Code: 9A21505 **R09**

B.Tech III Year I Semester (R09) Supplementary Examinations June 2017

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) Define and explain significance of following engine performance parameters with necessary correlations:
(i) Inlet loss coefficient (φ_{inlet}).
(ii) Nozzle loss coefficient (φ_{nozzle})
(iii) Uninstalled thrust (T).
(iv) Specific thrust (F/m)
(b) Define and explain significance of following engine parameters with necessary correlations:
(i) Gross thrust.
(ii) Net thrust.
(iii) Installed thrust.
(iv) Thrust-to-weight ratio.
(c) Discuss thrust augmentation requirement in aircraft propulsion. Mention various types of thrust augmentation techniques and discuss water-alcohol injection method.

2 (a) Enumerate performance measures of subsonic inlets.
(b) Define stall & discuss effects of stall encountered in a subsonic diffuser as well as on its performance.
(c) Flow enters into an ideal diffuser of inlet diameter 1 m with a Mach number of 0.8 and inlet pressure of 100 kPa. If the diffuser is required to operate with the optimum (or maximum or limiting pressure) coefficient of 0.6, assume isentropic flow & y = 1.40. (i) Calculate the diffuser area ratio. (ii) Calculate the resulting exit Mach number.

3 (a) Enumerate concept of boundary layer separation associated with internal flow in supersonic inlets with a suitable sketch.
(b) Explain objectives and different types of supersonic inlets fitted on a supersonic aircraft. Also derive a suitable relationship between minimum area ratio and external deceleration ratio.

4 (a) List and enumerate the factors affecting performance of gas-turbine combustors. Also explain how pressure loss and stability limits affect their performance.
(b) Explain combustion phenomena, typical flow patterns and various zones inside conventional gas-turbine combustors with neat sketches.

5 (a) Explain role of swirler in gas turbine combustors. Sketch the typical flame stability curve with reference to the fuel-air ratio and loading parameter in gas-turbine combustors and discuss their corresponding characteristic trends.
(b) List the important operating variables and performance variables of gas-turbine combustors and discuss them briefly.

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6 (a) Enumerate various functions of exhaust nozzles deployed in aircraft engines. Also explain significance of engine backpressure control for optimum operation of engine.

(b) Explain the following operational modes of a nozzle:
(i) Under expansion.
(ii) Over expansion.
(iii) Optimal expansion.

7 (a) Define, explain and quantify concepts of Pre-Whirl and Rotating stall experienced in centrifugal compressors with suitable sketches.

(b) A single sided centrifugal compressor is fitted to an aircraft that is flying at certain altitude. The impeller eye reaches air at a velocity of 230 m/s. The free stream pressure and temperature of the air are $0.23X10^5$ Pa and 217 K respectively. The impeller eye has a provision of air pre whirl of 25^o at all radii. The inner and outer diameters of impeller eye are 0.18 m and 0.33 m respectively. The diameter of the impeller periphery is 0.54 m and the impeller rotates at a speed of 16,200 rpm. The air mass flow rate is 3.6 kg/s. Estimate the stagnation pressure (P_o) at compressor outlet.

8 (a) Enumerate your conceptual understanding about the radial equilibrium condition experienced in axial flow compressor.

(b) Describe the concepts of pressure-, velocity- compounding in compressor stage design with suitable sketches.

(c) 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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