Code No: R21032 **R10** SET - 1

II B. Tech I Semester Supplementary Examinations, May/June - 2017
THERMODYNAMICS
(Com. to ME, AE, AME, MM)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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Note: Steam Tables are allowed

1. a) Distinguish between stored energy and energy in transit. (6M)
   b) A milk chilling unit can remove heat from the milk at the rate of 41.87 MJ/h. Heat leaks into the milk from the surroundings at an average rate of 4.187 MJ/h. Find the time required for cooling a batch of 500 kg of milk from 45°C to 5°C. Take the c_p of milk to be 4.187 kJ/kg K. (9M)

2. a) A certain quantity of water taken in a piston-cylinder device is being heated on top of a range. During this process, 65 kJ of heat is transferred to the water which gets evaporated and lifts the piston up at the expense of 5 kJ of energy. Heat losses from the sidewalls of the cylinder are 10 kJ. Determine the change in energy of the water for this process. (7M)
   b) The steam supply to an engine comprises two streams which mix before entering the engine. One stream is supplied at the rate of 0.01 kg/s with an enthalpy of 2952 kJ/kg and a velocity of 20 m/s. The other stream is supplied at the rate of 0.1 kg/s with an enthalpy of 2569 kJ/kg and a velocity of 120 m/s. At the exit from the engine the fluid leaves as two streams, one of water at the rate of 0.001 kg/s with an enthalpy of 420 kJ/kg and the other of steam; the fluid velocities at the exit are negligible. The engine develops a shaft power of 25 kW. The heat transfer is negligible. Evaluate the enthalpy of the second exit stream. (8M)

3. a) What do you understand by the entropy principle? (6M)
   b) A household refrigerator is maintained at a temperature of 2^0C. Every time the door is opened, warm material is placed inside, introducing an average of 420kJ, but making only a small change in the temperature of the refrigerator. The door is opened 20 times a day and the refrigerator operates at 15% of the ideal COP. The cost of work is Rs.2.50 per kWh. What is the monthly bill for this refrigerator? The atmosphere is at 30^0C. (9M)
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4\. a) A rigid vessel (capacity 0.2 m^3) holds 10 bar steam at 250°C. The vessel is slowly cooled till the steam pressure drops to 3.5 bar. Determine the (i) Final temperature and dryness fraction of the steam, (ii) Change in the internal energy, (iii) Heat transferred to the surroundings,(iv) Change in entropy of the steam due to the cooling process. (7M)

b) Steam generated at a pressure of 6 MPa and a temperature of 400°C is supplied to a turbine via a throttle valve which reduces the pressure to 5 MPa. Expansion in the turbine is adiabatic to a pressure of 0.2 MPa, the isentropic efficiency (actual enthalpy drop/isentropic enthalpy drop) being 82%. The surroundings are at 0.1 MPa, 20°C. Determine the availability or energy of steam before and after the throttle valve and at the turbine exhaust and calculate the specific work output from the turbine. The K.E. and P.E. changes are negligible. (8M)

5\. a) What is the compressibility factor Z? When is the relation $Pv = RT$ expected to be applicable? (6M)

b) A rigid tank (capacity = 0.75 m^3) fitted with a spring-loaded safety valve contains some quantity of air at 293 K/7 bar. The safety valve opens at 8.5 bar and remains open until the pressure inside drops to 8.15 bar. Now a fire breaks out and heats up the rigid tank. The safety valve opens once de-pressuring the tank to the lower limit stated above. Determine the (i) Air temperature just before the safety pops, (ii) Mass of air that escapes due to the break-out of fire. Assume the air behaves ideally and its temperature remains unchanged during the safety blow. (9M)

6\. a) Prove that the partial pressure water vapour in air remains constant as long as the specific humidity of air remains constant. (6M)

b) The atmosphere air in a locality during a summer day registered a dry bulb temperature of 30°C and wet bulb temperature of 18°C, while the barometer read 756 mmHg. Determine the (i) Relative humidity, (ii) Specific humidity, (iii) Dew point, (iv) Enthalpy of air per kg of dry air. (9M)

7\. a) Define mean effective pressure (MEP) and discuss its application in IC engines. (6M)

b) The following data are available for an engine working on Otto cycle: Intake air pressure = 100 kPa, Intake air temperature = 308 K, Compression ratio = 8, Heat supplied (during the air-fuel combustion) = 2100 kJ kg^{-1}, Determine the (i) Maximum pressure developed,(ii) Maximum temperature developed during the operation of the cycle, (iii) Cycle efficiency, (iv) MEP (mean effective pressure). Take $c_{p,air}$ = 1.005 kJ kg^{-1} K^{-1}, $c_{v,air}$ = 0.718 kJ kg^{-1} K^{-1}, R_{air} = 287 J kg^{-1} K^{-1}. (9M)

8\. a) How is a reversed Brayton cycle used for refrigeration? (6M)

b) An ideal Gas Turbine operates between the temperature limits of 300 K and 900 K and pressure limits of 1 bar and 4 bar. Air (300 K) is taken in the compressor at the rate of 1600 kg min^{-1}.$C_{p,air}$= 1.005 kJ kg^{-1} K^{-1}; ratio of specific heat = 1.4. Determine the (i) Thermal efficiency of the plant (i) Gas Turbine output (shaft power) (9M)