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

III B.Tech. I Semester Supplementary Examinations, May -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. Illustrate with neat sketches and plots various components of a gas turbine engine. What are its added advantages over a piston engine? Explain the thermodynamics of each component put on the same plot.

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.

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 cruising flight.

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?

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 barEstimate the pressure loss at a part load condition for which m is 7.0kg/s, $T_{01}$is 400K, T_{02} is 850K and p_1 is 3.4 bar.Also for these two operating conditions, compare the values of the pressure loss as a fraction of inlet stagnation (i.e. compressor delivery) pressure and comment on the result.

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 $\gamma = 1.33$
$P_{t9}/P_{t8} = 0.98$ $C_D = 0.98$ $P_0 = 40$ kPa

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.

8. Air flows through an axial flow compressor stage with the following properties: T_{t1} = 300K, $(u_2/u_1) = 1.0$, $V_1 = 120$m/s, $\alpha_1 = 0^0$, $\beta_2 = 45^0$ and U $=\omega r_m = 240$m/s. Determine the change in tangential velocity and the total pressure ratio of the stage for a stage efficiency of 0.88.

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

III B.Tech. I Semester Supplementary Examinations, May -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. Consider an air standard Brayton cycle, where the air enters the compressor at 0.12Mpa, 18^o C. It leaves the compressor at 0.5 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.

2. Describe with a neat sketch components and the thermodynamics of a turbo-jet engine. In what ways, this engine is superior to a turbo-prop engine. Are there any limitations in its applications? Comment.

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 derated in its flight prior to landing.

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 β = -2^o ?

5. What are the various practical problems coming across the efficient design of a combustion chamber? Discuss two important problems.

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 $T_{t8} = 2000^0R$ $\gamma = 1.33$
$A_9/A_8 = 2$ 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

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.

8. Show that in the case an axial flow compressor the maximum theoretical blading efficiency is obtained when the stage is symmetrical and the flow coefficient is 0.5 and under this condition its value is given by

$(\eta_b)_{\max} = 1 - 2(D/L)$
where L and D are lift and drag forces respectively.

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

III B.Tech. I Semester Supplementary Examinations, May -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 258K. It leaves the compressor at a pressure of 0.5 Mpa. The maximum temperature in cycle is 950^{o}C. 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.

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.

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 shallow angles in its flight.

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?

5. Write notes on the following:
   (a) Flame tube cooling
   (b) Fuel Injection System.

6. Explain the operating characteristics for isentropic flow nozzles with the help of plots.

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'.

8. (a) Explain the elementary theory of axial flow compressor.
   (b) Distinguish between free vortex and forced vortex condition briefly.

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Set No.4

III B.Tech. I Semester Supplementary Examinations, May -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. Consider an air standard Brayton cycle, where the air enters the compressor at 0.1 Mpa,15^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.

2. A turbo-prop driven airplane is flying at 650 Km / h at an altitude where the ambient conditions are 0.458 bar and -15^{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.

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.

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 yaw β = -2^o ?

5. Write notes on the following with respect to combustion chamber:
   (a) Duplex burner
   (b) Ignition
   (c) Use of cheap fuels
   (d) Use of flame holders.

6. Air at a total pressure of 1.4MPa, total temperature of 350K and Mach number of 0.5 is accelerated isentropically in a nozzle (Figure1) to a Mach number of 3 (station x), passes through a normal shock (x to y) and then flows isentropically to the exit. Given a nozzle throat area of 0.05 m^2 and the exit area of 0.5 m^2,
   (a) Find the area at the shock.
   (b) Find the static pressure and static temperature upstream of the shock. (station x).

(c) Find the Mach number and total & static pressures and temperatures downstream of the shock (station y).

(d) Find the Mach number, static pressure and static temperature at the exit.

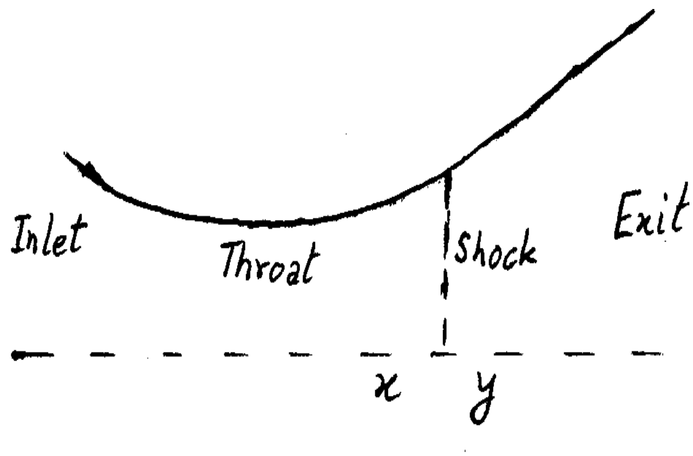

Figure 1:

7. An aircraft engine is fitted with a single-sided centrifugal compressor. The a/c flies with a speed of 230m/s at an altitude where the pressure is 0.23bar and the temperature is 217K. The intake duct of the impeller eye contains fixed vanes which gives the air pre-whirl of 25 degree at all radii. The inner and outer diameters of the eye are 18cm and 33cm respectively. The diameter of the impeller periphery is 54cm and the rotational speed is 270rev/s. Estimate the stagnation pressure at the compressor outlet when the mass flow is 3.6kg/s.
Neglect losses in the inlet duct and fixed vanes and assume the isentropic efficiency of the compressor is 0.80. Take slip factor and input factor as 0.9 and 1.04 respectively.

8. An axial flow compressor stage has blade root, mean and tip velocities of 150m/s, 200m/s and 250m/s respectively. The stage is to be designed for a stagnation temperature rise of 20K and an axial velocity of 150m/s, both constant from root to tip. The work done factor is 0.93. Assuming 50% reaction at mean radius, calculate stage air angles at root, mean and tip and degree of reaction at root and tip for a free vortex design.

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