(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4069   **Roll No.** [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2012-13
APPLIED THERMODYNAMICS

Time : 3 Hours   *Total Marks : 100*

Note : *(1) Answer **all** questions.*

(2) All questions carry equal marks.

1. Answer any **FOUR** questions :

    (a) Discuss briefly about the concept of thermodynamic equilibrium and its importance in engineering thermodynamics.   **(5)**

    (b) Define the terms 'system', 'boundary', 'surroundings' and 'universe'. Discuss about closed and open system giving examples of each.   **(5)**

    (c) A constant volume helium gas thermometer registers pressures 1000 mm of Hg of ice point and 1366 mm of Hg at steam point.

       (i) Find the relation between pressure and temperature if it follows linear relationship as

           $T = A + Bp$.

           where T is in °C and p is in mm of Hg.

       (ii) The thermometer shows the reading 1060 mm of Hg when left standing in atmosphere. Determine the atmospheric temperature.   **(5)**

(d) State and explain Gibb's function. **(5)**

(e) Prove the Maxwell relations. **(5)**

(f) The pressure on a copper block of 1 kg is increased from 10 bar to 1000 bar in a reversible process maintaining the temperature constant at 15°C. Determine :

    (i) Work done on the copper during the process

    (ii) Change in entropy. **(5)**

2. Answer any **FOUR** questions :

(a) Describe the construction of temperature-entropy and Mollier diagrams. **(5)**

(b) A vessel contains steam of 10 bar having dryness fraction of 0.95. The volume of the pressure vessel is 0.03 m³. Due to loss of heat by radiation, the pressure of steam falls to 3 bar. Determine the quality of steam in the final stage and the loss of heat. **(5)**

(c) Describe with neat sketch the working of Cochran boiler. **(5)**

(d) Explain why safety valves are needed in a boiler ? Draw a neat sketch of spring loaded safety valve and explain its working. **(5)**

(e) Explain the function of superheater. With neat sketch explain its working. **(5)**

(f) What is the purpose of steam stop valve ? Explain its working. **(5)**

3. Answer any **TWO** questions :

   (a) What do you understand by theoretical indicator diagram ? How and why it differs from the actual indicator diagram ? **(10)**

   (b) A single cylinder double acting steam engine receives steam at 1 MPa and exhausts at 55 kPa. The dryness of inlet steam is 96%. The power developed by the engine when running at 210 rpm is 45 kW, with steam consumption of 460 kg/hr. The engine bore is 25 cm and the stroke is 37.5 cm. The expansion ratio is 6. Calculate the diagram factor and the indicated thermal efficiency of the engine. **(10)**

   (c) Steam at a pressure of 10.5 bar and 0.95 dry is expanded through a convergent divergent nozzle. The pressure of steam leaving the nozzle is 0.85 bar. Find the velocity of steam at throat for maximum discharge. Take n = 1.135. Also find the area at the exit and the steam discharge if the throat area is 1.2 cm². Assume flow is isentropic and there are no friction losses.

   (10)

4. Answer any **TWO** questions :

   (a) The mean diameter of the blades of an impulse turbine with a single row wheel is 105 cm and the speed is 3000 rpm. The nozzle angle is 18° and the ratio of blade speed to steam speed is 0.42 and the ratio of the relative velocity at the outlet from the blade to that of the inlet is 0.84. The outlet angle of the blade is 3°

less than the inlet angle of the blade. The steam flow is 8 kg/sec. Determine :

(i) Resultant thrust on the blades,

(ii) Power developed in the blades, and

(iii) Blade efficiency. **(10)**

(b) Prove that the diagram or blade efficiency of a single stage reaction turbine is given by

$$\eta_b = 2 - \frac{2}{(1 + 2\rho\cos\alpha_1 - \rho^2)} \quad \text{where } R_d = 50\%$$

and $V_{f_1} = V_{f_2}$. **(10)**

(c) Prove that the Rankine efficiency of a modified Rankine cycle considering pump work is given by

$$\eta_r = \frac{\left[(h_1 - h_2) + \frac{v_2(p_2 - p_b)}{J}\right] - W_p}{h_1 - (h_{f_2} + W_p)}.$$

The notations carry the usual meaning. **(10)**

5. Answer any **TWO** questions :

(a) Describe with neat sketches the working of a simple constant pressure open cycle gas turbine. How does the actual cycle differ from the theoretical cycle ?

(10)

(b) What is ram-jet ? Explain the working of ram-jet with neat sketch. **(10)**

(c) Explain the working difference between propeller jet, turbo jet and turbo prop. **(10)**