Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER 2
SESSION 2020/2021

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

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

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

Q1 (a) Demonstrate the modifications that can be carried out to improve the performance of the power plants.

(2 marks)

(b) Construct the ideal Rankine cycle with three stages of reheating on a T-s diagram. Assume the turbine inlet temperature is the same for all stages. Justify how does the cycle efficiency vary with the number of reheat stages.

(2 marks)

(c) A steam power plant operates on the reheat Rankine cycle. Steam enters the high-pressure turbine at 12.5 MPa and 550°C at a rate of 7.7 kg/s and leaves at 2 MPa. Steam is then reheated at constant pressure to 450°C before it expands in the low-pressure turbine. The isentropic efficiencies of the turbine and the pump are 85 percent and 90 percent, respectively. Steam leaves the condenser as a saturated liquid. If the moisture content of the steam at the exit of the turbine is not to exceed 5 percent, evaluate;

(i) the condenser pressure;

(ii) the net power output; and

(iii) the thermal efficiency.

(16 marks)

Q2 (a) Identify the effectiveness of a regenerator and demonstrate why the enthalpy value before the turbine expansion process is important.

(6 marks)

b) A gas-turbine engine operates with 2-stage compression and 2-stage expansion. It receives incoming air at 100 kPa and 25°C before the air passes through a regeneration, reheating and intercooling processes. Across each compressor, the pressure ratio is 3.8, with 300 kJ/kg of heat are received by the air at each combustion chamber. The generator is operating perfectly and increases the cold air temperature by 22°C. Assuming isentropic operations during compression and expansion stages, with constant specific heats at room temperature, evaluate the system's thermal efficiency.

(14 marks)

Q3 (a) A three-stage, single-acting reciprocating compressor running at 1.013 bar and 15°C has a FAD of 2.83 m^3/min. The suction pressure and temperature are 0.98 bar and 32°C respectively and the delivery pressure is 70 bar. Assuming complete intercooling n=1.3 and that the compressor is designed for minimum work, solve the indicated power in kW.

(8 marks)

(b) In a single-acting two-stage reciprocating air compressor, 4.5 kg of air per min 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 $PV^{1.3}$=constant. Assume that the clearance volume of both stages is 5% of their respective swept volumes and that the compressor runs at 300 rev/min. Evaluate;

(i) the indicated power; and

(ii) the cylinder swept volumes required.

(12 marks)

PART B: ANSWER ALL QUESTIONS.

Q4 (a) You are working in an engineering company in South Korea. Your boss wanted to know whether a heat pump system will be more cost-effective in Jeju Island or Seoul? Justify your reasons.

(2 marks)

(b) Your boss also asks you to solve this problem: R-134a enters the condenser of a residential heat pump at 800kPa and 55°C at a rate of 0.018 kg/s and leaves at 750kPa subcooled by 4°C. The R-134a enters the compressor at 200kPa superheated by 4°C. Construct a T-s diagram and evaluate;

(i) the isentropic efficiency of the compressor;

(ii) the rate of heat supplied to the heated room;

(iii) the COP of the heat pump; and

(iv) the COP and the rate of heat supplied to the heated room if this heat pump operated on the ideal vapour compression cycle between the pressure limits of 200 and 800kPa.

(18 marks)

Q5 (a) Differentiate between Otto Cycle and Dual Cycle.

(4 marks)

(b) The compression ratio of an air-standard dual cycle is 12 and a cutoff ratio of 1.3. The pressure ratio during the constant-volume heat addition process is 1.5. This cycle is operated at 100 kPa and 20°C at the beginning of the compression. By using the constant specific heats at room temperature, evaluate;

(i) the maximum gas pressure;

(ii) the maximum gas temperature;

(iii) amount of heat added; and

(iv) thermal efficiency.

(16 marks)

Q6 (a) A 12 m^3-tank contains saturated air at 33°C, 100 kPa. Determine;

(i) the mass of dry air;

(ii) the specific humidity, and

(iii) the enthalpy of the air per unit mass of the dry air.

