CBCS SCHEME

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15MR54

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Turbomachines

Time: 3 hrs. Max. Marks: 80

Note:* 1. *Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of steam table and thermodynamic data book permitted.

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.

Module-1

1 a. Differentiate between a positive displacement machine and turbo machine. **(05 Marks)**

b. Four turbines of specific speed 762.7 SI units each installed in a hydel station. Each of turbine runs at 50 rpm and share equally a total discharge of 260 m^3/s available under a head of 1.73 m. Assuming each turbine has an efficiency of 82.5%, find the power of each turbine in KW. **(06 Marks)**

c. What are unit quantities? Derive expression for unit power. **(05 Marks)**

OR

2 a. Define infiniterimal stage efficiency or polytropic efficiency of a compressor and show that for a compressor, $\eta_p = \dfrac{\left(\frac{\gamma-1}{\gamma}\right) \times \ell n\left(\frac{p_2}{p_1}\right)}{\ell n\left(\frac{T_2}{T_1}\right)}$ **(10 Marks)**

b. Total to total efficiency for a power absorbing turbo machine handling liquid water of standard density is 70%. Suppose the total pressure of water is increased by 4 bar, evaluate:
i) The isentropic change in total enthalpy.
ii) The actual change in total enthalpy
iii) The change in total temperature of water. **(06 Marks)**

Module-2

3 a. With necessary velocity triangles, derive the alternate form of Euler's turbine equation and discuss importance of each term. **(08 Marks)**

b. At a stage of an impulse turbine the mean blade dia is 0.75 m. Its rotational speed being 3500 rpm. The absolute velocity of fluid discharging from a nozzle inclined at 20° to plane of wheel is 275 m/s. If utilization factor is 0.9 and relative velocity at rotor exit is 0.9 times that at inlet, find inlet and exit rotor angles. **(08 Marks)**

OR

4 a. With the help of inlet and outlet velocity triangles, show that the degree of reaction for an axial flow compressor, $R = \dfrac{V_a}{u} \tan\gamma_m$ where V_a is axial velocity, 'u' is blade speed and $\tan\gamma_m = \dfrac{\tan\gamma_1 + \tan\gamma_2}{2}$. **(08 Marks)**

b. The total power input at a stage in an axial flow compressor with symmetric inlet and outlet velocity triangles (R = 0.5) is 27.85 kJ/kg of air flow. If the blade speed in 180 m/s throughout the rotor, draw velocity triangles and compute inlet and outlet rotor blade angles. Assume axial velocity component to be 120 m/s. Would you recommend this compressor? **(08 Marks)**

Module-3

5 a. Briefly explain velocity compounding of impulse turbine. **(06 Marks)**

b. Steam issuing from a nozzle to De-laval turbine with a velocity of 1000 m/s. The nozzle is 20°, the mass blade speed is 400 m/s. The blades are symmetrical, the mass flow rate = 1000 kg/hr, friction factor = 0.8, nozzle efficiency = 0.95. Calculate: (i) blade angles (ii) axial thrust (iii) work done per kg of steam (iv) power developed (v) blade efficiency. **(10 Marks)**

OR

6 a. Define degree of reaction for a steam turbine and show that for a Parson's reaction turbine (R = 0.5), degree of reaction is $R = \left(\frac{V_f}{2U}\right)[\cot\beta_2 - \cot\beta_1]$. **(08 Marks)**

b. The following data refers to a particular stage of a Parson's reaction turbine. Speed of turbine = 1500 rpm, mean diameter of rotor = 1 m, stage efficiency = 0.8, blade outlet angle = 20°, speed ratio = 0.7. Determine available isotropic enthalpy drop, in the stage. **(08 Marks)**

Module-4

7 a. Define the following terms with respect to hydraulic turbine:
(i) Gross head (ii) Effective head (iii) Hydraulic efficiency
(iv) Mechanical efficiency (v) Overall efficiency **(08 Marks)**

b. A double jet pelton wheel is required to generate 7500 KW when the available head at the base of nozzle is 400 m. The jet is deflected through 165° and the relative velocity of jet is reduced by 15% in parsing over the buckets. Determine: (i) Diameter of each jet (ii) Total flow (iii) Force exerted by jets in tangential direction. Assume η_{gen} = 95%, η_0 = 80% and speed ratio (ϕ) = 0.47. **(08 Marks)**

OR

8 a. What is a draft tube? What are important functions of draft tube and with neat sketch, show different types of draft tube used in hydraulic power station. **(08 Marks)**

b. A Kaplan turbine working under a head of 15 m developed 7350 KW. The outer diameter of runner is 4 m and hub diameter is 2m. The guide blade angle at the extreme edge of runner is 30°. The hydraulic and overall efficiency of turbine are 90% and 85% respectively. If velocity of whirl at inlet is zero, then determine: (i) Runner vane angle at inlet and outlet (ii) Speed of turbine. **(08 Marks)**

Module-5

9 a. Explain the following:
(i) Pumps in series with neat sketch (ii) Pumps in parallel with neat sketch
(iii) Cavitation (iv) NPSH **(08 Marks)**

b. A CF pump delivers 1800 ℓpm against a total head of 20 m. Its speed is 1450 rpm. Inner and outer diameter of impeller are 120 mm and 240 mm respectively and diameter of suction and delivery pipe are both 100 mm. Determine blade angles β_1, β_2, if the water enters radially. Also find the power required to drive the pump. **(08 Marks)**

OR

10 a. Briefly explain the following with respect to CF compressor :
(i) Slip coefficient (μ) (ii) Power input factor (ψ)
(iii) Surging (iv) Chocking **(08 Marks)**

b. A CF compressor running at 6000 rpm having an impeller tip diameter of 101 cm has following test data: mass flow rate = 25 kg/s, static pressure ratio = 2.12, pressure at inlet = 100 kPa, temperature = 28°C, mechanical efficiency = 0.97, find: (i) Slip coefficient (ii) Temperature of exit air (iii) Power input (iv) Power coefficient. **(08 Marks)**

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