Paper Code: ME-303	**Roll No.**										

B.Tech.
THIRD SEMESTER EXAMINATION, 2016-17
THERMODYNAMICS

[Time: 3 hrs.] [Max. Marks: 100]

Note:- 1. Attempt All questions. All questions carry equal marks.
2. Use of steam table and Mollier chart is permitted.
3. Assume suitably, any missing data.

1. Attempt any four parts of the following: - **(5x4=20)**

(a) Define and explain a thermodynamics system. Differentiate between various types of thermodynamics system.
(b) What is the Quasi – static Process? What is the concept of continuum? Define in brief?
(c) State the Zeroth law of thermodynamics. In a thermoelectric thermometer for t° C temperature, the emf is given as: $E = 0.003t - 5x10^{-7}t^2 + 0.5 x10^{-3}$, volts. Thermometer is having reference junction at ice point and is calibrated at ice point and steam points. What temperature shall be shown by the thermometer for a substance at 40° C.
(d) A vacuum gauge mounted on a condenser reads 0.55 mm Hg. What is the absolute pressure in the condenser in kPa when the atmospheric pressure is 101.3 kPa?
(e) Discuss the working of constant volume gas thermometer.
(f) What do you understand by the internal energy? List the different forms of energy which contribute to the internal energy.

2. Attempt any two parts of the following: - **(10x2=20)**

(a) Answer the following
(i) Derive relation pv^{γ}=constant for adiabatic process.
(ii) 5 kg/s of air enters a nozzle at 1 MPa and 500 K and leaves at 200 kPa and 27 °C. The heat loss from the nozzle is estimated to be 75 kW. Find the velocity and area at the exit of nozzle. Neglect approach velocity.

(b) Differentiate work and heat transfer. 3 m^3 of air is contained in rigid insulated vessel at 50 ºC and 150 kPa. A wax candle is burning in the centre of a vessel. After one hour the final pressure in the vessel is 900 kPa. Find the change in internal energy of air and mass of wax combusted in one hour. Assume calorific value of wax as 12 MJ/kg and neglect the change in volume of air due to wax combustion. Also find the change in internal energy and work done by air in vessel.

(c) Define first law of thermodynamics for closed system undergoing non cyclic process. Air initially at 75 kPa pressure, 1000 K temp and 1.2 m^3 volume, first compressed isothermally till its volume becomes half of the initial volume then further compressed at constant pressure till its volume becomes half of the volume before constant pressure compression. And then return to its original state following polytropic process. Find work transfer and heat transfer during each process.

3. Attempt any four parts of the following: **-** **(5x4=20)**

(a) State the Clausius and Kelvin-Planck statement of the second law of thermodynamics and establish their equivalence.

(b) What is a thermodynamic temperature scale or absolute temperature scale? Explain the concept of clausius inequality.

(c) Show that the free expansion process is irreversible.

(d) A cyclic heat engine operates between a source temperature of 800^0C and a sink temperature of 30^0C. What is the least rate of heat rejection per kW net output of the engine?

(e) 2 kg of steam at 400 °C and 600 kPa is cooled at constant pressure by transferring heat to surroundings until the steam is completely condensed. The surroundings are at constant temperature of 25 °C. Find the net entropy change universe.

(f) An insulated tank is divided in two equal parts by a thin membrane. One part of tank contains air at 30 C and 5 bar and other part is completely evacuated. The membrane gets punctured and air quickly fills the entire volume. Determine the entropy change of the universe.

4. Attempt any two parts of the following: **-** **(10x2=20)**

(a) What do you mean by Available & Unavailable energy? A lump of 800 kg steel at 1250 K is to be cooled to 500 K. If the change in entropy is occur at constant pressure process then Calculate:

(i) Availability (ii) Unavailability of energy

(b) Answer the following

(i) What is Joule-Thompson coefficient? Show that it is zero for an ideal gas?

(ii) Write Maxwell equation and their significance.

(c) Show that when a perfect gas changes from a state (P_1,V_1,T_1) to another state(P_2,V_2,T_2) ,the change in entropy per unit mass is given by

$$S_2-S_1 = Cv \log_e (P_2/ P_1)+Cp \log_e (V_2/V_1)$$

5. Attempt any two parts of the following: **-** **(10x2=20)**

(a) Define the critical point and dryness fraction of steam. A pressure cooker contains 5 kg of dry and saturated steam at 4 bar. Calculate the amount of heat that must be rejected so that the steam becomes wet with 0.8 dryness fraction, Find pressure and temperature of steam after heat rejection.

(b) Draw rankine cycle on p-v, T-s and h-s diagram. In a thermal power plant operating on an ideal Rankine cycle,steam at 15 bar and 250 ^{0}C enters a turbine which generates 40 kW indicated power. If the steam consumption is 300 kg/hr and condenser is maintained at 0.15 bar, determine the final condition of steam, Rankine efficiency and relative efficiency. Neglect pump work. Determine the fuel to be supplied per hour if its calorific value is 42 MJ/kg.

(c) Answer the following.

(i) Steam is flowing in a pipeline at a pressure of 20 bar is throttled to a pressure of 1 bar and 115 °C. Find the dryness fraction, temperature and enthalpy of steam in the pipeline

(ii) Five kg of steam with a quality of 20% is heated in a cylinder piston arrangement at a constant pressure of 200 kPa until the temperature reaches 400 °C. Calculate the work done by the steam.