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CBCS SCHEME

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17AE46

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

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Compare and differentiate between positive displacement machines and turbomachines. **(06 Marks)**

b. Performance of lubricating oil ring in a turbomachine depends on the diameter (D), shaft speed (N), discharge of oil (Q), density (ρ), viscosity (μ), surface tension (σ) and specific weight (W) of oil. Find the relation for discharge of an oil in terms of non-dimensional terms. **(08 Marks)**

c. A centrifugal pump delivers 1 m^3/s against a pressure of 40 m of H2O at a speed of 1200 rpm. Calculate: (i) Specific speed of pump (ii) Power of pump if it requires 50% more discharge. Take diameter of impeller 0.5 m and $\eta_0 = 33\%$. **(06 Marks)**

OR

2 a. Derive an alternate from of Euler turbine equation and explain significance of each energy components. **(08 Marks)**

b. Define degree of reaction and derive relation between degree of reaction and utilization factor. **(06 Marks)**

c. Combustion products from combustion chamber in a turbojet engine approaches an axial flow turbine rotor with an absolute velocity of 550 m/s at 18° angle from wheel tangent the mass flow rate is 60 kg/s. If the axial velocity is constant at inlet and outlet of turbine find the power output and degree of reaction when blade speed is 300 m/s. Also the absolute velocity at rotor exit is in axial direction. **(06 Marks)**

Module-2

3 a. For a compression process in a compressor with the help of h-s diagram. Derive relation for: (i) Total - Total efficiency (ii) Static - Static efficiency **(06 Marks)**

b. Draw h-s diagram for pre-heat on compression process and explain about pre-heat factor. **(06 Marks)**

c. A nine stage centrifugal compressor has overall pressure ratio of 2.82. Air enters the compressor at condition of 1 bar and 17°C. The stage efficiency is 90%. Determine: (i) Pre-heat factor (ii) Polytropic efficiency (iii) Overall efficiency **(08 Marks)**

OR

4 a. Draw h-s diagram for infinitesimal stage efficiency for turbine and obtain the relation for polytropic efficiency and overall efficiency. **(08 Marks)**

b. Derive the relation for stage efficiency for a turbine if it is having a constant temperature drop in each stage. **(04 Marks)**

c. A 2-stage gas turbine develops 22 MW power. Inlet temperature is 1500 K. For constant stage pressure ratio of 8. Take isentropic expansion efficiency as 90%. Calculate: (i) Polytropic efficiency (ii) Mass flow rate (iii) Efficiency and power of each stage Take overall efficiency = 90%. **(08 Marks)**

Module-3

5 a. Draw the schematic diagram of centrifugal compressor and explain the principle of operation using h-s diagram. **(07 Marks)**

b. Explain the phenomenon of surging and choking in a centrifugal compressor. **(06 Marks)**

c. A centrifugal compressor rotor running at 6000 rpm having impeller tip diameter of 1.01 m, has the following test data: (1) $\dot{m}$ = 25 kg/s (2) $P_2/P_1 = 2.12$ (3) P_1 = 100 kPa, $T_1 = 28°C$ (4) $\eta_{mech} = 0.97$. Find:

(i) Slip coefficient (μ) (ii) Temperature at exit

(iii) Power input (iv) Power coefficient (Ψ_p) **(07 Marks)**

OR

6 a. Draw axial flow compressor and draw the velocity triangles. Also draw velocity triangle for various degree of reaction. **(07 Marks)**

b. Explain about the effect of axial velocity change at inlet and exit velocity triangle and derive relation for workdone factor. **(06 Marks)**

c. Explain various losses in axial flow compressors with energy flow diagram. **(07 Marks)**

Module-4

7 a. Define degree of reaction (R) and utilization factor (ϵ). For axial flow turbines obtain relation between R and ϵ. **(08 Marks)**

b. Air flows through one stage of turbomachine with a velocity diagram shown in Fig.Q7(b). Justify and find:

(i) Is this power absorbing or power generating machine

(ii) Change in total enthalphy

(iii) Degree of reaction

(iv) Utilization factor

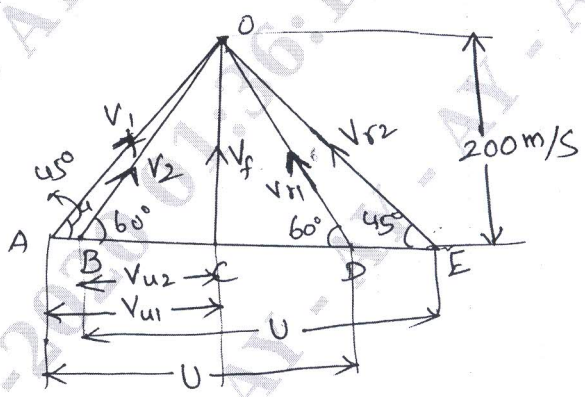

Fig.Q7(b) **(08 Marks)**

c. Justify why cooling is necessary for turbines and explain methods of cooling used for turbine blades. **(04 Marks)**

OR

8 a. Draw and explain the components of radial turbine and operational principle. **(08 Marks)**

b. Explain about losses in radial turbine. **(04 Marks)**

c. An inward flow radial reaction turbine has axial discharge at outlet with outlet blade angle of 45°. The radial velocity of flow is constant. The blade speed at the inlet is twice that of exit. Express energy transfer per unit mass and degree of reaction in terms of nozzle angle α_1. Assume $V_m = (29c)^{1/2}$. **(08 Marks)**

Module-5

9 a. Draw the centrifugal pump and explain the terminologies:
(i) Suction head (ii) Delivery head
(iii) Manometric efficiency (iv) Volumetric efficiency **(08 Marks)**

b. Explain the condition for using multistage pumps in series and parallel. **(04 Marks)**

c. A centrifugal pump has impeller diameter of 30 cm and a constant area of flow 210 cm^2. The pump runs at 1440 rpm and delivers 90 lps against a head of 25 m. If there is no whirl velocity at entry, find the pressure rise in terms of pressure head across the impeller and hydraulic efficiency of pump. The vanes at exit are bent back at 22° with reference to tangential speed. **(08 Marks)**

OR

10 a. Draw the Pelton wheel turbine and explain the efficiencies and head used in Pelton turbine. **(08 Marks)**

b. An inward flow reaction turbine with radial discharge with an overall efficiency of 80% is required to develop 147 KW. The total head is 8m. Peripheral velocity of wheel is $0.96\sqrt{2gH}$, the radial velocity of flow is 4.51 m/s. The wheel is to make 150 rpm and hydraulic losses in the turbine is 22% of available energy. Determine:
(i) Angle of guide blade at inlet
(ii) Wheel vane angle at inlet
(iii) Dia meter and width of wheel at inlet **(08 Marks)**

c. Draw the Kaplan turbine and explain the operation with velocity triangles. **(04 Marks)**

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