B. E. MECH ENGG. EXAMINATION 2019
First year, 2nd Semester (OLD)

THERMODYNAMICS

Time: Three hours **Full Marks: 100**

Answer **question No. 1 (Compulsory)**
and **any four questions** from the rest

NB: Assume any data, if not furnished, consistent with the problem. Use of relevant tables and charts are permitted.

1. a) Compare heat and work
   b) Show the following processes for a pure substance with proper labeling:

   i)) Isothermal process from compressed liquid zone to superheated vapor zone on p-v plane.
   ii) Isobaric process from superheated vapor zone to sub-cooled liquid zone on T-s plane.

   c) Prove that pv^k = constant for an adiabatic process where k is the ratio of the specific heats at constant pressure and constant volume respectively..
   d) A cyclic engine operating between two thermal reservoirs has a thermal efficiency of 0.3. What is the COP of the same system if reversed to use as a refrigerator ?
   e) A system is thermal equilibrium is also in thermodynamical equilibrium- explain if it the statement is correct

   4+6+5+3+2

2. a) Define triple point and dryness fraction
   b) Discuss critical point of steam.
   c) A piston-cylinder arrangement contains 1 kg of saturated water at 30^0 C . The piston has cross-sectional area of 0.065 m^2, a mass of 40 Kg and is resting on two stops. The volume at this point is 0.1 m^3. Atmospheric pressure is 94 kPa and the local gravitational acceleration is 9.75 m/s^2. Heat is now transferred to the system until the cylinder is filled up with saturated vapor. What is the temperature and dryness fraction of the water when the piston rises from the stop? Calculate the work done by the water during the overall process.

   4+4+12

3. a) State the first Law of Thermdynamics for a cyclic process and hence establish that internal energy is a property.
   b) Steam, in an enclosed rigid container, initially at 0.3 MPa, 250^0 C, is cooled till it attains a temperature of 80^0 C. Determine the final state. What is the amount of heat transferred .in the process? Label the process on T-v plane

   8+12

4. a) State the Clausius Statement of Second law of Thermodynamics. What do you understand by 'PMM-II'?
   b) The compressor of a large gas turbine receives air from the ambient at 95 kPa, 20^0 C with a low velocity. At the compressor discharge air exits at 1.52 MPa, 430^0 C. with a velocity of 90 m/s. The power input to the compressor is 5000 kW. Determine (i) the mass flow rate of the compressor, (ii) isentropic efficiency. Plot the processes on T-s and T-v diagram.

4+ 16

5. a) Define 'useful work', 'dead state' and 'second law efficiency'

   b) A piston cylinder device contains 0.05 kg of steam at 1 MPa, 300^0 C. The steam now expands to a final state of 200 kPa and 150^0 C, doing work. Heat losses from the system to the surroundings are estimated to be 2 kJ during this process. Assuming the surrounding to be at 25^0 C and 100 kPa, determine (i) the exergies of steam at the initial and final states, (ii) exergy change of the steam (iii) irreversibility and (iv) the second law efficiency of the process.

6+14

6. a) Establish the four Maxwell's relationships.
   b) Explain Adiabatic Flame Temperature
   c) Calculate the stochiometric air-fuel ratio of the combustion of coal of following Composition by mass: C 90%, H 2 3%, O 2 2.5%, N 2 1%, S 0.5%, Ash 3%.

6+4+10

7. Write short notes on any **four**:
   a) Thermodynamic Properties
   b) Irreversibility
   c) Inversion Curve
   d) Zeroth Law of Thermodynamics
   e) p-v_T surface
   f) Carnot cycle

5 +5+5+5