Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E / B. Tech (Full Time) END SEMESTER EXAMINATIONS – APRIL / MAY 2025

MECHANICAL ENGINEERING

ME371 Gas Dynamics and Jet Propulsion

(Regulation 2004)

Time: 3 Hours | Answer ALL Questions | Max. Marks 100

PART- A (10 x 2 = 20 Marks)

Q.No	Questions	Marks
1.	Define stagnation temperature.	2
2.	Distinguish between normal and oblique shock waves.	2
3.	Write down the governing equations for a Rayleigh flow.	2
4.	State the assumptions used in Fanno flow.	2
5.	Define an expansive wave.	2
6.	Define Mach number and classify sub-sonic, sonic, and super-sonic flows.	2
7.	What is bypass ratio in a turbofan engine?	2
8.	Which engine has the highest propulsive efficiency?	2
9.	Why a rocket can reach the moon, whereas an aircraft cannot reach the moon?	2
10.	Define specific impulse.	2

PART- B (5 x 16 = 80 Marks)

(Q. No 11 is Compulsory)

Q.No	Questions	Marks
11.	a) Explain the different types of aircraft engines with a neat schematic. Also list their merits and demerits.	16
12.	a) Sketch the flow through a CD nozzle for various back pressure values. Also explain the reasons for the flow pattern variation. Sketch the geometry for a sub-sonic nozzle and diffuser.	16
	OR	
	b) i) Derive the Area- Mach No. relation and sketch the various geometry for accelerating and decelerating subsonic and supersonic flows.	8
	ii) A nozzle in a wind tunnel gives a test-section Mach number of 2. Air enters the nozzle from a large reservoir at 0.69 bar, 310 K. The cross-sectional area of the throat is 1000 cm^2. Determine the pressure, temperature and velocity at nozzle throat and test sections, mass flow rate of air and area of cross section at test section.	8

13.	a) A combustion chamber in a gas turbine plant receives air at 350 K, 0.55 bar and 75 m/s. The air-fuel ratio is 29 and the calorific value of the fuel is 41.87 MJ/kg. Taking γ=1.4 and R= 0.287 kJ/kg.K for the gas, determine: i) Mach nos. at inlet and exit ii) pressure, temperature and velocity of gas at exit iii) maximum stagnation temperature attainable and iv) percentage stagnation pressure loss in the combustion chamber.	**16**
	OR	
	b) A fuel-air mixture, approximated as air with γ=1.4, enters a duct combustion chamber at V_1 = 60 m/s, P_1 = 150 kPa, and T_1 = 300 K. The heat addition by combustion is 870 kJ/kg of mixture. Compute (a) the exit properties V_2, P_2, and T_2 and (b) the total heat addition which would have caused a sonic exit flow.	**16**
14.	a) A CD nozzle operates at off-design condition while conducting air from a high pressure tank from a large container. A normal shock occurs in the divergent part of the nozzle at a section where cross-sectional area is 24 cm^2. If the stagnation pressure and temperature at the inlet of the nozzle are 2.1 bar and 36°C respectively, and the throat area is 12 cm^2 and the exit area is 36 cm^2 estimate the exit Mach number and exit pressure.	**16**
	OR	
	b) Calculate the air flow rate through the engine, exit nozzle cross-section area, thrust power, thrust, propulsive and overall efficiencies for a turbojet engine from the following data: Flight Mach number = 0.85 ; flight altitude = 12 km ; cross-sectional area of the inlet-diffuser at entry = 0.5 m^2 ; air-fuel ratio = 60 ; calorific value of the fuel = 43 MJ/kg ; exhaust jet velocity = 660 m/s ; exhaust jet temperature = 727°C ;exhaust jet pressure = 0.47 atm.	**16**
15.	a) Describe the various types of propellants used in a rocket motor. Also mention their advantages and disadvantages.	**16**
	OR	
	b) (i) Define the terms – escape velocity, overall efficiency of rocket and propellant mass fraction.	**6**
	(ii) Determine the maximum velocity of a rocket and the altitude attained from The following data: Mass ratio = 0.15, Burn out time= 75 s, Effective jet velocity = 2500 m/s. Also find the velocity loss and altitude loss due to gravity. Ignore drag and assume vertical trajectory.	**10**