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C – 2390

Reg. No. : .....

Name : .....

Eighth Semester B.Tech. Degree Examination, May 2017
(2013 Scheme)
13.806.12 : PROPULSION ENGINEERING (MP)

Time : 3 Hours

Max. Marks : 100

***Instruction** : Use of authorized charts and tables may be **permitted**.*

PART – A

Answer **all** questions. **Each** question carries **2** marks.

1. What is referred to as Air Screw ?
2. Define Propulsive Efficiency of a Jet Engine.
3. What types of compressors are preferred for turbojet engines ? Why ?
4. Explain how thrust augmentation is achieved in a turbojet engine ?
5. Define the following terms as applied to a rocket engine :
   a) Specific Impulse
   b) Specific Propellant Consumption.
6. Sketch an electrical rocket system and mark the major components.
7. Give one example each for fuel and oxidizer combination for a solid propellant rocket.
8. Write any one oxidizer-fuel combination used in a hybrid rocket engine.
9. What are the different modes of combustion instability in rocket engines ?
10. What are the different methods of cooling rocket motors ?

(2×10=20 Marks)

P.T.O.

PART – B

Answer **one full** question from **each** Module. **Each full** question carries **20** marks.

Module – I

11. a) With a neat sketch explain the various components and working of a turbo prop engine. **10**

b) Details of a turbojet engine are as follows : Flight Mach No. 0.9, Flight altitude 12 km (T = 216.65 K, p = 0.193 bar, ρ = 0.311 kg/m^3) area of inlet diffuser at entry 0.5 m^2, air-fuel ratio 50, exhaust jet pressure 0.5 bar, temperature 1000 K and velocity 600 m/s, calorific value of the fuel 43 MJ/kg.

Calculate :

i) The airflow rate
ii) Thrust
iii) Thrust power
iv) Propulsive efficiency and
v) Overall efficiency. **10**

12. a) Explain the working of a SCRAM jet engine. How does the pressure and temperature vary along the length of the engine ? **10**

b) A turboprop aircraft is flying at 600 kmph at an altitude where p = 0.458 bar, T = 258 K. The operating conditions are : Maximum temperature 1200 K, pressure ratio 9, efficiencies of intake duct 90%, compressor 89%, turbine 93%, transmission 98%, exhaust jet velocity 600 kmph relative to aircraft, C_p(air) 1005 J/kg/K, C_p(gases) 1147 J/kg/K, $\gamma_{(air)}$ 1.4 $\gamma_{(gases)}$ 1.33. Calculate

i) specific power output and
ii) thermal efficiency. **10**

Module – II

13. a) With a neat sketch explain the working of the combustion chamber in a turbojet engine. **8**

b) A jet aircraft flies at an altitude of 4500 m(p = 0.55 bar, T = 255 K) at Mach 0.6. Diffuser has a pressure coefficient 0.9 and reduces flow to negligible velocity. Compressor pressure ratio is 5 and maximum temperature during the operation 1273 K. After expansion in turbine the gases expand in the nozzle to a pressure 0.69 bar. η_c = 0.81, η_T = 0.85, η_N = 0.915. The calorific value of fuel is 45870 kJ/kg. Assume for air Cp = 1.005 kJ/kg/K, γ = 1.4 and combustion gases C_p = 1.147 kJ/kg/K, γ = 1.33, find

i) Compressor power input
ii) Turbine power output
iii) Fuel-air ratio. **12**

14. a) Sketch the actual aircraft gas turbine engine cycle. Mark the ideal processes in each component in the diagram and explain the reasons for the deviation between the actual and ideal processes. **10**

b) List the comparative merits and demerits of axial and centrifugal compressors for air compression in jet engines. **10**

Module – III

15. a) Sketch the different propellant grain configurations used in solid propellant rockets. **8**

b) A rocket flies at 3000 m/s with an effective exhaust jet velocity 1500 m/s using 5 kg/s of propellant. If heat of reaction of propellants is 6500 kJ/kg of the mixture, determine :

i) propulsion power
ii) propulsion efficiency
iii) engine output
iv) thermal efficiency and
v) overall efficiency. **12**

16. a) A rocket has the following data : propellant flow rate 5 kg/s, nozzle exit diameter 10 cm, nozzle exit pressure 1.02 bar, thrust chamber pressure 20 bar, thrust 7 kN, assuming ambient conditions at mean sea level determine

i) effective jet velocity
ii) actual jet velocity
iii) specific impulse and
iv) specific propellant consumption. **10**

b) With a neat sketch explain the working of a turbo pump fed liquid rocket engine. **10**

Module – IV

17. a) Explain the precautions to be observed in the handling of rocket propellants. **10**

b) With a neat sketch explain a hybrid rocket system. **10**

18. a) Define combustion instability. What are the different methods for control of combustion instability ? **10**

b) From the fundamental principles obtain the expression for the altitude gained by a three stage rocket at the end of its powered and coasting flights. **10**