Code No: RR312106 **Set No.1**

III B.Tech. I Semester Regular Examinations, November -2005
AERO SPACE PROPULSION-I
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. What is the basic principle of operation of a gas turbine engine? Explain various components with figures / sketches and its thermodynamics with a plot. [16]

2. Write a note on the application and utility of an afterburner in a turbo-jet engine. Explain the complete thermodynamics of the unit. Plot variation of pressure, temperature and velocity across the cross- section of the engine. [16]

3. What are different types of air intakes for subsonic airplanes powered by turbojets? Illustrate each of these categories with sketches and aerodynamic characteristics. [16]

4. Consider a supersonic airplane with Ear type air intakes ahead of the wing root ends on the fuselage. Describe its aerodynamics and thermodynamics at its design Mach number at a high angle of yaw. [16]

5. A J-57B afterburning turbojet engine had 169.4 lbm/s of air at 36psia and 1013^0F enter the afterburner and products of combustion at 31.9psia and 2540^0F leave the combustor. If the fuel flow in the afterburner was 25130 lbm/hr, determine the afterburner efficiency, η_{AB}, assuming h_{PR}=18400 Btu/lbm, C_{pt} = 0.27Btu/lbm^0R . and C_{PAB} = 0.29Btu/lbm.^0R. [16]

6. A nozzle in a wind tunnel gives a test section Mach number of 2.0. Air enters the nozzle from a large reservoir at 0.69 bar and 310K. The cross-sectional area of the throat is 1000 cm^2. Determine the following quantities for the tunnel for one-dimensional isentropic flow:

   (a) Pressure, temperature and velocity at the throat and test section.

   (b) Area of cross-section of the test section.

   (c) Mass flow rate.

   (d) Power required to drive the compressor. [16]

7. (a) Explain the effect of impeller blade shape on the performance of centrifugal compressor.

   (b) Explain the relative merits and demerits of centrifugal and axial flow compressors of a gas turbine engine. [16]

8. Write notes on the following with respect to axial flow compressors:

   (a) Three-dimensional blade losses

(b) Compressor stall and surge. [16]

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Code No: RR312106 **Set No.2**

III B.Tech. I Semester Regular Examinations, November -2005
AERO SPACE PROPULSION-I
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. What is the basic principle of operation of a gas turbine engine? Explain various components with figures / sketches and its thermodynamics with a plot. [16]

2. Explain with a lay out sketch the arrangement of a turbo-prop engine and its thermodynamic cycle of operation. Describe the role of each component in an integrated manner. [16]

3. Consider a front air intake for a subsonic turbojet airplane as that for He-178 or F-86 Saber jet. Show the internal layout for the air to be swallowed by the engine. Explain its aerodynamics and thermodynamics in details when the airplane dives at higher angles in its flight. [16]

4. Consider a supersonic airplane with Ear type air intakes ahead of the wing root ends on the fuselage. Describe its aerodynamics and thermodynamics at its design Mach number at a small angle of yaw. [16]

5. Describe various types of combustion chambers with the help of sketches? List down their relative merits and demerits. [16]

6. At launch, a space shuttle main engine (SSME) has 1030 lbm/s of gas leaving the combustion chamber at P_t = 3000 psia and T_t =7350^{0}R. The exit area of SSME nozzle is 77 times the throat area. If the flow through the nozzle is considered to be reversible and isentropic with $R_{gc} = 3800\ ft^2/(s^2.\ ^0R)$ and $\gamma = 1.25$, find the area of throat nozzle and the exit Mach number. [16]

7. (a) Explain the compressibility effects with respect to centrifugal compressor. How these effects can be taken care of?
   (b) Write a note on 'choking of centrifugal compressor'. [16]

8. Write notes on the following with respect to axial flow compressor:
   (a) Diffusion factor
   (b) Stage loading and flow coefficient. [16]

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Code No: RR312106 **Set No.3**

III B.Tech. I Semester Regular Examinations, November -2005
AERO SPACE PROPULSION-I
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. What is the basic principle of operation of a gas turbine engine? Explain various components with figures / sketches and its thermodynamics with a plot. [16]

2. Making use of first principle, develop an expression for thrust developed by a jet engine with inlet area of 0.5 sq. m .A turbojet engine is under static testing on a test bed. It develops a jet speed of 500 m /s at a pressure of 1 atm at 750 K at exit of the nozzle. Considering the location at sea level, calculate the static thrust in this case. [16]

