Code No RT21033 **R13** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, Oct/Nov - 2016
THERMODYNAMICS
(Com. to ME, AE, AME)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) Discuss about PMM I and PMM II
   b) Explain about Quasi static process.
   c) Show that the COP of a heat pump is greater than the COP of a refrigerator by unity.
   d) What is steam quality? What are the different methods of measuring the quality?
   e) Explain Mole fraction, Volume fraction.
   f) Explain Lenoir Cycle.

PART -B

2. a) Explain about thermodynamic system and control volume.
   b) A gas in a piston cylinder assembly undergoes an expansion process for which the relationship between pressure and volume is given by PV^n= const. The initial pressure is 0.3 MPa, the initial volume is 0.1 m^3 and the final volume is 0.2 m^3. Determine the work for the process in kJ if i) n = 1.5, ii) n=1.0 and iii) n=0.

3. a) What is first law of thermodynamics? Write the corollaries of first law of thermodynamics.
   b) In a turbo machine handling an incompressible fluid with a density of 1000 kg/m^3 the conditions of the fluid at the rotor entry and exit are as given below. The inlet conditions are pressure= 1.15 MPa, Velocity = 30 m/s, Height above datum = 10 m and the exit conditions are pressure = 0.05 MPa, Velocity= 15.5 m/s, Height above datum= 2 m. If the volume flow rate of the fluid is 40 m^3/s. Estimate the net energy transfer from the fluid as work.

4. a) Discuss about Clausius Inequality.
   b) One kg of ice at -5^0C is exposed to the atmosphere which is at 20-C. Ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of the universe.

5. a) A rigid closed tank of volume 3m^3 contains 5 kg of wet steam at a pressure of 200 kPa. The tank is heated until the steam becomes dry and saturated. Determine the final pressure and the heat transfer to the tank.
   b) Discuss about degree of super heat and degree of sub cooling.

6. a) Derive the expression for change of enthalpy of an ideal gas in a reversible adiabatic process in terms of pressure ratio.
   b) Two streams of air 25^0C, 50% RH and 25^0C, 60% RH are mixed adiabatically to obtain 0.3 kg/s of dry air at 30^0C. Calculate the amount of air drawn from both the streams and the humidity ratio of mixed air.

7. a) Explain the working of Bell- Coleman cycle.
   b) Explain the working of Atkinson Cycle.

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PART –A

1. a) What are the different types of systems available? Explain.
   b) What will be the velocity of steam leaving a nozzle, if the velocity of approach is very small?
   c) Explain about heat engine and heat pump.
   d) Draw the phase equilibrium diagram for a pure substance on T-s plot with relevant constant pressure lines.
   e) Discuss about Carrier's Equation.
   f) Explain sterling cycle.

PART -B

2. a) Explain the concept of ideal gas temperature scale.
   b) A milk chilling unit can remove heat from the milk at a rate of 41.87 MJ/H. Heat leaking into milk from surroundings at an average rate of 4.187 MJ/h. Find the time required for cooling a batch of 500 kg of milk from 45^0C to 5^0C. Take the C_P of milk to be 4.187 kJ/kg K.

3. a) Derive the steady flow energy equation for an open system.
   b) Air flows steadily at the rate of 0.04 Kg/s through an air compressor, entering at 6m/s with a pressure of 1 bar and specific volume of 0.85 m^3 /Kg and leaving at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3 /Kg. The internal energy of the air leaving is 88 KJ/Kg greater than that of the entering air. Cooling water surrounding the cylinder absorbs heat from the air at the rate of 59 W. Calculate the power required to drive the compressor and the inlet and outlet cross sectional areas
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4. a) State and prove Clausius theorem.

b) A reversible heat engine operates between two reservoirs at temperatures of 600^0C and 40^0C. The engine drives a reversible refrigerator which operators between reservoirs at temperatures 40^0C and -20^0C. The heat transfer to the heat engine is 2000kJ and the net work output of the combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerator and the net heat transfer to the reservoir at 40^0C.

5. a) Steam at 0.8 MPa, 250^0C and flowing at a rate of 1 kg/s passes into a pipe carrying wet steam at 0.8 MPa, 0.9 dry. After adiabatic mixing the flow rate is 2.3 kg/s. Determine the condition of steam after mixing. The mixture is now extended in a frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the velocity of steam leaving the nozzle. Neglect the velocity of steam in the pipe.

b) Discuss about dryness fraction of steam.

