Reg.No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
(Manipal University)

III SEMESTER B.S. DEGREE EXAMINATION – APRIL / MAY 2017

SUBJECT: PRINCIPLES OF THERMODYNAMICS (ME 231)

(BRANCH: MECHANICAL)

Tuesday, 9 May 2017

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

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

1A. Define following terms with suitable examples.

1. System and Surround.
2. Open system and closed system
3. Statistical thermodynamics and applied thermodynamics
4. Intensive and Extensive properties
5. Point and path function.

1B. Explain Joule's experiment of I^{st} law of thermodynamics

1C. In an engine, the charge is at 105 kPa and 310 K at the beginning of compression. It reaches 2.5 MPa after adiabatic compression by following the law $PV^{1.4}$= C. Calculate the temperature at the end of compression and work done. Take R=0.2927 KJ/kg.K **(5+5+10)**

2A. A Explain the first law of thermodynamics applied to a closed system executing a cyclic process and an open system executing a process.

2B. What are similarities and dissimilarities between work and heat transfer of a system.

2C. In a rotary compressor air enters at 16^0 C and at a pressure of 100 X 10^3 N/m^2, the enthalpy of which is being 391.2 kJ/kg. The corresponding properties of air at the exit are 245^0C, 600 X 10^3 N/ m^2 and 534.5 kJ/kg respectively. By assuming no heat interaction in the compressor, determine

(i) Work done per unit mass, by neglecting change in kinetic energy.

(ii) Work done per unit mass, when velocity at inlet and exit of compressor are 85 and 160 m/s. **(5+5+10)**

3A. Obtain an expression for PdV work done in the following cases and show the processes on P-V diagram. (i) Polytropic process ii) Isothermal process iii)

Adiabatic process.

3B. Show that the internal energy is the property of a system.

3C. A gas occupies 0.3 m^3 at 2 bar. It executes a cycle consisting of processes

(i) 1-2 constant pressure process with work interaction if 15 kJ.

(ii) 2-3 compression process which follows law PV = constant and $U_3 = U_2$.

(iii) 3-1 constant volume and change in internal energy $U_1 - U_3 = -40$ kJ.

Neglect changes in KE and PE. Draw P-V diagram for the above processes and determine network heat transfer for the cycle. Also show that first law is obeyed by the cycle. **(4+6+10)**

4A. Define the two parallel statements of second law of thermodynamics and show that violation of one equally violates the other.

4B. Derive the relationship between COP of Refrigerator and Heat pump.

4C. A reversible heat engine extracts heat from three reservoirs at 1000 K, 810 K and 595 K. The engine delivers 10 kJ/s of network and rejects 400 kJ/min of heat to a sink at 298 k. If the heat supplied to the reservoir at 1000 k is 55% of the heat supplied by the reservoir at 595 K. Determine the quantity of heat absorbed by each reservoir. **(6+4+10)**

5A. What are the limitations of separating and throttling calorimeters when they are used alone for the measurement of dryness fraction and explain the working principle of combined calorimeter.

5B. Explain P-V and P-T diagram for a pure substance.

5C. Determine condition of steam, whether it is wet, dry or superheated when,

(i) Steam pressure is 10 bar and has specific volume of 0.175 m^3/kg.

(ii) Steam pressure is 20 bar and temperature is 230^0 C.

Steam pressure of 20 bar and if 2750 kJ/kg of heat is required to generate the steam from water at 0^0C. **(8+6+6)**

6A. Explain clausius inequality of a thermodynamic cycle.

6B. Derive expression of Co-efficient of performance of a reversible Heat pump cycle.

6C. Air at a pressure of 15 bar and a temperature of 240^0C expands according to $PV^{1.3} = C$ to a pressure of 1.5 bar. Show the process on P-V and T-S diagrams. Also determine the work done, heat transfer and change in entropy of the system if it contains 0.9 kg of air. **(6+6+8)**

7A. Define Carnot's theorem and prove that the efficiency of a reversible heat engine is always greater than the efficiency of an irreversible heat engine.

7B. Define thermodynamic temperature scale and derive $\mathbf{Q_1/Q_2 = T_1/T_2}$.

7C. In a closed system, air is at a pressure of 1 bar, temperature of 300 K and volume of 0.025 m^3. The system executes the following processes during the completion of a thermodynamics cycle.

1-2 Constant volume heat addition till pressure reaches 3.8 bar.
2-3 Constant pressure cooling of air.
3-4 Isothermal heating to initial state.

Draw P-V & T-S diagram and determine entropy change in each process & Clausius inequality for the complete cycle. Take C_v = 0.718 kJ/kg.K, R=287 J/kg.K **(6+6+8)**

8A. Define Dalton's law of partial pressure and define the following terms applied to a mixture of ideal gases.

i) Mole fraction ii) Volume fraction iii) Mass fraction iv) Partial pressure ratio v) Specific volume.

8B. Explain PVT diagram indicating clearly solid, liquid and vapour regions.

8C. Obtain an expression for heat transfer during a polytropic process for an ideal gas in terms of work transfer. **(7+8+5)**