Code No: A109210305 **R09** **Set No. 2**

II B.Tech I Semester Examinations,MAY 2011
THERMODYNAMICS
Common to Mechanical Engineering, Aeronautical Engineering, Automobile Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define
   i. Closed System
   ii. Open System
   iii. Isolated System

   (b) Discuss the concept of Thermodynamic equilibrium. [9+6]

2. A simple Rankine cycle works between pressure of 28 bar and 0.06 bar, the initial condition of steam being dry saturated, calculate the cycle efficiency, work ratio and specific steam consumption. [15]

3. (a) Prove that Partial pressure fraction = Mole fraction = Volume fraction of constituent of a mixture of gases.

   (b) 4 kg of CO_2 at 50^0C and 1.4 bar are mixed with 8 kg of nitrogen at 150^0C and 1 bar to form a mixture at a final pressure of 0.7 bar. The process occurs adiabatically in a steady flow apparatus. Calculate
   (i) The final temperature of mixture (ii) Change in entropy. [7+8]

4. (a) Write Maxwells equations.

   (b) A heat pump is used to maintain an auditorium hall at 23^0C when the atmospheric temperature is -6^0C. The heat load is 2300 kJ/min. Calculate the power required to run the actual heat pump if the COP of the actual heat pump is 25% of the Carnot heat pump working between the same temperature limits. [7+8]

5. (a) State and explain joule's law of internal energy for an ideal gas.

   (b) In a system, executing non flow process, the work and heat per degee change of temperature are given by dW/dT = 200 J/ K and dQ/dT = 120 J/K, what will be the change in internal energy of the system when its temperature changes from 36^0C to 84^0C. [7+8]

6. (a) Write the clapeyson equation and point out its utility.

   (b) In a separating and throttling calorimeter the pressure of the steam before throttling is 10 bar .The pressure and temperature of steam after throttling is 1.1 bar and 110^0C respectively. At the separator 0.6 kgs of water is trapped and 3.4 kgs of condensed water is collected from the condenser. Determine the dryness fraction of steam in the main pipeline. Take C_p for superheated steam 2.1 kj /kg k. [7+8]

7. Stirling cycle uses air at the beginning of the isothermal expansion the air is at 1000K and 10 bar. The minimum pressure in cycle is 2 bar and at the end of the isothermal compression the volume is 60% of the maximum volume. Calculate the thermal efficiency of the cycle and the mean effective pressure. [15]

8. (a) Define compressibility and explain its significance.

   (b) The gas cylinders are usually color coded to ensure that the industrial gases are filled in he corresponding cylinders only. By mistaken identity, a nitrogen gas cylinder is filled with ethylene at 8 MPa and 300 K. The cylinder would contain 7 kg of Nitrogen, when filled at the same conditions of pressure and temperature. Determine the amount of ethylene filled in the cylinder. [5+10]

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Code No: A109210305 **R09** **Set No. 4**

II B.Tech I Semester Examinations,MAY 2011
THERMODYNAMICS
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Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Develop the expression for heat transfer from a mass of gas undergoing reversible polytrophic process.
   (b) During a particular process the specific heat of the system is given by C=0.2+0.002 T kj/kg k. Determine the heat transferred and mean specific heat of gas of 2 kg from 27^0C to 127^0C . [7+8]

2. (a) What do you mean by thermodynamic equilibrium?
   (b) A certain quantity of gas having initial volume, temperature and pressure as 0.5 m^3, 300 k and 425 kN/m^2 respectively undergoes an isothermal change of state and has the final pressure of 3.5 bar with a specific volume of 0.2 m^3/kg. Calculate the work done and Draw the process on a P-V diagram [7+8]

3. (a) Draw P-V and T-S diagrams for water starting from its liquid phase to super heated steam.
   (b) A vessel of volume 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 300^0C. The mass of liquid present is 10 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy, and the internal energy. [7+8]

4. In an ideal refrigeration cycle the temperature of the condensing vapour is - 40^0C and the temperature during evaporation is -15^0C. Calculate
   (a) the C.O.P. of the cycle
   (b) the power required to produce one ton of refrigeration and
   (c) mass flow rate of the refrigerant for each ton of refrigeration. Consider the working fluids F-12 and ammonia. [15]

