



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. Explain the following types of system
 - i. Open system
 - ii. Closed system
 - iii. Isolated system
 - iv. Homogenous system (6marks)
- b. Describe a reversible process and state any three criteria for reversibility (5marks)
- c. Derive an expression for work done when a gas expands from an initial volume of V_1 to a final volume V_2 . The pressure varies with volume according to the function.

$$PV^n = C$$

Where

P is pressure

V is volume

N and C are constants (6marks)

- d. If a gas of volume 6000cm^3 at a pressure of 100kpa is compressed according to PV^2 -constant until the volume become 2000cm^3 . Calculate the final pressure and work done (3 marks)

Question Two

- (a) What is the difference between an ideal and a perfect gas ?
(b) State the following gas laws
(i) Charles's
(ii) Boyle's (4 marks)

A certain quantity of air initially at a pressure of 8 bar and 280°C has a volume of 0.035 m^3 . It undergoes the following processes in the following sequence in a cycle :

- a) Expands at constant pressure to 0.1 m^3 ,
b) Follows polytropic process with $n = 1.4$, and
c) A constant temperature process (which completes the cycle)

Evaluate the following :

- i. The heat received in the cycle ;
ii. The heat rejected in the cycle ;
iii. Efficiency of the cycle. (10 marks)

Question Three

- (a) State the First law of thermodynamics. (2 marks)
(b) Derive from first principles the Steady flow energy Equation and state the assumptions (10 marks)
(c) Air enters a gas turbine system with a velocity of 1005 m/s and has a specific volume of $0.9\text{m}^3/\text{kg}$. 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 $1.4\text{m}^3/\text{kg}$, 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 Four

- a) State the properties of steam which make it a preferred working fluid. (3marks)
b) Explain the following terms
i. Wet steam
ii. Dry saturated steam
iii. Superheated steam (3 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°C , under the following conditions. (steam tables at 6 bar $h_f=6704.4\text{kJ/kg}$, $h_{fg}=2085\text{kJ/kg}$, $t=158.8^{\circ}\text{C}$)
- When the steam is wet having a dryness fraction of 0.9
 - When the steam is dry saturated
 - When it is superheated at a constant pressure of 250°C assuming the mean specific heat of superheated steam to be 2.3 kJ/kg K (8 marks)

Question Five

- Define a chemical fuel (2 marks)
- Explain the following
 - Stoichiometric (or chemically correct) mixture of air and fuel
 - adiabatic flame temperature (4 marks)
- The chief source of liquid fuels is petroleum, state its advantages against solid fuels. (4 marks)
- The percentage composition of sample of liquid fuel by weight is, $\text{C} = 84.8$ per cent, and $\text{H}_2 = 15.2$ per cent. Calculate
 - the weight of air needed for the combustion of 1 kg of fuel;
 - The volumetric composition of the products of combustion if 15 per cent excess air is supplied. (10 marks)