TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

Department of Mechanical & Automotive Engineering

UNIVERSITY EXAMINATION FOR:

BSc. Mechanical Engineering

EMG 2302 **:** Engineering Thermodynamics II

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2016

TIME: 2 HOURS

DATE: Pick Date **Dec 2016**

Instruction to Candidates:

You should have the following for this examination

- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt question **ONE** and any other **TWO** questions.

Maximum marks for each part of a question are as shown.

Do not write on the question paper.

Question One

a) Explain the following terms
   i. Available Energy
   ii. Unavailable Energy

b) Derive the equation for the decrease in available energy when heat is transferred through a finite temperature different.

c) What is the maximum useful work which can be obtained when 100 KJ are abstracted from a heat reservoir at 675 K in an environment at 288 K. What is the loss of useful work if

i. A temperature drop 50°C is introduced between the heat source and heat engine on one hand, the heat engine and sink on the other.

ii. The source temperature drops by 50°C and the sink temperature rises by 50°C during the heat transfer process according to the linear law

$$\frac{dQ}{dT} = \pm \text{Constant}$$

Question Two

a) State Gibbs-Dalton law and show the relation between properties of the mixture.(5 marks)

b) The usual cooking gas (mostly methane) cylinder is about 25 cm in diameter and 80 cm high. It is charged 12MPa at room temperature (27°C)

i. Assuming the ideal gas law, find the mass of the gas filled in the cylinder.
ii. Explain how the actual cylinder contains 15 Kgs of gas.
iii. If the cylinder is to be protected against excessive pressure by means of a fusible plug, at what temperature should the plug melt to limit maximum pressure to 15MPa.

(6 marks)

c) The pressure and temperature of 4 Kg of O_2 and 6 Kg of N_2 are 4 bar and 27°C respectively. For the mixture determine the following.

i. The mole fraction of each component
ii. The average molecular weight
iii. The specific gas constant
iv. The volume and density
v. The partial pressures and partial volumes. (9 marks)

Question Three

a) Define the following terms

i. Specific humidity
ii. Dew point depression
iii. Wet-bulb temperature
iv. Dry- bulb temperature

b) Derive the following expression for air-vapour mixture

$$W = 0.622\frac{P_v}{P_t + P_v}$$

Where P_v is partial pressure of water vapour

P_t is Total pressure of moist air

c) The atmospheric air has a dry bulb temperature of 21^{o}C and wet bulb temperature 18^{o}C.If the barometer reads 750 mmHg. Calculate
   i. Partial pressure of water vapour.
   ii. Relative humidity (6 marks)

Question Four

a) Describe a regenerative cycle with a single feed water heater and show it's efficiency (12 marks)

b) In a regenerative cycle, having one feed water heater, the dry saturated steam is supplied from the boiler at a pressure of 30 bar and the condenser pressure is 1 bar ,the steam is bled t a pressure of 5 bar .calculate
   i. The amount of bled steam per Kg of steam supplied and the efficiency of the cycle.
   ii. The efficiency without regenerative feed heating. (8 marks)

Question Five

a) Describe the various operations of Rankine cycle and derive it's efficiency. (10 marks)

b) The steam consumption of a steam engine is 20 tonnes per shift of 8 hours when developing 220 Kw. Dry and saturated steam enters the engine at 10 bar pressure and leaves at 0.1 bar pressure. calculate the Rankine efficiency and the Thermal efficiency. (10 marks)