Time: 3 hour Max. Marks: 80

Note:
1. Question No.1 is compulsory.
2. Attempt any three questions from the remaining.
3. Assume suitable data if required.
4. Use of a steam table is permitted.

Q1. Attempt any four. 5 Marks Each

a Differentiate water tube boilers from fire tube boilers.

b Write a short note on adiabatic flame temperatures.

c What are the methods of improving the thermal efficiency of simple open-cycle gas turbines?

d Differentiate between jet engines and rocket engines.

e Obtain the expression for the force exerted by a jet of water on a fixed curved plate when the jet strikes at the center of a symmetrically curved blade.

Q2. 20 Marks

a The following data refer to two types of boilers A and B. Compare their efficiency.
Boiler A: Steam produced / kg of fuel = 15 kg, Pressure of steam = 13 bar, Quality of steam (superheat) = 250°C, Feed water temperature = 65°C, Calorific value of oil = 45980 kJ/kg of fuel.
Boiler B: Steam produced / kg of fuel = 10 kg, Pressure of steam = 13 bar, Quality of steam = dry and saturated, Feed water temperature = 26°C, Calorific value of oil = 33890 kJ/kg of fuel. **10 Marks**

b Write short notes on (i) Net Positive Suction Head (ii) Centrifugal pumps. **10 Marks**

Q3. 20 Marks

a With the help of a neat diagram explain the construction and working of a Pelton wheel turbine. **6 Marks**

b Define slip, percentage slip, and negative slip of a reciprocating pump. **4 Marks**

c A Francis turbine working under a head of 30 m has a wheel diameter of 1.2 m at the entrance and 0.6 m at the exit. The vane angle at the entrance is 90° and the guide blade angle is 15°. The water at the exit leaves the vanes without any tangential velocity and the velocity of flow in the runner is constant. Neglecting the effect of the draft tube and losses in the guide and runner passages, determine the speed of the wheel in rpm and vane angle at the exit. **10 Marks**

Q4. 20 Marks

a Define (i) Thrust power (ii) Propulsive power (iii) Propulsive efficiency and (iv) Jet efficiency. **8 Marks**

b Calculate the theoretical air-fuel ratio for the combustion of Octane. **6 Marks**

c What are the different compounding methods of Impulse turbines? **6 Marks**

Q5. 20 Marks

a In a stage of an impulse turbine provided with a single-row wheel, the mean diameter of the blade ring is 80 cm and the speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 300 m/s and the nozzle angle are 20°. The rotor blades are equiangular and due to friction in the blade channels, the relative velocity of the steam at outlet from the blade is 0.86 times the relative velocity in the blade. What is the power developed in the blades when the axial thrust on the blades is 140 N? **10 Marks**

b The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 500 m. One-third of the gross head is lost in friction in the penstock. The rate of flow of water through the nozzle fitted at the end of the penstock is 2 m^3/s. The angle of deflection of the jet is 165°. Determine the power given by the water to the runner of the Pelton wheel. Take speed ratio 0.45 and velocity coefficient 1.0. **10 Marks**

Q6. 20 Marks

a In a gas turbine plant, the pressure ratio through which air at 15°C and 1 bar is compressed to 8 bar with a compression efficiency of 87 %. The air is then heated in the regenerator and the combustion chamber till its temperature is raised to 1500 K, and during this process, the pressure falls by 0.16 bar. The air is expanded in the turbine and passes to the regenerator which has 75 % effectiveness and causes a pressure drop of 0.14 bar. If the isentropic efficiency of the turbine is 88 % determine the thermal efficiency of the plant. **10 Marks**

b A Single-acting reciprocating pump has a stroke length of 15 cm. The suction pipe is 7 meters long and the ratio of the suction diameter to the plunger diameter is 3/4. The water level in the sump is 2.5 meters below the axis of the pump cylinder, and the connecting sump and pump cylinder is 7.5 cm in diameter. If the crank is running at 75 rpm, determine the pressure head on the piston: (i) in the beginning of the suction stroke, (ii) in the end of the suction stroke, and (iii) in the middle of the suction stroke. Take the coefficient of friction as 0.01. **10 Marks**