Code: 9A21505

R09

B.Tech III Year I Semester (R09) Supplementary Examinations December 2015

AEROSPACE PROPULSION - I

(Aeronautical Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

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1 (a) Enumerate relative advantages and disadvantages of turboprop engine over a turbojet engine. How may one have the best of both?

(b) Exemplify the importance of thrust for powering an aircraft. Classify and deduce a suitable expression for it, assuming any engine model/type of propulsive device 'taking into account important component losses'.

(c) Explain the following aircraft performance variables with necessary correlations:
(i) Performance equation.
(ii) Lift & drag.
(iii) Stall, takeoff and landing speed.
(iv) Fuel consumption.
(v) TSFC.
(vi) Range.
(vii) Endurance.
(viii) Maximum C_L/C_D
(ix) Condition of accelerated flight.

2 (a) Explain the various objectives/purposes of inlets in an aircraft engine. Derive a suitable relationship between minimum area ratio and external deceleration ratio.

(b) Consider ear type air intake for a Gnat/Ajit fighter subsonic airplane:
(i) Show internal layout for swallowed air to reach engine inlet and quantify its mass flow ingestion.
(ii) Explain its aerodynamics and thermodynamics in detail when the airplane takes a turn of about 10° in its yaw plane.

3 (a) What do you understand by shock swallowing in supersonic inlets? What is the need for it? How is it achieved?

(b) Explain need for total pressure recovery to substantiate variation in mach number to support smooth functioning of supersonic aircraft engines.

(c) Explain with suitable sketch the nomenclature & working of external compression and mixed compression types of supersonic inlets.

4 (a) List various types of conventional gas turbine combustors & explain anyone with a neat sketch.

(b) List basic requirements of fuel injection systems. Also discuss about the practical problems encountered with these systems in gas turbine combustors.

(c) Explain the working methodology of any typical fuel injection system adapted in gas turbine combustors with a neat sketch.

Contd. in page 2

5 (a) Explain the need for flame stabilization in gas turbine combustors. List the various methods used for it and explain swirl vane mechanism with a neat sketch.
(b) Explain necessity of cooling in gas turbine combustors. List various methods of cooling and explain flame tube cooling with a neat sketch.
(c) Determine combustor efficiency of a main burner with the following data:
$P_{t3} = 200\, psia;\ T_{t3} = 1000^0 R;\ m = 100\, lbm/s;\ \varphi = 0.6;\ A_{ref} = 1.5\, ft^2;\ H\ =\ 2\, inch$

6 (a) Describe the functional aspects of exhaust nozzles deployed in aircraft engines. Classify them based on their modes of operation and enumerate the significance of area-mach relationship using suitable correlation.
(b) Exemplify the necessity for thrust reversing and thrust vectoring in aircrafts. Show schematically the working of a typical two-dimensional thrust vectoring nozzle with thrust reversing using divergent flaps.
(c) Following is operational data for a nozzle:
Exit area = 0.01 m^2
Inlet pressure and temperature are 2.5 MPa and 1075 K respectively
Exit pressure is 113745 Pa.
The ratio of specific heats may be assumed as 1.35.
Assuming stagnation conditions at nozzle inlet.
Determine: (i) Temperature at nozzle exit.
(ii) Exit velocity as a fraction of maximum attainable velocity.

7 (a) Explain preliminary working concepts of drum, disc type centrifugal compressors with neat sketches.
(b) Compute the work done and pressure rise achieved in any of above types.
(c) Draw the corresponding velocity triangles for above types.
(d) Explain the design considerations adapted for diffuser vanes.

8 (a) Discuss and quantify the concepts of following related to axial flow compressors:
(i) Velocity triangles.
(ii) Degree of reaction.
(iii) Free vortex designs.
(b) A symmetrical blading axial flow compressor has airflow with axial velocity of 145 m/s. The blading is designed for 50% reaction at mean diameter. Pressure ratio is 1.5 and isentropic efficiency is 86%. Assuming that the flow is of vortex type, estimate the degree of reaction at the root and tip of the blade, if the ratio of inside diameter to outside diameter is 0.75. The inlet conditions to compressor correspond to standard state sea level.

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