

R18

Code No: 157EA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech IV Year I Semester Examinations, February/March - 2022

**TURBO MACHINERY
(Mechanical Engineering)**

Time: 3 Hours

Max. Marks: 75

**Answer any five questions
All questions carry equal marks**

- 1.a) Show that for a perfect gas when it is adiabatically decelerated stagnation temperature is $T_0 = T (1 + ((\gamma - 1)/2) M^2)$.
- b) Show that the discharge through a nozzle is maximum when there is sonic condition at its throat. [7+8]
- 2.a) Define critical pressure ratio? From fundamentals, derive the expression relating the critical pressure ratio to the index of expansion 'n' for expansion in nozzles?
- b) The inlet and exit conditions of steam supplied to a nozzle has enthalpy 3210 kJ/kg and 2930 kJ/kg. Taking velocity at inlet as 60m/s. Find
i) the exit velocity of steam
ii) mass flow rate of an inlet area of 0.1 m^2 and specific volume of $0.19 \text{ m}^3 / \text{kg}$ inlet. Neglect the effect of friction? [7+8]
- 3.a) Differentiate between (i) Radial and Axial flow machines (ii) Inward and Outward radial flow machines.
- b) Explain in detail the phenomenon of cavitation in pumps and also give the necessary precautions against cavitation? [8+7]
4. A centrifugal pump rotating at 1000 rpm delivers 160 litres/s of water against a head of 30 m. The pump is installed at the place where atmospheric pressure is $1 \times 10^5 \text{ Pa}$ (abs.) and vapour pressure of water is 3 kPa (abs.). The head loss in suction pipe is equivalent to 0.2 m of water then calculate (a) Minimum NPSH (b) Maximum allowable height of the pump from free surface of the water in the sump? [15]
- 5.a) Explain the terms slip factor and power input factor as applied to centrifugal compressor.
- b) The free air delivered by a centrifugal compressor is 20 kg/min. The suction condition is 1 bar and 20°C . The velocity of air at the inlet is 60 m/s. The isentropic efficiency of the compressor is 0.68. If the total head pressure ratio of compressor is 3. Determine
(i) The total need temperature of air at the exit of the compressor and
(ii) Power required to run the compressor assuming mechanical efficiency of 96%. [7+8]

6.a) Distinguish between normal shock and detached shock.

b) The following data is pertaining to a centrifugal compressor

Overall diameter of the impeller	-	60 cm
Speed	-	14000 RPM
Slip factor	-	0.9
Power input factor	-	1.04
Eye tip diameter	-	35 cm
Eye root diameter	-	20 cm
Total mass flow	-	20 kg/s
Inlet total head temperature and pressure	-	25 ⁰ C and 1.01 bar
Total head isentropic efficiency	-	82%

Determine the total head pressure ratio and power required to drive the compressor, if the velocity of air at inlet is axial. [7+8]

7.a) At 1.02 bar and 30⁰C, air enters an axial flow compressor stage with an axial velocity of 180 m/s. The rotor stage has a tip diameter of 0.55 m and 0.5 m and rotates at a speed of 65000 RPM. The air enters the rotor and leaves the stator in the axial direction with no change in velocity or radius. The air is turned through 30⁰ as it passes through rotor. Assuming constant specific heats and that the air enters and leaves the blade at the blade angles. Determine

(i) mass flow rate (ii) power requires (iii) degree of reaction

b) Explain the concept of surging in an axial flow compressor. [8+7]

8.a) Explain the working of a closed cycle gas turbine unit with flow diagram and T-s diagram.

b) What are the advantages and dis-advantages of a closed cycle gas turbine over open cycle gas turbine? [7+8]

---ooOoo---