Code No: RR322103 **Set No. 1**

III B.Tech II Semester Supplementary Examinations,
November/December 2005
AEROSPACE PROPULSION-II
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Explain the significance of flow coefficient and blade loading coefficient with the help of ψ - Φ diagram for 50% reaction turbine stage. [16]

2. Following data refers to a single stage turbine:

   Mass flow, m = 20 kg/s

   Isentropic efficiency $\eta_t = 0.89$

   Inlet temperature T_{01} = 1100 K

   Temperature drop (T_{01}- T_{03}) = 145 K

   Inlet pressure p_{01} = 4 bar

   Flow coefficient = 0.8

   Swirl angle α_3 = 10 degrees

   Nozzle efflux angle $\alpha_2 = 58^0 23'$

   Mean blade speed = 340 m/s

   Rotational speed N = 250 rev/s

   Draw velocity diagram and calculate blade height and tip/root radius ratio at stations 1, 2 and 3.

   Where 1 is nozzle inlet, 2 is nozzle exit and 3 is rotor exit. [16]

3. Define and derive the relationship for gross thrust coefficient of a ramjet engine. Explain the behavioural characteristics of gross thrust coefficient with the related parameters with the help of plots for a fixed geometry ramjet engine. [16]

4. (a) Write a note on **'SCRAMJET'**.

   (b) What are the advantages and disadvantages of integral ram-rocket over a simple ramjet? What are the applications of integral ram-rocket? [8+8]

5. What do you understand by re-entry? Explain the process of re-entry for a space-craft at orbital speed. Explain the various types of problems encountered and their remedies. [16]

6. The following data relates to composite solid propellant :

Specific impulse	= 240 sec at sea level and 1000 psi
Burning rate	= 1.0 in/sec at 1000 psi & 60^oF
Specific weight	= 0.066 lb/in^3

Specific heat ratio	= 1.25
Chamber pressure	= 1000 psi
Desired average thrust	= 20000 lb
Maximum vehicle dia	= 16 in
Desired duration	= 5.0 sec
Ambient pressure	= 3 psi (at altitude)
Vehicle payload	= 5010 lb
Thrust coefficient	= 1.73

Make a preliminary determination of (a) propellant weight & volume, (b) web thickness, (c) wall thickness, (d) grain configuration and (e) nozzle design. [16]

7. What are the various types of propellant tanks in case of liquid rocket motors? Explain the role, desirable characteristics, advantages and disadvantages of propellant tanks. [16]

8. Describe the concept of solid-core reactor rocket with the help of a schematic diagram. [16]

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Code No: RR322103 **Set No. 2**

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

Answer any FIVE Questions
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1. (a) Define blade loading coefficient and derive the relationship for it with the help of velocity diagrams for a turbine stage.
   (b) Explain briefly the significance of degree of reaction. [12+4]

2. (a) Explain the following with respect to an axial turbine blade design:
      i. Secondary loss parameter
      ii. Correction factor for trailing edge thickness
   (b) Write a note on 'forced convection air cooling of axial turbines' [5+5+6]

3. Explain the sub-critical, critical and supercritical conditions with the help of sketches under which a ramjet engine diffuser can operate. [16]

4. (a) An ideal ramjet engine operates with isentropic diffusion, no total pressure reduction in the engine, a choked isentropic converging nozzle and k = 1.4 constant. Calculate the values of effective jet Mach number (M_j) for M_0 = 1.0, 1.4, 1.8, 2.2 and infinity.
   (b) Explain the applications of SCRAMJET. [10+6]

5. Derive the general equation of motion for a rocket jet-propelled body in vertical flight. [16]

6. (a) Compare the various exhaust gas properties of a typical composite solid propellant (with aluminium and perchlorate) with that of a cryogenic liquid propellant such as O_2-H_2.
   (b) Explain the distinct features, advantages and disadvantages of the following with respect to solid rocket motor:
      i. Jetavators
      ii. Moveable nozzle (ball/socket/gimbal ring) [10+3+3]

7. (a) Explain the following with respect to liquid propellants:
      i. Bipropellants
      ii. Storable propellants
   (b) Write a note on 'control of combustion instability' with respect to liquid rocket motors. [5+5+6]

8. Explain the working principle of an electrical rocket with the help of a schematic diagram. Write down the merits and demerits of an electric rocket motor over a solid propellant rocket motor. [16]

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Code No: RR322103 **Set No. 3**

