CBCS Scheme

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15AE46

Fourth Semester B.E. Degree Examination, June/July 2018
Turbomachines

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define turbomachine. Explain the detailed classification of turbomachines with examples for each type. **(06 Marks)**

b. Compare positive displacement machines with turbomachines in detail. **(04 Marks)**

c. Show that the discharge of a centrifugal pump is given by, $Q = ND^3\phi\left\{\frac{gH}{N^2D^2}, \frac{\mu}{ND^2\rho}\right\}$, where N is the speed of the pump in rpm, D is the diameter of the impeller, g the acceleration due to gravity, H the manometric head, μ viscosity of fluid and ρ the density of the fluid. **(06 Marks)**

OR

2 a. A centrifugal pump running at 1500 rpm, with impeller diameter 200 mm, discharges 0.12 m^3/s of water working against a head of 40 m with an efficiency of 90% (i) Calculate the specific speed (ii) the performance / power of a similar pump twice its size keeping the speed constant. **(05 Marks)**

b. From the preliminary principles derive Euler's energy equation in the alternate form. And the different energy terms in it. **(06 Marks)**

c. For a given centrifugal pump with discharge angles (β_2) as 90°, less than 90°, more than 90°, draw the H-Q diagram with usual notations. **(05 Marks)**

Module-2

3 a. Prove that for a compression process, the stage efficiency is greater than the overall isentropic efficiency. **(06 Marks)**

b. An air compressor has six stages of equal pressure ratio 1.4. The mass flow rate is 45 kg/s . The overall isentropic compression efficiency is 84% Entry pressure is 1 and T_1 = 40°C. Calculate

(i) The state of the air at the exit.
(ii) Polytropic efficiency.
(iii) Stage efficiency.
(iv) Power required to drive the compressor, if the overall efficiency of the drive is 0.9

Assume γ = 1.4. R = 287 KJ/kgK, C_P = 1.005 KJ/kgK **(10 Marks)**

OR

4 a. Derive the relation between isentropic efficiency and polytropic efficiency for an expansion process with usual notations. **(06 Marks)**

b. A two stage gas turbine develops 22 MW at the shaft. The inlet temperature is 1500 K. The pressure ratio of each stage is same, and the P_2/P_1 equal to 8. Take the isentropic expansion efficiency is 0.9. Calculate

(i) The pressure ratio of each stage, if it has 2-stages.
(ii) Polytropic efficiency.
(iii) The mass flow rate.
(iv) The efficiency and power of each stage, assume γ = 1.4, C_P = 1.005 KJ/kgK, overall drive efficiency = 0.90 **(10 Marks)**

Module-3

5 a. With the help of a neat sketch, explain the working principle and components of a centrifugal compressor. **(06 Marks)**

b. Briefly explain the following for a centrifugal compressor,
(i) Pressure co-efficient. (ii) Slip factor.
(iii) Power factor. (iv) Surging **(10 Marks)**

OR

6 a. With the help of diagrams and graphs describe the working of an axial flow compressors. **(05 Marks)**

b. For an axial flow compressor, draw velocity triangles at inlet and at exit for the following values of R (degree of reaction)
(i) R = 50% (ii) R > 50% (iii) R < 50% **(08 Marks)**

c. Explain / Define the following:
(i) Work done factor (ψ)
(ii) Flow co-efficient (ϕ)
(iii) Pressure co-efficient (ϕ_P) **(03 Marks)**

Module-4

7 a. How do you differentiate between an impulse and a reaction turbine? With neat sketches explain the working of an impulse and a reaction stage. **(09 Marks)**

b. What do you understand by velocity compounding and pressure compounding in a turbine? **(04 Marks)**

c. Explain the following briefly,
(i) Loading co-efficient (ψ) Vs
Flow co-efficient (ϕ) graph. **(03 Marks)**

OR

8 a. Draw Enthalpy-Entropy diagram for a radial turbine and explain the same. **(06 Marks)**

b. Describe the various stage losses occurring in a radial turbines. **(06 Marks)**

c. Draw and explain Blade-to-gas speed ratio (σ) (Vs) Stage efficiency (η_s) graph for a radial turbine. **(04 Marks)**

Module-5

9 a. With the help of a neat sketch, explain the parts and working principle of a centrifugal pump. **(06 Marks)**

b. Briefly explain the following for a centrifugal pump:
(i) Manometric head.
(ii) Suction head and Delivery head.
(iii) Manometric efficiency (η_{mano}).
(iv) Mechanical efficiency (η_{mech})
(v) Hydraulic efficiency (η_H)
(vi) Volumetric efficiency (η_{vol})
(vii) Overall efficiency (η_O) **(10 Marks)**

OR

10 a. Briefly discuss the classification of hydraulic turbines. **(04 Marks)**

b. Elaborate the working principle of the following with figures:
(i) Pelton wheel.
(ii) Kaplan turbine. **(09 Marks)**

c. Briefly explain what is a draft tube, and what are it's functions. **(03 Marks)**

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