Register Number: ……

B.E. DEGREE EXAMINATIONS: NOV/DEC 2010

Seventh Semester

AERONAUTICAL ENGINEERING

U07ARE08: Rocket & Missiles

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

Answer ALL Questions:-

PART A (10 x 1 = 10 Marks)

1. Specific impulse may be expressed as ratio of
   a) Thrust & mass of the propellant.
   b) Thrust & Mass flow of the propellant.
   c) Effective jet velocity & characteristic velocity.
   d) Characteristic velocity & specific propellant consumption.
2. The total impulse of a rocket can be given by the product of nominal thrust & burn duration, provided.
   a) The propellant has a neutral burning characteristics.
   b) The propellant shows a progressive burning characteristics.
   c) The ignition characteristics are quite instant.
   d) The silver, responsible for tail off is negligibly small.
3. The burning rate augmentation due to erosive burning phenomenon is mainly attributed to
   a) Combustion chamber pressure. b) Initial temperature.
   c) Cross flow velocity. d) Included angle of star perforation.
4. A hypergolic liquid bipropellant system is one, which
   a) Uses compatible fuel/oxidizer system.
   b) Has very low ignition delay.
   c) Does not require any igniter.
   d) Can be operated over a wide range of ambient pressures.
5. The correction factor employed to take care of non-axial component of the gas velocity in a conical nozzle (with a finite nozzle angle 2α) may be given by
   a) $1 + \cos 2\alpha$ b) $1 + \cos \alpha$ c) $\frac{1}{2}(1 + \cos 2\alpha)$ d) $\frac{1}{2}(1 + \cos \alpha)$
6. The burning velocity is a function of
   a) Thrust b) Weight c) Thrust to weight ratio d) Thrust & weight

7. Magnus forces developed in the missiles because of

a) Back flow b) Cross flow c) Circulation d) Circulation & cross flow

8. The mass ratio Λ for a single stage rocket is

a) $2 < \Lambda < 10$ b) $0 < \Lambda < 1$ c) $-1 < \Lambda < 0$ d) $-10 < \Lambda < -2$

9. The choice of the material for the rocket and missile is influenced by

a) Its weight b) mechanical & thermal properties c) duty cycle d) All of the above

10. Use of titanium is preferred when higher strength to weight ratio is required at

a) Room temperature. b) Very low temperature

c) High temperature. d) All temperatures.

PART B (10 x 2 = 20 Marks)

11. What are the advantages of Ogival-fore body in missiles?
12. What is Geysering effect? How to minimize it?
13. Describe the adverse effects of body up-wash and downwash in missiles.
14. Classify missiles.
15. What do you mean by culmination altitude & burn-out velocity?
16. Describe 'gravity turn' trajectory.
17. What is SITVC?
18. What is multistaging of rockets? How is it different from the normal one?
19. What is the specific material that is preferred mostly in the manufacturing of nose tips in missiles & rockets?
20. List down a few criteria that govern the selection of materials for Air – to – Air missiles.

PART C (5 x 14 = 70 Marks)

21. a) (i) What are the important design considerations in the selection of Liquid rocket combustion chamber volume & shape? List & explain them briefly?

(ii) Sketch & explain a typical one-dimensional model of combustion mechanism of a composite propellant. Sketch the temperature profile in both gas phase & condensed phase of the propellant.

(OR)

b) (i) Explain briefly the working principle of a liquid rocket engine with pressure feed system.

(ii) Describe in detail about the types of igniters.

22. a) (i) What are the various aerodynamically shapes available for the for bodies of rockets & air breathing missiles? Sketch any two shapes & show the typical pressure coefficient variation over the aerodynamic surfaces.

(ii) What are the forces acting on a missile while passing through the atmosphere? How to estimate the drag of a flying object? What is wave drag?

(OR)

b) (i) With the neat sketch explain the lateral aerodynamic moment of a rocket & briefly explain the variation of lateral aerodynamic moment coefficient variation with angle of attack. How do these variations affect the stability of the rocket flight?

(ii) List any four basic aerodynamic design considerations for the development of air to air missiles. What factors limit the range of such missiles?

23. a) (i) With a neat sketch explain the basic operating principle of a rocket motor. Derive the basic rocket thrust equation.

(ii) For an ideal rocket with a characteristic velocity of 1300 m/s a mass flow rate of 75 kg/s, a thrust coefficient of 1.6 and a nozzle thrust area of 0.025 m^2, Calculate the thrust, specific impulse and the effective exhaust velocity.

(OR)

b) (i) Derive an expression for finding the altitude of a powered vertical flight in terms of effective jet velocity burning time and propellant mass ratio.

(ii) A missile has a maximum flight speed to jet speed ratio of 0.02105 and specific impulse equal to 250 seconds. Determine for a burn out time of 12 seconds

(a) Effective jet velocity

(b) Mass ratio and propellant mass fractions.

(c) Maximum flight speed and

(d) Altitude gain during powered and coasting flights.

24. a) (i) Sketch a simplified trajectory for an air-launched rocket projectile and write down an expression for total time to reach the target. State clearly the assumptions made.

(ii) What are the different types of rocket-dispersion? What factors cause rocket dispersion?

(OR)

b) (i) With the help of neat sketch, illustrate the various forces & moments experienced by a missile while passing through the atmosphere.

(ii) What are the various types of drag that supersonic missile experiences during its flight in atmosphere? Describe them. What is the role of boat tailing in missile drag reduction?

25. a) (i) Suggest the materials for the following missile components: Fore bodies, motor-case, wing leading edges, nozzle throat. Explain the reason for the suitability of the materials.

(ii) List any four types of thrust-vector control mechanisms and describe its merits and demerits.

(OR)

b) (i) Describe the considerations for selection of materials to be used for the construction of thrust chambers of liquid rocket engines?

(ii) Explain in detail about the materials used in the re-entry capsules.

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