Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	THERMODYNAMICS II
COURSE CODE	:	BDA 30403
PROGRAMME	:	3 BDD
EXAMINATION DATE	:	JUNE/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY FROM SIX (6) QUESTIONS

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

Q1 (a) State the methods of improving thermal efficiency of a steam power plant working on Rankine cycle and evaluate them with necessary diagrams.

(5 marks)

(b) An ideal reheat–regenerative steam power plant with one open feedwater heater generates 150 MW energy from the electric generator directly couple to steam turbine.The boiler pressure is 10 MPa, the condenser pressure is 15 kPa, the reheater pressure is 1 MPa, and the feedwater pressure is 0.6 MPa. Steam enters both the high- and low-pressure turbines at 500°C. The quality at turbine exhaust is 0.9665. Based on T-s diagram and by neglecting the pumps work, determine;

(i) the fraction of steam extracted for regeneration,
(ii) the thermal efficiency of the cycle, and
(iii) the mass flow rate of steam through the boiler.

(20 marks)

Q2 In a regenerative gas-turbine engine, air is compressed from 300 K and 100 kPa to 580 K and 800 kPa. Using a regenerator with 70% effectiveness, air enters the turbine at 1200 K. The turbine operates with 86% efficiency. Assume variable specific heats for air. Based on T-s diagram determine;

(i) the amount of heat transfer in the regenerator, and
(ii) cycle thermal efficiency.

(20 marks)

Q3 (a) With an aided of appropriate sketch, explain working cycle of multi-staging compressor.

(5 marks)

(b) 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 is 5% of their respective swept volumes and it runs at 300 rpm. If intercooling is complete, calculate;

(i) indicated power,
(ii) volumetric efficiency, and
(iii) cylinder swept volume required.

(15 marks)

Q4 (a) Sketch the T-s diagram of a two-stage cascade refrigeration system. Identify the influential parameters and explain the advantages of this refrigeration system.

(4 marks)

(b) Consider a two-stage cascade refrigeration system operating between the pressure limits of 1.2 MPa and 200 kPa with refrigerant-134a as the working fluid. The refrigerant leaves the condenser as a saturated liquid and is throttled to a flash chamber operating at 0.45 MPa. Part of the refrigerant evaporates during this flashing process, and this vapor is mixed with the refrigerant leaving the low-pressure compressor. The mixture is then compressed to the condenser pressure by the high-pressure compressor. The liquid in the flash chamber is throttled to the evaporator pressure and cools the refrigerated space as it vaporizes in the evaporator. The mass flow rate of the refrigerant through the low-pressure compressor is 0.15 kg/s. Assuming the refrigerant leaves the evaporator as a saturated vapor and the isentropic efficiency is 80% for both compressors, determine:

(i) the mass flow rate of the refrigerant through the high-pressure compressor; and
(ii) the rate of heat removal from the refrigerated space.

(16 marks)

Q5 (a) What is compression ratio and explain how it affects the thermal efficiency of the Otto cycle.

(3 marks)

(b) A four-stroke four-cylinder SI car engine operates on the ideal Otto cycle which uses air as the working fluid. The pressure and temperature before the compression process is 100 kPa and 15°C respectively. The maximum temperature the engine cylinder can tolerate is 1800°C. The clearance volume is 15% of the volume when the piston is at the bottom dead center. Using the cold-air-standard assumptions,

(i) show the cycle process in a p-V diagram;
(ii) determine the compression ratio;
(iii) the net work output; and
(iv) the thermal efficiency of the cycle.

(17 marks)

Q6 (a) Describe the process of evaporative cooling and state the limitation of this kind of cooling method.

(4 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% relative humidity at a rate of 35 m^3/min. It then leaves the humidifying section at 20°C and 60% relative humidity.

(i) Sketch the system diagram;
(ii) Determine the temperature and relative humidity of air when it leaves the heating section;
(iii) Determine the rate of heat transfer in the heating section; and
(iv) Determine the rate at which water is added to the air in the humidifying section.

