KUMARAGURU college of technology
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Register Number: ……..

B.E DEGREE EXAMINATIONS: MAY2015

(Regulation 2009)

Fifth Semester

AERONAUTICAL ENGINEERING

AER109:Aircraft Propulsion

GAS TABLES ARE ALLOWED

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. At low flight speeds(M =0.5) the following propulsion system is more efficient
   a) Turbojet b) Turbofan
   c) Turboprop d) Piston
2. Jet engines work on the following thermodynamic cycle
   a) Otto cycle b) Diesel cycle
   c) Brayton cycle d) Rankine cycle
3. In an over-expanded nozzle, the relation between the exit pressure(P_e) and ambient pressure P_a is
   a) $P_e > P_a$ b) $P_e = P_a$
   c) $P_e < P_a$ d) $P_e = 0$
4. The condition in which a shock just hangs on the inlet is called as
   a) Subcritical b) Supercritical
   c) Critical d) Choking
5. A cooling technique in which a porous blade wall is used for effective cooling of a gas turbine is called
   a) Transpiration cooling b) Film cooling
   c) Radiation cooling d) Convective cooling
6. The following shock system will give low stagnation pressure loss in a supersonic inlet
   a) Normal shock b) Single oblique shock
   c) Multiple oblique shock d) Bow shock
7. Free vortex condition is satisfied for the flow when the whirl(tangential) velocity
   a) Inversely with radius b) Directly with radius
   c) Remains constant d) Becomes zero

8. The ratio of thrust power to the kinetic energy is known as

a) Propulsive efficiency b) Thermal efficiency

c) Overall efficiency d) Propeller efficiency

9. Because of its high propulsion efficiency, the bigger versions of passenger aircraft (M = 0.8) employs the following engine

a) Turbojet b) Turbofan

c) Turboprop d) Turboshaft

10. The following aircraft operates at supersonic flight speeds but the combustion is subsonic

a) Fighter jet b) Airbus A320

c) Helicopter d) X-15

PART B (10 x 2 = 20 Marks)

11. What is the difference between an impulse stage and a reaction stage?
12. Why is turbine blade to be cooled?
13. Define degree of reaction of an axial flow compressor.
14. Why the number of stages of a compressor is greater than that in a turbine of a jet engine?
15. What is the basic operating principle of a ramjet?
16. Define SFC. Write down its significance.
17. Define nozzle efficiency.
18. What are the methods of thrust augmentation?
19. What is the need for supersonic combustion?
20. Name the various types of thrust reversal mechanisms in a gas turbine engine.

PART C (5 x 14 = 70 Marks)

21. a) (i) Describe with the aid of illustrative sketches, the working of a turbojet engine (8)

(ii) Show the various processes occurring in the turbojet engine on a T-s diagram. How does it change with after burning? (6)

(OR)

b) (i) Derive thrust equation for a general propulsion system. (8)

(ii) Describe the working of a turbofan engine with neat sketch. (6)

22. a) What are the major features of external flow near a subsonic inlet? Derive a relation between minimum area ratio and external deceleration.

(OR)

b) With the help of neat sketches, explain the starting problem of supersonic inlets.

23. a) Discuss the various factors affecting the combustion chamber performance. Briefly explain the flame tube cooling.

(OR)

b) Air at a temperature of 290 K enters a ten stage axial flow compressor at a rate of 3Kg/s. The pressure ratio is 6.5 and the isentropic efficiency is 90%, the compression process being adiabatic. The compressor has symmetrical blades. The axial velocity of 110 m/s is uniform across the stage. The mean blade speed of each stage is 180 m/s. Determine the direction of air at entry to and exit from the rotor and the stator blades and also the power given to the air.
Assume C_p =1005 J/Kg-K and γ=1.4.

24. a) (i) Discuss the limiting factors in gas turbine design. (7)

(ii) Explain the various operating conditions of a convergent-divergent nozzle (7)

(OR)

b) In a single stage impulse turbine, the nozzle discharges the fluid on to blades at an angle of 65^o to the axial direction and the fluid leaves the blades with an absolute velocity of 300 m/s at an angle of 30^o to the axial direction. If the blades have equal inlet and outlet angles and there is no axial thrust, estimate the blade angle, power produced per kg/s of the fluid and the blade efficiency

25. a) (i) With the help of neat sketches, elaborate the essential features of a ramjet engine and depict the various thermodynamic processes on a T-s diagram. (10)

(ii) Compare the subsonic and supersonic ramjets. (4)

(OR)

b) A ramjet is to propel an aircraft at Mach 3 at a high altitude where the ambient pressure is 8.5 kPa and ambient temperature T_a is 220 K. The maximum temperature in the engine is 2540 K. If all the components of the engine are frictionless(ideal), determine (i) the thermal efficiency (ii) the propulsion efficiency and (iii) the overall efficiency.

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