Code No: RR222102 **Set No. 1**

II B.Tech II Semester Regular Examinations, Apr/May 2006
ENGINEERING THERMODYNAMICS
(Aeronautical 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. [8+8]

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. [16]

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.hfill[8+8]

4. (a) Explain : "Available energy" and "Availability" and Irreversibility.
   (b) Define Melmholtz and Gibbs free energy function. [9+7]

5. (a) Define
      i. Compressibility factor Z.
      ii. Isothermal compressibility
   (b) What is the value of the compressibility factor at the critical point for a Vander Waal's gas?
   (c) There are two regions in the compressibility chart. They are Z<1 and Z>1. Name the factors which play a dominant role in each of the two regions for expressing the deviations from ideal gas behaviour. [6+4+6]

6. (a) Define
      i. Mole fraction
      ii. Partial pressure
      iii. Partial volume

(b) A mixture consisting of 40% oxygen and 60% nitrogen by volume is cooled under constant volume conditions from 1 bar, 85^0C to a final temperature of 10^0C. Compute the partial pressures of the constituents and the volumetric analysis at the final temperature. [6+10]

7. (a) Define mean effective pressure. What is its importance in reciprocating engines.

   (b) A diesel cycle operating on an air standard cycle has a compression ratio at 15. The pressure and temperature at the beginning of the compression are 1.04 bar and 15^0c. If the maximum temperature of the cycle is 2330K, determine

      i. the thermal efficiency and
      ii. The mean effective pressure. [6+10]

8. In a Bell-Coleman refrigerating plant the air is drawn from the cold chamber at a Pressure of 1.03 bar and temperature of -10^0C and compressed isoentropically to 6.18 bar. The same is cooled to 25^0C. It is then expanded in expansion cylinder following the law PV1-3 = constant and discharged back to the cold chamber. Assure C_p = 1.004 kJ/kg^0k, C_v = 0.717 kj/kjk for air throughout the cycle determine.

   (a) Work input to the cycle per kg of air
   (b) Refrigeration produced in cold chamber and
   (c) C.O.P. of the cycle. [16]

⋆⋆⋆⋆⋆

Code No: RR222102

Set No. 2

II B.Tech II Semester Regular Examinations, Apr/May 2006
ENGINEERING THERMODYNAMICS
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. The readings t_A and t_B of two centigrade thermometers A and B, agree at the ice point (0^oC) and the steam point (100^oC), but elsewhere are related by the equation $t_A = l + m\, t_B + n\, {t_B}^2$ where l, m and n are constants. When both the thermometers are immersed in a well stirred oil bath, A registers 51^0C while B registers 50^oC.

   (a) Determine the reading on B when A reads 25^oC and

   (b) Discuss which thermometer is correct. [16]

2. (a) Two kg of air expands polytropically (n=1.25) from a pressure of 15 bar and temperature of 300^oC to a pressure of 1.5 bar, then heated at constant pressure to initial volume. Find

   i. Work done
   ii. Change in enthalpy
   iii. Heat transer.

   (b) Show that the heat transfer in polytropic process $\frac{\gamma-n}{\gamma-1}$ times of work [8+8]

3. (a) State and prove Clausius inequality and hence deduce that the property entropy exist.

   (b) A cylinder contains $0.5m^3$ of a gas at 0.1 MPa and 90^0C,. The gas is compressed to a volume of $0.125m^3$. The final pressure is 800 kPa. Determine the heat transferred and the change in entropy of the gas during the process. Assume R = 0.287 kJ/kgK and C_v = 0.713 kJ/kgK [8+8]

4. (a) Prove that irreversibility is created (entropy generated) whenever heat transfer with finite temperature difference occurs.

   (b) Explain the significance of entropy. [10+6]

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? [8+6+2]

6. A mixture of gases contains 1 kg of oxygen and 1.5 kg of Nitrogen. The pressure and temperature of the mixture are 3.5 bar and 27^0 C. Determine for the mixture.

   (a) The mass and mole fraction of each constituent gas

(b) The average molecular weight

(c) the specific gas constant

(d) the density [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) Sketch the Rankine cycle on P-V and T-S diagram and explain clearly different process of the cycle. State in what respect it differs from carnot cycle working between the same temperature limits.

