 20°C, and 60% relative humidity and leaves saturated at 30°C. Neglecting the power input to the fan. Determine;

i) indicated power; and

ii) volumetric efficiency.

(17 marks)

– END OF QUESTION –

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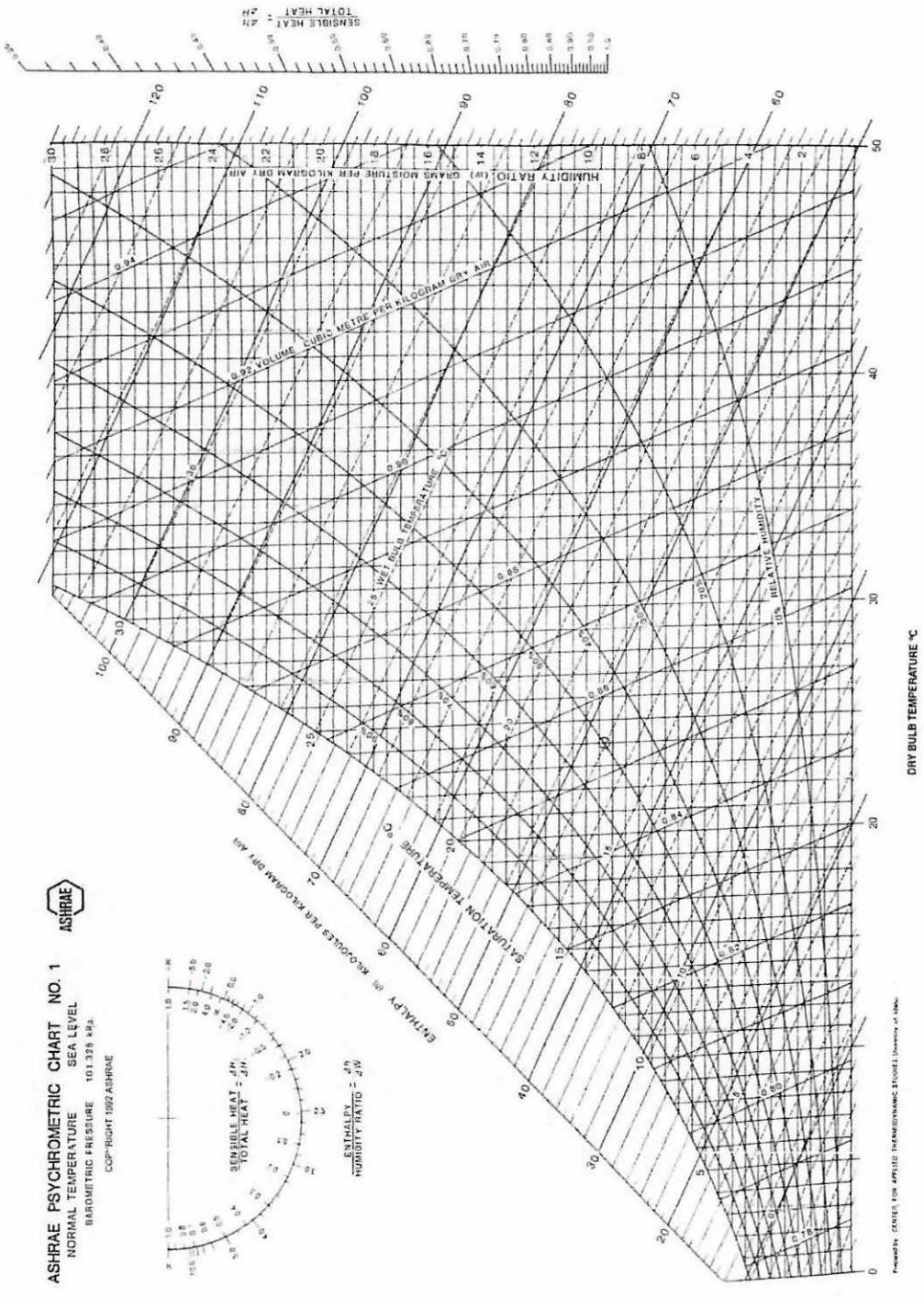

Figure Q6(b)