Question Bank

Applied Thermodynamics (BTME-401-18)

Section-A

1. Classify air compressors.
2. List out merit of gas turbines over steam turbines?
3. Write down the methods of cooling the turbine blades. g) Define thrust power.
4. What are the advantages of multistage compressor?
5. Differentiate among wet, dry and saturated and superheated steam.
6. Give a sketch of Binary vapour cycle.
7. How are steam nozzles different from liquid nozzles?
8. How do you define degree of reaction and its calculation?
9. What is the objective of reheating in a steam turbine?
10. List the various types of condensers giving its principle.
11. Define Isothermal efficiency of a reciprocating air compressor.
12. What is stalling?
13. What is clearance volume in reciprocating air compressor?
14. Define 'angle of attack'.
15. Write name of different fuels used in the gas turbine.
16. What is surging?
17. Write the function of 'Economiser'.
18. What is bleeding?
19. Distinguish between impulse and reaction turbine.
20. List the various losses of steam in turbine.

Section-B

1. What is the role of air pump in condensers? How do you calculate its capconstan.
2. A single acting air compressor is connected to a receiver which feeds a pipe line. The compressor speed is 300 rpm and its stroke volume is 0.914 Kgf/cm2 and the low compression is pv1.2 = c. Assuming receiver if the air is to remain in it within the pressure limits of 5.5 kfg/cm2. The temperature of the receiver remains in it constant and the mass of air passing from the receiver to the pipe line also remains constant.
3. Describe with a neat sketch the construction and working of a single stage single acting Reciprocating air compressor.
4. A two-cylinder double acting reciprocating compressor sucks in air at pressure 0.98 bar and temperature 300 K. The delivery of the compressed air to the receiver is at 6 bar. The breathing capacity of the compressor is stated to be 2.5 m^3/min when measured at 1 bar and 228 K. The mean speed of the compressor is limited to 120 mm/minute and the stroke is 0.75 times the cylinder diameter. If the law of compression is pV1.3, make calculation for (a) Cylinder diameter and stroke length (b) Compressor speed in rev/min (c) Shaft power if the mechanical efficiency is 85% (d) isothermal efficiency.
   Neglect the effect of clearance and piston rod diameter.

5. The steam supply to an impulse turbine with a single row of moving blades is 2 kg/s. The 10 turbine develops 130 kW, the blade velocity is being 175 m/s. The steam flows from a nozzle with a velocity of 400 m/s and the velocity coefficient of blade is 0.9. Find the nozzle angle, blade angle at entry and exit, if the steam flows axially after passing over the blades.
6. What is meant by co-generation? How it is used in industries? Explain.
7. Write a descriptive note on 'Cooling Towers'.
8. Classify the steam turbines based on different criteria.
9. Determine the percentage excess air supplied to boiler for burning the coal having following composition on mass basis, C: 0.82 , H2: 0.05, O2: 0.08, N2: 0.03, S: 0.005 and moisture: 0.015 Volumetric analysis of dry flue gases shows the following composition, CO2 = 10%, CO = 1%, N2 = 82%, O2 =7%
10. Obtain the volumetric composition of combustion products obtained after combustion of C7H16 (heptane) being burnt with 50% excess air. Also obtain the average molecular weight and specific volume of combustion products at S.T.P. Consider the volume per kg mol. at S.T.P. to be 22.4 m^3 and air to have 21% O2 and 79% N2 by volume.

Section-C

1. A blast furnace gas has the following volumetric composition CO2 = 11%; CO = 27%; H2 = 2% and N2 = 60%. Find the theoretical volume of air required for the complete combustion of 1 m3 of the gas. Find also the percentage composition of dry flue gases by volume. Assume that air contains 21% of O2 & 79% of N2 by volume.
2. A vessel of volume 0.04 m^3 contains a mixture of saturated water & saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure of the mass, the specific volume, enthalpy and entropy.
3. (a) Describe the different operations of Rankine cycle. Derive also the expression for its efficiency.

   (b) In a thermal power plant operating on an ideal Rankine cycle, steam at 15 bar and 250°C enters a turbine which generates 40kW indicated power. If the steam consumption is 300 kg/hr and condenser is maintained at 0.15 bar, determine the final condition of steam, Rankine efficiency and relative efficiency. Neglect pump work. Also determine the fuel to be supplied per hour if its calorific value is 41850 kJ/kg.
4. What is critical pressure ratio in a steam nozzle? What is its significance and its effect on discharge? Draw the discharge versus ratio of pressure at outlet to inlet curve for a convergent steam nozzle.
5. Dry saturated steam at a pressure of 10 bar is expanded in a nozzle to a pressure of 0.7 bar. With the help of Mollier diagram find the velocity and dryness fraction of steam issuing the nozzle, if the friction is neglected. Also find the velocity and dryness fraction of the steam, if 15% of the heat drop is lost in friction.

6. (a) Describe the pressure and velocity variation in an impulse steam turbine.
   (b) The following data relate to a single stage impulse turbine: Steam velocity = 600 m/s : Blade speed = 250 m/s Nozzle angle = 20° : Blade angle at outlet = 25° Neglecting the effect of friction, calculate the work done by the turbine for the steam flow rate of 20 kg/s. Also calculate the axial thrust on the bearings.
7. Following data refer to a De Laval steam turbine having equiangular blades: Steam entering nozzle = 100 m/s, Nozzle Efficiency = 0.90, Blade speed = 200 m/s, Blade velocity coefficient = 0.85, rate of steam mass flow = 3 kg/s, absolute velocity of steam at exit from stage = 90 m/s, angle of absolute velocity of steam at exit from stage with tangent of wheel = 75°. Determine: (a) the blade angles, (b) the nozzle angle, (c) the absolute velocity of steam at inlet, (d) the axial thrust, (e) the HP developed.
8. (a) Define the terms axial thrust, work and black efficiency for a reaction turbine.
   (b) A 50% reaction turbine with symmetrical velocity triangles running at 400 rpm has the exit angle of the blades as 20° and the velocity of steam relative to the blades at the exit is 1.35 times the mean blade speed. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m3/kg. Calculate for this stage a) A suitable blade height, assuming rotor mean diameter 12 times the blade height. And b) The Diagram work.
9. (a) How air leakage in condenser is damaging to the performance of condenser? Describe the methods to detect and prevent air infiltration in condensers.
   (b) The inlet and outlet temperatures of cooling water in a condenser are 27 °C and 35 °C respectively. If the vacuum in the condenser is 700 mm of Hg against barometric pressure of 760 mm of Hg, calculate the efficiency of the condenser.