Register Number:……..

KUMARAGURU
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**B.E DEGREE EXAMINATIONS: MAY 2017**

(Regulation 2014)

Sixth Semester

**MECHANICAL ENGINEERING**

U14METE67: Gas Dynamics and Jet Propulsion

(Use of Steam table and Gas table are permitted)

**COURSE OUTCOMES**

**CO1:** Know the differences between compressible and incompressible flows.

**CO2:** Study the behavior of flow through variable area.

**CO3:** Solve problems in Rayleigh and Fanno flow.

**CO4:** Understand and explain the concept of normal and oblique shock.

**CO5:** Understand the knowledge about the rocket propulsion and various propellants.

**Time: Three Hours** **Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Match the following based on the classifications of rocket CO5 [$K_2$]

| List I | List II |
|---|---|
| A) Turbo-prop engine | i)Supersonic combustion |
| B) Thrust augmentation | ii)Short run way |
| C) Rocket engine | iii)Water injection |
| D) SCRAM jet engine | iv)Non-air breathing engine |

| | A | B | C | D |
|---|---|---|---|---|
| a) | ii | iii | iv | i |
| b) | iii | ii | iv | i |
| c) | ii | iii | i | iv |
| d) | i | iii | iv | ii |

2. The value of $\gamma$ for a polyatomic ideal gas is CO1 [$K_1$]

a) 1.3 b) 1.4

c) 1.23 d) 1.66

3. The locus of stagnation enthalpy of subsonic and supersonic branch of Rayleigh flow meet at a point where CO3 [$K_2$]

1) $T_o$ is maximum 2) Entropy is maximum

3) Flow is sonic 4) Velocity is zero

a) 1,2,3 b) 1,2

c) 2,3 d) 1,4

4. Chocking condition at a section in a duct represents CO2 [$K_1$]

a) Maximum mass flow b) Maximum static temperature

c) Maximum stagnation temperature d) Maximum stagnation pressure

5. **Assertion (A):**Compared to a turbo-jet engine, a turbo-prop engine has a higher power for take –off and higher propulsive efficiency at low speeds CO5 [$K_2$]

**Reason (R):**By mounting the propeller on the turbine shaft, the propeller can be run at a very high speed to obtain higher efficiency

a) Both A and R are Individually true and R is the correct explanation of A

b) Both A and R are Individually true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

6. In Fanno and Rayleigh flows, choking occurs when Mach number (M) is CO3 [$K_1$]

a) M<1 b) M>1

c) M=1 d) M<<1

7. Arrange the following terms in a sequence based on energy transformation CO2 [$K_2$]

i) Diffuser flow ii) Constant stagnation enthalpy

iii) Static enthalpy increases iv) Kinetic energy decreases

a) i-iv-iii-ii b) i-ii-iii-iv

c) i-iii-iv-ii d) iv-ii-iii-i

8. The shock phenomena is a CO4 [$K_2$]

a) Reversible process b) Irreversible process

c) Adiabatic process d) Constant pressure process

9. **Assertion (A):**After burning increases the thrust of a jet engine CO5 [$K_1$]

**Reason (R):**The air fuel ratio of jet engine is high

a) Both A and R are Individually true and R is the correct explanation of A

b) Both A and R are Individually true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

10. When air flows through a divergent part of a CD nozzle shock occurs at a section where Mach no is 3.5 then shock strength is — CO4 [$K_2$]

a) 10.125 b) 12.125

c) 14.125 d) 13.125

**PART B (10 x 2 = 20 Marks)**
**(Answer not more than 40 words)**

11. If an aeroplane goes to higher altitude maintaining the same speed, will the mach number of the plane change? Answer with reason. — CO1 [$K_2$]
12. List the impact of designing supersonic vehicle on ground. — CO1 [$K_2$]
13. Differentiate isentropic flow from adiabatic flow — CO2 [$K_1$]
14. State the necessary conditions for an isentropic flow to be choked. — CO2 [$K_1$]
15. Give the important difference between Nozzle and Venturimeter. — CO2 [$K_1$]
16. Give the reason for sudden drop in static temperature when the flow is about to reach sonic from subsonic in Rayleigh flow. — CO3 [$K_2$]
17. List the merits of turbo-prop engines. — CO3 [$K_1$]
18. Shock waves cannot develop in subsonic flow. State the reason. — CO4 [$K_2$]
19. Define air breathing engine — CO5 [$K_2$]
20. Sketch and name the components of Turbo jet engine. — CO5 [$K_2$]

**Answer any FIVE Questions:-**
**PART C (5 x 14 = 70 Marks)**
**(Answer not more than 300 words)**

**Q.No. 21 is Compulsory**

21. Explain the working principle of turbo fan engine with neat sketch and also compare turbo prop engine with turbo jet engine. — CO5 [$K_3$]

22. Air at 3 bar and 300 K enters a duct of varying cross sectional area with an entry velocity of 150 m/s. At inlet the area is 0.05 $m^2$. At another section downstream of it the fluid properties are 2 bar, 280 K with a flow velocity of 250 m/s. Assuming air to be a perfect gas and isentropic flow. Calculate the internal thrust produced — CO1 [$K_3$]

| | | | |
|---|---|---|---|
| 23. | Air enters a converging –Diverging nozzle at 1.0 MPa and 800 K with a negligible velocity. The flow is steady, one dimensional and isentropic with □ =1.4. For an exit Mach number of $M_2$=2 and a throat area of 20 $cm^2$. Determine (a) throat conditions, (b) exit pressure, exit temperature, exit area and mass flow rate through the nozzle | CO2 | [$K_3$] |
| 24. | Air is flowing in a frictionless constant area duct with a Mach number of 2. The stagnation temperature and stagnation pressure are 250ºC and 6 bar respectively. The stagnation temperature is brought down to a temperature to 150ºC by some cooling process. Determine the Mach number, pressure and temperature after cooling | CO3 | [$K_3$] |
| 25. | Derive the complete form of adiabatic steady flow energy equation for a compressible flow through a duct. | CO1 | [$K_2$] |
| 26. | A normal shock occurs in a diverging section of a CD air nozzle. The throat area is 1/3 x times the exit area, static pressure at exit area is 0.4 times the stagnation pressure at the entry. The flow is throughout isentropic except through shock. Determine (a) Mach number $M_x$ and $M_y$ (b) Static pressure and (c) area of cross section of the nozzle at the section where shock occurs. | CO4 | [$K_3$] |
| 27. | An aircraft flies at 960 kmph. One of its turbojet engine takes in 40 kg/s of air and expands the gases to the ambient pressure. The air-fuel ratio is 50 and the 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 | CO5 | [$K_3$] |

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