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Question Paper Code : 40522

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018

Fourth Semester

Aeronautical Engineering

AE 6404 – PROPULSION – I

(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

(Gas table permitted)

PART – A (10×2=20 Marks)

1. Define propulsion efficiency and what is the condition for maximum propulsion efficiency ?
2. What is the relation between thrust and propulsive efficiency ?
3. Name the pollutants that are generated from combustor.
4. What are the factors to be considered while designing a subsonic inlet ?
5. What are the factors affection stage for ratio of a centrifugal compressor ?
6. Distinguish between surging and stalling.
7. What are the advantages of the axial flow turbines over the radial flow turbines ?
8. What is the need for using shrouds in axial flow turbines ?
9. Mention the problems associated with sub critical mode of operation of ramjet.
10. Name the various components in Ramjet engine.

PART – B (5×13=65 Marks)

11. a) i) Draw a neat diagram of turbofan engine with axial flow compressor and explain its working principle. (7)

ii) What is an afterburner and why is it used ? Draw the T-S diagram of an ideal turbojet engine with an afterburner; explain the state points in the T-S diagram. Write down the expression for optimum compressor pressure ratio for maximizing specific thrust. (6)

(OR)

b) i) Explain the operation principle of turbo propeller engines with T-S diagrams and neat sketch. (7)

ii) List down the charts of high bypass ratio turbo fan engines. (6)

12. a) i) Plot mach number, static temperature, static pressure and static density variations along the longitudinal axis of a convergent-divergent nozzle, when it flows full. Explain the variations. (5)

ii) A De Lavel nozzle has to be designed for an exit mach number of 1.5 with exit diameter of 200 mm. Find the ratio of throat area/exit area necessary. The reservoir conditions are given as P_0 = 1.0 bar, T_0 = 20°C. Find also the maximum mass flow rate through the nozzle. What will be the exit pressure and temperature ? (8)

(OR)

b) i) Discuss the effect of shock waves in supersonic inlets. Schematically describe the working principle of internal compression and external compression type of supersonic inlets. (5)

ii) An aircraft is flying at an altitude where the ambient static pressure is p_0 = 10 kPa and flight Mach Number is M_0 = 0.85. The total pressure at the engine face is measured to be p_{t2} = 15.88 kPa. Assuming the inlet is adiabatic and γ = 1.4, calculate (a) the inlet total pressure recovery (b) the inlet adiabatic efficiency and (c) the non-dimensional entropy rise caused by the inlet $\Delta s_d/R$. (8)

13. a) i) What do you understand by degree of reaction in an axial flow compressor ? Prove that degree of reaction $\wedge$ in an axial flow compressor is given by $\wedge = (\tan\beta_1 - \tan\beta_2)C_a/2U$. (7)

ii) Draw a neat diagram of axial flow compressor and explain function of all parts and its working. (6)

(OR)

b) What do you mean by radial equilibrium condition ? Prove that for an axial flow compressor $C_w r$ = constant and state the assumptions made in deriving.

14. a) i) Discuss the limiting factors in turbine design. **(7)**

ii) What are the various stresses in a gas turbine blade that a designer must evaluate ? Describe the procedure for evaluating atleast 3 types of these stresses. **(6)**

(OR)

b) i) Discuss how pitch and chord for an axial turbine stage will be selected ? **(6)**

ii) What is need for matching of compressor and turbine ? Write down the matching procedure with suitable sketches. **(7)**

15. a) An ideal ramjet engine is being designed for a Mach 3.2 aircraft at an altitude of 33,000 ft. The fuel has a heating value of 43,264 kJ/kg, and the burner exit total temperature is 1889 K. A thrust of 42.258 kN is needed. What is the required airflow ? What is the resulting nozzle exit diameter ? What is the resulting TSFC ? **(13)**

(OR)

b) i) With a neat sketch explain the concept of integral ram-rocket and mention its advantages and disadvantages. **(7)**

ii) Describe the working of a ramjet engine. Depict the various thermodynamic processes occurring in it on h-s diagram. **(6)**

PART – C **(1×15=15 Marks)**

16. a) i) Discuss the main factors of importance in assessing combustion chamber performance. **(7)**

ii) Consider n-decane fuel, balance the chemical equation for the stoichiometric combustion of this fuel in air and find the stoichiometric fuel-to-air ratio. **(8)**

(OR)

b) A turbojet engine is traveling at 270 m/s at an altitude of 5000 m. The compressor pressure ratio is 8 : 1 and maximum cycle temperature is 1200 K. By assuming the following data : **(15)**

Ram efficiency	93%
Isentropic efficiency of compressor	87%
Pressure loss in combustion chamber	4% of compressor delivery pressure
Calorific value of fuel	43,100 kJ/kg
Combustion efficiency	98%
Mechanical transmission efficiency	99%
Isentropic efficiency of turbine	90%
Propelling nozzle efficiency	95%

Ambient conditions at 5000 m are 0.5405 bar and 255.7 K.

Calculate the : (i) Specific thrust and (ii) TSFC.

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