B.E. DEGREE EXAMINATIONS: APRIL / MAY 2010

Sixth Semester

AERONAUTICAL ENGINEERING

U07AR602: Propulsion II

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

Answer ALL the Questions:-

PART A (10 x 1 = 10 Marks)

1. An impulse stage turbine is characterized by

   A. Only in Rotor   C. Only in Stator Nozzle

   B. Both in stator nozzle and rotor   D. Only in Exhaust Nozzle

2. The condition for fifty percent reaction stage is

   A. $\beta_3 > \alpha_2$ B. $\beta_3 < \alpha_2$ C. $\beta_3 < \alpha_2$ D. $\beta_3 = \alpha_2$

3. The best performance of a ramjet is about

   A. 0 to 1   B. 2 to 5   C. 0.8 to 1.2   D. 5 to 9

4. Which of the following is the first experimental Scramjet engine?

   A. NASA X – 43 A   C. Boeing X – 51

   B. Rockwell X – 30   D. Hyper – X

5. Specific propellant consumption is given by

   A. $\dfrac{1}{I_s}$ B. $\dfrac{1}{\sqrt{I_s}}$ C. I_s^2 D. $\dfrac{F}{P_0 A}$

6. What is the condition for over expansion in nozzle?

   A. $P_e > P_b$ B. $P_t > P_b$ C. $P_e < P_b$ D. $P_t < P_b$

7. The molecular weight of the liquid oxygen and liquid hydrazine combination is

   A. 18   B. 20   C. 19   D. 21

8. The chemical formula for Nitrocellulose is

   A. CH_3NHNH_2 B. NH_2OHNO_3 C. $(CH_3)_2\,NNH_2$ D. $C_6H_8\,(NO_2)_2\,O_5$

9. _____ is used as a common propellant in nuclear rocket engine.

   A. Aniline   B. Hydrogen   C. Fluorine   D. Ethyl diamine

10. Which of the following is electrostatic type electrical rocket engine?

    A. Nuclear   B. Ion propulsion   C. MHD   D. Solar

PART B (10 x 2 = 20 Marks)

11. Differentiate between impulse stage and reaction stage turbines.

12. Define match point.

13. What do you mean by supercritical mode of operation in ramjet?

14. What is the need for supersonic combustion?

15. Compare air breathing engine and rocket engine.

16. Define specific impulse.

17. What do you mean by hypergolic propellant? Give any one example?

18. Define temperature sensitivity coefficient of a solid propellant.

19. What is solar sail?

20. What is nozzle less propulsion system?

PART C (5 x 14 = 70 Marks)

21. (a) (i) Describe the working of an axial flow turbine stage with a neat sketch. Draw the
       T-S diagram and velocity triangles.   (7)

    (ii) Discuss the limiting factor in turbine design.   (7)

(OR)

(b) The following particulars of a single stage turbine of free vortex

   type is given below:

Total head inlet pressure	:	4.6 bar
Total head inlet temperature	:	700 ^{0}C
Static head pressure at mean radius	:	1.6 bar
Mean blade diameter/blade height	:	10
Nozzle loss co-efficient	:	0.10
Nozzle outlet angle	:	60^0

Determine the gas temperature, velocities and discharge angle at the

blade root and tip radii. Take $C_p = 1.147$ and $\gamma = 1.33$ and mass flow

rate = 20 kg/s.

Draw the combined velocity diagram. Assume suitable data if required.

22. (a) A ramjet is to propel an aircraft at Mach 3 at high altitude where ambient pressure is 8.5 KPa and the ambient temperature is 220 K. If all components of the engine are frictionless, determine

          (i)   The thermal efficiency   (ii) The propulsion efficiency

          (iii) The overall efficiency

Let the specific heat ratio be γ = 1.3 and make the approximation appropriate to $f << 1$.

(OR)

(b) (i) Describe the working of a ramjet engine. Depict the various thermodynamic processes occurring in it on h-s diagram. (7)

   (ii) Discuss the performances of supersonic combustion Ramjet. Compare subsonic and supersonic combustion Ramjet. (7)

23. (a) (i) With a neat sketch derive fundamental thrust equation of a rocket. Explain the basic operating principle of a rocket. (8)

   (ii) What are the various classifications of Rocket propulsion system and give its application. (6)

(OR)

(b) Design a nozzle for an ideal rocket that has to operate at 25 Km altitude and give 5000N thrust at a chamber pressure of 2.068 Mpa and a chamber temperature of 2800 K. Assuming that k = 1.30 and R = 355.4 J/Kg-K, determine Throat area, Exit area, Throat velocity and Exit temperature.

24. (a) (i) Explain the working of liquid propellant rocket engine with a gas pressure feed system. Write down its merits and demerits. (7)

   (ii) How do you classify solid propellant rocket. Name any four solid propellant ingredients with its function and give any two examples for each. (7)

(OR)

(b) A rocket projectile has the following characteristics:-

          Initial mass = 200 Kg

          Mass after rocket operation = 130 Kg

          Payload, non-propulsive structure, etc., = 110 Kg

Rocket operating duration = 3 sec

Average specific impulse of propellant = 240 sec

Determine the vehicles mass ratio, propellant mass fraction, propellant flow rate, thrust to weight ratio, acceleration of vehicle, effective exhaust velocity, total impulse and impulse to weight ratio.

25. (a) (i) Explain various methods of thrust vector control with sketches   (7)

    (ii) Draw neat sketch and explain about electric rocket propulsion.   (7)

(OR)

  (b) (i) Draw neat sketch and explain the general working principle of nuclear rocket engine.   (7)

    (ii) With the neat sketch, explain the working principle of solar rocket.   (7)

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