   (b) Dry and saturated steam at pressure 11 bar is supplied to a turbine and expended isentropicelly to a pressure or 0.07 bar. Calculate the following.

      i. Heat supplied
      ii. Total change of entropy
      iii. Heat rejected
      iv. Theoretical thermal efficiency. [8+8]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR222102

Set No. 3

II B.Tech II Semester Regular Examinations, Apr/May 2006
ENGINEERING THERMODYNAMICS
(Aeronautical 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. Steam enters a nozzle at a pressure of 7 bar and 205^{o}C. Initial enthalpy being 2850 kj/kg and leaves at a pressure of 1.5 bar. The initial velocity of steam at the entrance is 40 m/s and the exit velocity from the nozzle is 700 m/s. The mass flow rate through the nozzle is 1400 kg / h. The heat loss from the nozzle is 11705 kj/ h. Determine the final enthalpy of steam and the nozzle exit area, if the specific volume is 1.24 m^3/ kg. [16]

3. (a) What is absolute temperature scale? Develop this scale from Carnot theorem
   (b) A reversible engine during a cycle of operation interacts with three thermal reservoirs maintained at 200K,300K and 400K. It receives 5 MJ of heat from the reservoir at 400K and produces a net positive work of 840 kJ. Find the amount and direction of heat interaction with other reservoirs. [8+8]

4. (a) Show that available energy decreases during heat transfer through finite temperature difference.
   (b) A mass of 6.98 kg of air is in a vessel at 200 kPa and 27^{0}C . Heat is transferred to the air from a reservoir at 727^{0}C until the temperature of the air rises to 327^{0}C. The environment is at 100kPa, 17^{0}C . Determine
      i. the initial and final availability of air and
      ii. the maximum useful work associated with the process. Assume for air Cp= 1.005 kJ/kg.K and R = 0.287kJ/kg.K. [8+8]

5. (a) It is desired to design a tank to store 10 kmol methane at 6.0 MPa. Determine the size of the tank using the ideal gas law, Van der Walls equation of state the Generalized compressed chart. Van der Walls constant are a = 228.5 KPa (m^3/k mol)^2 and b=0.0427m^3/k.
   (b) A 10 m^3 rigid container is filled with wet steam at 100KPa pressure so that upon heating it passes through the critical point. Determine
      i. the amount of steam to be filled,
      ii. ratio of the vapor volume to the liquid volume. The critical volume of water is 0.003155m^3/kg. [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) Compare the efficiency of the Otto, the diesel cycle and the dual cycle under the conditions.

      i. Constant maximum pressure and output and.
      ii. Constant maximum pressure and temperature,

   (b) At the beginning of compression in an air standard Otto cycle, engine cylinder temperature is 37.8^0C, the pressure is 0.99 bars and the volume is 0.000707m^3. At the end of the compression the pressure is 10.55 bars. The heat supplied to the cycle is 1.5kJ. Calculate

      i. The compression ratio
      ii. Network per cycle
      iii. The mean effective pressure. [8+8]

8. (a) Discuss the effect of sub cooling on C.O.P. would you desire large sub cooling and why?

   (b) A simple saturation ammonia compression system has a high pressure of 1.35 MN/m^2 and a low pressure of 0.19 MN/m^2, Find per 4,00,000 Kj/hr of refrigerating capacity, the power consumption of compressor and C.O.P. of the cycle. [4+12]

⋆ ⋆ ⋆ ⋆ ⋆

II B.Tech II Semester Regular Examinations, Apr/May 2006
ENGINEERING THERMODYNAMICS
(Aeronautical 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. $0.2m^3$ of an ideal gas at a pressure of 2000 kpa and 327^0C is expanded isothermally to 5 times the initial volume. It is then cooled to 25^0C at constant volume and then compressed back polytropically to its initial state. Determine
   (a) Work done
   (b) Heat transfer during the cycle. [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 421^0C, and engine B is in thermal communication with a sink at 4.4^0C. 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) Prove that irreversibility is created (entropy generated) whenever heat transfer with finite temperature difference occurs.
   (b) Explain the significance of entropy. [10+6]
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. Derive the air standard efficiency of the Brayton cycle and explain why it is the true constant pressure cycle. Also explain its use in modern engines. [16]

8. (a) Discuss the effect of sub cooling on C.O.P. would you desire large sub cooling and why?

   (b) A simple saturation ammonia compression system has a high pressure of 1.35 MN/m^2 and a low pressure of 0.19 MN/m^2, Find per 4,00,000 Kj/hr of refrigerating capacity, the power consumption of compressor and C.O.P. of the cycle. [4+12]

⋆ ⋆ ⋆ ⋆ ⋆