(16 marks)

- END OF QUESTION -

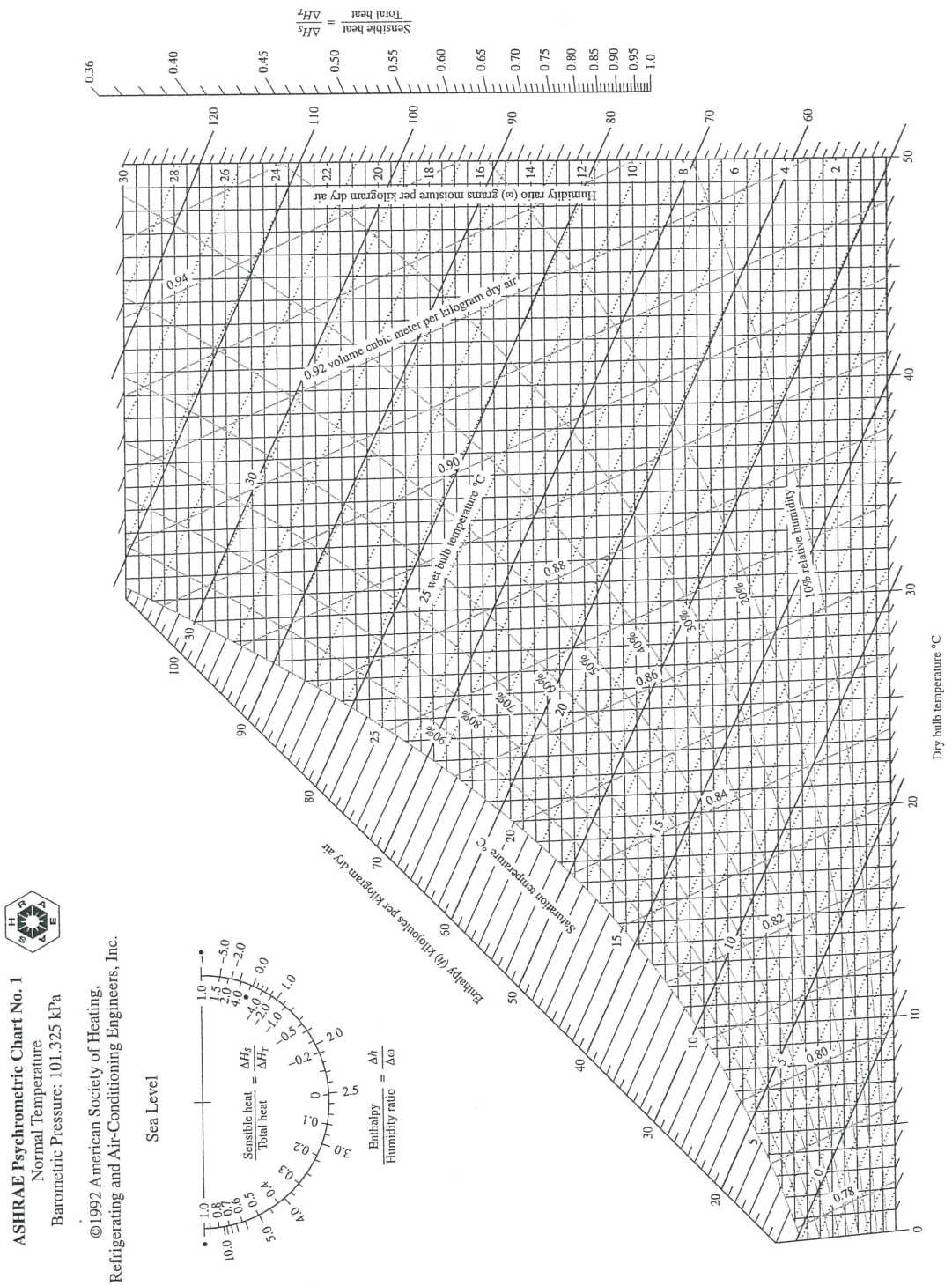

FIGURE A–31
Psychrometric chart at 1 atm total pressure.

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