TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN MECHANICAL ENGINEERING (DMEN)

EME 2202
THERMODYNAMICS I

END OF SEMESTER EXAMINATIONS

YEAR 2 SEMESTER I

SERIES: DECEMBER, 2013

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. You should have the following for this examination:
   - Answer Booklet
   - Scientific Calculator
2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. All Questions carry equal marks.
5. **This paper consists of FOUR printed pages.**

Question ONE

(a) Show proof that:

(i) For an ideal monoatomic gas, $\gamma = 1.67$ **(4 marks)**

(ii) For an ideal diatomic gas, $\gamma = 1.40$ **(4 marks)**

(b) The compression ratio of a diesel engine is 15 to 1; this means that air in the cylinders is compressed to $^1/_{15}$ of its initial volume. If the initial pressure is $1.0 \times 10^5\, Pa$ and the initial temperature is 27°C:

(i) Find the final pressure and the temperature after compression **(7 marks)**

(ii) How much work does the gas do during the compression if the initial volume of the cylinder is 1L. **(5 marks)**

(This is a case of adiabatic compression, assume air to be a diatomic ideal gas, γ = 1.40).

Question TWO

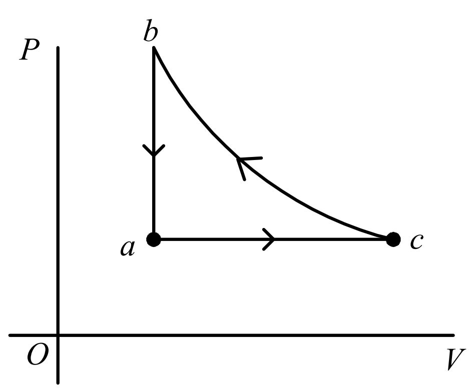
(a) When ice melts at 0°C, its volume decreases. Is the internal energy change greater than, less than, or equal to the heat added? Show proof for your answer. **(4 marks)**

(b) A metal cylinder with rigid walls contains 2.5mol of oxygen gas. The gas is cooled until its pressure decreases to 30% of its original value.

(i) Draw a p-V diagram for this process. **(3 marks)**

(ii) Calculate the work done by the gas **(2 marks)**

(c) Three moles of an ideal gas are taken around the cycle abc shown below:



For this gas, Cp = 29.1J/mol.K. Process ac is a constant pressure process, process ba is at constant volume and process cb is adiabatic. The temperatures of the gas in states a, c and b are T_a = 300K, T_c = 492K and T_b = 600K. Calculate the total work for the cycle. **(11 marks)**

Question THREE

(a) Briefly explain the meaning of the following terms:

(i) Saturation temperature
(ii) Saturation pressure
(iii) saturated vapour
(iv) Superheated vapour
(v) Saturated liquid

(10 marks)

(b) A mass of 200g of saturated liquid water is completely vapourised at a constant pressure of 100kPa. Given that:

$V_g = 1.6941 m^3/kg$
$V_f = 0.001043 m^3/kg$
$h_{fg} = 2257.5 kJ/kg$

Determine:

(i) The volume change. **(3 marks)**
(ii) The amount of energy transferred to the water. **(5 marks)**

(c) Discuss the relevance of "Steam quality", x. **(2 marks)**

Question FOUR

(a) Starting with the general energy equation, derive the simplified nozzle equation, stating all the assumptions that are made. **(10 marks)**

(b) Steam enters a nozzle with negligible upstream velocity at 1MPa and 240°C and leaves at 0.6MPa and 200°C. The initial enthalpy is 2920kJ/kg and the final enthalpy is 2840kJ/kg. Calculate the steam velocity leaving the nozzle. **(10 marks)**

Question FIVE

(a) Starting with the general energy equation, derive the simplified turbine equation, starting all the assumptions that are made. **(10 marks)**

(b) Steam passes through a turbine under the inlet (1) and exhaust (2) conditions given below:

P_1 = 8MPa
T_1 = 500°C
u_1 = 3064kJ/kg
V_1 = 0.04175m^3/kg
P_2 = 0.8MPa
T_2 = 250°C
u_1 = 2716kJ/kg
v_2 = 0.2931m^3/kg

If the steam flow rate is 250kg/s, calculate the power output from the turbine.

(10 marks)