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Total No. of Pages : 03

Total No. of Questions : 09

B.Tech. (ANE) (Sem.–5)

AIRCRAFT PROPULSION-II

Subject Code : ANE-314

Paper ID : [A1038]

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION–A

1) Answer briefly :

a) Define Degree of Reaction.

b) Obtain a relation for pressure ratio required to accelerate the flow to Mach 1 in an isentropic duct.

c) How flow properties vary across a normal shock? Mention them on a diagram.

d) Define flow coefficient.

e) Differentiate centrifugal compressor from axial compressor.

f) Draw the shock pattern at the exit of an under expanded nozzle and over expanded nozzle.

g) Advantages of a multistage rocket.

h) Define specific impulse.

i) Describe the variation of Mach no. with heat addition in a neat graph.

j) Differentiate between ram jet and scram jet engines.

SECTION-B

2) A three stage air compressor has the following stag pressure ratio and adiabatic efficiencies:

Stage	Stagnation pressure ratio	Adiabatic efficiency
1	1.6	0.87
2	1.4	0.89
3	1.3	0.90

a) What are the compressor pressure ratio and overall adiabatic efficiency?

b) What is the average polytropic efficiency?

3) Consider the flow of air through a pipe of inside diameter = 0.4 m and length = 5 m the inlet flow conditions are $M_1 = 3$, $p_1 = 1$ atm. $T_1 = 300$ K. assuming f = const. = 0.005. Calculate the flow conditions M_2, p_2, T_2, and P_{02} at the exit.

4) With help of a neat velocity diagram, differentiate an impulse turbine from a reaction turbine.

5) Explain the construction and working of a liquid rocket motor.

6) Explain the starting problem faced in supersonic inlets. Name a technique to overcome this problem.

SECTION-C

7) Explain the operation of a CD nozzle when subjected to different back pressures with help of a neat diagram.

8) An axial turbine is to be designed for a work ratio at the mid-radius of $\left(\frac{\Delta C_\theta}{U}\right)$=2 and a free-vortex swirl distribution upstream and downstream of the rotor. At mid-radius the degree of reaction is to be 50%. The hub-tip ratio is to be 0.8. At the hub radius, the start exit angle a_{1h} is 70° to the axial direction.

a. Draw the mean and hub velocity triangles.

b. Determine the axial velocity ratio $c_z/U_{m.}$

c. Determine the rotor blade angles β2h and β3h at the hub radius.

d. Determine the degree of reaction at the hub radius.

9) For a 2 stage launched into gravity free vacuum, the following flight parameters are given :

a. Total velocity increment = 6200 m/s

b. Specific Impulse = 310 s

c. Effective Exhaust Velocity = 3038 m/s

d. Initial launch vehicle mass = 4500 kg

e. Propellant mass fraction for each stage (M_P/M_0) = 0.88

f. Structural mass fraction for each stage = 0.12

Determine the payload mass.

a) If the two stage masses are equal.

b) If the mass ratios (M_{0i}/M_{fi}) of the two stages are equal.