III B.Tech II Semester Supplementary Examinations,
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AEROSPACE PROPULSION-II
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Define the loss coefficient for nozzle blades and derive the following relationship with the help of T-s diagram

$$Y_N = \lambda_N \left\{ 1 + [(\gamma - 1) M_2^2]/2 \right\}$$

Where Y_N = nozzle blade loss, λ_N = nozzle blade loss coefficient ,M_2 = Mach number at blade exit [16]

2. (a) Explain the following with respect to an axial turbine blade design:
   i. Secondary loss parameter
   ii. Correction factor for trailing edge thickness
   (b) Write a note on 'forced convection air cooling of axial turbines' [5+5+6]

3. (a) Explain the combustion characteristics of acetylene with respect to ramjet engines.
   (b) Explain the nozzle effects on the performance of ramjet engine. [8+8]

4. Explain the working principle and operation of a **SCRAMJET** engine with the help of a suitable diagram. How is it different from ramjet? [16]

5. (a) Describe various types of rocket engines and the concept of staging of rockets.
   (b) How control is achieved on space vehicles? [10+6]

6. Explain the role of igniters in case of solid propellant rocket motor. What are the desirable characteristics of an igniter and how these characteristics affect the performance of solid rocket motor? [16]

7. (a) What are the various components of a thrust chamber of a liquid rocket motor? What factors affect the selection of thrust chamber?
   (b) Write a short note on 'injectors' with respect to liquid rocket motor. [10+6]

8. Describe the concept of solid-core reactor rocket with the help of a schematic diagram. [16]

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1. Explain the vortex theory with respect to an axial flow turbine. [16]

2. The following particulars relate to a single stage turbine of free vortex design:

   Inlet temperature T_{01}= 1050 K

   Inlet pressure p_{01} = 3.8 bar

   Pressure ratio (p_{01}/p_{03}) = 2.0

   Outlet velocity C_3 = 275 m/s

   Blade speed at root radius = 300 m/s

   Isentropic efficiency η_t = 0.88

   The above data yields the following results for the gas angles:

	α_2	β_2	α_3	β_3
Tip	$54^0 56'$	0^0	$8^0 31'$	$58^0 20'$
Mean	$58^0 23'$	$20^0 29'$	10^0	$54^0 57'$
Root	$62^0 9'$	$39^0 19'$	$12^0 7'$	$51^0 8'$

   The values of radius ratio in plane 2 were $(r_m/r_r)_2 = 1.164$ and $(r_m/r_t)_2 = 0.877$.

   Using the same mean diameter angles, calculate β_2 at tip and root for constant nozzle angle design in which α_2 and C_{w2}. $r^{(sin\alpha 2)*(sin\alpha 2)}$ are constant over the annulus.

   Compare the two designs by sketching the velocity diagrams and commenting qualitatively on such aspects as the radial variation of degree of reaction and blade inlet Mach number. [16]

3. Explain the operating principle and essential features of a ramjet with the help of a suitable diagram. [16]

4. A 20-in diameter ramjet engine has a diverging conical inlet diffuser and a converging exhaust nozzle. The ramjet is designed to operate at a flight Mach number M_0 = 1.7 at 20000 ft altitude, the temperature of the gases at the entrance to the exhaust nozzle (T_6) is 3500^0R. The fuel has a calorific value of 19300 Btu/lb. Assume that there are no pressure losses due to friction, that the air enters the combustion chamber with the Mach number M_2 = 0.2 and that at the design point a normal shock forms at the entrance to the diffuser and the nozzle is choked. Calculate (neglecting variation of k and effect of fuel flow rate:

(a) Cross-sectional area A_2,

(b) Exit area of the nozzle A_7,

(c) Weight rate of air flow,

(d) Loss in total pressure (P_2-P_6) and

(e) Effective jet velocity V_j. [16]

5. (a) What is ballistic factor? How it affects the free flight dispersion?

(b) Show that the burnout velocity of a single stage rocket motor moving vertically is given by:

$$V_b = g.I_{sp}.\ln[m_o/(m_o - m_f)]$$

Where m_o is initial mass of missile, m_f is mass of fuel and I_{sp} is the specific impulse. State any assumptions, if made. [6+10]

6. Write notes on the following with respect to solid rocket motor:

(a) Thrust vector control

(b) Nozzles [8+8]

7. Explain the various exhaust properties of a liquid propellant rocket. [16]

8. Write notes on the following:

(a) Solar Sail

(b) Antimatter rockets [8+8]

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