Q. Code:667517

Reg. No. | | | | | | | | | | | | | |

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2024

Sixth Semester

ME18603 – GAS DYNAMICS AND JET PROPULSION

(Mechanical Engineering)

(Use of gas table is permitted)

(Regulation 2018 /2018A)

TIME:3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO1	Student will understand the one dimensional compressible flow through variable area duct.	**1**
CO2	Student can apply governing equations to compressible flow through constant area duct with friction and heat transfer.	**3**
CO3	Students evaluate the compressible flow having normal and oblique shock.	**4**
CO4	Student will analyze the propulsion methods, concepts of aircraft propulsion system and performance of the jet.	**2**
CO5	Student apply the concepts of gas dynamics in space propulsion system.	**2**

PART- A(10x2=20Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	An aeroplane travels at an altitude where the temperature is –37° C with a Mach number of 1.2. Determine the velocity of the plane in km per hour.	**1**	**3**
2.	What is the necessity of using M* instead of M?	**1**	**2**
3.	Write the practical examples of Fanno and Rayleigh flow.	**2**	**1**
4.	Define choking in Fanno flow.	**2**	**2**
5.	Define strength of the shock.	**3**	**1**
6.	Why shock does not occur in subsonic flow?	**3**	**2**
7.	What is after burning in jet engine?	**4**	**1**
8.	Define the terms specific impulse and specific power consumption.	**4**	**1**
9.	Define the terms weight flow coefficient and thrust coefficient.	**5**	**1**
10.	Distinguish between monopropellant and bipropellant.	**5**	**2**

PART- B (5x 14=70Marks)

			Marks	CO	RBT LEVEL
11.(a)	**(i)**	An aircraft is flying at an altitude of 14,000 m at a Mach number of	**(7)**	**1**	**3**

		0.82. The cross-sectional area of the inlet diffuser before the LP compressor stage is 0.5 m^2. Determine (i). The mass of air entering the compressor, (ii). The speed of aircraft, (iii). The stagnation pressure, temperature of air at the diffuser entry.			
	(ii)	Discuss about the various regions of flow and drive the energy equations in various forms.	**(7)**	**1**	**2**
		(OR)			
(b)		A nozzle in a wind tunnel gives test section Mach number of 2.0. Air enters the nozzle from a large reservoir at 0.69 bar and 310 K. The cross-sectional area of the throat is 1000 cm^2. Determine the following quantities for the tunnel for one dimensional isentropic flow (i) pressures, temperatures and velocities at the throat and test section (ii) area of cross section of the test section. (iii) mass flow rate.	**(14)**	**2**	**3**
12.(a)		The friction factor for a 25 mm diameter, 11.5 m long pipe is 0.004. The conditions of air at entry are pressure 2 bar, temperature 301 K and Mach number 0.26. Determine the mass flow rate, pressure, temperature and the Mach number at exit. Take (γ = 1.3, R = 460 J/kg K) .	**(14)**	**2**	**3**
		(OR)			
(b)		The data for a gas (γ = 1.3, C_p = 1.244 kJ/kg K) at entry of the combustion chamber are velocity 150 m/s, pressure 4 bar and temperature 395 K. if the exit Mach number is 0.78, Calculate the following (i) Entry Mach number (ii) The mach number, pressure and temperature at the exit, (iii) Air fuel ratio. Take Calorific value as 42 MJ/Kg.	**(14)**	**2**	**3**
13.(a)	**(i)**	Derive Prandtl Meyer relation for normal shock waves.	**(8)**	**3**	**3**
	(ii)	A jet of air at 275 K and 0.69 bar has an initial Mach number of 2.0. It passes through a normal shock wave determine Mach number, pressure, temperature, and jet velocity downstream of the shock. Take γ = 1.67, R= 0.208 kJ/kg K	**(6)**		
		(OR)			

(b)	**(i)**	A Supersonic stream of air at M= 3.0, deflected inwards by 15 degrees. This generates weak shock waves. Calculate the following quantities for this wave. (i)Wave angle, (ii) Downstream Mach number, (iii) Temperature ratio, static and stagnation pressure values.	**(7)**	**3**	**3**
	(ii)	A jet of air at a Mach number of 2.5 is deflected inwards at the corner of a curved wall. The wave angle at the corner of 60°. Determine the deflection angle of the wall, pressure and temperature ratio and final Mach number.	**(7)**	**3**	**3**
14(a)	**(i)**	Derive the Propulsive, thermal and overall efficiency for the aircraft propulsion.	**(7)**	**4**	**2**
	(ii)	The diameter of an aircraft propeller is 4.0 meters. The speed ratio is 0.8 at a flight speed of 450 kmph. If the ambient conditions of air at the flight altitude are T = 256 K and P = 0.54 bar, determine (i). Propulsive efficiency, (ii). Thrust and (iii). Thrust power, (iv) Specific thrust.	**(7)**	**4**	**3**
		(OR)			
(b)	**(i)**	An aircraft flies at 960 kmph. One of its turbojet engines takes in 40 kg/s of air and expands the gases to the ambient pressure. The air-fuel ratio is 50 and lower calorific value of the fuel is 43 MJ/kg. for maximum thrust power determine (a) jet velocity (b) thrust (C) specific thrust (d) thrust power (e) propulsive, thermal and overall efficiency and TSFC.	**(7)**	**4**	**3**
	(ii)	Explain with a neat sketch the working principle of turbo jet engine.	**(7)**	**4**	**2**
15.(a)	**(i)**	The data for a rocket engine is given below combustion chamber pressure = 38 bar, combustion chamber temperature = 3500 K, oxidizer flow rate = 41.67 kg/s, mixture ratio 5.0,if the expansion in the rocket nozzle takes place to the ambient pressure of 583.58 N/m^2, calculate nozzle throat area, thrust, thrust coefficient and exit gas velocity. Take $\gamma = 1.3$, R = 287 J/kg K.	**(7)**	**5**	**3**

			Marks	CO	RBT LEVEL
	(ii)	Write the properties of liquid propellants and solid propellants.	**(7)**	**5**	**2**
		(OR)			
(b)	**(i)**	Explain with a neat sketch the working principle of liquid propellant rocket engine.	**(7)**	**5**	**3**
	(ii)	A rocket engine has the following data, thrust coefficient =1.2, propellant flow rate = 20 N/s, combustion chamber pressure = 15 bar, exhaust nozzle throat diameter = 5 cm, from the above data compute the valves of thrust, specific impulse, effective jet velocity and characteristic velocity.	**(7)**		

PART- C (1x 10=10Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	The pressure, velocity and temperature of air (γ = 1.4, C_p = 1. 0 kJ/kg K) at the entry of a nozzle are 200 kPa, 145 m/s and 350 K, the exit pressure is 150 kPa. (i)What is the shape of the nozzle? (ii) Determine for isentropic flow, the Mach number at entry and exit, the flow rate and maximum possible flow rate.	**(10)**	**1**	**3**