Roll No. | | | | | | | | | | | | | Total No. of Pages : 03

Total No. of Questions : 09

B.Tech.(Aerospace Engg.) (2012 Onwards) (Sem.–4)

AEROSPACE PROPULSION – I

Subject Code : ASPE-207

Paper ID : [A2623]

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 thrust coefficient.

b) State the purpose of diffuser in front of a compressor.

c) Define propulsive efficiency of an engine.

d) Define effective exhaust velocity.

e) A single stage rocket of 10 kg was launched for research purpose, before preparing for the launch, it was found that the propellant took 120 seconds to consume 1 kg of propellant while producing 10 N of thrust continuously. What is the Specific Impulse of the Propellant? Note: consider the acceleration due to gravity is constant with altitude and is $10 m/s^2$.

f) Under controlled conditions, a thruster was found to produce a constant thrust of 417 N for 95 seconds, calculate the total impulse of the thruster.

g) What is the efficiency of the turbine operating under a pressure ratio of 2; If the turbine inlet temperature being 980 K & the temperature drop observed was 0.88 times the isentropic temperature drop.

h) A convergent nozzle was tested under laboratory conditions, the inlet total pressure and total temperature was 3 atm and 480 K respectively, what is the velocity at the exit of the nozzle?

i) What is a hypergolic propellant & give an example?

j) State Tsiolkovski's rocket equation.

SECTION-B

2) Discuss any two types of propellant injectors used in liquid propellant rockets with neat descriptive diagrams.

3) Multiple stage rockets with identical stages utilize less propellant mass than the single stage rocket; prove the same (you may use an example or the relations).

4) Briefly explain the ideal Bryton cycle with a neat figure.

5) Obtain the relation for the ratio of total to static pressure (P_0/P) in a 1D isentropic flow. Starting from the Energy equation, clearly mention the conditions in every step.

6) State advantages and disadvantages (any five) of Propeller aircraft and jet (gas turbine) propelled aircraft.

SECTION-C

7) Discuss any four grain structure of a solid rocket motor with a neat diagram. Mention their advantages and disadvantages.

8) A turbojet engine is flying at an altitude of 10 km & at a Mach no. of 0.8, the component performance of the engine are given below :

Compressor pressure ratio = 8;

Turbine inlet temperature = 1200 K,

Isentropic efficiency of Compressor = 0.87

Isentropic efficiency of turbine = 0.90

Isentropic efficiency of Intake = 0.93

Isentropic efficiency of Propelling nozzle = 0.95

Mechanical Transmission Efficiency = 0.99

Combustion efficiency = 0.98

Combustion pressure loss = 4% compressor delivery pressure

Find the total temperature & total pressure at

a) Diffuser Outlet

b) Compressor Outlet

c) Combustor Outlet

d) Turbine Outlet

e) Nozzle Outlet

And also find the specific thrust and specific fuel consumption

Note : $p_\infty = 0.2650$ Pa; $T_\infty = 223.3$ K, $f = 0.0194$.

9) A diffuser was employed in reducing the speed of hot air jet in an industrial process. If the jet of 330 m/s at 500°C (velocity and static temperature respectively) is slowed down to 20 m/s, considering isentropic process find the static temperature of the flow downstream of the diffuser. What is the total enthalpy of the flow? If the diffuser inlet pressure was 1.5 bar, what is the downstream pressure? If the same process was carried out with helium gas of specific heat ratio 1.66, what is the temperature at the diffuser outlet and how much is the difference as compared to the case involving air?