TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
Diploma in Marine Engineering
EMR 2217**:** Thermo-Fluids II
SPECIAL/ SUPPLEMENTARY EXAMINATION
SERIES: AUGUST 2019
TIME: 2 HOURS
DATE: Pick Date **August 2019**

Instruction to Candidates:

You should have the following for this examination

- *Student I.D. Card & Examination Pass*
- *Answer booklet*
- *Non-Programmable scientific calculator*
- *Table of Thermodynamic and Transport Properties of Fluids (Steam Tables)*

This paper consists of **FIVE** questions. Attempt any **THREE** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.

Question ONE

a) State the flow equation for a mixing chamber and define the terms used. (3 marks)

b) 1 kg of air, at 75^{o}C, is heated at constant pressure of 3 bar until its volume is increased to 0.5 m^{3}. Determine the heat supplied and the work done. Take c_p = 1.005 kJ/kg-K (7 marks)

c) A well steam turbine develops an output power of 8 MW. The inlet and the outlet conditions of the steam are as indicated in the Fig Q1 (c). Determine: (10 marks)

i) The work done per unit mass of the steam flowing through the turbine

ii) The mass flow rate of the steam through the turbine.

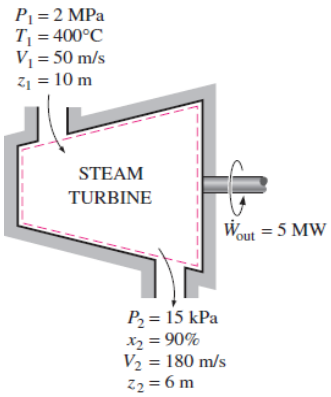

Fig Q1(c)

Question TWO

a) Sketch a reversed Carnot cycle on a T-s diagram and describe the cycle events. (6 marks)

b) The pressure in the evaporator of ammonia refrigerator is 2 atmospheres and the pressure in the condenser is 11.67 bar. For a cycle where dry saturated vapour is delivered to the compressor where it is compressed isentropically, with no undercooling of the condensed liquid, determine the refrigerating effect per unit mass of refrigerant and the COP_{ref}. Sketch the cycle on a *T-s* diagram (14 marks)

Question THREE

a) What is heat transfer? (1 mark)

b) State the Newton's Law of Cooling. (2 marks)

c) Show that for a cylindrical pipe of internal radius R_1 and outside radius R_2, the inside and outside surface temperatures, T_1 and T_2, respectively, and unit length, the heat transfer rate is given by the relation; (6 marks)

$$\dot{Q} = \frac{2\pi k(T_1 - T_2)}{\ln(R_2/R_1)}$$

d) A furnace wall consists of 300 mm firebrick, 170 mm insulating brick, and 320 mm building brick. The inside wall is at a temperature of 550 °C and the atmospheric temperature is 25 °C. The heat transfer coefficient for outside surface is 11 W/m² K, and the thermal conductivities of the firebrick, insulating brick, and building brick are 1.5, 0.4, and 0.9 W/m-K, respectively. Neglecting radiation, calculate the rate of heat loss per unit wall surface area and the temperature of the outside wall surface of the furnace. (11 marks)

Question FOUR

a) Sketch Brayton's cycle on a *p-v* diagram and describe each process (4 marks)

b) State the expression for determining the thermal efficiency for an Otto cycle based on compression ratio (2 marks)

c) The minimum pressure and temperature in an Otto cycle are 98 kPa and 24°C respectively. The amount of heat added to the air per cycle is 1500 kJ/kg and the compression ratio is 11:1. Determine (14 marks)

i) The pressures and temperatures at all points of the air standard Otto cycle.

ii) The thermal efficiency of the cycle.

(Take for air: Cv = 0.72 kJ/kg-K, and γ = 1.4.)

Question FIVE

a) State the Second Law of Thermodynamics. (2 marks)

b) 1.27 kg of steam enters a turbine at a pressure of 105 bar and entropy 4.8 kJ/kg-K. It is then allowed to expand isothermally and reversibly in the turbine, and exit at a pressure of 15 bar. Calculate:

i) The total heat supplied steam during this process (7 marks)

ii) The work done per unit kilogram of steam during this process. (5½ marks)

iii) If the steam flowrate through the turbine is 0.8 kg/s, determine the power developed by the turbine (2 marks)

iv) Sketch the process on a *T-s* diagram indicating the area which represents the heat supplied (3½ marks)