

B.E. Power Engineering 3rd Year 2nd Semester Examination, 2013**Steam Turbine and Condenser****Time : 3 Hours****Full Marks: 100**

Use separate answer scripts for each part

Part – I**Answer Q. No. 1 and any two from the rest.**

1. Answer any four questions.

4×5=20

- (a) What do you mean by nozzle efficiency? How is it related to the velocity coefficient of the nozzle?
- (b) Why the moving blade exit angle of an impulse turbine is kept somewhat less than its inlet angle? How do such angles affect the axial thrust generated?
- (c) Show that for frictionless flow over equiangular blades the maximum blade efficiency of a simple impulse turbine is reached when $\frac{u}{C_1} = \frac{\cos \alpha_1}{2}$, where the terms have their usual nomenclature.
- (d) How does a reaction turbine differ from an impulse turbine? What is degree of reaction?
- (e) Why is the air cooling section required in a power plant condenser?
- (f) What are the advantages and disadvantages of a two pass surface condenser over a single pass one? – explain.
2. A De Laval nozzle of an impulse turbine stage discharges 0.5 kg/s of steam from 20 bar, 400°C into the turbine casing where pressure is 0.5 bar. Frictional loss in the divergent part is 15% of the isentropic specific enthalpy drop in that part. The convergent part is frictionless. Neglecting velocity of approach, determine (i) throat and exit diameters of the nozzle and (ii) quality of steam at the nozzle exit. **(15)**
3. In a stage of an impulse turbine provided with a single row wheel, the mean diameter of the blade ring is 100 cm and the speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 360 m/s and the nozzle angle is 20°. The rotor blades are equiangular and due to friction in the blade channel the relative velocity of steam at the outlet from the blades is 0.85 times of that at the inlet. Determine the power developed in the blades when the axial thrust on the blade is 160 N. **(15)**
4. The outlet angle of the blade of Parson's turbine is 20° 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 80 cm and the speed of

rotation is 3000 rpm. Find the inlet angle of blades if the steam is to enter the blade channel without shock. If the blade height is 6.5 cm and the mean specific volume of steam is $0.5 \text{ m}^3/\text{kg}$, find out the mass flow rate of steam through the turbine.

5. A surface condenser receives 500 ton/h of steam at 0.08 bar pressure and with 0.9 dryness fraction. The cooling water enters the condenser at 25°C and the TTD of the condenser is 6°C . The velocity of the cooling water through the tubes is 1.8 m/s. The condenser tubes are of 25.4 mm outer diameter and 1.25 mm thick. The overall heat transfer coefficient based on the water side heat transfer area of the tubes is $2800 \text{ W/m}^2\text{K}$. Determine (i) flow rate of cooling water through the condenser, (ii) number of condenser tubes, (iii) length of each tube. Consider no air leakage and no sub-cooling of water. (15)

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Part-II

Answer Q. No. 1 and any three from the rest

1. Answer the following questions briefly (Any ten).

Marks 2 X 10

- What is turbine blade windage loss?
- What is Parson's reaction turbine?
- What is the function of primary oil in governing system?
- Which element in electro-hydraulic governing system does sense speed?
- What are the different mechanical protections are there in turbine governing system?
- What are the different stresses that induced in the turbine blade?
- Which loss is dominant in nozzle governing system?
- What is the function of lacing wire?
- What are the chief methods of governing?
- What is frequency regulation??
- What is Rateau turbine?
- How the overall efficiency of the plant can be calculated from boiler, turbine and generator and cycle efficiency?

2. a) Write down the different classification of steam turbine.

b) Make a comparison between Impulse turbine and Reaction turbine.

c) Explain the pressure compounded impulse steam turbine showing pressure and velocity variations along the axis.

Marks: 3+3+4

3. a) What is the purpose of governing in steam turbine?

b) Write down the various methods of governing based on the methods of varying steam flow rate.

c) Make a comparison of throttle governing and nozzle governing.

Marks: 2+4+4

4. a) Write down the different losses in steam turbine.

b) Describe 'Disc friction loss' and 'Partial admission loss' in steam turbine.

Marks 4+6

5. a) What are the causes of vibration in turbine blades?

b) What are the remedial measures are taken to prevent turbine blade vibration? Marks 4+6

6. a) What is the reason that the blades of LP stages are twisted?

b) Discuss Inverted T attachment, serrated blade root attachment

c) What are the common blade materials for HP turbine?

Marks:3+4+3