TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATION FOR:

THE DEGREE IN BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

TMC 4226 : Engineering Thermodynamics I

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2017

TIME: 2 HOURS

DATE: Pick Date Aug 2017

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

- Tables of 'Thermodynamic and Transport Properties of Fluids' by G.F.C Rodgers and Y.R Mayhew

This paper consists of **FIVE** questions. Attempt any THREE questions.

Do not write on the question paper.

Question One

a) What is an Ideal gas (2 marks)

b) State and explain the following

i. Charle's Law

ii. Boyle's Law

iii. Avogadro's Law (9marks)

c) A gas occupies a volume of 0.1m^3 at a temperature of 20^{0}C and a pressure of 1.5 bar. Find the final temperature of the gas, if is compressed to a pressure of 7.5 bar and occupies a volume of 0.04 m^3. (3 marks)

d) A quantity of gas has a pressure of 350 KN/m^2 when its volume is 0.03m3 and its temperature is 35Oc.If the value of R=0.29 KJ/kg K.

i. Calculate the mass of the gas .

ii. If the gas pressure is increased to 1.05 MN/m^2 while the volume remains constant ,Calculate new temperature. (6 marks)

Question Two

(a) State the First law of thermodynamics. (2 marks)

(b) Derive from first principles the Steady flow energy Equation (10 marks)

(c) Air enters a gas turbine system with a velocity of 1005 m/s and has a specific volume of 0.9m^3/kg. The inlet area of the gas turbine system is 0.06m^2. At exit the air has velocity of 140m/s and has a specific volume of 1.4m^3/kg, the specific enthalpy of the air is reduced by 140KJ/kg and the air also has a heat transfer loss of 30 KJ/kg. Determine:-

(i) The mass flow rate of the air through the turbine system in kg/s

(ii) The power developed by the turbine system in kw (8 marks)

Question Three

a) State Kelvin-Planck and Clausius statements of second Law of thermodynamics (4 marks)

b) Differentiate between heat engine and reversed heat engine. (5 marks)

c) Derive the efficiency equation of a heat engine. (4 marks)

d) A MPUC students claims to have developed a heat engine with specifications as follows:

Power Developed =76 kW

Fuel Burnt 4.8 kg/hr

Heating value of fuel = 7300kJ/kg

Temperature limits = 980k and 393 k

Evaluate if the student claim is valid? (7marks)

Question Four

a) State the properties of steam which make it a preferred working fluid. (3 marks)

b) Explain the following terms

i. Wet steam

ii. Dry saturated steam

iii. Superheated steam (6 marks)

c) Define dryness fraction of steam (2 marks)

d) State advantages of superheated steam (4 marks)

e) Calculate the quantity of heat required to produce 1 kg of steam at a pressure of 6 bar at a temperature of 25^{o} C , under the following conditions. (steam tables at 6 bar h_f=6704.4kJ/kg ,h_{fg}=2085kJ/kg ,t=158.8^{o}C)

i. When the steam is wet having a dryness fraction of 0.9

ii. When the steam is dry saturated

iii. When it is superheated at a constant pressure of 250^{o}C assuming the mean specific heat of superheated steam to be 2.3 kJ/kg K (8 marks)

Question Five

(a) Define the term fuel. (2 mark)

(b) Explain the advantages and disadvantages of liquid fuels over solid fuels. (5 marks)

(c) A sample of coal has the following composition by mass.

Carbon 75%; Hydrogen 6%; Oxygen 8%, Nitrogen 2.5%; Sulphur 1.5% and ash %

Calculate the higher and lower calorific values per kg of coal (4 marks)

(d) A blast furnance gas has the following volumetric composition:

CO_2=11%, CO = 27%, H_2 = 2% and N_2 = 60%

Calculate

(i) The theoretical volume of air required for the complete combustion of $1m^3$ of the gas

(ii) The percentage composition of dry flue gasses by volume

(Assume that air contains 21% of O_2 and 79% of N_2 by volume) (9 marks)