Rockets and Missiles VTU CBCS Question Paper Set 2018

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10AE666

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Rockets and Missiles

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. What are the different classifications of Rocket propulsion? **(08 Marks)**

b. The following data are given for a certain rocket. Unit thrust = 8896 N, Propellant consumption = 3.876 kg/s, Velocity of vehicle = 400 m/s, Energy content of propellant = 6.911 MJ/kg. Assume 100% combustion efficiency and determine (i) effective exhaust velocity (ii) Kinetic jet energy rate per unit flow of propellant (iii) Internal efficiency (iv) Propulsive efficiency (v) Overall efficiency (vi) Specific impulse (vii) Specific propellant combustion. **(12 Marks)**

2 a. For a vehicle in gravitational-less space determine the mass ratio required to boost the vehicle velocity by (i) 1600 m/s (ii) 3400 m/s. The effective exhaust velocity is 2000 m/s. If the initial total vehicle mass is 4000 kg. What are the corresponding propellant mass? **(10 Marks)**

b. For an ideal rocket with a characteristic velocity of 1200 m/s, a mass flow rate of 73 kg/s, the thrust coefficient of 1.50, and the nozzle throat area of 0.0248 m^2, compute effective exhaust velocity, thrust, chamber pressure and specific impulse. **(10 Marks)**

3 a. Describe the desirable physical properties of liquid propellants. **(08 Marks)**

b. Explain in detail about the grain and configuration of solid propellants with neat sketches. **(12 Marks)**

4 a. Discuss about merits and demerits of solid propellant rocket propulsion system. **(10 Marks)**

b. Explain the advantages and disadvantages of liquid propellant rocket engines. **(10 Marks)**

PART – B

5 a. Derive an expression for lift and moment of a slender body revolution with usual notation. **(12 Marks)**

b. With the help of a neat sketch, discuss about the wing body interference. **(08 Marks)**

6 a. List and explain the different types of missile aerodynamic controls. **(10 Marks)**

b. Derive an equation of motion for missile with pitch control with usual notations. **(10 Marks)**

7 a. What are the importance of thrust vector control? **(05 Marks)**

b. Explain the four categories of thrust vector control mechanisms and its types. **(10 Marks)**

c. How do you control the rocket and missiles by thrust vector control with multiple thrust chamber or nozzle? Explain. **(05 Marks)**

8 a. Explain in detail about the test facility of chemical rocket propulsion system with neat sketch. **(12 Marks)**

b. What are the physical quantities to be measured during rocket propulsion testing? **(08 Marks)**

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10AE666

Sixth Semester B.E. Degree Examination, June/July 2015
Rockets and Missiles

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART - A

1 a. Define Rocket propulsion systems and classify them. **(04 Marks)**

b. With a neat sketch, explain the electric rocket propulsion system. **(07 Marks)**

c. A rocket projectile has the following characteristics :
Initial mass – 200kg ; Mass after rocket operation – 130kg ; Payload, non propulsive structure – 110 kg ; Rocket operating duration – 3.0 sec ; Average specific impulse of propellant – 240 sec. Determine the vehicles mass ratio, Propellant mass fraction, Propellant flow rate, Thrust, Thrust – to – weight ratio , Acceleration of vehicle , Effective , Exhaust velocity, Total impulse and the Impulse to weight ratio. **(09 Marks)**

2 a. Define the terms : i) Thrust co-efficient ii) Characteristic velocity. **(05 Marks)**

b. What are principal losses in real Nozzles? **(05 Marks)**

c. Explain with a neat sketch, what is the necessity to align nozzle axis of all propulsion system with fixed (non – gimbal) nozzle very accurately. List the types of nozzle misalignments. **(10 Marks)**

3 a. List and explain desirable physical properties of rocket propellants. **(08 Marks)**

b. List out the liquid oxidizers and liquid monopropellants used in rocket engine. **(05 Marks)**

c. Explain briefly hybrid rocket propulsion with its applications and grain - configuration. **(07 Marks)**

