TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIOS FOR:

THE DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

(BSME)

EMG 2206: ENGINEERING THERMODYNAICS I

END OF SEMESTER EXAMINATION

SERIES: APRIL 2016

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES

1. You should have the following for this examination:
   - **Answer Booklet**
   - **A Non-Programmable Scientific Calculator**
   - **Thermodynamic and Transport Properties of Fluids (SI Edition) by Y.R Mayhew and G.F.C Rogers**
2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. All questions carry equal marks.
5. **This paper consists of SIX printed pages.**

Question 1

a) Give concise definitions of the following terms used in the study of thermodynamics.
   i) System
   ii) Open System

iii) Closed System
iv) Surroundings
v) Thermodynamic Equilibrium
vi) External Work

(12 Marks)

b) Starting from the statement of the first law of thermodynamics, derive the equation which relates heat transfer, work transfer, and change in internal energy for a closed system.
(28 Marks)

Question 2

a) A system consists of a working fluid enclosed in a piston and cylinder device such that the pressure exerted by the piston is constant.

The system is heated from equilibrium state 1 to equilibrium state 2. Show how this process can be used to define the relationship between enthalpy, internal energy, pressure and volume.

(16 Marks)

b) State the pressure and temperature set as the reference point (datum) for water and the thermodynamic properties chosen to be zero at the reference point.

Given $v_{f0} = 0.0010002\ m^3/kg$, demonstrate why it is accepted that $h_{f0} = 0$ kJ/kg

(9 Marks)

c) A cylinder and the piston device contains 0.10kg of air initially at 20^0 C and 1.0 bar. The system is supplied with heat until the final volume is double the initial volume. Calculate:

i) Final temperature
ii) Heat transferred
iii) Work done
iv) Change in internal energy

(15 Marks)

Question 3

a) Write the general steady flow energy equation in which both heat transfer and electrical energy transfer are permitted.
(6 Marks)

b) State six (6) assumptions made for the above equation to be valid.
(6 Marks)

c) Starting from the above steady flow energy equation, derive simplified equations for the following devices (all assumptions made must be stated).
   i) Water pump
   ii) Steam turbine
   iii) Water turbine
   iv) Heat exchanger
   v) Throttling valve

(18 Marks)

d) A water pump has inlet and outlet pressures of P_1 and P_2 , show that the shaft work is given by $-w_{12} = \bar{v}(P_2 - P_1)$ where $\bar{v}$ is the mean specific volume.
(10 Marks)

Question 4

a) State the following laws governing the behaviour of ideal gases:
   i) Boyle's Law
   ii) Charles's Law
   iii) Avogadro's Law

   (9 Marks)

b) An ideal gas at State 1 changes state to State 2 following Boyle's law and then changes state from State 2 to State 3 following Charles's law.
   Use these processes to arrive at the ideal gas equation.
   (11 Marks)

c)
   i) A mass of 1.5 kmol of an ideal gas of molecular mass 25 is contained in a rigid vessel of volume 4.0 m^3 at a temperature of 100^0 C .
   Evaluate the mass, pressure, specific volume, and gas constant of the gas.
   ii) Assuming that $\gamma = 1.38$, calculate the values of C_p and C_v
   iii) Subsequently, the gas is cooled to 15^0 C. Calculate the final pressure, change in internal energy, change in enthalpy and magnitude and sign of the heat transfer.

   (20 Marks)

Question 5

a) Draw the T – s diagram for water and indicate the constant pressure lines and critical point.
(5 Marks)

b) Draw the p – h diagram for water and indicate the constant temperature lines and the critical point.
(5 Marks)

c) Draw the p – v diagram for water and indicate the constant temperature lines and the critical point.
(5 Marks)

d) 0.9 kg of steam at a pressure of 15 bar and temperature of 250^0C expands reversibly and polytropicaly to 1.5 bar. Find the final temperature, work done, heat transferred and change of entropy if the index of expansion is 1.25.
The process must be shown on T- s and p-v diagrams.
(25 Marks)