Code No: R05312105 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2008
AEROSPACE PROPULSION-I
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Exaplain in detail performance characteristics of various components of a gas turbine engine. Also discuss effect of variables on the working of these components. [16]

2. Describe the flight regime for the suitability of a turbo-prop engine in aviation and explain with examples. Make a lay out sketch of this engine, explain its thermodynamic cycle and work out its efficiency. [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 climbs in its flight at higher angles. [16]

4. Write notes on:
   (a) Oswatitsch type oblique shock diffuser,
   (b) starting of an oblique shock inlet. [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. (a) Explain the importance of 'thrust spoiler' and 'noise suppressor' with respect to convergent propelling nozzle.
   (b) Distinguish between choked and un-choked flows. [16]

7. A centrifugal compressor is desired to have a total pressure ratio of 4:1. The inlet eye of the compressor impeller is 30cm in diameter. The axial velocity at inlet is 130m/s and the mass flow is 10kg/s. The velocity in the delivery duct is 115m/s. The tip speed of the impeller is 450m/s and runs at 16000rpm with total head isentropic efficiency of 78% and pressure coefficient of 0.72. The ambient conditions are 1.03kgf/cm^2 and 15^0 C. Calculate
   (a) Static pressure ratio. .
   (b) Static pressure and temperature at inlet and exit of compressor
   (c) Work of compressor per kg of air.
   (d) Theoretical horsepower required to drive the compressor. [16]

8. Explain the three-dimensional flow in axial flow compressor and derive the free vortex condition. What does free vortex condition signify? [16]

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Code No: R05312105 **Set No. 2**

III B.Tech I Semester Regular Examinations, November 2008
AEROSPACE PROPULSION-I
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Make use of a block diagram to illustrate the operation of a gas turbine engine and explain its operation in details. Show the variation of pressure, temperature and velocity along the engine. [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 dives in its flight at shallow angles. [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. Enumerate the various factors affecting the performance of a combustion chamber. How 'combustion efficiency' and 'combustion intensity' affect the performance?[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. (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. Find the polytropic efficiency of an axial flow compressor from the following data:
   Total head pressure ratio = 4
   Overall total head isentropic efficiency = 85%
   Total head inlet temperature = 290K
   The inlet and outlet air angles from the rotor blades of the above compressor are 45^0 and 10^0 respectively. The rotor and stator blades are symmetrical. The mean blade speed and axial velocity remain constant throughout the compressor. Assuming blade speed of 220m/s and work done factor of 0.86, find the number of stages required. Also find the inlet Mach number relative to rotor at the mean blade height of the first stage. [16]

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Code No: R05312105 **Set No. 3**

III B.Tech I Semester Regular Examinations, November 2008
AEROSPACE 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 operational gas turbine engine in an airplane. Taking effect of all the components explain its working. Make use of neat sketches. Plot the pressure, temperature and velocity across this engine. [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 a fighter plane of the type of front air intake (F-86 Saber) and compare its performance with that of Ear type air intakes of Gnat / Ajit fighter plane manufactured by HAL in level flight. Compare their aerodynamics and thermodynamics in brief. [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 the design Mach number at a small angle of yaw $\beta = 2^o$? [16]

5. Explain the importance of following terms in deciding the performance of a combustion chamber:
   (a) Combustion Efficiency
   (b) Pressure Loss
   (c) Combustion Intensity
   (d) Stability Limits [16]

6. Products of combustion (γ=1.3) at a static pressure of 2.0Mpa, static temperature of 2000K and Mach number of 0.05 are accelerated in an isentropic nozzle to a Mach number of 1.3. Find downstream static pressure and temperature. If the mass flow rate is 100kg/s and the gas constant R is 286J/kg.K, using mass flow parameters, find the flow areas for M = 0.5 and M = 1.3. [16]

7. (a) What factors affect the design of a diffuser of a centrifugal compressor? Explain.
   (b) Write a note on ‘centrifugal compressor surge and its prevention’. [16]

8. Air enters at repeating row, repeating stage axial compressor which has the following properties: mass flow = 40 lbm/s, D = 0.5, M_1 = 0.5, α_1=38^0, T_{t1} = 290K, P_{t1} =1.013kPa, ϕ_{cs} = 0.03, e_c = 0.9, ω = 1000rad/s, γ = 1.4 and R = 0.286kJ/(kg.K). Determine the temperature rise, pressure ratio, mean radius and flow areas and associated hub and tip radii at stations 1, 2 and 3. [16]

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Code No: R05312105 **Set No. 4**

III B.Tech I Semester Regular Examinations, November 2008
AEROSPACE 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 0.15 Mpa and temperature of 288K. 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. A turbo-prop driven airplane is flying at 600 Km / h at an altitude where the ambient conditions are 0.458 bar and -15^oC. The compressor pressure ratio is 9:1 and the turbine inlet temperature is 1200 K. The isentropic efficiencies of compressor and turbine are 0.89 and 0.93 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 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 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. Show graphically the variation of area ratio (A/A*), temperature ratio (T/T*), Mach number (M*) and mass flow ratio (m/m_{max}) with pressure ratio in isentropic flow in a convergent-divergent nozzle. Mark the points where these quantities have a value of 1.0. [16]

7. A single-sided straight vaned centrifugal compressor is required to deliver 10kg/s of air with a total pressure ratio of 4:1 when operating at a speed of 16500rpm. The air inlet pressure and temperature are 1.013bar and 300K respectively. Calculate:

   (a) Tip speed of the impeller.

   (b) Actual rise in stagnation temperature.

   (c) Tip diameter.

   (d) Inlet eye annulus area.

   (e) Theoretical power required to drive the compressor. The air enters the eye axially with a velocity of 150m/s. [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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