4 a. Explain briefly the sequence in idealized process for selecting propulsion system? **(10 Marks)**

b. List out the typical criteria used in selection of particular rocket propulsion system. **(06 Marks)**

c. List out the advantages and disadvantages of solid propellants. **(04 Marks)**

PART - B

5 a. Briefly describe the lift distributions for slender bodies of revolution. **(10 Marks)**

b. Describe the generalized nature of Aerodynamic forces and stability derivatives. **(10 Marks)**

6 a. Discuss the pitching effectiveness of the cruciform configuration with all movable controls. **(10 Marks)**

b. Name the various types of missile controls and also discuss about change in missile attitude due to impulsive pitch control. **(10 Marks)**

7 a. Mention the merits and demerits of various Thrust vector control mechanisms. **(08 Marks)**

b. Write a short note on :
i) TVC with multiple thrust chamber or Nozzle ii) Testing of TVC iii) Integration of TVC with vehicle. **(12 Marks)**

8 a. Outline the different types of Rocket testing in the sequence in which they are normally performed. **(05 Marks)**

b. Explain briefly : i) Instrumentation and data management ii) Flight testing iii) Post accident procedure. **(15 Marks)**

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10AE666

Sixth Semester B.E. Degree Examination, June/July 2016
Rockets and Missiles

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define rocket propulsion systems and classify them. **(04 Marks)**

b. The following measurements were made in a sea level test of a solid propellant rocket motors, Burn duration = 40 sec; Initial mass before test = 1210 kg; Mass of rocket motors after test = 215kg; Average thrust = 62250 N; Chamber pressure = 7 MPa; Nozzle exit pressure = 0.070 MPa; Nozzle throat diameter = 0.0855 M; Nozzle exit diameter = 0.2703m. Determine m, V_2, C^*, C and I_s at sea level and C and I_s at 1000 m and 25000 m in altitude. Assume an invariant thrust and mass flow rate and negligible short start. For altitudes of 1000 m and 25000 m the ambient pressure is 0.0898 and 0.00255 MPa. **(12 Marks)**

c. Define: i) Specific impulse; ii) Effective exhaust velocity. **(04 Marks)**

2 a. Define the terms: i) Thrust co-efficient; ii) Characteristics velocity. **(04 Marks)**

b. What are the principal losses in real nozzles? **(04 Marks)**

c. A satellite is launched from a circular equatorial parking orbit at an altitude of 160 km into a coplanar circular synchronous orbit by using a Herman transfer ellipse. Assume a homogeneous spherical earth with a radius of 6374 km. Determine the velocity increments for entering the transfer ellipse and for achieving the synchronous orbit at 42200 km altitude. Refer following figure for the terminology of the orbits. **(12 Marks)**

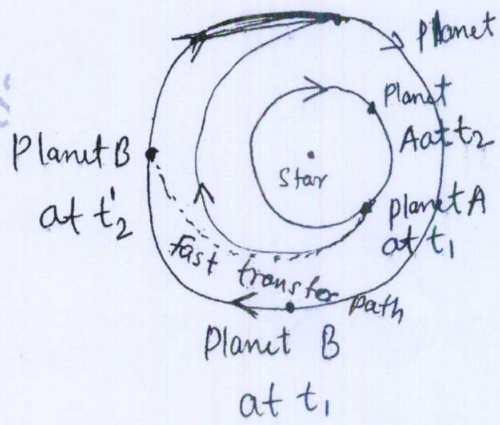

Fig.Q.2(c)

3 a. Explain with the help of a neat diagram solid propellant rocket motor. Explain progressive, regressive and burning with sketches. **(08 Marks)**

b. List out the liquid oxidizers and liquid monopropellants used in rocket engine. **(05 Marks)**

c. Explain briefly hybrid rocket propulsion with its applications and grain-configuration. **(07 Marks)**

