Sem VI / CBGS / Mech-Auto / TFPE / M-J-16 26/05/16

QP Code :601300

05

(3 Hours) **[Total Marks: 80]**

N.B. Question no.1 is compulsory.
Attempt any THREE from question no. 2 to 6.
Use of steam table is permitted.

Q1) Solve any four 20

a) What is the function of blow off cock? Where is it located?

b) What are the functions of guide vanes in water reaction turbine?

c) What is cavitation and what are its causes? How will you prevent the cavitation in hydraulic machine?

d) State the fundamental differences between jet propulsion and rocket propulsion.

e) Define and explain degree of reaction as applied to steam reaction turbine.

Q2) a) Sketch and explain velocity compounded impulse steam turbine showing pressure and velocity along the axis. 08

b) In a gas turbine plant, the pressure ratio, through which air at 15^0C is compressed, is 6. The same air is then heated to a maximum permissible temperature of 750^0C first in a heat exchanger which is 75% efficient, and then in the combustion chamber. The same air at 750^0C is expanded in two stages such that expansion work is maximum. The air is reheated to 750^0C after the first state. Determine the cycle thermal efficiency, the work ratio and the net shaft work per kg of air. The efficiencies may be assumed to be 80% and 85% for the compressor and turbine respectively. 12

Q3) a) What are high pressure boilers and how do they differ in construction and working from ordinary boilers? 08

b) A Pelton wheel is to be designed for a head of 60 m when running at 200 rpm. The Pelton wheel develops 95.6 kW shaft power. The velocity of the buckets = 0.45 times the velocity of the jet, overall efficiency = 0.85 and co-efficient of the velocity is equal to 0.98. Calculate diameter of jet, diameter of wheel and number of buckets on the wheel. 08

c) Compare the constructional features and operating performance of turboprop and turbojet engines. 04

Q4) a) Prove that for a Brayton cycle gas turbine optimum pressure ratio for maximum work output is given by 06

$$r_p = \left(\frac{T_{max}}{T_{min}}\right)^{\frac{\gamma}{2(\gamma-1)}}$$

[Turn Over

b) The following data was recorded during a trial on steam boiler: 06
Pressure of steam = 12 bar, mass of feed water = 4500 kg/hr, temperature of feed water = 75^0C, dryness fraction of steam = 0.96, coal used = 490 kg/hr, calorific value of coal = 35700 kJ/kg, ash and unburnt coal collected in ash pit = 2% by mass, moisture in coal = 4% by mas, calorific value of ash and unburnt coal = 13500 kJ/kg, mass of dry flue gases = 18.57 kg/kg of coal, temperature of flue gases = 300^0C, boiler house temperature = 16^0C, specific heat of flue gases = 0.97 kJ/kg K. Draw the heat balance sheet of the boiler per kg of coal consisting of heat utilized to generate steam, heat carried away by dry flue gases, heat lost in ash and unburnt coal and unaccounted heat losses.

c) Steam is expanded in a set nozzles from 10 bar and 200^0C to 1.5 bar. Are the nozzles convergent or convergent-divergent? Find the minimum area of the nozzles to flow 2 kg/s of steam. Assume the expansion of steam is isentropic. The heat loss from the nozzle is 17 kJ/kg of steam flow. Take coefficient of discharge as 0.98. Velocity at inlet, throat and exit are 90, 480 and 550 m/s respectively. Calculate the dryness fraction and the area at exit. 0

Q5) a) Obtain an expression for the work done per second by water on the runner of a Pelton wheel. Hence derive an expression for maximum efficiency of the Pelton wheel. 10

b) At a stage in a reaction turbine, the mean blade ring diameter is 1 m and turbine runs at 500 rpm. The blades are designed for 50% reaction with exit angle 30^0 and inlet angle 50^0. The turbine is supplied with steam at the rate of 60,000 kg/hr and stage efficiency is 85%. Determine power output, specific enthalpy drop in the stage in kJ/kg and percentage increase in relative velocity. 10

Q6) a) Explain the construction and working of a Ramjet engine. 08

b) Define unit quantities: Unit speed, Unit power and Unit discharge 06

c) Differentiate between Kaplan and Propeller turbines, radial and axial flow turbines? 06
