Applied Thermodynamics

(ME-207/209, Dec. 2003)

Time: 3 Hours Max. Marks: 60

Note: Question No. 1 is compulsory. Attempt any four questions from section B and two questions from section C.

Section-A

1. **(a) Explain the term 'Quality of steam'.**
   (b) Show how the boilers are classified.
   (c) Draw the mechanical system to show different processes of the Rankine Cycle.
   (d) What is meant by critical pressure ratio of a nozzle?
   (e) How does a turbine differs from a steam engine?
   (f) Discuss the use of combined velocity triangle of an impulse turbine.
   (g) Distinguish between impulse and reaction turbines.
   (h) State Dalton's law of partial pressure.
   (i) Draw P-V and T-S diagram for a single stage reciprocating compressor.
   (j) What are the uses of compressed air in industry?

Section-B

2. Discuss formation of steam in detail.
3. Describe briefly the Rankine cycle using superheated steam and show in what respect this cycle differs from Carnot cycle between the same temperatures.
4. Starting from fundamentals, show that for maximum discharge through a nozzle, the ratio of throat pressure is given by $[2/(n+1)]^{n/(n-1)}$ where n is the index for isentropic expansion through the nozzle.
5. What do you understand by the term 'friction' in an impulse turbine? How does it affect the combined velocity triangle?
6. A single-stage reciprocating air compressor is required to compress 1 kg of air from 1 bar to 4 bar. The initial temperature is 27ºC. Compare the work requirement in the following cases:
   (a) Isothermal compression
   (b) Compression with $PV^{1.2}$ = constant

Section-C

7. Draw a neat sketch of a locomotive boiler and label its parts. Explain its working also.
8. A reaction turbine runs at 300 r.p.m. and its steam consumption is 15400 kg/h. The pressure of steam at a pair is 1.9 bar, its dryness 0.93 and power developed by the pair is 3.5 kW. The discharge blade tip angle is 20ºC for both fixed and moving blades and the axial velocity of flow is 0.72 of the blade velocity. Find the drum diameter and the blade height. Take the tip leakage steam as 8%, but neglect blade thickness.
9. The air leakage into a surface condenser operating with a steam turbine is estimated as 84kg/m. The vacuum near the inlet of air pump is 700mm of Hg when parameter reads 760 mm of Hg. The temperature at inlet of vacuum pump is 20ºC. Calculate
   (a) The minimum capacity of the air pump (m^3/m)
   (b) The dimensions of the reciprocating air pump to remove air if it turns out 200 rpm. Take L/D ratio = 1.5 and volumetric efficiency = 100 % and
   (c) The mass of vapour extracted per minute.