THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2410: CONTROL ENGINEERING I

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2011

TIME: 2HOURS

INSTRUCTION TO CANDIDATES

You should have the following for this examination
- *Scientific Calculator*
- *Answer booklet*
- *Thermodynamic properties (vapour) tables*

This paper consists of **FIVE** questions. Answer any **THREE** questions.
Maximum marks for each part of a question are as shown.
This paper consists of **FOUR** printed pages

QUESTIO ONE (20 MARKS)

a) Explain the following processes giving one example for each
   (i) Adiabatic process
   (ii) Isochoric process
   (iii) Irreversible process (6 marks)

b) A working liquid is contained in a rigid vessel at 3bar and 315°c. It is then cooled isochorically to a pressure of 1.5 bar. If the fluid has a molar mass of 26kg/kmol, a value of

   γ = 1.26, calculate.
   i) The specific heat constants at constant volume (Cv)
   ii) The final Temperature of the liquid
   iii) The amount of heat rejected (8 marks)

c) A gas is passed through the following processes of a constant pressure cycle.

Process 1: Isentropic compression from T_1 to T_2 and V_1 to V_2

Process 2: reversible cooling from T_2 to T_3 and V_2 to V_3

Process 3: isentropic expansion from T_3 to T_4 and V_2 to V_3

Process 4: reversible cooling from T_4 to T_1 and V_4 to V_1

Represent the cycle on a temperature entropy (T-S) diagram (6 marks)

QUESTION TWO (20 MARKS)

a) A fluid is flowing at the rate of 0.4kg/s through a pipe of varying cross-section. The fluid conditions at the inlet arc. 6m/s velocity, 1 bar of pressure and a specific volume of $0.85m^3/kg$. the conditions at the outlet are 4.5m/s of velocity, 6.9 bars of pressure and a specific volume of $0.16m^3/kg$. If the amount of heat removed from the fluid is 59 KJ/s and the difference of the specific internal energy between the outlet and inlet is 88KJ/kg (with that at the outlet being greater). Calculate:
   i) The work done by the fluid
   ii) The cross-sectional area of the pipe's inlet and outlet (12 marks)

b) calculate the temperature, specific volume internal energy and enthalpy of dry saturated steam at 9.8bar (8 marks)

QUESTION THREE (20 MARKS)

a) 1kg of air is at initial conditions of $0.05m^3$ volume and 20bar is passed through the following processes.

Process 1: Expanded polytropically according to $PV^2 = C$ until the volume is doubled.

Process 2: Reversible cooling at constant pressure back to $0.05m^3$ of volume

Process 3: Reversible heating at constant volume upto 20 bars of pressure

Represent the cycle on a pressure-volume diagram (10 marks)

b) Calculate the specific volume, specific enthalpy and specific energy of wet steam at 18 bar and dryness fraction of 0.9 (6 marks)

c) Define the following terminologies.
   i) A thermodynamic cycle
   ii) An isentropic process
   iii) Specific heat constant at constant volume
   iv) Absolute zero temperature (4 marks)

QUESTION FOUR (20 MARKS)

a) In a certain process 0.05kg of a working fluid is isobarically heated at 2 bars until it occupies a final volume of $0.0658m^3$.

Calculate the amount of heat supplied and the work done if the initial conditions of the fluid are:

(i) The fluid is initially dry saturated steam
(ii) When the fluid is initially air at 130^{o}C

Given Roof air = 0.287 x 10^3 KJ/kgK and Cp of air = 1.005 (14 marks)

b) State the **THREE** laws of thermodynamics and give a thermodynamic equation for each law (6 marks)

QUESTION FIVE

a) A perfect wet gas of 1kg mass is polytropically expanded from 7 bars to a pressure of 0.34 bar according to the law PV^{1-1} = constant. If the gas has a dryness fraction of 0.95, calculate:
(i) The work done
(ii) The heat supplied (10 marks)

b) A carnot cycle operates between 8000^{o}c and 15^{o}c of temperature and between 1.535 KJ/kgK and 1.321 KJ/kgK of entropy.
i) Represent the cycle on a temperature entropy diagram
ii) Calculate the Net work output
iii) Calculate the efficiency of the cycle (10 marks)