337413(37)

B. E. (Fourth Semester) Examination, Nov.-Dec., 2007

(Mechanical Engg. Branch)

APPLIED THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Solve all questions subject to internal choice. Use of Mollier chart and Steam Table are permitted. Assume suitable data if required only because relevant data has been presented in question concerned.

1. (a) State principle of increase in entropy. 2

(b) A reversible heat engine in a satellite operates between a hot reservoir at T_1 and a radiating panel at T_2. The heat radiation from the panel is proportional

to its area and to T_2^4. For a given work output and value of T_1, show that the area of panel will be minimum when $\left(\frac{T_2}{T_1}\right) = 0.75$. Take heat rejected $Q_2 = KAT_2^4$, where K is a constant. 1.

Or

Calculate the decrease in available energy when 25 kg of water at 95°C mix with 35 kg of water at 35°C, the pressure being taken as constant and the temperature of surroundings being 15 °C. 1.

2. (a) Define Joule-Kelvin coefficient.

(b) The vapour pressure in mm of mercury of solid ammonia is given by :

$$\log p = 23.03 - \frac{3754}{T}$$

and that of the liquid ammonia by :

$$\log p = 19.49 - \frac{3063}{T}$$

Find out :

(i) temperature at tripple point. Also find pressure

(ii) latent heats of sublimation and vaporization

(iii) latent heat of fusion at tripple point 1:

Or

The neon gas has a molecular weight of 20·183 and its critical temperature and volume are 44·5 K, 2·73 MPa and 0·0416 m³/kg-mol. The compressibility chart for Neon shows that reduced pressure is 2 and a reduced temperature of 1·3. The compressibility factor z = 0·7. Find corresponding specific volume, pressure, temperature and reduced volume. 14

Define Binary cycle. 2

(b) A steam turbine is fed with steam having enthalpy of 3100 kJ/kg. It moves out of the turbine with an enthalpy of 2100 kJ/kg. Feed heating for regeneration is adopted at a pressure of 3·2 bar with steam enthalpy of 2500 kJ/kg. The condensate from a condensor with an enthalpy of 125 kJ/kg enters into the feed water. The quantity of bled steam is 11200 kg/h. Find power developed by turbine. Assume that water leaving the feed heater is saturated at 3·2 bar and the heater is direct mixing type. 14

Or

The steam at 100 bar and 400 °C is supplied to a steam turbine whose isentropic efficiency is 80%. The condenser pressure is 0·1 bar. If the plant capacity is 120 MW and the specific steam consumption is 4 kg/kWh, find out :

(i) Cooling water required per hour in the condenser assuming no undercooling.

(ii) cooling water required per hour if there is 5°C undercooling.

The rise of temperature in both cases for cooling water is 10°C. 14

4\. (a) What are main elements of vapour compression refrigeration. 2

(b) A refrigeration plant works between temperature units of –5°C and 25°C. The working fluid ammonia has a dryness fraction of 0·62 at entry to the compressor. If the machine has a relative efficiency of 55%, calculate the amount of ice formed during a period of 24 hours. The ice is to be formed at 0°C from water at 15°C and 6·4 kg of ammonia is circulated per minute specific heat of water is 4·187 kJ/kg-°C and latent heat of ice is 365 kJ/kg. 14

Properties of NH_3 (datum –40°C).

Temp. °C	Liquid heat	Latent heat	Entropy of liquid
°C	kJ/kg	kJ/kg	kJ/kg-K
25	298·9	1167·1	1·124
–5	158·2	1280·8	0·630

Or

A single stage double acting air compressor of 62·5 kW I.P. at 120 RPM takes air at 1 bar and delivers it at 10 bar. Assuming the law of compression and expansion as $pv^{1.35}$ = constant, find the diameter and stroke of the cylinder.

Data given is as follows:

Piston speed = 200 m/min

Volumetric efficiency = 90%

Also find the following from above data :

Clearance volume as percentage of stroke. If the mechanical efficiency of this compressor is 80% what is the brake power? 14

5. (a) Define Stagnation enthalpy. 2

(b) A convergent-divergent nozzle has a throat area 500 mm^2 and an exit area of 1000 mm^2. Air enters the nozzle with a stagnation temperature of 360 K and a stagnation pressure of 1 MPa. Determine the maximum flow rate of air that the nozzle can pass; and the static pressure and static temperature, Mach number and velocity at the exit from the nozzle if :

(i) divergent section acts as a nozzle and

(ii) the divergent section acts as a diffuser.

Given that the flow is isentropic and ratio $\frac{A_2}{A^*} = 2\cdot0$ and the two Mach numbers for conditions : (i) and (ii) above are 2·197 and 0·308. Take higher Mach no. Also take $\frac{p_2}{p_o} = 0\cdot0939$, $\frac{T_2}{T_o} = 0\cdot5089$, $\frac{p^*}{p_o} = 0\cdot528$ and $\frac{T^*}{T_o} = 0\cdot833$. 14

Or

A stream of air flows in a duct of 100 mm diameter at a rate of 1 kg/s. The stagnation temperature is 37°C. At one section of the duct the static pressure is 40 kPa. Calculate Mach number, velocity and stagnation pressure at this section. 14