3. Consider Ear type air intakes for a subsonic airplane as that for Gnat / Ajit fighter plane. Show the internal layout for the swallowed air to reach the engine. Explain its aerodynamics and thermodynamics in details when the airplane takes a turn of about 10 in its yaw plane. [16]

4. Write notes on:

   (a) Oswatitsch type oblique shock diffuser,

   (b) starting of an oblique shock inlet. [16]

5. What are the basic requirements of a fuel injection system? Explain the working of a typical fuel injection system of a turbine engine with the help of a sketch. [16]

6. Find the dimensions and the values of C_{fg}, F_g and C_V of an axisymmetric exhaust-nozzle with a mass flow rate of 75kg/s with the following given data:
   $P_{t8} = 350$ kPa $T_{t8} = 1600$K
   $A_9/A_8 = 1.8$ R = 0.287 kJ/kg.K $\gamma = 1.33$
   $P_{t9}/P_{t8} = 0.98$ $C_D = 0.98$ $P_0 = 40$ kPa [16]

7. A 12in diameter rotor of a centrifugal compressor for air is needed to produce a pressure ratio of 4.0. Assuming a polytropic efficiency of 0.86, determine the angular speed, total temperature rise and adiabatic efficiency. Also determine the input power for a mass flow rate of 10 lbm/s at 1atm and 518.7^0R. Assume a slip factor of 0.9. [16]

8. The first stage of an axial compressor is designed on free vortex principle, with no inlet guide vanes. The rotational speed is 6000rev/min and the stagnation temperature rise is 20K. The hub-tip ratio is 0.60, the work-done factor is 0.93 and the isentropic efficiency of the stage is 0.89. Assuming an inlet velocity of 140m/s and ambient conditions of 1.01bar and 288K, calculate:

(a) The tip radius and corresponding rotor air angles β_1 and β_2 if the Mach number relative to the tip is limited to 0.95.

(b) The mass flow entering the stage.

(c) The stage stagnation pressure ratio and power required. [16]

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Code No: RR312106 **Set No.4**

III B.Tech. I Semester Regular Examinations, November -2005
AERO SPACE PROPULSION-I
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Air enters a compressor at a pressure of 0.1 Mpa and temperature of 248K. It leaves the compressor at a pressure of 0.65 Mpa. The maximum temperature in cycle is 900^oC. Assume the compressor efficiency of 80% and turbine efficiency of 85%.a pressure drop of 0.15Kpa takes place in the combustion chamber. Determine the compressor work, turbine work and cycle efficiency. [16]

2. Plot P-v and T-s plots for a turbo-jet and turbo-prop engines. Explain the functioning and thermodynamics of a turbojet engine and plot the variation of pressure, temperature and velocity in as best manner as you can. [16]

3. Consider Ear type air intakes for a subsonic airplane as that for Gnat / Ajit fighter plane. Show the internal layout for the swallowed air to reach the engine. Explain its aerodynamics and thermodynamics in details when the airplane is in its flight at its near stalling speed. [16]

4. Illustrate with sketches and diagrams, various types of supersonic air inlets employed by aircraft industry. Explain salient features and aerodynamic performance of each of these. [16]

5. What are the various types of burners used for fuel injection system in gas turbines? Which one will you prefer and why? [16]

6. Describe the behaviour of the flow in a convergent-divergent nozzle when it is operated at

   (a) design pressure ratio,

   (b) pressure ratio higher than the design value and

   (c) pressure ratio lower than the design value. [16]

7. A single-sided compressor is to deliver 14kg/s of air when operating at a pressure ratio of 4:1 and a speed of 200rev/s. The inlet stagnation conditions may be taken as 1.0bar and 288K. Assuming a slip factor of 0.9, power input factor of 1.04 and an overall isentropic efficiency of 0.80, estimate the overall diameter of the impeller.If the Mach number is not to exceed unity at the impeller tip and 50% of the losses are assumed to occur in the impeller, find the minimum possible axial depth of the diffuser. [16]

8. A four stage axial compressor has stage temperature rise 30^0C using symmetrical stages with a stator outlet angle of 20^0. If the mean diameter of each stage is

250mm and each stage is identical, calculate the required rotational speed and total pressure ratio. Assume a work done factor of 0.86, polytropic efficiency of 0.92 and a constant axial velocity of 150m/s. Ambient conditions are 1.01bar and 288K. [16]

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