5. (a) Explain how diesel gas power cycle differs from Otto gas power cycle with the help of P-V and T-S diagrams. Derive an expression for its air standard efficiency. Define mean effective pressure of a gas power cycle and establish an equation for m.e.p. of diesel power cycle.
   (b) A diesel engine has a clearance volume of 250 cm^3 and a bore and stroke of 15 cm and 20 cm respectively. The inlet conditions are 100 kN/m^2 and 20^0C. The maximum temperature of the engine is 1500^0C Calculate :
      i. the ideal thermal efficiency of the cycle and
      ii. its m.e.p. [7+8]

6. A certain quantity of air initially at a pressure of 7 bar and 280^0C has a volume of 0.045 m^3 .It under goes the following processes in the following sequence in cycle
   (a) Expands at constant pressure to 0.1 m^3
   (b) Follows polytrophic process with n= 1.4 and
   (c) A constant temperature process (which completes) evaluate the following
      i. Heat received in cycle
      ii. Heat rejected in cycle
      iii. Efficiency of cycle. [15]

7. A mixture of ideal gases consists of 3 kg of nitrogen and 6 kg of CO_2 at a pressure of 250 kpa and a temperature of 23^0C. Find
   (a) the mole fraction of each constituent
   (b) equivalent weight of the mixture
   (c) equivalent gas constant of the mixture
   (d) partial pressures and partial volumes
   (e) volume and density of mixture
   (f) C_p and C_v of mixture. If the mixture is heated at constant volume to 60^0C find the internal energy, enthalpy, and entropy of mixture. Find the changes in internal energy, enthalpy, and entropy of mixture if the heating is done at constant pressure. Take γ for $CO_2$and N_2 be 1.286 and 1.4. [15]

8. (a) What is a PMM 2?
   (b) A heat pump operates between two identical bodies of specific heat C and T_1. The operation of the pump cools down one of the bodies to T_2. Show that for the operation of pump the minimum work input is given by
   $W_{\min} = C\left[\frac{T_1^2}{T_2} + T_2 - 2T_1\right]$. [5+10]

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Code No: A109210305 **R09** **Set No. 1**

II B.Tech I Semester Examinations,MAY 2011
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Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. (a) Determine an expansion for the heat transfer in a closed system isochoric process?
   (b) A gas turbine receives gases from the combustion chamber at 7.5 bar and 600^0 C, with a velocity of 100 m/s. The gases leave the turbine at 1 bar with a velocity of 45 m/s. Calculate the work done if the expansion is isentropic. Assume $\gamma = 1.333$ and $C_p = 1.11kJ/kg.K$ [7+8]

2. 0.5 m^3 of air at 200^0C and 6 bar expands to 1 bar according to the law
   (a) PV= constant
   (b) $PV^{1.2}$ = constant and
   (c) Adiabtically, make calculations for the work done , heat transfer and change in entropy for the each of the process. [15]

3. (a) State the methods of improving thermal efficiency of steam power plant working on Rankine vapour cycle and describe them with necessary diagrams.
   (b) Describe an ideal vapour compression refrigeration cycle. [7+8]

4. A mixture of perfect gases at 40^0C and pressure 400 kN/m^2 has
   $N_2 = 40\%$ $NH_3 = 20\%$ $CH_4 = 40\%$
   $O_2 = 20\%$ and $H_2 = 10\%$.

   Calculate :
   (a) mass fraction, mole fraction, volume fraction and partial pressure of each constituent gases;
   (b) M and R of the mixture of gases ; and
   (c) partial volumes of each constituent gases. [15]

5. Steam at 0.8 MPa, 250^0C and flowing at the 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 2.5 kg/s. Determine the condition of steam after mixing. The mixture in now expanded in a frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the velocity of the steam leaving the nozzle. Neglect the velocity of steam in the pipe line. [15]

6. The compression ratio in an air standard Otto cycle is 7.5. At the beginning of compression process the pressure is120 kN/m^2 and the temperature is 300 K. The heat added to the air per cycle is 1650 kJ/kg of air. Calculate.

