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

III B.Tech I Semester Regular Examinations, November 2006
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. Consider an air standard Brayton cycle, where the air enters the compressor at 0.12 Mpa, 18^oC. It leaves the compressor at 0.65 Mpa. TIT is 950^o C. Determine pressure and temperature at each point in the cycle. Work out the efficiency of its compressor, turbine and the overall engine. [16]

2. Making use of first principle, develop an expression for thrust developed by a jet engine with inlet area of 0.55 sq. m .A turbojet engine is under static testing on a test bed. It develops a jet speed of 550 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 is in its flight at its maximum level speed. [16]

4. Consider a conical spike type supersonic air inlet with fixed geometry for optimum performance at one Mach number. Describe its aerodynamics and thermodynamics at the design Mach number. What happens when the operating mach number is higher than the design Mach number? [16]

5. A gas turbine combustion chamber is supplied with liquid fuel at 325K and air at 450K. The fuel approximates to $C_{10}H_{12}$ and five times the quantity of air required for stoichiometric combustion is supplied. Calculate the fuel air ratio and estimate the fuel products temperature assuming the combustion to be adiabatic and complete. Use (Figure5) for the initial approximate value of the products temperature.

   In addition to following data assume suitable value of C_p

   $C_{10}H_{12}(liq)+13O_2 \rightarrow 10CO_2+6H_2O(liq)$, ΔH_{298K} = -42500kJ/kg $C_{10}H_{12}$

   For water at 298K, h_{fg} = 2442 kJ/kg

   For the liquid fuel, mean C_p= 1.945 kJ/kg.K

   Composition of air by volume = 0.79 N_2, $0.21O_2$. [16]

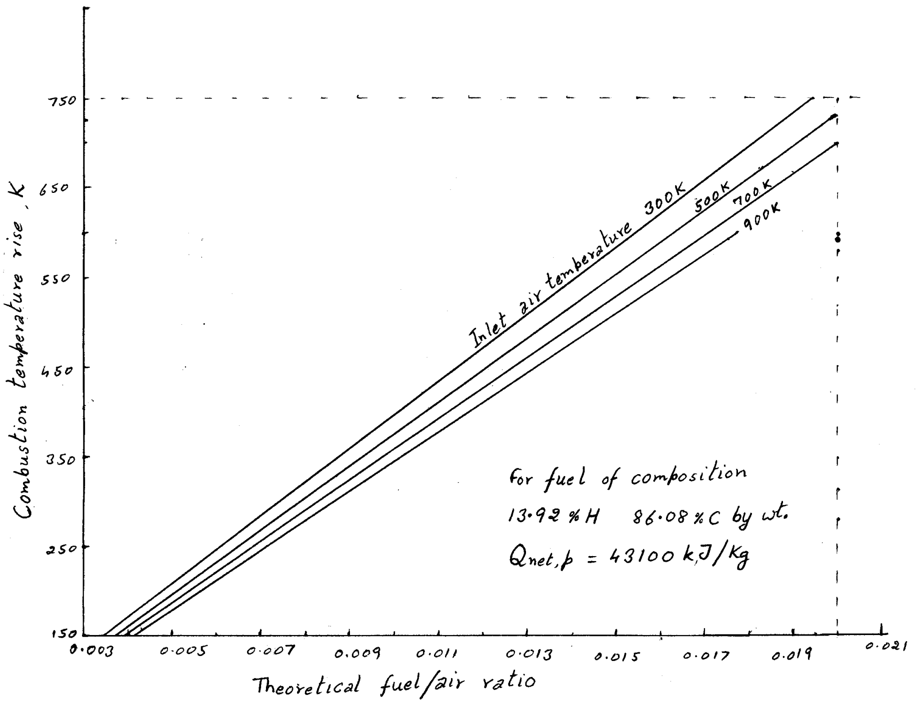

Figure 5

6. Find the dimensions of an axisymmetric nozzle and the values of Cfg, Fg and CV with the following given data:
   $P_{t8} = 30$ psia $T_{t8} = 2000^0 R$ $\gamma = 1.33$
   $A_9/A_8 = 2$ R = 53.34 ft.lbf/lbm.^0R
   $P_{t9}/P_{t8} = 0.98$ $C_D = 0.98$ $P_0 = 5$ psia
   $(massflow)_8 = 200$ lbm/s. [16]

7. (a) What is pre-whirl? Sketch velocity triangles with and without pre-whirl. What are its effects on pressure ratio developed by the compressor?
   (b) A compressor of a turbojet engine operates in standard sea level air with a pressure ratio of 5 and an air consumption of 35kg/s at an isentropic efficiency of 86%. Calculate the work per kg, the horsepower required to drive the compressor and the total temperature at the compressor discharge. [16]

8. Write notes on the following:
   (a) Axial compressor characteristics.
   (b) Compressibility effects in axial flow compressors. [16]

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

III B.Tech I Semester Regular Examinations, November 2006
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. Consider an actual gas turbine engine. How does each of its parts function to accomplish the work of the engine? Illustrate with sketches and plots. Show the variation of various parameters across the engine. [16]

2. A turbo-prop driven airplane is flying at 680 Km / h at an altitude where the ambient conditions are 0.458 bar and -10^{o}C. The compressor pressure ratio is 9.5:1 and the turbine inlet temperature is 1250 K. The isentropic efficiencies of compressor and turbine are 0.85 and 0.90 respectively. Assuming that no thrust is generated by the jet exhaust from the engine; calculate the specific power input available to the propeller. [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. Consider a conical spike type supersonic air inlet with fixed geometry for optimum performance at one Mach number. Describe its aerodynamics and thermodynamics at the design Mach number. What happens when the operating mach number is higher than the design Mach number at a small angle of attack $\alpha = 2^o$? [16]

