Seat No. | | | | | | |

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Turbo Machinery
(1100)

P. Pages : 4

Time : Three Hours **Max. Marks : 100**

Instructions to Candidates :

1. Do not write anything on question paper except Seat No.
2. Answersheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. Solve **any two** subquestions from each unit.
5. Use of steam table, mollier chart and non programmable calculator is allowed.
6. Draw neat sketches wherever necessary.
7. Assume suitable data if necessary.

UNIT - I

1. i) The mean diameter of the blade of an impulse turbine with a single row wheel is 105 c.m. and the speed is 3000 r.p.m. The nozzle angle is 18 degree, the ratio of blade velocity to steam velocity is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3 degree less than the inlet angle. The steam flow is 8 kg/sec. Draw the velocity diagram for the blades and calculate the following -

a) Resultant thrust on the blades.
b) Tangential thrust on the blades.
c) Axial thrust on the blades.
d) Power developed by blades.
e) Blading efficiency. **10**

ii) The outlet angle of the blade of parson's turbine is 20 degree and the axial velocity of flow of steam is 0.5 times the mean blade velocity. Draw the velocity diagram for a stage consisting of one fixed and one moving row of blades, given that the mean diameter is 71 c.m and the speed of rotation is 3000 rpm. Calculate the inlet angle of blades if steam is to enter the blade channels without shock. If the blade height be 6.4 cm, the mean steam pressure 5.5 bar, the steam dry and saturated at this stage specific volume of steam 0.3427 m^3/kg. Find the power developed in the stage. **10**

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iii) a) Show that the diagram work per unit mass of steam for maximum blading efficiency of a 50% reaction stages is Vb^2 where Vb is the mean blade velocity. **5**

b) Why are steam turbines compounded ? What are the different methods of compounding ? **5**

UNIT - II

2. a) An open gas turbine plant works between the fixed absolute temperature limit 300 k and 1500 k, the absolute pressure limit being 1 bar and 14 bar. The isentropic efficiency of compressor 85% and that of turbine is 86%. Estimate the actual thermal efficiency of the plant and the power developed. The calorigic value of fuel is 4200 kJ/kg. Assume efficiency of combustion 99%, mechanical efficiency for whole assembly 98% efficiency of generator is 98.5% and mass flow rate of air is 500 kg/sec. **10**

b) State the advantages and disadvantages of closed cycle gas turbine plant over open cycle gas turbine plant. **10**

c) How practical gas turbine cycle differ from ideal gas turbine cycle discuss in detail. **10**

UNIT - III

3. a) Air enters a turbojet engine of 120000 kg per hour at 15 °C and 1.03 bar and is compressed adiabatically to 182 °C and four times the pressure. Products of combustion enter the turbine at 815 °C and leave it at 650 °C to enter the nozzle. Calculate the isentropic efficiency of the compressor, the power required to drive the compressor, the exit speed of gases and thrust developed when flying at 800 km per hour. Assume the isentropic efficiency of turbine is same as that of the compressor and the nozzle efficiency 90%. **10**

b) A centrifugal compressor has to deliver 35 kg of air per sec. The impeller is 76 c.m. diameter revolving at 11500 rpm with an adiabatic efficiency of 80%. If the pressure ratio is 4.2 : 1 estimate the axial width of impeller at the impeller tip if the radial velocity is 120 m/sec. The inlet conditions are 1 bar and 47 °C. **10**

c) Explain the working of the following by drawing their schematic diagram. **10**
   i) Pulse jet engine.
   ii) Centrifugal compressor.

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UNIT - IV

4. a) A Pelton wheel employs four jet of each 60 mm diameter. These jets strike the bucket and each jet deflected by an angle of 165 degree. The speed of the bucket wheel is 50 m/sec. Calculate :

i) The velocity of jet for maximum efficiency.

ii) Maximum power.

iii) Maximum blade efficiency. **10**

b) Explain in detail the governing system used for impulse water turbine. **10**

c) i) Show that the force exerted by a jet of water on moving inclined plate in the direction of jet is given by

$$Fx = e\, a(v-u)^2 \sin^2\theta$$

where a = area of jet

v = velocity of jet, u = velocity of plate

θ = inclination of plate with the jet.

ii) Classification of water turbine. **10**

UNIT - V

5. a) In an inward flow reaction turbine (vertical shaft) the sum of pressure and kinetic heads at entrance to the spiral casing is 132 meter and vertical distance between this section and tail race level is 3.3 meter. The peripheral velocity of the runner at entry is 33 meter/sec, the radial components of velocity of water (velocity of flow) is constant at 11 meter/sec and the discharge from the runner is without whirl. The hydraulic losses are -

i) Losses between turbine entrance and discharge from guide vanes = 4.95 meter.

ii) Losses in the runner = 8.8 meter.

iii) Losses in the draft tube = 0.88 meter.

iv) Kinetic energy rejected to the tail race = 0.55 meter.

Determine -

i) Guide Vane angle and runner blade angle at inlet.

ii) The pressure head at entry to and discharge from the runner. **10**

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b) What is cavitation ? On what factors does the cavitation in water turbine depends and how it can be avoided. **10**

c) Write short note on the following : **10**

i) Selection of hydraulic turbine.

ii) Draft tube.

iii) Francis turbine.

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