b. Prove that

$$1+\frac{1}{4}M^2+\frac{1}{40}M^4+.....$$

29. a. A conical diffuser has entry and exit diameters of 15cm and 30cm respectively. The pressure, temperature and velocity of air at entry are 0.69 bar, 340K and 180 m/s respectively. Determine,
   (i) Exit pressure
   (ii) Exit velocity
   (iii) The force excreted on the diffuser wall (τ).

(OR)

b. A convergent divergent air nozzle has exit to throat area ratio of 3. A normal shock appears at the divergent section where the existing area ratio is 2.2. Find the mach number, before and after the shock, if the inlet properties are 500 KPa and 450 K. Find the properties of air at exit and entropy increase across the shock.

30. a. Air at 120 KN/m^2 and 40°C flows through a 200 mm diameter pipe adiabatically. If the upstream mach number is 2.5, determine the maximum length of pipe and the properties of air at exit. Also estimate the length of the pipe if the exit mach number is 1.8. Take f=0.01.

(OR)

b. A gas at a pressure of 0.69 bar and temperature 278K enters a combustion chamber at velocity of 60 m/s. the heat supplied in the combustion chamber is 1450 KJ/kg/ Determine the mach number, pressure, temperature and velocity of the gas at the exit.

31. a. Explain about ramjet engine and pulse jet engine with neat sketch.

(OR)

b. A turbojet propels an air craft at a speed of 900 km/h while taking 3000 kg of air per minute. The isentropic enthalpy drop in the nozzle is 200 kJ/kg and then nozzle efficiency is 90%. The air fuel raio is 85 and the combustion efficiency is 95%. The calorific value of the fuel is 42,000 KJ/kg. calculate
   (i) Propulsive power or thrust power
   (ii) Thermal efficiency
   (iii) Propulsive efficiency

32. a. Explain about liquid propellant rocket engines and solid propellant rocket motors.

(OR)

b. Calculate the thrust, specific impulse, propulsive efficiency, thermal and overall efficiencies of a rocket engine from the following data
Effective jet velocity = 1250 m/s
Flight to jet speed ratio = 0.8
Oxidizer flow rate = 3.5 kg/s
Fuel flow rate = 1 kg/s
Heat of reaction of exhaust gases = 2500 KJ/kg.

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Reg. No.															

B.Tech. DEGREE EXAMINATION, NOVEMBER 2016
Sixth Semester

ME1023 – GAS DYNAMICS AND SPACE PROPULSION
(For the candidates admitted during the academic year 2013 – 2014 and 2014 -2015)

Note:
(i) **Part - A** should be answered in OMR sheet within first 45 minutes and OMR sheet should be handed over to hall invigilator at the end of 45th minute.
(ii) **Part - B** and **Part - C** should be answered in answer booklet.

Time: Three Hours Max. Marks: 100

PART – A (20 × 1 = 20 Marks)
Answer **ALL** Questions

1. Argon is stored in a reservoir at 300K, determine the stagnation enthalpy (γ =1.4, M.W of argon = 39.94)
   (A) 157 KJ/kg (B) 157 KJ/kg K
   (C) 157 J/kg (D) 157 J/kg K

2. An air stream at P=1.0 bar, T=400K and C=400 m/s is brought to rest isentropically. Determine the stagnation temperature.
   (A) 449.5 K (B) 459.5 K
   (C) 469.5 K (D) 479.5 K

3. Air at P_1=3 bar and T_1=500K flows in a constant area duet. Calculate density (γ =1.4, R=289 J/kg K)
   (A) $2.076\times10^{-5} kg/m^3$ (B) $2.076\ kg/m^3$
   (C) $3.076\ kg/m^3$ (D) $3.076\times10^{-5} kg/m^3$

4. Calculate C_{max} for the adiabatic flow if *Cp=1006 J/kg K and To=311.15K.*
   (A) 591 *m/s* (B) 691 *m/s*
   (C) 791 *m/s* (D) 891 *m/s*

5. If $\frac{F_1}{F_1^*}=1.203$ *and* $\frac{F_2}{F_2^*}=4.30(F^*=1370N)$; Calculate the force excerted on the diffuser wall.
   (A) 4243 N (B) –4243 N
   (C) 4243 KN (D) –4243 KN

