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7E7014

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B.Tech. VII Semester (Main/Back) Examination, November - 2019

Mechanical Engineering

7ME4A Turbomachines

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

Min. Passing Marks : 26

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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) Explain the following : **(4×2=8)**

   i) Principle of conservation of Mass

   ii) First law of thermodynamics

   iii) Newton's second law of motion

   iv) Second law of thermodynamics

   b) One - fifth scale model of a pump was tested in a laboratory at 1000 rpm. The head developed and the power input at the best efficiency was found to be 8 m and 30 kW respectively. If the prototype pump has to work against a head of 25 m, determine its working speed, the power required to drive it and the ratio of flow rates handled by the two pumps. **(8)**

(OR)

1. a) What is similitude? What are the different types of similarities between the model and its prototype? **(8)**

   b) The efficiency of a turbomachine depends on density 'ρ', dynamic viscosity 'μ' of the fluid, angular velocity ω, diameter 'D' of the rotor and the discharge 'Q'. Express 'η' in terms of the dimensionless parameters. **(8)**

UNIT - II

2. a) An axial compressor has a mean diameter of 60 cm and runs at 15000 rpm. If the actual temperature rise and pressure ratio developed are 30°C and 1.3 respectively.

Determine :

i) Power required to derive the compressor while delivering 57 kg/s of air, assuming η_m = 86% and initial temperature of 35°C,

ii) The stage efficiency,

iii) The degree of reaction if the temperature at the rotor exit is 55°C. Take C_p = 1.005 kJ/kg - K. (8)

b) Explain the working principle of a double acting reciprocating compressor. (8)

(OR)

2. a) Explain surging, choking and stalling phenomenon in compressor. (8)

b) What is meant by a stage and explain in detail the stage velocity triangles of axial flow compressor. (8)

UNIT - III

3. a) Derive the expression for minimum starting speed of centrifugal pump. (8)

b) An axial flow pump has an impeller of outlet diameter 1 m. The diameter of boss is 0.5 m. If specific speed of pump is 38 and velocity of flow is 2m/s. Suggest a suitable speed of the pump to give a head of 6 m. Also determine vane angle at the entry of the pump, if the flow is axial at inlet. (8)

(OR)

3. a) Explain the working of a centrifugal pump with neat diagram. (8)

b) Explain cavitation and methods of preventing cavitation. (8)

UNIT - IV

4. a) With the aid of the schematic diagram and thermodynamic cycle, explain the working of a turbo prop engine. (8)

b) Draw the schematic diagram of a simple gas cycle with a heat exchanger and explain briefly the working principle. (8)

(OR)

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

i) the output per kg of air,

ii) the efficiency of the cycle,

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

h) Mention the various advantages and disadvantages of the pulse jet engine (8)

UNIT - V

4. a) Write the difference between impulse turbine and reaction turbine. (8)

b) What do you understand by compounding of turbine? Name different types of compounding used. (8)

(OR)

5. a) Explain the following :

i) Zero percent reaction stage.

ii) Fifty percent reaction stage. (8)

b) A multistage gas turbine is to be designed with impulse stage, and is to operate with an inlet pressure and temperature of 6 bar and 900 k 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 maximum number of stages required. Assume C_p = 1.15 kJ/kg - K, γ = 1.33 and optimum blade speed ratio. (8)