THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A CONSTITUENT COLLEGE OF JKUAT)

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

Diploma in Mechanical Engineering (Plant)
Diploma in Mechanical Engineering (Production)
Diploma in Mechanical Engineering (Automotive)

EME 2201
THERMODYNAMICS I

YEAR II SEMESTER I SPECIAL/SUPPLEMENTARY EXAMINATIONS

SERIES: OCTOBER, 2011

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination:
- Scientific Calculator
- Steam/Vapour Table
- Mathematical Tables

This paper consists of **FIVE** questions.
Answer Question **ONE** and any other **TWO** Questions.
This paper consists of ***4 printed*** **pages.**

Question ONE (COMPULSORY)

(a) Define the following with reference to thermodynamic:

(I) Working substance
(II) Cycle
(III) Homogeneous system

(6 Marks)

(b) Define the following **THREE** types of properties giving **TWO** examples of each property:

(I) Intensive properties
(II) Extensive properties
(III) Specific properties

(6 Marks)

(c) (i) Derive the steady flow energy equation from first principles.

(ii) A turbine uses steam whose velocity at the carry is 16m/sec and specific enthalpy 2990kJ/kg. Heat lost to the surroundings as the steam passes through the turbine is 25kJ/kg. The steam flow rate is 34000kg/hr. Calculate the work done (output) from the turbine.

(18 Marks)

Question TWO

(a) Define the following processes:

(i) Hyperbolic process
(ii) Isobaric process
(iii) Adiabatic process

(3 Marks)

(b) In a closed system, 1kg of air initially at $100kN/m^2$ and $27^{\circ}C$ is compressed adiabatically to $3mN/m^2$, and then expanded isothermally back to the original volume. Determine the excess of work done by the gas over work done on the gas.

Take $12 = 287 J/kgk \quad and \quad \gamma = 1.4$ for air. Sketch a PV diagram for the process.

(10 Marks)

(c) 1kg of gas expands adiabatically in a closed system until its pressure is halved. During the expansion its temperature falls from $240°C \ to \ 145°C$. Calculate the value of the adiabatic index.

(7 Marks)

Question THREE

(a) Show that for a closed system going through a non flow process:

$$Q = \frac{\gamma - n}{\gamma - 1} \times Poly \quad tropic \quad work$$

Where:

Q = Heat label in or rejected

γ = Adiabatic index

n = Polytropic index

(b) A spark ignition engine has a cylinder diameter of 95mm and a stroke of 127mm, clearance volume 230cm^2. The temperature at the beginning of compression is 57°C. Calculate:

(i) The temperature at the end of stroke

(ii) Work done during the compression stroke. Take $PV^{1.3} = C$ and initial pressure as 100kN/m^2.

(20 Marks)

Question FOUR

(a) Show that for a polytropic process of steam, heat transfer for unit mass is given by:

$$Q = (h_2 - h_1) + \frac{n}{n-1}(P_1V_1 - P_2V_2)$$

Where:

Q = Heat transfer

h_2 = Fuel enthalpy

h_1 = Initial enthalpy

η = Polytropic index

P_1 = Initial pressure

v_1 = Initial volume

v_2 = Final Volume

(10 Marks)

(b) (i) Calculate the volume of steam occupied by 1kg of steam at a

pressure of 0.85MN/m^2 and having a dryness fraction of 0.95.

(ii) The steam in (i) above is expanded to a pressure of 0.17MN/m^2, according to the law of expansion being $PV^{1.13}$= C. Calculate:

(I) Final dryness fraction of steam.

(II) The change of internal energy of the steam during the expansion.

(10 Marks)

Question FIVE

(a) 1kg of steam is compressed in a closed system according to the law $PV^{1.2}$ = C from a pressure of 100kN/m^2 and dryness fraction 0.80 to a final pressure of 220kN/m^2. Calculate:

(i) The final condition of steam.

(ii) The external work done on the steam.

(iii) The heat flow across the boundaries of the system.

(10 Marks)

(b) 1.5kg of steam originally at a pressure of 1Mn/m^2 and temperature 225◦C is expanded until the pressure becomes 0.28Mn/m^2. The dryness fraction of the steam is then 0.9. Calculate the change of internal energy. **(5 Marks)**

(c) 1kg of steam initially 0.8 dry is throttled from a pressure of 600kN/m^2 to a pressure of 100kN/m^2. Calculate the dryness fraction of steam after throttling. **(5 Marks)**