6. The choked flow condition in which the pressure ratio (γ =1.4) is
   (A) 0.328 (B) 0.428
   (C) 0.528 (D) 0.628

7. If (*γ =1.3, R=0.469 KJ/kg K) Mx=2.5, Px=2* bar; then calculate *My*?
   (A) 0.493 (B) 0.593
   (C) 0.693 (D) 0.793

8. The following area ratio are $\frac{A_2}{A^*}=3;\frac{A_x}{A_t^*}$ and $\frac{A_x}{A_y^*}=1.287$ then. Calculate $\frac{A_2}{A_y^*}=$

(A) 8.49 (B) 5.128
(C) 0.94 (D) 1.755

9. If $\gamma=1.4$, $\frac{4\bar{f}L_{max}}{D}=0.522$, then determine the entry mach number (M_1)

(A) 2.98 (B) 3.00
(C) 3.20 (D) 3.40

10. If D=30 cm, friction factor is 0.003, the ratio $\frac{4\bar{f}L}{D}=0.2d$, then the length of duet is

(A) 5.025m (B) 6.025m
(C) 7.025m (D) 8.025m

11. The heating process takes place in a subsonic region in which mach number
(A) Increases (B) Decreases
(C) Constant (D) Increases and then decreases

12. The cooling process takes place in a supersonic region in which velocity
(A) Increases (B) Decreases
(C) Constant (D) Increases and then decreases

13. The air standard efficiency of the engine for the pressure ratio of 5.779 is
(A) 0.6942 (B) 0.5942
(C) 0.4942 (D) 0.3942

14. Determine the area of cross section of the propeller disc if diameter = 2.5m
(A) 3.9 m^2 (B) 4.9 cm^2
(C) 4.9 m^2 (D) 3.9 cm^2

15. If (propulsive efficiency) η_p=66.6%, (theoretical efficiency) $\eta_{th=12.65\%}$ then calculate overall efficiency
(A) 8.42% (B) 9.42%
(C) 10.42% (D) 11.42%

16. If thrust produced is 20 KN and flight speed is 1000 kmph then calculate thrust power
(A) 5555 N (B) 5555 KN
(C) 5555 W (D) 5555 KW

17. The oxidizer used in gasoline fuel
(A) LO_x (B) H_2O_2
(C) N_2O_3 (D) N_2O_4

18. The molecular weight of hydrazine
(A) 22 (B) 32
(C) 36 (D) 40

19. The boiling point of liquid hydrogen
(A) 40K (B) −40K
(C) 20K (D) −20K

20. If thrust = 7KN,weight flow rate=50 N/s, then calculate specific impulse
(A) 140 sec (B) 140 min
(C) 142 sec (D) 142 min

PART – B (5 × 4 = 20 Marks)
Answer **ANY FIVE** Questions

21. A plane is flying at a speed of 300 m/s at an altitude where temperature and pressure of air are 250K and 0.7 bar respectively. Determine the pressure read by a pilot tube mounted on the nose of the aircraft.

22. An aircraft is flying at an altitude of 11,500 KM. The air is compressed isentropically in an inlet diffuser. The temperature at the inlet of the diffuser is 200K. If the mach number and temperature at the diffuser exit are 0.4 and 235K, Calculate the mach number at the entry of the diffuser.

23. A bicycle tire is filled with air at 165KPa and 30°C. the valve breaks and air exhausts into atmosphere of 100KPa and 25°C. The valve exit is 2mm diameter and is the smallest area in the system. Assuming one dimensional isentropic flow. Find the mach number at the exit and mass flow rate.

24. A jet of air at 270K and 0.7 bar has an initial mach number of 1.9. If it passes through a normal shock wave, determine the following for downstream of the shock.
(i) Mach number
(ii) Temperature
(iii) Pressure
(iv) Speed of sound

25. What are the assumptions made for Fanno flow and Rayleigh flow?

26. Why tail pipe is used in aircraft engine?

27. Write the difference between liquid propellants and solid propellants in terms of their properties.

PART – C (5 × 12 = 60 Marks)
Answer **ALL** Questions

28. a. An air jet (γ =1.4, R=287 J/kgK) at 400K has sonic velocity. Determine,
(i) Velocity of sound at 400K
(ii) Velocity of sound at the stagnation conditions
(iii) Maximum velocity of the jet
(iv) Stagnation enthalpy
(v) Crocco number

(OR)