

**IV B.Tech I Semester Regular Examinations, November 2005**  
**JET PROPULSION AND ROCKET ENGINEERING**  
**(Mechanical Engineering)**

**Time: 3 hours****Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. In an open cycle constant pressure gas turbine air enters the compressor at 1.02 bar and  $27^{\circ}\text{C}$ . The pressure of air after the compression is 4 bar. The isentropic efficiencies of compressor and turbine are 78% and 85% respectively. The air fuel ratio is 80:1. Calculate the power developed and thermal efficiency of the cycle if the flow rate of air is 2.5 kg/sec. Take  $C_p = 1.005 \text{ kJ/kgK}$ ,  $\gamma = 1.4$  for air and  $C_p = 1.147 \text{ kJ/kgK}$  and  $\gamma = 1.33$ , for gasses,  $R = 0.287 \text{ kJ/kgK}$ . C.V. of fuel = 42000 kJ/kg. [16]
2. (a) Explain the energy flow in an atmospheric thermal jet engine and what are powers corresponding to brake and indicated power of i.c. engines.  
(b) What is the need for thermal jet engines and discuss the applications of thermal jet engines. [8+8]
3. What is “after burning” in turbojet engines, and why is it required. Explain briefly with the aid of a diagram and represented on T-s chart after burning. [16]
4. (a) Draw the sketch of a pulse jet engine. Write down its main advantages and disadvantages.  
(b) Describe the working of a scramjet engine. What are its advantages over the ram jet engine. [8+8]
5. Explain the basic theory of operation of rocket engine. What are the salient features of liquid propellant rockets? [16]
6. (a) Give the examples liquid propellants and explain the applications of liquid propellant rocket engines?  
(b) Explain the combustion process in liquid propellant rocket engine? [8+8]
7. (a) Derive an expression for the velocity of a rocket vehicle at the end of the powered flight.  
(b) What is the effect of mass ratio, specific impulse and burnout time on the maximum velocity attained by the rocket-vehicle? [6+10]
8. (a) What is the working principle of plasma arc rocket engine?  
(b) What are the basic components of the plasma arc rocket engine. Explain the function of each. [8+8]

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1. (a) What do you understand by a closed cycle gas turbine, what difficulties are encountered in the development of closed cycle plant.  
(b) Sketch and explain simple cycle with inter cooling and reheating. Draw P-v and T-s diagrams of the cycle. [8+8]
2. (a) Present some examples of reaction principle used for propulsion. What is thrust and how is it evaluated.  
(b) What are the essential features of propulsion devices based on reaction principles.  
(c) List out the important applications where thermal jet engines are indispensable. [6+5+5]
3. An Aircraft flies at 960 kmph. One of the 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 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, overall efficiencies and TSFC. [16]
4. (a) Why a ram jet engine does not require a compressor and a turbine?  
(b) How an air craft having a ram jet engine takes off?  
(c) Give two important difference between Ram jet and pulse jet engine? [6+6+4]
5. (a) What are the important elements used in the rocket engines? Explain.  
(b) Explain the arc plasma rocket engine? [8+8]
6. What do you understand from monopropellant fuels? What are the merits and demerits over the bipropellant fuels used in rocket engines? [16]
7. (a) Draw a simple sketch of multi stage rocket vehicle depicting clearly the booster stage, propellant tanks and exhaust nozzle, instruments and navigational equipment.  
(b) Explain briefly the meaning of the following.

