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
END OF SEMESTER 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) Write the integral equation showing the change in entropy as relates to the Second Law of thermodynamics defining the terms used. (3 marks)

b) 1kg of steam at 10 bar and dryness fraction of 0.93 expands isothermally and reversibly in a cylinder behind a piston to a pressure of 1.5 bar. If the heat supplied during the process is 545 kJ/kg, determine (10 marks)
   i) The change in specific internal energy of the steam
   ii) The work done.

c) 0.7 kg of air, at 100^{o}C, is heated at constant pressure of 1.5 bar until its volume is increased to 0.07 m^{3}. Determine the heat supplied and the work done.

Take C_p= 1.005 kJ/kg-K (7 marks)

Question TWO

a) Sketch a schematic diagram showing a simple vapour compression system as used in refrigeration systems (5 marks)

b) A refrigerator uses Refrigerant (R) 134a. The condenser and the evaporator pressures are 14.91 bar and 2.006 bar respectively. A dry saturated vapour is delivered to the compressor, which, after condensing, the liquid is undercooled by 20 K. Calculate: (15 marks)

i) The refrigeration effect per unit mass of refrigerant

ii) The COP_{ref}

Question THREE

a) Starting from the general steady flow energy equation, show that, for an adiabatic mixing chamber with two inlets A and B and one exit E, the flow equation is given by:

$$\dot{m}_a(h_e - h_a) = \dot{m}_b(h_b - h_e)$$

Where $\dot{m}_a$ and $\dot{m}_b$ are flowrates at A and B respectively and h are respective enthalpies at inlets and exit. (6 marks)

b) Air at 40°C enters a mixing chamber at the rate of 225 kg/s where it mixes with air at 15°C entering at a rate of 540 kg/s. Calculate the temperature of air leaving the chamber, assuming steady-flow conditions. Assume that the heat loss is negligible. (3 marks)

c) Steam at 3Mpa and 400 C enters an adiabatic nozzle steadily with a velocity of 40 m/sec and leaves at 2.5 MPa and 300 m/sec. Determine,

i) The exit temperature and

ii) The ratio of inlet to exit area.

iii) Sketch the process on a *pv* –diagram

(11 marks)

Question FOUR

a) Differentiate between Convection and Conduction (2 marks)

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

c) Show that from Fourier's Law of conduction, the rate of flow of heat through a solid is given by;

$$\dot{Q} = \frac{kA}{x}(T_1 - T_2)$$

Where T_1 *and* T_2 are temperatures of hot and cold surface respectively.

(8 marks)

d) Water at 100 ^oC flows through a 36 mm bore steel pipe of 5 mm thickness, and the atmospheric temperature is 20 ^oC. The thermal conductivity of steel is 50 W/m K and the inside and outside heat transfer coefficients are 2650 and 17 W/m^2 K respectively. Neglecting radiation, calculate;

i) The rate of heat loss per unit length of pipe

ii) The temperature of the outside surface of the pipe

(8 marks)

Question FIVE

a) Sketch the Carnot cycle on a *p-v* diagram and describe each process (5 marks)

b) An engine operates on the theoretical diesel cycle with a compression ratio of 22. At the beginning of the compression process, the pressure and temperature of the air are 100 kPa and 23^oC. If the maximum cycle temperature is 1150 ^oC and the mass flow rate is 1.2 kg/s, determine:

(13 marks)

i) Temperatures at the end of compression and expansion processes
ii) The cut-off ratio
iii) The thermal efficiency of the cycle
iv) The output power from the engine

(Take γ = 1.4 for air, and c_p= 1.005 kJ/kg K)