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BE (4th Semester)

Examination, April-May, 2022

Branch : Mechanical

APPLIED THERMODYNAMICS

Time Allowed : Three Hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Answer all questions. Part (a) of each question is compulsory. Solve any two parts from part (b), (c) and (d). Use of Steam Table and Mollier Chart is permitted.

UNIT - I

Q. 1. (a) What do you understand by entropy principle ? 2

(b) A fluid undergoes a reversible adiabatic compression from 0.5 MPa pressure and 0.2 m^3 to 0.05 m^3 according to law, $PV^{1.3}$ = constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process. 7

(c) Air expands through a turbine from 500 kPa, 520°C to 100 kPa, 300°C. During expansion 10 kJ of heat is lost to the surrounding which is at 98 kPa, 20°C. Neglecting the K.E. and P.E. changes, determine per kg of air

(i) the decrease in availability

(ii) the maximum work

(iii) the reversibility

For air take C_p = 1.005 kJ/kg K, $h = C_pT$. 7

(d) What do you understand by 'useful work' ? Derive expressions for useful work for a closed system and a study flow system which interact only with the surrounding. 7

UNIT - II

Q. 2. (a) Define volumetric expansivity and isothermal compressibility. 2

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

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

and that of liquid ammonia is given by

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

Find :

(i) What is the temperature of the triple point ? and what is the pressure ?

(ii) What are the latent heats of sublimation and vaporization ?

(iii) What is the latent heat of fusion at the triple point ? 7

(c) What do you mean by Maxwell's Equations ? With the help of Maxwell's equation derive first and second TdS equations. 7

(d) (i) Give the virial expansions for pv in terms of p and v. What are virial coefficients ? When do they become zero ? 3

(ii) What is the law of corresponding states ? 4

UNIT - III

Q. 3. (a) What do you understand by steam rate and heat rate ? What are their units ? 2

(b) In a steam power plant the condition of steam at inlet to the steam generator is 20 bar and 300°C and the condenser pressure is 0.1 bar. Two feed water heaters operate at optimum temperatures. Determine :

(i) The quality of steam at turbine exhaust

(ii) Net work per kg of steam

(iii) Cycle efficiency and

(iv) The steam rate.

Neglect pump work. Draw the cycle flow diagram and T-S diagram of the cycle. **7**

(c) With the help of neat sketch explain Reheat cycle and derive expressions for thermal efficiency and steam rate. Also represent the cycle on T-S and h-s coordinate. **7**

(d) With the help of diagram explain any two types of condenser ? What do you mean by condenser efficiency, vacuum efficiency and air leakage in the condenser. 7

UNIT - IV

Q. 4. (a) Define volumetric efficiency of a compressor. 2

(b) With the help of diagram explain construction and working of simple vapour compression refrigeration cycle. Find a expression for its C.O.P. 7

(c) With suitable diagram explain the working of reciprocating air compressor and derive expressions for work required to drive it. What are its advantages and disadvantages. 7

(d) Show that the optimum intermidiate pressure of a two stage reciprocating compressor for minimum work is the geometric mean of the section and discharge pressure. 7

UNIT - V

Q. 5. (a) What is compressible fluid ? What are the basic laws in compressible flow ? 2

(b) (i) What is a shock ? Where does it occur in a nozzle ? 3

(ii) What do you mean by Fanno line and Rayleigh line ? Why do the end states of a normal shock lies on the Fanno and Rayleigh lines. 4

(c) Derive an expression for discharge through a nozzle. Show that the discharge through a nozzle is maximum when there is a sonic condition at it's throat. 7

(d) 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 the Mach number, velocity and stagnation pressure at this section. 7