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

II B.Tech. I Semester Regular Examinations, November -2005
THERMODYNAMICS
(Common to Mechanical Engineering and Automobile 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. [8+8]

2. Nitrogen(C_p=1.0kJ/kg^0k γ=1.4) expands through a nozzle at a steady flow rate of 1000 kg/hour from 6 bar to 3.5 bar velocity and temperature at inlet to the nozzle are 100m/s and 90^{0}C respectively. Find the exit area of the nozzle. [16]

3. (a) Prove that Kelvin-planck statement and Clausius statement of Second law of thermodynamics are equivalent.

   (b) Two reversible heat engines A and B are arranged in series with A rejecting heat directly to B through an intermediate reservoir. Engine A receives 200 kJ of heat from a reservoir at 421^{0}C, and engine B is in thermal communication with a sink at 4.4^{0}C. If the work out put of A is twice that of B find

      i. the intermediate temperature between A and B,
      ii. the efficiency of each engine and
      iii. the heat rejected to the cold sink. [8+8]

4. (a) Explain : "Available energy" and "Availability" and Irreversibility.

   (b) Define Melmholtz and Gibbs free energy function. [9+7]

5. (a) What is the pure substance? Draw and explain P-T (pressure-temperature) diagram for a pure substance.

   (b) Explain the following terms relating to steam formation:

      i. Sensible heat of water
      ii. Dryness fraction of steam
      iii. Enthalpy of wet steam
      iv. Superheated steam. [6+10]

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. [16]

7. (a) Explain different processes in a dual combustion cycle with the help of P-V and T-S diagram.

   (b) Derive an expression for mean effective pressure of true's cycle. [6+10]

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. [16]

⋆⋆⋆⋆⋆

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

II B.Tech. I Semester Regular Examinations, November -2005
THERMODYNAMICS
(Common to Mechanical Engineering and Automobile Engineering)

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

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

1. (a) Define zeroth law of thermodynamics. Explain how it is basis for the temperature measurement.
   (b) Differentiate between intensive and extensive properties. Give examples in each case. [8+8]

2. A cylinder fitted with a piston has an initial volume of $0.1m^3$ and contains nitrogen at 150kpa, 25^0C. The piston is moved to compress the nitrogen until the pressure is 1 Mpa and the temperature is 150^0C. The work done on the nitrogen is 20kJ. Determine the amount of heat transfer from the nitrogen. [16]

3. (a) State and explain any four factors which render processes irreversible.
   (b) A reversible heat engine receives heat from a reservoir at 700^0C and rejects heat to another reservoir at temperature T_2. A second heat engine receives the heat rejected by the first engine and rejects heat to a sink at 37^0C. Calculate temperature T_2 for
      i. equal efficiency for both engines
      ii. equal work for both engines [6+10]

4. (a) Distinguish between available energy and availability.
   (b) Air at 1 bar and 30^0C is heated in a reversible manner at constant pressure until its temperature reaches 205^0C. How much of the heat added is available energy (per kg of air heated) if the lowest sink temperature is 4^0C. Also prove the formula used in this calculation. [6+10]

5. (a) Following observation were recorded in a test on a combined separating and throttling calorimeter. Determine the quality of steam. For superheated steam C_{ps} = 2kJ/kg K. Pressure in the steam line = 800kPa; Pressure of the steam after throttling = 100 kPa;
   Temperature of the steam after throttling = 105^0C.
   Mass of steam collected in the separator = 0.25kg;
   Mass of the steam condensed after throttling = 2.25kg;
   (b) Find the enthalpy of vaporization of water at 100^0C using both steam table and Clausis-Clapeyron equation. [8+8]

6. (a) Methane at 150kPa, 20^0C enters an insulated mixing chamber at a rate of 1.0kg/s .It is mixed with air at 150kPa and 180^0 C in an air methane mass ratio of 15:1. The flow is steady and kinetic energy changes are negligible. Ambient pressure and temperature are 100kPa 15^0C. Determine:

i. The temperature of the mixture leaving the chamber and

ii. The irreversibility of the mixing per kg of methane.

(b) How gravimetric analysis can be compared with volumetric analysis? [10+6]

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. [6+10]

8. In a refrigerating plant working on the Bell-Coleman cycle the air is drawn from the cold chamber at -5^0C and 1.03 bar. The same air is compressed reversibly and adiabatically to 5.25 bar before being cooled in the heat exchanger to 15^0C. After the exchanger the air is expanded adiabatically and reversibly to cold chamber state. Assuming the value of $C_p = 1.004$ kj/kg^0k and $C_v = 0.717$ kj/kgk for air determine.

