Code No: NR420301 **Set No.1**

IV B.Tech. II Semester Supplementary Examinations, July -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. (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.
2. (a) Explain the principle of jet propulsion and mention how the jet propulsion engines are classified.
   (b) The effective jet velocity from a jet engine is 2700 m/sec. The forward flight velocity is 1350 m/sec and the air flow rate is 78.6 kg/sec. Calculate
   i. thrust
   ii. thrust power
   iii. Propulsive efficiency.
3. (a) What is the thermodynamic cycle for turbojet and list out the main components of turbojet unit, and present a schematic lay out.
   (b) Show the various processes occurring in the engine on a T.S. diagram
4. (a) Describe the working of a ramjet engine.
   (b) Depict the various thermodynamic processes occurring in it on h-S diagram.
   (c) What is the effect at flight mach number on its efficiency
5. Explain the basic theory of operation of rocket engine. What are the salient features of liquid propellant rockets?
6. (a) What are the important properties required for a good propellant used for a rocket engine?
   (b) What are different advantages and disadvantages of solid propellant over a liquid propellant?
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.

8. (a) Give the classification of liquid propellent rocket engines.

(b) With the help of a neat diagram, explain the working of a liquid bi-propellent rocket engine.

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1. (a) Give the schematic of semi closed cycle plant in gas turbines.
   (b) A gas turbine operates on a pressure ratio 6, the inlet air temperature to the compressor is 300 K and the air entering the turbine is at a temperature of 577^0C. If the volume rate of air entering the compressor is 240 m^3/sec. Calculate the net power output of the cyle in MW. Also compute its efficiency, assume that the cycle operates under ideal conditions.

2. (a) Explain the principle of jet propulsion and how you determine the thrust.
   (b) Explain clearly the various efficiencies associated with propulsion devices.

3. A turbojet air craft is flying at 800 km/hr at an altitude where the pressure is 0.25 bar and temperature is -4^0 C. The pressure ratio in the compressor is 10:1 and the maximum cycle temperature is 800^0C. Calculate the thrust developed and specific fuel consumption. Assume the following data : isentropic efficiency of compressor = 90% Total head pressure loss in the combustion chamber = 0.15 bar, calorific value of fuel = 40200 KJ/hr combustion efficiency = 98%, isentropic efficiency of Turbine = 92% and Jet Nozzle = 94%, nozzle outlet area = 800 cm^2. The nozzle in the turbojet is convergent.

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?

5. (a) What are the requirements of an ideal rocket propellant?
   (b) Derive the equation for calculation of effective jet velocity in rocket?

6. Draw the neat diagram of liquid propellant rocket engine? Compare with the principle of operation with solid propellant rocket engine?

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.

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.

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Code No: NR420301 **Set No.3**

IV B.Tech. II Semester Supplementary Examinations, July -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. (a) Why maximum temperature in gas turbine cycle is limited to 850^0C, why lean A:F ratio is used in gas turbines and what is the range of it.
   (b) In a gas turbine plant air enters the compressors at 1 bar and 27^0C, the pressure ratio is 6. The temperature at turbine inlet is 1000 K. the mass flow rate of air is 10 kg/sec. Determine
      i. Power required to drive the compressor and the turbine power output
      ii. thermal efficiency.

2. (a) What is meant by jet propulsion? What are the basic differences between jet propulsion cycle and shaft power cycle?
   (b) The exit velocity from a jet unit is 650 m/s from an air flow of 40 kg/s through the unit. The air craft is flying at 250 km/hr. Calculate the thrust developed, the thrust power and the propulsion efficiency. Neglect the effect of fuel.