(3 marks)

(b) An air-conditioning system operates at a total pressure of 1 atm and consists of a heating section and a humidifier that supplies wet steam (saturated water vapour) at 100°C. Air enters the heating section at 10°C and 70 percent relative humidity at a rate of 0.6 m^3/s, and it leaves the humidifying section at 20°C and 60 percent relative humidity. Evaluate;

(i) the temperature and relative humidity of air when it leaves the heating section;

(ii) the rate of heat transfers in the heating section, and

(iii) the rate at which water is added to the air in the humidifying section.

(17 marks)

– END OF QUESTION –

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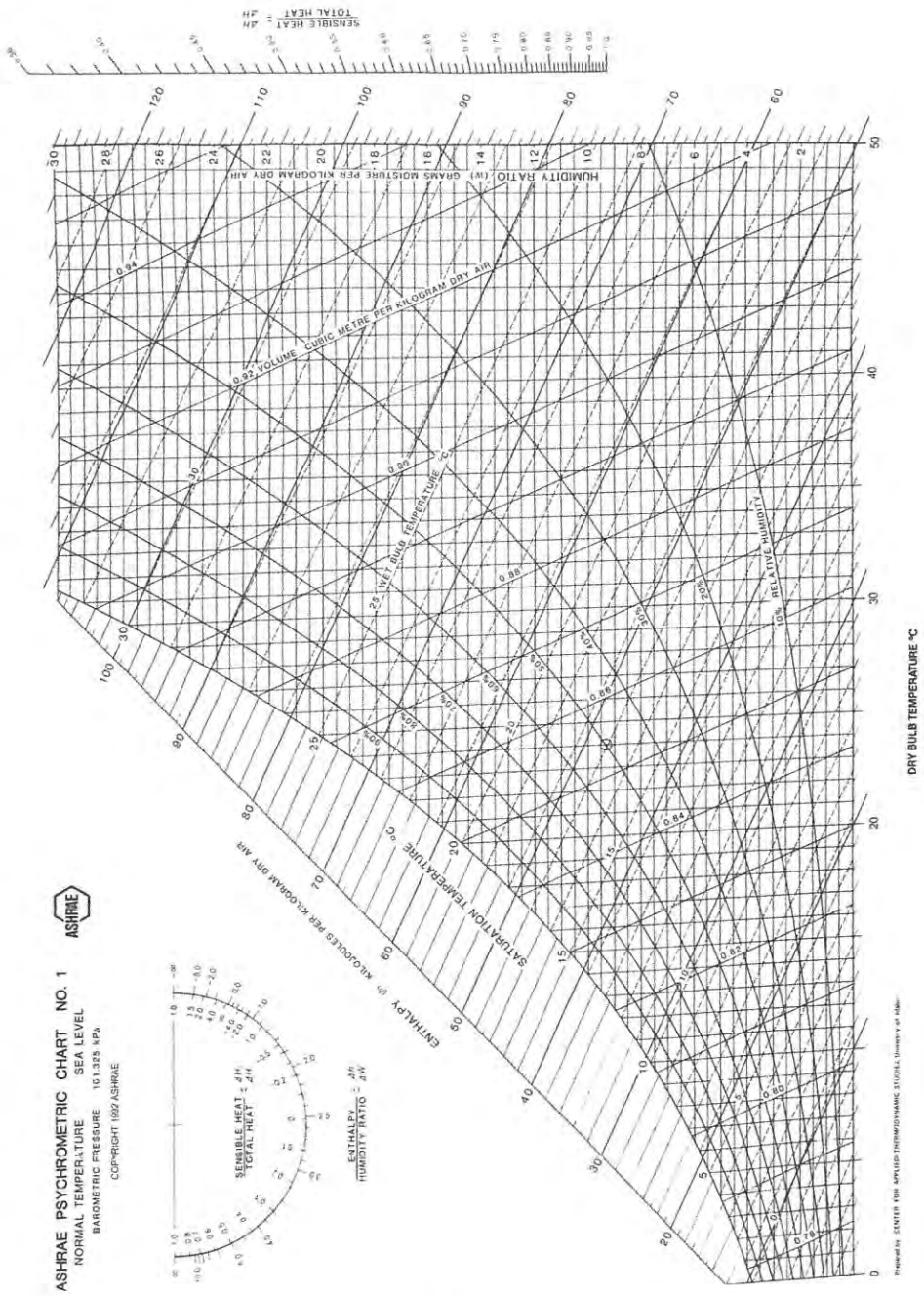

Figure Q6(b)