   (a) the pressures and the temperatures at the end of each process of the cycle
   (b) the thermal efficiency
   (c) the m.e.p of the cycle; and
   (d) power output/kg of air. [15]

7. An engine working on Carnot cycle absorbs Q_1 units of heat from a source at T_1 and rejects Q_2 units of heat to a sink at T_2. Te temperature of the working fluid is θ_1 and θ_2, where $\theta_1 < T_1$ and $\theta_2 > T_2$,
   If $\theta_1 = T_1$-KQ_1 and $\theta_2 = T_2$+kQ_2
   where k is constant, then show that efficiency of the engine is given by:
   $\eta = 1 - \frac{T_2}{T_1 - 2kQ_1}$. [15]

8. (a) Show that energy of an isolated system remains unchanged?
   (b) A system comprises a stone of mass 20 kg and a drum containing 1000 kg of water. Initially the stone is 50 m above the water and the stone and water are at the same temperature. The stone is then made to fall into water. Determine change in internal energy, kinetic energy, potential energy heat transfer, and work transfer for the changes of state given below?
      i. The stone is to just enter water.
      ii. The stone just comes to rest in drum, and
      iii. The heat transferred to surroundings is such that water and stone remain in the same temperature. Assume g = 9.81 m/s^2. [5+10]

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Code No: A109210305 **R09** **Set No. 3**

II B.Tech I Semester Examinations,MAY 2011
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Time: 3 hours **Max Marks: 75**
Answer any FIVE Questions
All Questions carry equal marks
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1. One kg of a air at a pressure of 9 bar and a temperature of 120^0 C undergoes a reversible polytrophic process following law $pv^{1.3}$ = constant. If the final pressure is 2 bar determine
   (a) The final values specific volume, temperature
   (b) Increase in entropy and
   (c) Work and heat transfer. [15]

2. A steam turbine receives steam at 20 bar and superheated by 80^0C. The exhaust pressure is 0.10 bar and expansion takes place isentropically. Calculate
   (a) heat supplied, assuming that the feed pump supplies water to the boiler at 20 bar,
   (b) heat rejected
   (c) turbine work,
   (d) net work,
   (e) thermal efficiency, and
   (f) theoretical steam consumption. [15]

3. State and explain
   (a) Daltons law of partial pressures
   (b) Avogadros Law. [15]

4. In a stirling cycle the volume varies between 0.03 and 0.06 m^3, the maximum pressure is 0.2 MPa and temperature varies between 540^0C and 270^0C. The working fluid is air. Determine
   (a) efficiency and work done per cycle for the simple cycle
   (b) efficiency and work done per cycle with an ideal regeneration and compare with carnot cycle having same isothermal heat supply process and temperature range. [15]

5. (a) Write clausius and Kelvin- Planck statements and their equivalence.

(b) It is desried to maintain an auditorium at 27^0C through the year. Hence it is planned to use a reversible device which can be used as a refrigerator in summer and as a heat pump in winter. The ambient temperature in summer is expected to reach 42^0C and in winter the minimum temperature may touch 5^0C The energy loss through the walls roof and doors is estimated at 50 kj/s. Determine the minimum power required to operate the device in summer and in winter. [8+7]

6. (a) State and explain steam Calorimetry.

   (b) The following data were obtained in a test on a combined separating and throttling calorimeter: Pressure of steam sample =12 bar, pressure of steam at exit = 1 bar, temperature of steam at the exit =150^0C, discharge from separating calorimeter =0.5 kg/min, discharge from throttling calorimeter =10 kg /min. Determine the dryness fraction of the sample steam. [7+8]

7. (a) Distinguish between closed, open and isolated system with examples

   (b) Gas from a bottle of compressed Helium is used to inflate an inelastic flexible balloon, originally folded completely flat to a volume of 0.35 m^3. If the barometer reads 760 mm Hg, what is the amount of work done upon the atmosphere by the balloon? Sketch the system before and after the process. [7+8]

8. A fluid is confined in a cylinder by a spring loaded friction less piston so that the pressure in the fluid is a linear function of the volume (p=a + b V). The internal energy of the fluid is given by the following equation U = 32 + 3.15 pV .where U is in kj , p in kpa and V in cubic meter. If the fluid changes from an initial state of 120kpa, 0.025 m^3 to a final state of 300 kpa,0.056 m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer. [15]

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