Code No: RR210304 **Set No.1**

II B.Tech. I Semester Supplementary Examinations, May -2005
THERMODYNAMICS
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
⋆⋆⋆⋆⋆

1. (a) Explain the terms state, path, process and cyclic process.
   (b) Discuss the macroscopic and microscopic point of view of thermodynamics.
2. Calculate the final temperature, pressure, work done and heat transfer if the fluid is compressed reversibly from volume 6 m^3 to 1 m^3 when the initial temperature and pressure of the fluid are 20^{o}C and 1 bar. The index of compression may be assumed as 1, 1.3 & 1.4 respectively. Take C_p= 1.005 & C_v = 0.718 & R= 0.287 kj / kg K.
3. (a) Explain : heat engine and heat pump . Also show how a reversible heat engine operates as a reversible refrigerator.
   (b) The volume of one kg of air increases from 0.5m^3 to 1.3m^3 while its pressure decreases from 1 MPa to 250 kPa. Then 420 kJ of heat were added to it isothermally. Calculate the total entropy change for the system for the combined processes. Assume for air C_p= 1.005 kJ/kg.K and R = 0.287 kJ/kg.K.
4. (a) Deduce an expression for the non-flow availability for a system.
   (b) A 2-kg piece of iron is heated from room temperature of 25^{o}C to 400^{o}C by a heat source at 600^{o}C. What is the irreversibility in the process? Assume for iron C_p=0.450kJ/kgK.
5. (a) Determine the value of compressibility factor at critical point for the Vander Waal's gas.
   (b) A spherical shaped balloon of 12m diameter contain H_2 at 30^0 C and 1.21 bar Find the mass of H_2 in the balloon using real gas equation.
6. Two kg mole of Carbon di oxide at a pressure of 1.8 bar, 80^{0}C is mixed in a thermally insulated vessel with 3 kg-mole of Nitrogen is at equilibrium, Determine the final temperature and pressure and the change in entropy of the mixture.
7. (a) What do you mean by air standard cycles? What are the assumptions for air standard cycles.
   (b) An air standard Otto cycle has a compression ratio of 8. At the start of the compression process, the temperature is 26^{0}C and the pressure is 1 bar. If the maximum temperature of the cycle is 1080^{0}C calculate
      i. The heat supplied per kg of air
      ii. The network done per kg of air

iii. The thermal efficiency of the cycle.

8. A refrigerant R-12 vapour compression system operating at a condenser temperature of 40^0C and an evaporator temperature of -5^0C develops 15 tons of refrigeration. Using p-h chart for R-12, determine:

   (a) The mass low rate of refrigerant circulated
   (b) The theoretical piston displacement of compressor and piston displacement per ton of refrigeration.
   (c) The theoretical horsepower of the compressor and horsepower per ton of refrigeration.
   (d) The heat rejected in the condenser and
   (e) The car not C.O.P. and actual C.O.P. of the cycle.

⋆⋆⋆⋆⋆

Code No: RR210304 **Set No.2**

II B.Tech. I Semester Supplementary Examinations, May -2005
THERMODYNAMICS
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
⋆⋆⋆⋆⋆

1. (a) Show that work is a path function and not a state function.
   (b) Justify the statement that work and heat are not properties.

2. (a) Show that the internal energy is a property of the system.
   (b) Air at a pressure of 50 bar and a volume of $0.2m^3$ is expanded at constant pressure until the volume is doubled. It is then expanded according to $PV^{1.3}$ = constant until the volume is $0.8m^3$. Calculate the work done in each process.

3. (a) Prove that the change in entropy during a polytropic process is given by
   $s_2 - s_1 = C_v(n - \gamma/n - 1)log_e(T_2/T_1)$
   where γ is ratio of specific heats and n- index of compression or expansion.
   (b) A closed system consists of 1kg of air which is initially at 1.5 bar and 67^0C. The volume doubles as the system undergoes a process according to the law $pV^{1.2}$ = Constant. Find the work done, Heat transfer and change in entropy.

4. (a) Derive expression for the Gibbs Function of a mixture of inert ideal gases.
   (b) Show that on a Mollier diagram (h-s diagram) the slope of a constant pressure line increases with temperature in the superheat region.

5. (a) Derive the expressions for Heat transfer and work done during a reversible hyperbolic process.
   (b) One Kg of a ideal gas is heated from 18.3^0 C to 93.4^0C Assuming R = 287J/KgK and $\gamma = 1.18$ for the gas, find out:
      i. Specific heat
      ii. Change in internal energy and
      iii. Change in enthalpy.

6. (a) An air tank of volume $10m^3$ is at 70kPa and 100^0C. Now water is injected into the tank keeping the temperature at 80^0C. Determine the mass of water required to be injected so that the tank is just filled with saturated vapour.
   (b) If the water injection continues upto 30%more than what is required for saturated vapour calculate the total pressure in the tank.

7. In an air standard diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15^0C and the pressure is 0.1Mpa. Heat is added until the temperature at the end or the constant pressure process is 1480^0C. Calculate

(a) The cut off ratio.

(b) The heat supplied per Kg of air

(c) The cycle efficiency and

(d) The mean effective pressure.

8. Explain clearly Rankine cycle and derive on expression for thermal efficiency of the cycle.

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR210304 **Set No.3**

II B.Tech. I Semester Supplementary Examinations, May -2005
THERMODYNAMICS
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. Define a new temperature scale, say ^{o}M. At ice and steam point the temperatures are 80^o M and 300^o M respectively. Correlate this with centigrade scale. The ^{o}N reading on this scale is a certain number of degrees on a corresponding absolute temperature scale. Find this absolute temperature at ^{o}N.

