KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 203: ENGINEERING THERMODYNAMICS 1

DATE: Wednesday 7th December 2011 **TIME: 8.00a.m – 10.00a.m**

INSTRUCTIONS

Attempt any three(3) of the following five questions. Any relevant data/information sheet is provided along with the question paper.

Question 1

(a) With the aid of simple sketches, give a concise definition and brief description of the under listed terms used in Engineering Thermodynamics citing types and examples where necessary.

(i) Thermodynamic system

(ii) Process

(iii) Property

(9 marks)

(b) State the First Law of thermodynamics and demonstrate how it may be used to show that the difference between heat supplied and work done during any change of state for a cyclic process is independent of the path taken during the process, hence give the Non-Flow Energy Equation (NFEE).

(11 marks)

Question 2

(a) Show that in a non flow polytropic process, the ratio of the heat transferred to the work done is given by

$$\frac{Q}{W} = \frac{\gamma - n}{\gamma - 1}$$

Where Q = heat transferred

W = the work done

γ =adiabatic index

n = polytropic index of expansion/compression

(8 marks)

(b) A mass of air occupies a volume of $10m^3$ at $15^{\circ}C$ and a pressure of 1 bar. It is compressed polytropically in accordance with the relationship $pV^{1.25}$ = constant to a pressure of 5 bar. Calculate:

(i) the mass of air (6 marks)

(ii) the heat transferred (6 marks)

Question 3

(a) Explain the meaning of the term reversibility as applied in engineering thermodynamics. (2 marks)

(b) Distinguish between a turbine and a compressor (4 marks)

(c) A gas turbine receives hot gases from the combustion chamber at 6.5 bar and 700°C at a velocity of 9.5m/s. The gas leaves the nozzle of the turbine at 1.03 bar at a velocity of 50m/s. Assuming that the expansion is adiabatic and reversible, calculate the power output per unit mass of the flow rate.

Assume $\gamma = 1.35$ and C_p =1.10kJ/kg°K (14 marks)

Question 4

(a) The enthalpy of steam at a temperature of 30°C is 2000kJ/kg. Determine the following for 1.0kg of steam:

(i) The pressure of stem

(ii) The condition of steam (dryness fraction)

(iii) The internal energy of the steam

(iv) The specific volume of the steam

(8 marks)

(b) Steam enters a turbine at a steady rate 13kg/s. The temperature and pressure at which the steam enters the turbine is 300°C and 6 bar respectively. If the steam leaves the turbine at a pressure of 1 bar and a specific volume of 1.2m^3/kg, calculate the power output from the turbine. (12 marks)

Question 5

(a) 1.0 kg of saturated steam at a temperature 165°C is heated at constant pressure to a volume of 0.35m^3. Determine the final temperature, change in enthalpy and work done during the constant pressure process. (14 marks)

(b) If the stem in (a) above is then expanded isothermally to a pressure of 4 bar, determine the change in internal energy during the isothermal process. (6 marks)