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B. E. (Fifth Semester) Examination, April-May 2021

(New Scheme)

(Mech. Engg. Branch)

TURBO MACHINERY

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each question is compulsory are 2 marks. Solve any* ***two*** *parts from (b), (c) and (d) are 7 marks. Use of Steam table.*

Unit-I

1. (a) Classify the steam turbine on the basis of principle of operation.

(b) Describe the pressure-velocity compounded Impulse Turbine with diagrammatic arrangements.

(c) In a stage of an impulse turbine provided with a single raw wheel, the mean diameter of the blade ring is 80 cm and the speed of rotation is 3000 r.p.m. The steam issues from the nozzles with a velocity of 300 m/sec and the nozzle angle is 20°. The rotor blades are equiangular and due to friction in the blades channels the relative velocity of steam at outlet from the blades is 0·86 times the relative velocity of the steam entering the blades. What is the power developed in the blades when the axial thrust on the blades is 140 N?

(d) The isentropic heat drop in given stage of a multi stage impulse turbine is 33.5 kJ/kg of steam. The nozzle outlet angle is 20°. The efficiency of the nozzle defined of the ratio of the actual gain in kinetic energy in the nozzle to the adiabatic (isentropic) heat drop is 90%. The mean diameter of the blade is 95·5 cm and the revolution per minute 3000. The carry over factor

is 0·88. Blades are equiangular with a velocity coefficient of 0·87. Calculate steam velocity at outlet of the nozzle, blade angles and gross stage efficiency.

Unit-II

2. (a) Define the "Degree of Reaction"?

(b) Describe the Parson's reaction turbine with velocity diagram.

(c) Steam flows into the nozzles of an impulse reaction turbine stage from the blades of the preceeding stage with a velocity of 100 m/sec. and issue from the nozzles with a velocity of 325 m/sec. at an angle of 20° to the wheel plane. Calculate the gross stage efficiency for the following data : Mean blade velocity = 180 m/sec., Expansion efficiency of nozzles and blades = 0·9, Carryover factor for nozzles and blades = 0·9, Degree of reaction = 0·26, Blade outlet angle = 28°.

(d) Describe the following terms :

(i) Blade friction losses

(ii) Leakage or clearance losses

(iii) Carryover loss

Unit-III

3. (a) Define the stage efficiency of Impulse Turbine.

(b) In a four stage pressure - compounded impulse turbine steam is at a pressure of 23 bar and superheated to a temperature of 345°C. The exhaust pressure is 0·07 bar and overall turbine efficiency is 0·72. Assuming that the work is shared equally between the stages and the condition line is straight, estimate the stage pressures, the efficiency of each stage and reheat factor.

(c) Compare the Throttle and Nozel control governing in steam turbine?

(d) Superheated steam is expanded from a pressure of 20 bar to 0·1 bar in a turbine. The initial temp. of steam is 350°C. At a pressure of 1·6 bar the steam is found to be just dry & saturated and at 0·1 bar it is 10% wet. Draw T-S & h-s plot & calculate the following :

(i) The total enthalpy drop with isentropic expansion between the initial state and final pressure.

(ii) The actual enthalpy drop.

Unit-IV

4. (a) Classify the gas turbines on the basis of combustion process?

(b) Describe the "Simple Open Cycle Gas Turbine" on P-V & h-s plot & define the thermal efficiency for it.

(c) Air at temperature of 15°C enters a gas turbine plant working at pressure ratio is 15. Turbine inlet temperature is 0·91. Assume C_p = 1·005 & 1·128 for air and gases respectively. The calorific value of fuel used = 42000 kJ/kg of fuel. Calculate :

(a) Overall efficiency

(b) Specific output

(c) Fuel to air ratio

(d) In a gas turbine plant, the air at 10°C and 1 bar is compressed to 12 bar with compression efficiency

of 80%. The air is heated in regenerator and combustion chamber till its temperature is raised to 1400°C and during the process the pressure falls by 0·2 bar. The air is then expanded in the turbine and passes to regenerator which has 75% effectiveness, and causes a pressure drop of 0·2 bar. If the isentropic efficiency of the turbine is 85%. Determine the thermal efficiency of the plant.

Unit-V

5. (a) Define Slip factor.

(b) Describe the surging and choking phenomenon in compressors.

(c) Describe the stalling in axial flow compressor?

(d) A centrifugal compressor running at 9000 rpm delivers 6000 m^3/min of free air. The air is compressed from 1 bar and 20°C to a pressure ratio of 4 with an isentropic efficiency of 0.82. Blade are radial at outlet of impeller and flow velocity of 62 m/sec. may be assumed throughout constant. The outer radius of impeller is twice the inner and

the slip factor may be assumed as 0·9. The blade area coefficient of 0·9 may be assumed at inlet. Calculate the following :

(i) Final temperature of air

(ii) Theoretical power

(iii) Impeller diameter at inlet & outlet