4 a. Explain briefly the sequence in idealized process for selecting propulsion system. (10 Marks)
b. List out the typical criteria used in selection of particular rocket propulsion system. (06 Marks)
c. List out the two advantages and disadvantages of solid and liquid propellant. (04 Marks)

PART – B

5 a. Briefly describe the lift distribution for slender bodies of revolution. (10 Marks)
b. Describe the generalized nature of aerodynamic forces and stability derivatives. (10 Marks)

6 a. Discuss the pitching effectiveness of the cruciform configuration with all movable controls. (10 Marks)
b. Name the various types of missiles controls and also explain. (10 Marks)

7 a. Mention the merits and demerits of various Thrust Vector Control Mechanisms. (08 Marks)
b. Write a short note on:
i) TVC with multiple thrust chamber or nozzle.
ii) Testing of thrust vector control.
iii) Integration of thrust vector control with vehicle. (12 Marks)

8 a. Explain the different types of test performed before qualifying a rocket propulsion systems. (05 Marks)
b. Explain with the help of sketch, vertical static test stand for a large liquid propellant thruster. (09 Marks)
c. List important physical quantities measured in rocket testing. (06 Marks)

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Sixth Semester B.E. Degree Examination, June/July 2017
Rockets and Missiles

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Show in a tree diagram about different classes of Chemical rocket propulsion. **(08 Marks)**

b. A spacecraft engine ejects mass at the rate of 30kg/s with an exhaust velocity of 3000m/s. The pressure at the nozzle exit is 0.8 KPa, and the exit area is 1.0 sqm. Calculate the thrust of the engine in vacuum. **(08 Marks)**

c. Define i) Specific Impulse ii) Effective Exhaust velocity. **(04 Marks)**

2 a. Determine the mass of the propellant required to send 4000 kg space craft from LEO to Mars in 0.7 years, mission requiring a velocity of 5.7km/s. Assume 4000 kg includes the propellant on board at the start of the burn. Also assume specific impulse of 300s. **(08 Marks)**

b. Sketch the pressure distribution in a convergent – divergent nozzle for different flow conditions, when the inlet pressure is the same, but the exit pressure changes. **(06 Marks)**

c. Write the equations of motion for a rocket flight in atmosphere. Draw a neat sketch and show the forces acting on the vehicle. **(06 Marks)**

3 a. Explain with the help of a neat diagram, Solid propellant rocket motor. Explain Progressive, Regressive and Neutral burning with sketches. **(08 Marks)**

b. Explain with the help of a diagram, pressure fed bi – propellant rocket engine. **(08 Marks)**

c. Name two commonly used : i) Mono – propellant ii) Bi – propellant liquid propellants. **(04 Marks)**

4 a. Draw and show in a simplified diagram the idealized process for selecting propulsion systems. **(12 Marks)**

b. List two advantages and disadvantages of : i) Liquid propellant rockets ii) solid propellant rockets. **(08 Marks)**

PART – B

5 a. Discuss Slender body theory at supersonic speeds, Stating the assumptions clearly. **(10 Marks)**

b. Sketch the flow field and pressure distribution over a single stage rocket at supersonic speed. **(10 Marks)**

6 a. Describe various types of aerodynamic control in a missile. **(10 Marks)**

b. Write the differential equations describing the missile dynamics in pitch plane. **(10 Marks)**

7 a. With the help of neat sketches, explain Thrust Vector Control by :
i) Gimbal or hinge ii) Flex Nozzle iii) Jet Vanes and iv) Secondary injection.
Explain merits and demerits of each system. **(16 Marks)**

b. Explain how TVC system is integrated with guidance and control system of a rocket. **(04 Marks)**

8 a. Explain five important types of tests performed before qualifying a rocket propulsion system for operations. **(05 Marks)**

b. Explain with the help of a sketch, vertical static test stand for a large liquid propellant thruster. **(09 Marks)**

c. List three importance physical quantities measured in rocket testing. **(06 Marks)**

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