MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR DIPLOMA IN MECHANICAL ENGINEERING

MED-PR 204: THERMODYNAMICS I

DATE: 5/6/2017 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS

Answer all questions in Section A and choose any other TWO in Section B

SECTION A (COMPULSORY) (30 MARKS)

1. a) Define the following terminologies as used in applied thermodynamics;
   i. System.
   ii. Property.
   iii. Flow work.
   iv. Phase (4 marks)

   b) State three conditions necessary for a fluid to undergo a reversible process. (3 marks)

   c) With the aid of a diagram, show that reversible work is given by;
   $w = P\delta v$ (4 marks)
   Hence solve;
   A fluid at a pressure of 3 bar and with specific volume of 0.18m^3/kg contained in A cylinder behind a piston expands reversibly to a pressure of 0.6 bar according to a law, $p = \frac{C}{v^2}$ where C is a constant. Calculate the work done by a fluid on the piston. (9 marks)

d) A quantity of steam at a pressure of 2.1 MN/m² and 0.9 dry occupies a volume of 0.427m³. It is expanded according to the law $PV^{1.25}$ = constant to a pressure of 0.7MN/m². Determine the mass of steam present and amount of work transferred. (10 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTIONS

2. a) In a certain steam plant, the turbine develops 1000KW. The heat supplied to the steam in the boiler is 2800kj/kg. Calculate the steam flow round the cycle in kg/s if the heat rejected by the system to cooling water in the condenser is 2100kj/kg and the feed pump work required in the system is 5 KW. (7 marks)

b) In the cylinder of an air motor, the compressed air has a specific internal energy of 420kJ/kg at the beginning of the expansion and a specific internal energy of 200kJ/kg after expansion, calculate the heat flow to or from the cylinder when the work done by the air during the expansion is 100kj/kg. (4 marks)

c) Show that the non-flow energy equation is given by

$$Q = \delta U + W$$

hence solve;

During the working stroke of an engine the heat transferred out of the system was 150kj/kg of working substance. The intrinsic energy also decreased by 400kj/kg of working substance. Determine the work done and state whether it is work done on or by the engine. (9 marks)

3. a) From first principles and with aid of a sketch derive the steady flow energy equation. (8 marks)

b) Air passes through a gas turbine system at the rate of 4500g per every one second. It enters the turbine system with a velocity of 90m/s and a specific volume of 0.85m^3/kg. It leaves the turbine system with a specific volume of 1.4m^3/kg. The exit area of the turbine system is 0.038m^3. In its passage through the turbine system, the specific enthalpy of the air is reduced by 200kj/kg and there is a heat transfer loss of 40kj/kg. Determine;

i. The inlet area of the turbine in m². (4 marks)

ii. The exit velocity of the air is m/s. (4 marks)

iii. The power developed by the turbine system in kilowatts. (4 marks)

4. a) State the following Laws;

   i. Boyles Law. (1 mark)

   ii. Charles Law. (1 mark)

   iii. Ideal gas Law. (1 mark)

   b) A gas whose pressure, volume and temperature are 275 KN/m², 0.09m^3 and 185°c respectively, has its state changed at constant pressure until its temperature becomes 15°c. How much heat is transferred from the gas and how much work is done on the gas during the process. (take R = 0.29KJ/kgK, C_p = 1.005kJ/kgK) (7 marks)

   c) A perfect gas has a molecular weight of 26 kg/kmol and a value of γ= 1.26. Calculate the heat rejected per kg of gas;

      i. When the gas is contained in a rigid vessel at 3 bar and 315°c and is then cooled until the pressure falls to 1.5 bar.

      ii. When the gas enters the pipe line at 280°c and flows steadily to the end of the pipe where the temperature is 20°c.

   Neglect velocity changes in the pipeline. (10 marks)

5. Steam of 1kg has dryness fractions of 0.97. Calculate the volume the steam occupies at a pressure of 0.85MN/m^2. If the steam is expanded adiabatically to a pressure of 0.17MN/m^2 following the law $PV^{1.13}$= Constant, determine

   a) Its final dryness fraction (8 marks)

   b) The change in internal energy during the expansion (12 marks)