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

6. What do you understand by propelling nozzles? Differentiate between convergent and convergent-divergent nozzles. Which type is suitable for aircraft gas turbine engine and why? [16]

7. A single-sided centrifugal compressor has to be designed with the following given data:
Power input factor = 1.04
Slip factor = 0.9
Rotational speed = 290rev/s
Overall diameter of impeller = 0.5m
Eye tip diameter = 0.3m
Eye root diameter = 0.15m
Inlet stagnation temperature = 295K
Inlet stagnation pressure = 1.1bar
Air mass flow = 9kg/s
Isentropic efficiency = 0.78

(a) Determine the pressure ratio of the compressor and the power required to drive it assuming that the air at inlet is axial.

(b) Calculate the inlet angle of the impeller vane at the root and tip radii of the eye assuming that the axial inlet velocity is constant across the eye annulus. [16]

8. Write notes on the following:

   (a) Axial compressor characteristics.

   (b) Compressibility effects in axial flow compressors. [16]

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

III B.Tech I Semester Regular Examinations, November 2006
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. Consider an air standard Brayton cycle, where the air enters the compressor at 0.1 Mpa, 18^o C. It leaves the compressor at 0.5 Mpa. TIT is 900^o C. Determine pressure and temperature at each point in the cycle. Work out the efficiency of its compressor, turbine and the overall engine. [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 flies near its stalling angle in its flight. [16]

4. Consider a conical spike type supersonic air inlet with fixed geometry for optimum performance at one Mach number. Describe its aerodynamics and thermodynamics at the design Mach number. What happens when the operating mach number is less than the design Mach number at a small angle of yaw $\beta = 2^o$? [16]

5. The overall pressure loss factor of a combustion chamber may be assumed to vary with the temperature ratio according to the law
$\frac{\Delta p_0}{m^2/2\rho_1 A_m^2} = K_1 + K_2[(T_{02}/T_{01}) - 1]$
For a particular chamber having an inlet area of $0.0389m^2$ and a maximum cross-sectional area A_m of $0.0975m^2$, cold loss tests show that K_1 has the value of 19. When tested under design conditions, the following readings were obtained:
Air mass flow, m = 9.0kg/s
Inlet stagnation temperature, T_{01} = 475K
Outlet stagnation temperature, T_{02} = 1023K
Inlet static pressure, p_1 = 4.47 bar
Stagnation pressure loss = 0.27 bar
Estimate the pressure loss at a part load condition for which m is 7.4kg/s, T_{01} is 439K, T_{02} is 900K and p_1 is 3.52 bar.
Also for these two operating conditions, compare the values of the velocity at inlet to the chamber and comment on the result. [16]

6. (a) Sketch various types of exhaust nozzles for a turbojet engine. What are their advantages and disadvantages?
   (b) Explain the theory of flow in isentropic nozzles. [16]

7. Following data pertains to a centrifugal compressor:
   Mass flow rate = 8kg/s P_{t1} =101.3kPa
   Pressure ratio = 4.0 T_{t1} = 288.16K
   Polytropic efficiency = 0.85 Slip factor = 0.9
   Inlet root diameter = 15cm V_3 = 90m/s
   Outlet diameter of impeller = 50cm $w_2 = u_1$
   Inlet tip diameter = 30cm
   Find
   (a) rotational speed and r.p.m. of the rotor.
   (b) rotor inlet Mach number, velocity and relative flow angles at the root and tip.
   (c) Rotor exit velocity, Mach number, total temperature, total pressure and direction.
   (d) depth of rotor exit.
   (e) diffuser exit Mach number, area, total temperature and pressure. [16]
8. Explain the following with respect to axial flow compressor:
   (a) Cascade characteristics
   (b) Reynolds and Mach number effects. [16]

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Code No: RR312106

Set No. 4

III B.Tech I Semester Regular Examinations, November 2006
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. Consider an air standard Brayton cycle, where the air enters the compressor at 0.12 Mpa,25^o C .It leaves the compressor at 0.5 Mpa. TIT is 1000^o C. Determine pressure and temperature at each point in the cycle.Work out the efficiency of its compressor,turbine and the overall engine. [16]

2. A turbo-prop driven airplane is flying at 680 Km / h at an altitude where the ambient conditions are 0.458 bar and -10^oC. The compressor pressure ratio is 9.5:1 and the turbine inlet temperature is 1250 K. The isentropic efficiencies of compressor and turbine are 0.85 and 0.90 respectively. Assuming that no thrust is generated by the jet exhaust from the engine; calculate the specific power input available to the propeller. [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. Enumerate the various factors affecting the performance of a combustion chamber. How 'combustion efficiency' and 'combustion intensity' affect the performance?[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} = 1600K
A_9/A_8 = 1.8   R = 0.287 kJ/kg.K γ = 1.33
P_{t9}/P_{t8} = 0.98 C_D = 0.98 P_0 = 40 kPa [16]

7. (a) How do you classify centrifugal compressors? Explain how physically the pressure ratio is achieved in practice. What are the limitations of a centrifugal compressor?
   (b) Define and differentiate between 'slip factor' and 'power input factor'. [16]

8. Explain the following with respect to axial flow compressor:
   (a) Cascade characteristics
   (b) Reynolds and Mach number effects. [16]

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