2. A cylinder contains 0.115m^3 of gas at 1 bar and 90^{o}C. The gas is compressed to a volume 0.0288m^3,the final pressure being 5.67 bar. Calculate
   (a) the mass of the gas
   (b) the value of index of compression
   (c) the increase in internal energy of the gas and
   (d) the heat transfer during the compression.

   If, after the above compression, the gas is to be cooled at constant pressure to its original temperature of 90^{o}C, find the further work of compression required. Assume $\gamma = 1.4$ and R = 0.3 kj / kg K.

3. (a) Prove the statement "Of all engines which operate between given two thermal reservoirs the reversible engine possesses the maximum thermal efficiency".
   (b) A heat engine is used to drive a heat pump. The heat transfer from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and C.O.P. of the heat pump is 4. Evaluate the ratio of heat transfer to the circulating water to the heat transfer to the heat engine.

4. (a) Distinguish between available energy and availability.
   (b) Air at 1 bar and 30^{0}C is heated in a reversible manner at constant pressure until its temperature reaches 205^{0}C. How much of the heat added is available energy (per kg of air heated) if the lowest sink temperature is 4^{0}C. Also prove the formula used in this calculation.

5. (a) Describe the process of formation of steam and give its graphical representation.
   (b) Find the specific volume, enthalpy and internal energy of wet steam at 18 bar dryness fraction 0.9.
   (c) What is the triple point?

6. (a) An air tank of volume $10m^3$ is at 70kPa and 100^0C. Now water is injected into the tank keeping the temperature at 80^0C. Determine the mass of water required to be injected so that the tank is just filled with saturated vapour.
   (b) If the water injection continues upto 30%more than what is required for saturated vapour calculate the total pressure in the tank.

7. (a) Derive an expression for air standard efficiency for an engine working on the otto cycle.
   (b) An air standard diesel cycle operator with a compression ratio of 14.8 and a cut off ratio of 2. At the beginning of compression the air pressure and temperature are 37.8^0C and 1 bar respectively. Calculate
      i. The maximum temperature in the cycle and the heat input per cycle.

8. Draw the line diagram of the Bell-Coleman refrigeration cycle retrigesetion. Explain with the help of a P-V diagram, different processes in the cycle. Explain its advantages and disadvantages.

⋆⋆⋆⋆⋆

II B.Tech. I Semester Supplementary Examinations, May -2005
THERMODYNAMICS
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Distinguish between closed and open systems by giving practical examples.
   (b) A computer in a closed room of volume $200m^3$ dissipates energy at a rate of 10kW. The room has 50kg wood, 25kg steel and with all material at 300^0k; 100kpa. Assume all the mass heats up uniformly, how long will it take to increase the temperature 10^0c.

2. A steam turbine operates under steady flow conditions. It receives 7200 kg/h of steam from the boiler. The steam enters the turbine at an enthalpy of 2800 kj / kg, a velocity of 4000 m/min. and at an elevation of 4m. The steam leaves the turbine at an enthalpy of 2000 kj / kg, a velocity of 8000 m/min and at an elevation of 1m. Due to radiation, heat losses from the turbine to the surroundings amounts to 1580 kj / h. Calculate the output of the turbine.

3. A heat pump working on the reversed Carnot cycle takes in heat from a reservoir at 5^0C and delivers heat to a reservoir at 60^0C. The heat pump is driven by a reversible heat engine which, receives heat from a reservoir at 840^0C and rejects heat to a reservoir at 60^0C. the reversible heat engine also drives a machine that absorbs 30 kW. If the heat pump extracts 17kJ/s from the 5^0C reservoir, determine
   (a) the rate of heat supply from 840^0C source, and
   (b) the rate of heat rejection to the 60^0C sink.

4. (a) Explain : partial molal properties
   (b) Define chemical potential and express the same in terms of partial molal Helmholtz function.

5. (a) State the characteristics of
      i. an isothermal and
      ii. an adiabatic expansion
   (b) 1 Kg of air at 1 bar pressure and 15^0 C is compressed isentropically to 6 bar. Find the final temperature and the work done. If the air is cooled at the upper pressure to the original temperature of 15^0 C, what amount of heat is rejected and what further work of compression is done?
   The final state could have been reached by a reversible isothermal compression instead of by foregoing two process. What would be the work and heat transfers in this case ? Take for air $\gamma = 1.4$.

6. (a) A gas mixture consists of 0.5 Kg of carbon monoxide,1kg of carbon dioxide and 1.5 Kg of nitrogen .Determine
   i. Mass fraction of each component
   ii. Mole fraction of each component
   iii. Average molar mass of the mixture and
   iv. Gas constant of the mixture.

   (b) State Daltons law of additive pressure and Amagats law of additive volumes.

7. (a) Explain with the help of suitable graphs the variation of the efficiency of the diesel cycle with compression ratio and cut-off ratio.

   (b) In an air standard diesel cycle, the compression ratio is 15.Compression begins at 0.1MPa, 40^0c. the heat added is 1.675 MJ/Kg. Find
   i. The maximum temperature of the cycle.
   ii. The work down per Kg of air.
   iii. The cycle efficiency.
   iv. The temperature at the end of the isentropic expansion.
   v. The cut-off ratio.
   vi. The mean effective pressure of the cycle.

8. A power plant operating on the Ranking cycle has steam entering the turbine at 37 bar and 425^0C. If the turbine output is equivalent to 10,000 Kw, determine the efficiency of the cycle and the mass flow rate of steam for condenser pressure of

   (a) 0.07 bar and
   (b) 0.035 bar.

⋆ ⋆ ⋆ ⋆ ⋆