6. a) Derive the expression for change of internal energy of an ideal gas in a reversible adiabatic process in terms of pressure ratio.

b) 1 kg of air at 20^0C, 40% RH is mixed adiabatically with 2 kg of air at 40^0C, 40% RH (on dry basis). Find the final condition of air.

7. With a neat sketch explain the working of Diesel cycle and derive the expression for its thermal efficiency

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PART –A

1. a) Show that work is a path function and not a property.
b) Discuss about Vander Waals equation of state.
c) Discuss mechanical, thermal and chemical irreversibility with one example each.
d) Find the saturation temperature, change in specific volume and entropy during evaporation, and the latent heat of vaporization of steam at 3 MPa
e) Explain Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity
f) Explain Lenoir Cycle.

PART –B

2. a) Why does free expansion has zero work transfer?
b) A new scale N of temperature is divided in such a way that the freezing point of ice 100^0N and the boiling point is 400^0N. What is the temperature reading on this new scale when the temperature is 160^0C. At what temperature both the Celsius and the new temperature scale reading would be the same.

3. a) Derive the energy balance equation of a steam nozzle and heat exchanger.
b) In a gas turbine installation air is heated inside the heat exchanger up to 750^0C from the ambient temperature of 27^0C. Hot air then enters into the gas turbine with a velocity of 50 m/s and leaves at 600^0C. Air leaving the turbine enters a nozzle at 60m/s velocity and leaves the nozzle at the temperature of 500^0C. for unit mass of the flow rate of air, Examine the following assuming the adiabatic expansion in the turbine and nozzle. (i) Heat transfer to air in heat exchanger (ii) Power output from turbine (iii) Velocity at the exit of the nozzle. Take Cp of air as 1.005kJ/Kg K

4. a) Derive the expression for maximum work obtained from two finite bodies at temperature T_1 and T_2.
b) Discuss about Maxwells equations.

5. a) Steam initially at 0.3 MPa, 250^0C is cooled at constant volume.
i) At what temperature will steam become superheated vapour?
ii) What is the quality of steam at 80^0C?
iii) What is the heat transferred per kg of steam in cooling from 250^0C to 80^0C
b) Discuss about triple point, critical temperature and critical pressure.

6. a) A reversible adiabatic process begins at P1= 10 bar, T1 = 300^0C and ends with P2= 2 bar. Find the specific volume and the work done per kg of fluid if
(i) the fluid is air, and (ii) the fluid is steam.
b) Discuss about sensible heating, cooling and dehumidification processes.

7. With a neat sketch explain the working of Brayton cycle and derive the expression for its thermal efficiency

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PART –A

1. a) What do you understand by path and point functions.
b) What is First law of Thermodynamics? Write its Corollaries.
c) What is a heat pump? How does it differ from a refrigerator?
d) Find the saturation temperature, change in specific volume and entropy during evaporation, and the latent heat of vaporization of steam at 2 MPa
e) Explain Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature
f) Explain Erricsson cycle.

PART -B

2. a) Explain the working of constant volume gas thermometer.
b) 2kg of gas at a pressure of 1.5 bar, Occupies a volume of 2.5 m^3. If this gas compresses isothermally to 1/3 times the initial volume. Find initial. Final temperature, work done, heat transfer.

3. a) With a neat sketch explain Joule's experiment.
b) A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2MPa, temperature 188^0C , enthalpy 2785 KJ/Kg, velocity 33.3m/s and elevation 3m. The steam leaves the turbine at the following state: Pressure 20 MPa, enthalpy 2512 KJ/Kg, velocity 100m/s and elevation 1 m. Heat is lost to the surroundings at the rate of 0.29 KJ/s. If the rate of steam flow through the turbine is 0.42 Kg/s, What is the power output of the turbine?

4. a) Determine the maximum work obtained by using one finite body at temperature T and a thermal energy reservoir at temperature T_0, $T > T_0$.
b) Discuss about reversibility and irreversibility.

5. a) Explain the working of throttling calorimeter.
b) Steam initially at 1.5 MPa, 300^0C expands reversibly and adiabatically in a steam turbine to 40^0C. Determine the ideal work output of the turbine per kg of steam.

6. a) A fluid at 200 kPa and 300^0C has a volume of 0.8 m^3. In a friction less process at constant volume the pressure changes to 100 kPa. Find the final temperature and heat transferred (i) if fluid is air, and (ii) if the fluid is steam.
b) Explain the following processes
i) Cooling and dehumidification, ii) Heating and humidification.

7. With a neat sketch explain the working of simple Rankine cycle and derive the expression for its thermal efficiency. Discuss the methods to improve the thermal efficiency.

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