   (a) Work done on the cycle per kg of air

   (b) The refrigeration effect produced in cold chamber

   (c) C.O.P. [16]

⋆⋆⋆⋆⋆

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

II B.Tech. I Semester Regular Examinations, November -2005

THERMODYNAMICS

(Common to Mechanical Engineering and Automobile Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A new temperature scale in degrees N is to be defined. The boiling and freezing points on this scale are 400^o N and 100^oN respectively.
   (a) Correlate this with
      i. Centigrade scale and
      ii. Fahrenheit scale.
   (b) What will be the reading on new scale corresponding to 60^oC. [16]

2. A system receives 200 kj of heat at constant volume process and rejects 220 kj of heat at constant pressure and 40 kj of work is done on the system. The system is brought to its original state by an adiabatic process calculate the adiabatic work. If the initial internal energy is 240 kj, then calculate the value of internal energy at all points. [16]

3. (a) Explain the need for heat engines and refrigerators considering the limitations of the first law of thermodynamics.
   (b) Two kg of air at 500kPa, 80^0 C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100kPa, 5^0 C. For this process, determine
      i. the maximum work, and
      ii. the change in availability. [6+10]

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. [8+8]

5. (a) A gas of $0.15m^3$ volume at pressure of 50 bar weighs 6 Kg. It is expanded isentropically until the temperature falls to 600 K. The values of specific heats are given as: c_p = 0.225 + 0.00005 T and c_v = 0.155 + 0.00005 T. Calculate
      i. Work done
      ii. Pressure at the end of expansion
   (b) The temperatures at the five salient point of a Dual combustion cycle are 363^0K, 988^0K, 1294^0K, 2135^0K,and 950^0K, Find the thermal efficiency of the cycle. Assume c_p = 0.2395 + 0.00003 T and c_v = 0.171 + 0.00003 T. [8+8]

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. [8+8]

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 26^0C and the pressure is 1 bar. If the maximum temperature of the cycle is 1080^0C calculate

      i. The heat supplied per kg of air
      ii. The network done per kg of air
      iii. The thermal efficiency of the cycle. [6+10]

8. An ammonia ice plant operates between a condenser temperature of 35^0C and an evaporator temperature of -15^0C. It producers 10 tons of ice per day from water at 30^0C to ice at -5^0C. Assume simple saturation cycle. Using only tables of properties for ammonia, determine:

   (a) The capacity of the refrigeration plant
   (b) The mass flow rate of refrigerant
   (c) The discharge temperature
   (d) The compressor cylinder diameter and stroke if its volumetric efficiency is 0.65, rpm = 1200 and stroke/bore ratio = 1.2,
   (e) The horse power of the compressor motor if the adiabatic efficiency of the compressor 0.85 and mechanical efficiency 0.95 and
   (f) The theoretical and actual C.O.P. [16]

⋆⋆⋆⋆⋆

Code No: RR210304 **Set No.4**

II B.Tech. I Semester Regular Examinations, November -2005
THERMODYNAMICS
(Common to Mechanical Engineering and Automobile Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Define zeroth law of thermodynamics. Explain how it is basis for the temperature measurement.
   (b) Differentiate between intensive and extensive properties. Give examples in each case. [8+8]

2. (a) Define internal energy of a system and show that it is a property of the system.
   (b) Derive an expression for finding the work done during a polytrophic process. [6+10]

3. (a) What is a heat pump? Define its COP. Compare the COP of a heat pump with that of a refrigerator.
   (b) What are the two statements of 2^{nd} law of thermodynamics? Explain.
   (c) Show that the violation of Kelvin-Planck statement leads to the violation of Clausius statement. [6+6+4]

4. (a) A pressure vessel has a volume of $1m^3$ and contains air at 1.4 MPa, 175^0C. The air is cooled to 25^0C by heat transfer to the surroundings at 25^0C. Calculate the availability in the initial and final states and the irreversibility for the process. Assume for air Cp= 1.005 kJ/kg.K and R = 0.287kJ/kg.K.
   (b) What is third law of thermodynamics? State its significance. [10+6]

5. (a) Explain the determination of dryness fraction of steam using a throttling calorimeter.
   (b) A throttling calorimeter is used to measure the dryness fraction of the steam in the steam main which has steam flowing at a pressure of 8 bar. The steam after passing through the calorimeter is at 1 bar pressure and 115^0C. Calculate the dryness fraction of the steam in the main.
   The C_{ps} = 2.1 KJ/Kg K. [6+10]

6. A mixture of 25% Nitrogen and 75% Hydrogen by volume is compressed. Isentropically from 300 K and 100 kPa to 500 kPa in the first stage of multistage compressor in a fertilizer plant. The compression to still higher pressure is acheived in subsequent stages after the gas mixture is passed through the intercooler. Find the temperature of the gas mixture after compression as well as the work required per unit mass of the mixture. Also evaluate the entropy change for each gas. Assume that the mixture behaves like an ideal gas. [16]

7. In an air standard brayton cycle the air enters the compressor at 1 bar and 25^0c. The pressure after compression is 3 bars. The temperature at the turbine inlet is 650^0c. Calculate per Kg of air
   (a) heat supplied .
   (b) heat rejected .
   (c) Work available at the shaft .
   (d) Temperature of air leaving the turbine and
   (e) cycle efficiency. [16]

8. A R-12 simple saturation cycle operates at temperature of 35^0C and -15^0C for the condenser and evaporator respectively. Determine the C.O.P. and power/ton of refrigeration of the system using
   (a) Refrigeration charts .
   (b) R-12 tables. Compare the result. [16]

⋆⋆⋆⋆⋆