- i. Booster rocket stage
  - ii. Sustainer stage
  - iii. Retro Rocket. [10+6]
8. (a) With the help of a neat diagram, write about nuclear rocket engine.
- (b) What are the advantages it has over other rocket engines. [8+8]

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1. (a) What are the effects on thermal efficiency and specific output of gas turbine plant due to the following factors
  - i. load on the plant
  - ii. pressure ratio
  - iii. turbine inlet temperature
  - iv. compressor inlet temperature
  - v. regenerator.
- (b) Derive the thermal efficiency of the air standard Brayson cycle. [8+8]
2. (a) What is the principle of working of Thermal jet engines and their classification.
- (b) Derive an expression for Propulsive efficiency of Thermal jet engine. [8+8]
3. A Turbojet aircraft flies at 875 kmph at an altitude of 10000 m above mean sea level. Calculate.
  - (a) air flow through the engine
  - (b) thrust,
  - (c) Specific thrust
  - (d) thrust power and TSFC from the following data.  
Diameter of the air inlet section = 0.75 m.  
Diameter of jet pipe at exit = 0.5 m.  
Velocity of the gases at the exit of the jet pipe = 500 m/s  
Pressure at the exit of the jet pipe = 0.3 bar.  
Air to fuel ratio = 40. [16]
4. (a) Why a ram jet engine does not require a compressor and a turbine?
- (b) How an air craft having a ram jet engine takes off?
- (c) Give two important difference between Ram jet and pulse jet engine? [6+6+4]
5. (a) How the propulsive efficiency of rocket engine can be estimated?
- (b) What are the major differences between Air breathing engine and rocket engine. [8+8]
6. (a) What are the requirements for the design of combustion chamber for rocket engines?

- (b) What are the differences between liquid propellant and solid propellant combustion chamber? [8+8]
7. (a) Derive an expression for the velocity of a rocket vehicle at the end of the powered flight.
- (b) What is the effect of mass ration, specific impulse and burnout time on the maximum velocity attained by the rocket-vehicle? [6+10]
8. (a) Discuss the relative merits of gas-pressurization rocket power plant and the pump-pressurization system.
- (b) What is meant by mono propellant and bi-propellant fuels for rocket engines? Give important examples of each and their uses. [8+8]

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1. (a) Explain with neat sketches the working of a simple constant pressure open cycle gas turbine.  
(b) What are the advantages and disadvantages of a closed cycle gas turbine over open cycle gas turbine? What are the desirable properties of working fluid suitable for closed cycle operation? [8+8]
2. (a) What is the principle of working of Thermal jet engines and their classification.  
(b) Derive an expression for Propulsive efficiency of Thermal jet engine. [8+8]
3. What is “after burning” in turbojet engines , and why is it required. Explain briefly with the aid of a diagram and represented on T-s chart after burning. [16]
4. A ramjet engine has the following data. Altitude = 6.5 km. Flight Mach number = 4.0 Air fuel ratio = 50. Calorific value of the fuel used = 44.18 MJ/Kg. Diffuser inlet diameter = 0.5,  $\gamma = 1.4$ ,  $R = 287 \text{ J/KgK}$  for both air and the products of combustion. Efficiencies of the diffuser, combustor and the nozzle are 0.85, 0.98 and 0.95 respectively. [16]
5. (a) Explain the working of nuclear rocket engines?  
(b) What are the important parameters to evaluate the performance of a rocket engine? Explain. [8+8]
6. (a) What are the difference between bipropellant and monopropellants used in rocket engines?  
(b) How the liquid bipropellants are prepared for the rocket engines? [8+8]
7. (a) Define the following quantities, write down their formulae and units: specific impulse, total impulse, and specific propellant consumption.  
(b) Calculate thrust, specific impulse, propulsive, thermal and overall efficiencies of a rocket engine from the following data:  
Effective jet speed = 1250m/s.  
Flight to jet speed ratio = 0.80  
Oxidizer flow ratio = 3.5 kg/s  
Fuel flow rate = 1.0 kg/s  
Heat of reaction per kg of exhaust gases = 2500 KJ/kg. [8+8]
8. (a) Discuss the relative merits of gas-pressurization rocket power plant and the pump-pressurization system.

- (b) What is meant by mono propellant and bi-propellant fuels for rocket engines?  
Give important examples of each and their uses. [8+8]

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