3. A turbojet engine is travelling at 270 m/s at an altitude of 5000 m. The compressor pressure ratio is 8:1 and maximum cycle temperature is 1200 K. By assuming the following data, calculate the specific thrust and TSFC : Ram efficiency 93%, Isentropic efficiency of compressor 87% pressure loss in combustion chamber 4 % compressor deliver pressure, calorific value of fuel 43,100 KJ/Kg, combustion efficiency 98%, mechanical transmission efficiency 99%, isentropic efficiency of turbine 90% propelling nozzle efficiency 95%. Ambient conditions at 5000 m are 0.5405 bar and 255.7 k

4. A ramjet engine operates at M=1.5 at an altitude of 6500 m. The diameter of the inlet diffuser at entry is 50 cm and the stagnation temperature at the nozzle entry is 1600 K. The calorific value of the fuel is 40 MJ/Kg. The properties of the combustion gases are same as those of air ($\gamma = 1.4$, R = 287 J/KgK). The velocity of air at the diffuser exit is negligible. Calculate
   (a) the efficiency of ideal cycle
   (b) flight speed
   (c) air flow rate
   (d) diffuser pressure ratio
   (e) fuel air ratio
   (f) nozzle pressure ratio
   (g) nozzle jet mach number

(h) propulsive efficiency and

(i) thrust. Assume the following values $\eta_D = 0.9$, $\eta_s = 0.98$, $\eta_j = 0.96$, stagnation pressures loss in the combustion chamber $= 0.02\ P_{02}$.

5. Write short notes on the following terms:

   (a) Thrust

   (b) specific thrust

   (c) specific impulse

   (d) specific propellant consumption.

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?

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.

8. (a) With the help of neat diagram, explain the working of magneto-plasma rocket engine.

   (b) Can rocket work in vacuum? Explain.

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Code No: NR420301 **Set No.4**

IV B.Tech. II Semester Supplementary Examinations, July -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. (a) Explain the terms air rate, specific power, work ratio in gas turbine plants.
   (b) A simple ideal gas turbine operates with a pressure ratio 8. The compressor and turbine inlet temperatures are 300 k and 800 k respectively. If the volume flow rate is $250m^3$/sec. compute the net power output and cycle efficiency.

2. (a) Explain the principle of jet propulsion and mention how the jet propulsion engines are classified.
   (b) The effective jet velocity from a jet engine is 2700 m/sec. The forward flight velocity is 1350 m/sec and the air flow rate is 78.6 kg/sec. Calculate
      i. thrust
      ii. thrust power
      iii. Propulsive efficiency.

3. Simple turbojet is operating with a compressor pressure ratio of 8.0, a turbine inlet temperature of 1200 K and a mass flow of 15 kg/s, when the aircraft is flying at 260 m/s, at an altitude of 7000m. Assuming the following data, calculate the propelling nozzle area required, the net thrust developed and the TSFC. Polytropic efficiency of compressor and Turbine 0.87, Ram efficiency 0.95, isentropic efficiency of the propelling nozzle 0.95 Mechanical efficiency 0.99, combustion chamber pressure loss 6% comp deliver pressure, combustion efficiency 0.97, Ambient conditions at 7000 m in are 0.405 bar and 241.7 K.

4. A ramjet engine operates at M=1.5 at an altitude of 6500 m. The diameter of the inlet diffuser at entry is 50 cm and the stagnation temperature at the nozzle entry is 1600 K. The calorific value of the fuel is 40 MJ/Kg. The properties of the combustion gases are same as those of air ($\gamma = 1.4$, R = 287 J/KgK). The velocity of air at the diffuser exit is negligible. Calculate
   (a) the efficiency of ideal cycle
   (b) flight speed
   (c) air flow rate
   (d) diffuser pressure ratio
   (e) fuel air ratio
   (f) nozzle pressure ratio
   (g) nozzle jet mach number

(h) propulsive efficiency and

(i) thrust. Assume the following values $\eta_D = 0.9$, $\eta_s = 0.98$, $\eta_j = 0.96$, stagnation pressures loss in the combustion chamber $= 0.02\ P_{02}$.

5. (a) Explain the essential differences between rocket propulsion and turbojet propulsion?

   (b) What is the importance of specific impulse in rocket engines?

6. (a) Compare liquid propellant rocket engine with solid propellant rocket engine?

   (b) What are different applications of solid propellant rocket engines?

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?

8. (a) With the help of a neat diagram, explain the working of liquid bi-propellent gas pressurization system.

   (b) Discuss the possibility of rocket-powered vehicle having a flight velocity greater than the exhaust velocity of the rocket motor.

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