Code No: R31215/R10 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2012
AEROSPACE PROPULSION-I
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 75**

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. 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 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 5 in its yaw plane.

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.

5. For the turbojet engine combustion chamber, 45 lbm of air enters with each 1 lbm of JP-4 (kerosene) fuel. Assume that these reactants enter an adiabatic combustor at 1200^0R. The heating value, h_{PR} of JP-4 is 18400Btu/lbm of fuel at 298K. Thus the heat released $\Delta\ H_{298K}$ by the fuel per 1 lbm of the products is 400 Btu/lbm at 298K. Determine the temperature of the products leaving the combustor.
Given: C_pp =0.267 Btu/(lbm. ^0R) and C_{pR} = 0.240 Btu/(lbm.^0R)

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?

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. Determine the pressure ratio for a stage of an axial flow compressor with symmetric blades under the following conditions:
   Absolute velocity at mean radius = 220m/s
   Axial velocity = 150m/s
   Solidity for moving blades = 0.98
   Coefficient of lift for moving blades = 0.8
   The ratio of drag to lift = 0.045
   Ambient conditions = 1bar and 300K
   Calculate the pressure ratio for non-symmetric blading and compare with pressure ratio of symmetric blading.

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Code No: R31215/R10 **Set No. 2**

III B.Tech I Semester Regular Examinations, November 2012
AEROSPACE PROPULSION-I
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. Air enters a compressor at a pressure of 0.14 Mpa and temperature of 258K. It leaves the compressor at a pressure of 0.65 Mpa. The maximum temperature in cycle is 900^{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. A turbo-prop driven airplane is flying at 670 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.

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 is derated in its flight prior to landing.

4. Explain the aerodynamics and thermodynamics of an external compression supersonic air inlet. Provide one example of such supersonic inlet.

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

6. (a) What do you understand by an 'ejector'? Explain the functioning of an ejector with the help of a sketch.
   (b) Write a note on 'variable area nozzles'.

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'.

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

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Code No: R31215/R10 **Set No. 3**

III B.Tech I Semester Regular Examinations, November 2012
AEROSPACE PROPULSION-I
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 75**

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 0.11 Mpa,15^o C .It leaves the compressor at 0.55 Mpa. TIT is 970^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. 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 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.

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 $\alpha = 2^o$?

5. A J-57B afterburning turbojet engine had 169.4 lbm/s of air at 36psia and 1013^{0}F enter the afterburner and products of combustion at 31.9psia and 2540^{0}F 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.

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.

7. (a) List the three main types of centrifugal compressor impellers. Discuss the characteristics of each with the aid of velocity diagrams and give their field of application.
   (b) Explain the factors affecting the selection of number of blades used in an impeller of a centrifugal compressor. How are number of passages on the diffuser related to the number of passages in the impeller?

8. Ax axial flow compressor stage blade diagram at mean radius has values of U=172m/s, V_1=745m/s, V_2=133m/s, V_{r1}=270m/s, V_{r2}=210m/s and V_3 leaving the next fixed row is equal to V_1. Find the probable maximum pressure change in the moving

and in the fixed row if the medium flowing has a density of 1.6kg/m^3, which can be considered essentially constant throughout the stage. What type of blading is this?

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Code No: R31215/R10 **Set No. 4**

III B.Tech I Semester Regular Examinations, November 2012
AEROSPACE PROPULSION-I
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 75**

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.

2. What are various components of a turbo-prop engine? What are the requirement of each component towards this engine. Explain the themodynamics and advantages of a turbo-prop over other power plants available for this purpose in aviation and military usage?

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.

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 β = -2^o ?

5. (a) Determine the combustor efficiency of a main burner with the following data:
   P_{t3} = 200 psia T_{t3} = 1000^0R m= 100 lbm/s
   ϕ = 0.6 A_{ref} = 1.5 ft^2 H = 2 in
   (b) Define the following terms and explain their importance with respect to combustion chamber:
      i. Equivalence ratio
      ii. Combustor loading parameter
      iii. Profile factor correlation parameter.

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.

7. A centrifugal compressor runs at 10000rpm and delivers 600m^3/min of free air at a pressure ratio of 4:1. The isentropic efficiency of the compressor is 82%. The outer radius of impeller (which has radial blades) is twice the inner one and slip

coefficient is 0.9. Assume that the ambient air conditions are 1kgf/cm^3 and 293K. The axial velocity of flow is 60m/s and is constant throughout. Determine:

(a) Theoretical horsepower. .

(b) Impeller diameter at inlet and outlet and width at inlet

(c) Impeller and diffuser blade angles at inlet.

8. Explain the following with respect to axial flow compressor:

(a) Cascade characteristics

(b) Reynolds and Mach number effects.

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