Model Question Paper (CBCS) with effect from 2015-16

USN | | | | | | | | | | |

15ME53

Fifth Semester B.E. Degree (CBCS) Examination

Turbomachines

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

MODULE – I

1 **a** Define turbomachine. Give a comparison between turbomachines and positive displacement machines (08 Marks)

b A single stage centrifugal pump works against a height of 30m, running at 2000rpm, supplies $3m^3/s$ and has an impeller diameter of 300mm. Calculate (a) the number of stages and (b) the diameter of each impeller required to pump $6m^3/s$ of water to a height of 220m when running at 1500rpm. (08 Marks)

OR

2 **a** Define total to total, total to static, static to static and static to total efficiencies for power developing and power consuming turbomachines and write the T-s Diagrams. (08 Marks)

b Total to total efficiency for a power absorbing turbomachine handling liquid water of standard density is 70%. Suppose the total pressure of water increased by 4 bar, evaluate (a) the isentropic change in total enthalpy (b) the actual change in total enthalpy (c) the change in total temperature of the water and (d) the power input to the water, flow rate is 30kg/s. (08 Marks)

MODULE – II

3 **a** In a certain turbomachine, the blade speed at exit is twice that at inlet ($u_2=2u_1$), the meridian component of fluid velocity at inlet is equal to that at exit and the blade angle at inlet is 45^0. Show that the energy transfer per unit mass and degree of reaction are given by $\frac{E}{m} = -2V_{m1}^2(2 - cot\beta_2)$ $and\ R = \frac{(cot\beta_2+2)}{4}$ (08Marks)

b At a stage of 50% reaction axial flow turbine running at 3000 rpm, the mean blade diameter is 68.5 cm. If the maximum utilization factor for the stage is 0.915, Calculate (a) the inlet and outlet absolute velocities and (b) the power output. Also, find the power developed for a steam flow rate of 15 kg/s. (08 Marks)

OR

4 **a** Derive the theoretical head capacity relation in case of centrifugal pump $H = \frac{U_2^2}{g_c} - \frac{U_2^2 Q cot\beta_2}{A_2 g_c}$. Discuss the effect of blade angle at outlet on head. (08 Marks)

b Draw the inlet and outlet triangles for an axial flow compressor for which given (1) Degree of reaction =0.5 (2) inlet blade angle $=40^0$ axial velocity of flow which is constant throughout = 125m/s (4) RPM =6500 (5) Radius = 0.2m. Calculate the power required in kW at an air flow rate = 15kg/s. Find fluid angles at inlet and outlet. Blade speed is same at exit and inlet. (08Marks)

MODULE – III

5 **a** Derive the condition for maximum efficiency of an impulse turbine and show that the maximum efficiency is $\cos^2\alpha$. (08 Marks)

b Steam issues from nozzle to a de Laval turbine at a velocity of 1000m/s. The nozzle angle is 20^0. The mean blade velocity is 400m/s. the blades are symmetrical. The mass flow rate is 1000kg/h, friction factor is 0.8, and nozzle efficiency is 0.95. Calculate Blade angle, Axial thrust, and Power developed, Blade efficiency, Stage efficiency. (08 Marks)

OR

6 **a** Show that the maximum diagram efficiency of a stage of a reaction turbine is given by the expression $\emptyset = \frac{2cos^2\alpha_1}{1+cos^2\alpha_1}$ (08 Marks)

b In a Curtis steam turbine stage there are two rows of moving blades with equiangular rotors. Steam enters the first rotor at an angle of 20^0 each and the second rotor at an angle of 32^0 each. The absolute velocity of steam as it enters the first rotor is 530m/s and the blade velocity coefficient is 0.9 in the first rotor, 0.91 in stator, and 0.93 in the second rotor. If the final discharge should be axial, Compute (a) the power output for a steam flow rate of 3.2kg/s and the axial thrust. (08 Marks)

MODULE – IV

7 **a** Derive an expression for maximum efficiency of a pelton wheel. (08 Marks)

b A Pelton wheel has a water supply rate of $5m^3/s$ at a head of 256m and runs at 500rpm. Assuming a turbine efficiency of 0.85, a coefficient of velocity for nozzle as 0.985, speed ratio of 0.46, calculate (a) the power output, (b)the specific speed.

OR

8 **a** With a neat sketch explain the working principle of Kaplan turbine. (08 Marks)

b An inward flow reaction turbine with a supply of $0.6m^3/s$ under a head of 15m develops 75kw at 400 rpm. The inner and outer diameter of the runner are 40cm and 65cm respectively. Water leaves the exit of the turbine at 3m/s calculate the hydraulic efficiency and the inlet blade angles. Assume radial discharge and width to be constant.

MODULE –V

9 **a** Explain the phenomenon of cavitation in a centrifugal pump? What are the effects? How do you prevent cavitation? (08 Marks)

b A centrifugal pump delivers 50l/s of water per second against a total head of 24m at 1500 rpm. The velocity of flow is maintained constant at 2.4 m/s and blades are curved backward at 30^0 to tangent at exit. The inner diameter is half of the outer diameter, if the Manometric efficiency is 80%. Find the blade angle, and power required to pump. (08 Marks)

OR

10 **a** Draw a sketch of an axial flow compressor with inlet guide vane and explain the working principle of the compressor (08 Marks)

b An air compressor has eight stages of equal pressure ratio 1.35. The flow rate through the compressor and its overall efficiency are 50kg/s and 82% respectively. If the conditions of air at entry are 1.0bar and 400c Determine a) the state of air at the compressor exit b) polytropic efficiency (08 Marks)

Important Note: 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.