Reg.No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

III SEMESTER B.S. DEGREE EXAMINATION – MAY 2016

SUBJECT: PRINCIPLES OF THERMODYNAMICS-I (ME 231)

19TH May, 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE full Questions.**
- ✓ **Use of thermodynamic data handbook is permitted.**
- ✓ **Missing data, if any, may be suitably assumed**

1 (A) Distinguish between the following:

(i) Control volume and Control mass
(ii) Classical and Statistical Thermodynamics
(iii) Intensive and Extensive properties
(iv) Point and Path Functions

1 (B) Explain Thermodynamic Equilibrium.

1(C) The emf of a thermocouple with the test junction at t°C on gas thermometer scale and reference junction at ice point is given by, $\varepsilon = 0.2\ t - 5.0\text{x}10^{-4}\ t^2$ mV. The millivoltmeter is calibrated at ice and steam points. What will this thermometer read in a place where the gas thermometer reads 50°C?

(8+5+7=20 marks)

2(A) Give the mechanics and thermodynamic definition of work.

2(B) Show that internal energy is a point function.

2(C) A certain quantity of air has a volume of 0.028m^3 at a pressure of 1.25 bar and 25°C. It is compressed to a volume of 0.0042m^3 according to the law $pV^{1.3}$=C. Find the final temperature and work done during compression. Also determine the reduction in pressure at a constant volume required to bring the air back to its original temperature.

(4+6+10=20 marks)

3(A) Show that work done in a steady flow process is given by $-\int vdp$.

3(B) List out the similarities and dissimilarities between heat and work.

3(C) A steam turbine operates under steady flow conditions receiving steam at the following state: pressure 15 bar; internal energy 2700 kJ/kg; specific volume 0.17m^3/kg and velocity 100m/s. The exhaust of steam from the turbine is at 0.1 bar with internal energy 2175kJ/kg, specific volume 15m^3/kg and velocity 300m/s. The intake is 3 meters above the exhaust. The turbine develops 35kW and heat loss over the surface of the turbine is 20kJ/kg. Determine the steam flow rate through the turbine.

(6+6+8=20 marks)

4(A) Derive an expression for pdV work for an adiabatic expansion process.

4(B) Define a quasi-static process with a suitable example.

4(C) A gas initially at 603K expands until its volume is 5.2 times the initial volume, according to $pv^n=C$. If the initial and final pressures are observed to be 8.5 bar and 1 bar, determine: (i) the index of expansion, (ii) Work done per kg of gas and (iii) heat exchange per kg of gas. Assume $c_v=0.712$ kJ/kgK and $\gamma=1.4$. Sketch the process on a p-v plane.

(6+6+8=20 marks)

5(A) Sketch and explain the phase diagram of water.

5(B) What are the advantages of superheated steam.

5(C) Steam at 0.8MPa, 250° C and flowing at the rate of 1 kg/s passes into a pipe carrying wet steam at 0.8 MPa, 0.95 dry. After adiabatic mixing the flow rate is 2.3 kg/s. Find the condition of steam after mixing. The mixture is now expanded in a frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the velocity of the steam leaving the nozzle. Neglect the velocity of steam in the pipeline. Sketch the process.

(6+4+10=20 marks)

6(A) State the two statements of second law of thermodynamics and show that the violation of one statement leads to the violation of other statement.

6(B) List out the limitations of first law of thermodynamics.

6(C) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and $-20°C$. The heat transfer to the heat engine is 2000kJ and the network output of the combined engine refrigerator plant is 360kJ. Sketch the system and

(i) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C.

(ii) Reconsider (i) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values.

(8+4+8=20 marks)

7 (A) Define entropy and Prove that entropy is a property of the system.

7 (B) State and prove 'Clausius inequality'.

7 (C) 1.2 m^3 of air is heated reversibly at constant pressure from 300K to 600K, and is then cooled reversibly at constant volume back to initial temperature. If the initial pressure is 1 bar, calculate: (i) The net heat flow (ii) The overall change in entropy. Take $c_p=1.005$ kJ/kg K and R=0.287 kJ/kg K.

(8+6+6=20 marks)

8 Write short notes on the following:

(i) Equation of state

(ii) Compressibility factor

(iii) Compressibility Chart

(iv) Van-der-waal's equation

(4x5=20 marks)