CBCS SCHEME

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

15AE46

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Turbomachines

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamic data hand book is permitted.

Module-1

1 a. Define specific speed of a pump and turbine. Write the equations for the same in dimensionless form. **(06 Marks)**

b. A centrifugal pump delivers, m^3/s against a pressure of 40m of water at 1200rpm. Calculate the dimensionless specific speed of the machine. Further, find the speed of rotation and power of the motor (prototype) for delivering 50% more discharge. Take the impeller diameter as 0.5m and overall efficiency of 33%. Assume ($D_1 = D_2$). **(10 Marks)**

OR

2 a. Derive an expression for Euler turbine equation in alternate form and explain each term with significance, involved in it. **(06 Marks)**

b. Define degree of reaction of a turbomachine. For an impulse type of turbine, why degree of reaction R is zero? Supplement your answer with the definition. **(04 Marks)**

c. An inward flow radial turbine has the following data: Power = 180kW; speed = 34000rpm, outer diameter of impeller = 0.20m; inner diameter of impeller = 0.08m; Absolute fluid inlet velocity = 293m/s (radial). The fluid enters the impeller axially. Determine the percentage of energy transfer due to change of radius. **(06 Marks)**

Module-2

3 a. With reference to a compression process, define: i) Stage efficiency ii) Overall efficiency. Represent the same on a T-S diagram. **(08 Marks)**

b. An air compressor has eight stages of equal pressure ratio 1.3. The flow rate and the overall efficiency are 45 kg/s and 80% respectively. For an inlet condition of 1 bar and 35°C, determine: i) State of air at compressor exit ii) Polytropic efficiency iii) Stage efficiency. **(08 Marks)**

OR

4 a. With the help of a T-S diagram define 'reheat' factor in a turbine. Why 'reheat factor' is greater than unity? Explain. **(06 Marks)**

b. In an expansion process in a turbine, isentropic expansion ($\gamma = 1.4$) is replaced by a polytropic expansion process ($n = 1.2$). Determine the polytropic efficiency for the expansion process. If the overall efficiency of turbine is 80% and the stage efficiency is 75%, what is the reheat factor? **(06 Marks)**

c. Define the following with reference to an expansion process:
i) Total-to-total efficiency
ii) Total-to-static efficiency. **(04 Marks)**

Module-3

5 a. Define: i) Power input factor ii) Slip factor with reference to a centrifugal compressor. Derive an equation for Euler work in terms of power input factor and slip factor, assuming a radial vaned impeller for no slip. **(08 Marks)**

b. A centrifugal compressor has to deliver 30kg of air per second, the impeller is 70cm diameter revolving at 11000rpm with an adiabatic efficiency of 80%. If the pressure ratio is 4.2:1, calculate the probable axial width of the impeller at the impeller tip, if the radial velocity is 120m/s. The inlet conditions are 1 bar and 47°C. **(08 Marks)**

OR

6 a. With the help of a schematic diagram explain the working of an axial flow compressor. **(06 Marks)**

b. An 8-stage axial flow compressor provides an overall pressure ratio of 6:1 with an overall isentropic efficiency of 89%, when the temperature of air at inlet is 19°C. The work is divided equally between stages. A 50% reaction is used with a mean blade speed of 190m/s and a constant axial velocity of 100m/s through the compressor. Assuming a work done factor of unity, estimate the power required and the blade angles. **(10 Marks)**

Module-4

7 a. Construct the velocity triangles for an axial flow turbine for the following conditions: i) R = 0 ii) R = 0.5 iii) R = 1. Comment on how energy transfer takes place in each of the above cases. **(08 Marks)**

b. At a 50% reaction stage axial flow turbine, the mean blade diameter is 60cm. The maximum utilization factor is 0.9. Steam flow rate is 10kg/s. Calculate the inlet and outlet absolute velocities and power developed if the speed is 2000rpm. **(08 Marks)**

OR

8 a. Define 'nozzle loss' and 'rotor loss' coefficients writing suitable expressions. **(04 Marks)**

b. In a multi stage Inward Flow Radial turbine (IFR), what are the aerodynamic losses occur in the stage. Discuss. **(12 Marks)**

Module-5

9 a. Define the following terms with relevant equations, with reference to a centrifugal pump: i) Hydraulic efficiency ii) Mechanical efficiency. **(04 Marks)**

b. What do you mean by Net Positive Suction Head (NPSH)? **(02 Marks)**

c. A centrifugal pump having 120cm diameter pumps 1880 lps running at 200rpm. If the radial flow velocity is 2.5m/s, exit vane angle tangent to the impeller is 26°, determine the manometric efficiency and the minimum speed to start the pump against a head of 6m. The ID of impeller is 60cm. **(10 Marks)**

OR

10 a. Sketch and explain the working of a Kaplan turbine showing all vital components. **(06 Marks)**

b. Two inward flow reaction turbines have same runner diameter of 60cm and same hydraulic efficiency. They work under the same head and have the same flow velocity of 6m/s. Runner B has an inlet vane angle of 110° and runs at 600rpm. The runner A has an inlet vane angle of 65°. For both turbines, discharge is radial at outlet. Determine speed of the runner A, and draw the velocity triangle for both runners. **(10 Marks)**

* * * * *