Code No: RR410306 **Set No. 1**

IV B.Tech I Semester Regular Examinations, November 2007
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) Draw the schematic diagram of simple cycle with inter cooler and explain briefly the working principle. Draw also P-v and T-s diagrams of the cycle.
   (b) A gas turbine is supplied with 60 kg/sec of gas at 5 bar and 800^0C and expands isentropically to 1 bar. Take the mean specific heats of the gas at constant pressure and constant volume to be 1 kJ/kgK and 0.717 kJ/kg K respectively. Calculate the exhaust gas temperature and power developed in Mw. [6+10]

2. What is meant by thrust? Derive the thrust equation for a general propulsion system. Explain the effective jet exit velocity, thrust power and propulsive power. [16]

3. A Turbojet engine is traveling at 850 km/hr at standard sea-level conditions. The ram efficiency is 85%, the compression ratio is 4:1, the compressor efficiency is 80%, the burner pressure coefficient is 2%, the fuel air is 0.0122, the turbine inlet total temperature is 700^0C. The turbine efficiency is 84% and equivalent jet efficiency is 95% calculate
   (a) specific net thrust and
   (b) the thrust specific fuel consumption (TSFC)

   Assume $C_{pa} = 1.005$ kg/ kgk $\gamma_a = 1.4$, $C_{pg} = 1.155$ kg/kg, $\gamma_g = 1.33$. [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. Write short notes on the following terms:
   (a) Thrust
   (b) specific thrust
   (c) specific impulse
   (d) specific propellant consumption. [16]

6. Sketch the layout of liquid propellant rocket engine and explain its working. Give its applications. [16]

7. Describe briefly with the aid of graphs, the variation of the following quantities in rocket propulsion.

(a) Rocket thrust with altitude.

(b) Thrust coefficient Vs Exhaust nozzle pressure ration P_o/P_c

(c) Thrust coefficient Vs area ratio of exhaust nozzle.

(d) Acceleration due to gravity Vs altitude. [4×4]

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. [8+8]

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Code No: RR410306 **Set No. 2**

IV B.Tech I Semester Regular Examinations, November 2007
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. The pressure ratio of an open cycle constant pressure gas turbine plant is 6. The temperature range of the plant is 15^0C and 800^0C. Using the following data Cpa = 1.005 kJ/kg, Cpg = 1.102 kJ/kgk, r = 1.4 for air and gases, c.v. of fuel = 42.300 kJ/kg, $\eta_c = 0.85$, η_t=0.9 ,R_{com} = (combustion) = 0.95, find
   (a) the thermal efficiency of the plant
   (b) power of the plant if the circulation of air is 5 kg/sec
   (c) A:F ratio
   (d) specific fuel consumption. [16]

2. What is meant by thrust? Derive the thrust equation for a general propulsion system. Explain the effective jet exit velocity, thrust power and propulsive power. [16]

3. (a) Discuss the effect of forward speed and effect of Altitude in Aircraft engine.
   (b) Discuss the overall Turbojet process in aircraft engine. [8+8]

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 requirements of an ideal rocket propellant?
   (b) Derive the equation for calculation of effective jet velocity in rocket? [8+8]

6. (a) What are different types of pressurization systems used in liquid propellant rocket engines?
   (b) Explain the working of solid propellant rocket engine with a neat diagram. [8+8]

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) 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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Code No: RR410306 **Set No. 3**

IV B.Tech I Semester Regular Examinations, November 2007
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. The gas turbine takes air at 15^0C the pressure ratio is 4 and maximum temperature is limited to 560^0C. Assuming isentropic efficiencies of compressor and turbine as 83% and 86% respectively. Determine the overall efficiency
   (a) with out heat exchanger and
   (b) with heat exchanger of an effectiveness of 0.75. [16]

2. The leaving velocity is 1750 km/hr from a jet and inlet velocity is 88 km/hr. The specific fuel consumption is 12 kg/hr for each kg of thrust. Fuel of 42385 kJ/kg lower heating value is used. For 2000 kg thrust, compute the air flow in kg/sec. Also calculate the probable propulsion and thermal efficiencies and finally determine the overall efficiency of this unit. [16]

3. (a) Describe the working of a Turboprop engine
   (b) Show the various processes occurring in the engine on h-s diagram. [12+4]

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}. [16]

5. (a) Explain the working principles of Magneto Plasma Rocket engine?
   (b) Discuss the relative merits and demerits of gas pressurization system over the pump pressurization system? [8+8]

6. (a) Explain different types of propellants used in rocket engines?
   (b) How the rockets are classified based on propellants? [8+8]

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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Code No: RR410306 **Set No. 4**

IV B.Tech I Semester Regular Examinations, November 2007
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) Draw the schematic diagram of a simple cycle with a heat exchanger and explain briefly the working principle, draw also the P-v and T-s diagrams of the cycle.
   (b) A gas turbine cycle has a perfect heat exchanger. Air enters the compressor at a temperature and pressure of 300 k and 1 bar and discharges at 475 k and 5 bar. After passing through heat exchanger the air temperature increases to 655 k. The temperature of air entering and leaving the turbine are 870^0C and 450^0C. Assume no pressure drop through the heat exchanger. Compute
      i. the output per kg of air
      ii. the efficiency of the cycle
      iii. the work required to drive the compressor. [6+10]

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. [8+8]

3. Calculate the air flow rate through the engine, cross section area of the propelling nozzle exit, thrust, thrust power, propulsive and overall efficiencies for a turbojet engine from the following data, flight mach number = 0.85, flight altitude = 12000 m, cross sectional area of the inlet - diffuser at entry = 0.5 m^2. Air fuel ratio = 60, conditions at the exit of the exhaust jet, pressure = 477 bar, temperature = 1000k, velocity = 660 m/s, calorific value of the fuel = 43 MJ /kg. [16]

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 (γ = 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}. [16]

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) Draw a neat sketch of turbo pump feed system employed in rockets.

   (b) How does cavitation occur in this system and what measures are taken to prevent it?

   (c) What is the effect of cavitations on the operation of the rocket? [6+6+4]

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. [8+8]

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