7E7014

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B.Tech. VII Semester (Main) Examination, Dec. - 2015

Mechanical Engineering

7ME4A Turbomachines

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 24

Instructions to Candidates:

*Attempt any **five** questions, selecting **one** question from **each unit**. All questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.*

Unit - I

1. a) **What is Similitude? What are different types of similarities between the model and its prototype?** **(6)**

b) A model of a kaplan turbine, one tenth of the actual size is tested under a head of 5m when actual head for proto turbine is 8.5m,The power to be developed by prototype is 9000kW. When running at 120 rpm at an overall efficiency of 85%, determine

i) Speed,

ii) Discharge, and

iii) Power of model. **(10)**

OR

1. a) Define turbo machinery? Classify turbo machinery. Derive the Euler's expression for turbo machinery? **(8)**

b) The drag force exerted by a flowing fluid on a solid body depends 4pm the length of the body 'L', velocity of flow, V, density of fluid δ and viscosity μ. Find an expression for drag force using Buckingham's theorem. **(8)**

Unit - II

2. a) Explain the phenomena of surging, stalling and choking in centrifugal compressor stage? What is their effect on the performance? How to minimize or prevent them. **(8)**

b) A centrifugal blower takes in air at 100 KPa and 309K. It develops a pressure head of 750 mm W.G. while consuming a power of 33 kW. If the blower efficiency (ηB) is 80% and mechanical efficiency is 86%, determine the mass rate and volume rate and exit properties of air. **(8)**

OR

2. a) What is free vortex blade? Derive the work done and reaction ratio for a free vortex blade. **(8)**

b) Briefly explain with suitable diagram how does the blade shape affect the performance of the compressor. **(8)**

Unit - III

3. a) What do you understand by characteristic curves of a pump? What is the significance of the characteristic curve? **(8)**

b) An impeller of a centrifugal pump having internal and external diameter are 150 mm & 300 mm respectively. The vane angles of the impeller at inlet and outlet are 20^0 & 30^0 respectively. The pump is running at 1300 rpm. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water. **(8)**

OR

3. a) The stroke and bore of a cylinder reciprocally engine running at 70 rpm are 500 mm and 250 mm respectively. The 20m long delivery pipe has a diameter of 80 mm. Determine the power saved by installing in an vessel in the delivery pipe, if pipe friction factor is 0.008. **(8)**

b) Derive an expression to obtain the work done by axial flow pump on fluid. **(8)**

Unit - IV

4. a) Derive the expression for specific work output and the efficiency of a simple cycle with reheat. Also draw their trends as a function of pressure ratio. **(8)**

b) A gas turbine cycle has a perfect heat exchanger air enters the compressor at a temp. and pressure of 300k and 1 bar and discharges at 475K and 5 bar. After passing through the heat exchanger the air temperature increases its 655K. The temp. of air entering and leaving the turbine are 870^0C and 450^0C. Assuming no pressure drop through the heat exchanger, compute:

i) The output per kg of air

ii) The efficiency of the cycles

iii) The work required to drive the compressor. **(8)**

OR

4. a) Define polytropic efficiency. Derive expressions for polytropic efficiency and bring out the relation between the polytropic efficiency and isentropic efficiency. **(6)**

b) Write short notes on following.

i) Ram jet engine

ii) Pulse jet engine

iii) Turbo fan engine. **(10)**

Unit - V

5. a) Explain a single stage velocity triangle with a neat sketch and derive an expression for blade efficiency. **(6)**

b) A multistage gas turbine is to be designed with impulse stages, and is to operate with an inlet pressure and temperature of 6 bar and 900K and an outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85%. All the stages are to have a nozzle outlet angle of 75° and equal outlet and inlet blade angles. Mean blade speed of 250 m/s and equal inlet and outlet gas velocities.

Estimate the max. number of stage required. 'Assume Cp = 1.15 KJ/Kg-K. γ = 1.333 and optimum blade speed ratio. **(10)**

OR

5. a) Explain the following: **(8)**

i) Zero percent reaction stage.

ii) Fifty percent reaction stage, and

iii) Hundred percent reaction stage.

b) What do you understand by blade and stage efficiency? Derive an expression for blade efficiency. **(8)**