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

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2023

Sixth Semester

ME18603 – GAS DYNAMICS AND JET PROPULSION

(Mechanical Engineering)

(Use of gas table is permitted)

(Regulation 2018 /Regulation2018A)

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

Course outcome	Statement	RBT level
CO1	Student will understand the one dimensional compressible flow through variable area duct.	3
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.	3
CO4	Student will analyze the propulsion methods, concepts of aircraft propulsion system and performance of the jet.	3
CO5	Student apply the concepts of gas dynamics in space propulsion system.	3

PART- A (10x2=20Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Define Mach number and Crocco number.	1	2
2.	An air jet at 400K has sonic velocity. Determine (i). Velocity of sound at 400K, (ii). Velocity of sound at stagnation conditions.	1	3
3.	What is Rayleigh flow? Give two practical examples.	2	1
4.	Explain choking in Fanno flow.	2	1
5.	Define strength of the shock.	3	2
6.	Differentiate between Normal and oblique shock.	3	1
7.	What is a bypass engine and define bypass ratio.	4	1
8.	Define thrust augmentation.	4	1
9.	Distinguish between monopropellant and bipropellant.	5	2
10.	Classify the Rockets based on applications.	5	2

PART- B (5x 14=70Marks)

			Marks	CO	RBT LEVEL
11.(a)	(i)	Derive the expression for the effect of Mach number on the compressibility. $\frac{p_0 - p}{\frac{\rho c^2}{2}} = 1 + \frac{M^2}{4} + \frac{(2-\gamma)}{24} M^4 + - - - -$	(7)	1	2

			Marks	CO	RBT LEVEL
	(ii)	An aircraft is flying at an altitude of 14,000 m at a Mach number of 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	(7)	1	3
		(OR)			
	(b)	Air is discharged from a reservoir at 6.91 bar, 325ºC through a nozzle to an exit pressure of 0.98 bar. If the flow rate is 3,600 kg/hr. determine for isentropic flow (i) Throat area, pressure and velocity, (ii) Exit area, Mach number, velocity and temperature.	(14)	1	3
12.(a)		A circular duct passes 8.25 kg/sec of air at an exit Mach number of 0.5. The entry pressure and temperature are 3.45 bar and 38^0C respectively and the coefficient of friction 0.005. If the Mach number at entry is 0.15, determine (i) The diameter of duct, (ii) length of the duct, (iii) Pressure and temperature at exit and (iv) Stagnation pressure loss.	(14)	2	3
		(OR)			
	(b)	The data for a combustion chamber employing hydrocarbon fuel is given below. entry gas velocity = 152 m/s, pressure= 4 bar and temperature =400 K, exit mach number 0.8, Take γ = 1.3, C_p = 1.244 kJ/kgK for the products of combustion. If the calorific value of the fuel burnt is 44MJ / kg, Determine (i) Entry Mach number (ii) Pressure, temperature and velocity of gas at exit iii) Air fuel ratio (iv) stagnation pressure loss.	(14)	2	3
13.(a)		A Mach Number 2 aircraft employs a subsonic inlet diffuser of area ratio 3. A normal shock is formed just upstream of the diffuser. The air stream condition upstream of the diffuser are pressure 0.10 bar and temperature 300 K. Determine Mach number, the pressure and temperature at the diffuser exit. Assume isentropic flow in the diffuser downstream of the shock.	(14)	3	3
		(OR)			

(b)	**(i)**	A gas (γ = 1.3) at P_1 = 0.345 bar, T_1= 350 K and M_1 = 1.5 is to be isentropically expanded to 0.138 bar. Determine (a) deflection angle, (b) final Mach number and (c) the temperature of the gas.	**(7)**	**3**	**3**
	(ii)	A Supersonic stream of air at M= 3.0, is deflected inwards by 15 degrees. This generates strong shock waves. Calculate the following quantities for this wave. (i)Wave angle, (ii) Downstream Mach number, (iii)Temperature ratio, static and stagnation pressure.	**(7)**	**3**	**3**
14.(a)	**(i)**	The diameter of the propeller of an aircraft is 2.5 m. If it flies at a speed of 500 kmph at an altitude of 8000 m, for a flight to jet speed ratio of 0.75, determine (i) the flow rate of the air through the propeller(ii) thrust produced (iii) specific thrust (iv) specific impulse (v) the thrust power.	**(7)**	**4**	**3**
	(ii)	Explain with a neat sketch the working principle Turbojet engine.	**(7)**	**4**	**2**
		(OR)			
(b)		An aircraft flies at 960kmph. 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, lower calorific value of the fuel is 43 MJ/kg and jet speed ratio is 0.5, determine (a) jet velocity (b) thrust (C) specific thrust (d) thrust power (e) propulsive and thermal efficiency, overall efficiency and TSFC.	**(14)**	**4**	**3**
15.(a)	**(i)**	Describe the properties of liquid propellants and solid propellants.	**(7)**	**5**	**2**
	(ii)	A rocket flies at 10080 kmph with an effective exhaust jet velocity of 1400m/s and propellant flow rate of 5.0 kg/s. If the heat of reaction of the propellant is 6500 kJ/kg of the propellant mixture, determine propulsion efficiency and propulsion power, engine output, thermal efficiency and overall efficiency.	**(7)**	**5**	**3**
		(OR)			
(b)	**(i)**	Draw a schematic diagram of a solid propellant rocket and explain its working.	**(7)**	**5**	**2**

	(ii)	A rocket engine has the following data. Thrust coefficient =12, propellent flow rate = 20 N/s, combustion chamber pressure = 15 bar, exhaust nozzle throat diameter = 5 cm. From the above data, compute thrust, specific impulse, effective jet velocity and characteristic velocity.	**(7)**	**5**	**3**

PART- C (1x 10=10Marks)

(Q.No.16 is compulsory)

		Marks	**CO**	**RBT LEVEL**
16.	A conical air diffuser has an intake area 0.11m^2 and an exit area of 0.44 m^2. Air enters the diffuser with static pressure of 0.18 Mpa, static temperature of 37^{o}C and velocity of 267 m/s. Calculate the (i) mass flow rate of air through the diffuser (ii) The Mach number, static pressure and static temperature of air leaving the diffuser.	**(10)**	1	**3**

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