T.E. (SEM.-VI)(CBSGS) (MECHANICAL ENGG.) 28th May 2015

THERMAL AND FLUID POWER ENGINEERING

QP Code : 4998

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

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 meant by Jet Propulsion? Explain.

b) Write a short note on: Classification of water turbine.

c) Explain briefly the governing system of a Kaplan turbine.

d) Differentiate water tube boilers with fire tube boilers.

e) With neat sketch explain the working of closed cycle gas turbine plant.

Q2) a) Explain the working of a Once through boiler with the help of a neat sketch. 08

b) A 4500 kW gas turbine generating set operates with two compressors stages; the overall pressure ratio is 9:1. A high pressure turbine is used to drive the compressors, and a low pressure turbine drives the generator. The temperature of the gases at entry to the high pressure turbine is 625°C and the gases are reheated to 625°C after expansion in the first turbine. The exhaust gases leaving the low pressure turbine are passed through a heat exchanger to heat air leaving the high pressure stage compressor. The compressors have equal pressure ratios and inter-cooling is complete between the stages. The air inlet temperature to the unit is 20°C. The isentropic efficiency of each compressor stage is 0.8 and the isentropic efficiency of each turbine stage is 0.85, the heat exchanger thermal ratio is 0.8. A mechanical efficiency of 95 % can be assumed for both the power shaft and compressor turbine shaft. Neglecting all pressure losses and changes in kinetic energy calculate: 12

i) the thermal efficiency
ii) work ratio of the plant
iii) the mass flow in kg/s

Neglect the mass of the fuel and assume the following: Cp = 1.005 kJ/kg K, and $\gamma = 1.4$

Q3) a) Derive the expression for the condition for maximum blade efficiency in Parson's reaction turbine. 10

b) A boiler generates 7.5 kg of steam per kg of coal burnt at a pressure of 11 bar, from feed water having a temperature of 70°C. The efficiency of the boiler is 75 % and factor of evaporation is 1.15, specific heat of steam at constant pressure is 2.3 kJ/kg K. Calculate: 10

i. Degree of superheat and temperature of steam generated;

ii. Calorific value of coal in kJ/kg
iii. Equivalent evaporation in kg of steam per kg of coal

Q4) a) Obtain the expression for the force exerted by a jet of water on a fixed curved plate when jet strikes at the center of a symmetrical curved plate. 04

b) Explain the function of following in Reaction water turbine: 06

i) Guide vane
ii) Scroll casing
iii) Draft tube

c) A single stage steam turbine is supplied with steam at 5 bar, 200°C at the rate of 50 kg/min. It expands into a condenser at a pressure of 0.2 bar. The blade speed is 400 m/s. The nozzles are inclined at an angle of 20^0 to the plane of the wheel and the outlet blade angle is 30^0. Neglecting friction losses, determine power developed, blade efficiency and stage efficiency. 10

Q5) a) Discuss and explain: Methods to improve efficiency of a gas turbine. 06

b) The three jet Pelton turbine is required to generate 10,000 kW under a net head of 400 m. The blade angle at outlet is 15^0 and the reduction in the relative velocity while passing over the blade is 5 %. If the overall efficiency of the wheel is 80 %, Cv = 0.98 and speed ratio = 0.46, then find: (i) the diameter of the jet, (ii) total flow in m^3/s and (iii) the force exerted by a jet on the buckets. 10

c) What are the effects of friction in a nozzle? Define nozzle efficiency, coefficient of velocity. 04

Q6) a) Explain the working of a turboprop engine by means of a sketch. What are its advantages, limitations and applications? 10

b) In a hydroelectric generating plant, there are four similar turbines of total output 220 MW. Each turbine is 90 % efficient and runs at 100 rpm under a head of 65 m. It is proposed to test the model of the above turbine in a flume where a discharge is 0.4 m^3/s under a head of 4 m. Determine the size (scale ratio) of the model. Also calculate the model speed and power results expected from the model. 06

c) Write a short note on boiler mountings. 04
