Paper id: 250931

Roll No: | | | | | | | | | | | | | |

BTECH
(SEM VI) THEORY EXAMINATION 2024-25
GAS DYNAMICS AND JET PROPULSION

TIME: 3 HRS **M.MARKS: 100**

Note: Attempt all Sections. In case of any missing data, choose suitably.
Use the Steam Table appropriately.

SECTION A

1. Attempt *all* questions in brief. **2 x 10 = 20**

Q No.	Question	CO	Level
a.	Define Mach number and explain the significance of Mach waves in compressible flow.	1	K1
b.	What is the basic difference between compressible and incompressible fluid flow?	1	K1
c.	Define choked flow in a converging-diverging nozzle.	2	K2
d.	Explain why a subsonic flow accelerates in a converging duct while a supersonic flow decelerates.	2	K2
e.	Define Rayleigh Flow and Fanno Flow.	3	K3
f.	State the key differences between normal shock and oblique shock.	3	K3
g.	Write the general thrust equation for jet engines and explain each term.	4	K4
h.	What is the difference between propulsive efficiencyand thermal efficiency in jet engines?	4	K4
i.	What is the role of propellant in rocket engines?	5	K5
j.	Why is staging used in rocket engines?	5	K5

SECTION B

2. Attempt any *three* of the following: **10 x 3 = 30**

a.	Define stagnation (total) temperature (T_0) and stagnation pressure (P_0), and derive their relationships with static properties in terms of Mach number for an isentropic flow.	1	K2
b.	Air is discharged from a reservoir at P_0=6.91 bar and to 325°C through a nozzle to an exit pressure of 0.98 bar. If the flow rate is 3600 kg/hour,Determine the throat area, pressure, and velocity at the throat, exit area, exit Mach number, and maximum velocity. Consider that the flow is isentropic.	2	K2
c.	Explain choking in Fanno flow?What are the Rayleigh line and the Fanno line? Show these lines with the help of a diagram.	3	K3
d.	A 260mm diameter steam turbine runs at 20500 rpm with a nozzle angleof 20°C and issues at a steam jet with a velocity of 910m/sec. The mass flow rate of steam through the turbine nozzle is 2kg/sec. Draw a velocity triangle and calculate i. Tangential force on the blade ii. Axial thrust force on the blade iii. Power developed by the turbine iv. Diagram efficiency	4	K3
e.	Describe Solid propellant rocket Engines. Compare air-breathing and rocket engines.	5	K5

M	$\frac{T}{T_0}$	$\frac{P}{P_0}$
1	0.834	0.528

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SECTION C

3. Attempt any *one* part of the following: 10 x 1 = 10

a.	Consider a convergent-divergent nozzle expanding air from a reservoir at stagnation conditions P_0 = 500 kPa, and T_0 = 400 K, to an exit where the Mach number is 1.5.Determine the exit static pressure and temperature.	1	K2
b.	Starting from the fundamental conservation laws, derive the steady, one-dimensional mass, momentum, and energy equations for compressible flow. Clearly state all assumptions (e.g., inviscid, adiabatic, perfect gas).	1	K2

4. Attempt any *one* part of the following: 10 x 1 = 10

a.	A conical diffuser has an entry diameter of 20cm, the Mach number, temperature, and pressure are 0.6, 120kN/m^2, and 340K. Mach number at exit is 0.2. For 1-D isentropic flow, calculate pressure, temperature, and velocity at the exit.	2	K2
b.	Derive the relationship between stagnation and static temperature in terms of flow and Mach number for the case of isentropic flow.	2	K2

5. Attempt any *one* part of the following: 10 x 1 = 10

a.	Derive the normal shock relations for pressure ratio (P_2/P_1) and temperature ratio (T_2/T_1) in terms of upstream Mach number (M_1).	3	K3
b.	Explain the use of isentropic and shock tables in compressible flow calculations.	3	K3

6. Attempt any *one* part of the following: 10 x 1 = 10

a.	What is the principle of Jet propulsion? An aircraft with a turbojet engine flies at a velocity of 100m/s. If the jet exhaust velocity is 300 m/s. Determine the propulsion efficiency of the engine.	4	K3
b.	Explain the construction and working of a Ramjet Engine with the help of a neat sketch.	4	K3

7. Attempt any *one* part of the following: 10 x 1 = 10

a.	Explain the following concerning rocket engines i. Staging ii. Terminal Velocity iii. Space Flights	5	K4
b.	A rocket moves with a velocity of 10000 Km/hr with an effective exhaust velocity of 1400m/s, thepropellant flow rate is 5kg/sec,and the propellant mixture has a heating value of 6500 kJ/kg. Find i. Propulsion efficiency ii. Engine output power iii. Thermal efficiency iv. Overall efficiency	5	K4