Register Number:…………….

M.TECH DEGREE EXAMINATIONS: APRIL/MAY 2024

(Regulation 2018)

Second Semester

DEFENCE TECHNOLOGY

P18DTT2008**:** Guidance and Control

COURSE OUTCOMES

CO1: Describe the basic principles of operation of a terrestrial radio navigation system.

CO2: Explain the methods and subsystems of missile guidance.

CO3: Derive the guidance law for missile guidance methods.

CO4: Explain the structure of missile control system.

CO5: Derive the mathematical model for missile dynamics.

CO6: Analyze the missile autopilot systems.

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Which one of the following is a key component in an inertial guidance system? CO2 [K_1]

   a) RF seeker b) Accelerometer

   c) Optical mirror d) Air data sensor

2. In PN guidance, the PN constant for which a missile is turning at the same rate as LOS is ____________. CO3 [K_2]

   a) 0.5 b) 1

   c) 2 d) 4

3. A suitable feedback sensor for roll stabilization in aerodynamic missiles is CO6 [K_2]

   a) Integrating gyro b) Rate gyro

   c) Directional gyro d) Pitch gyro

4. Assertion (A): Closed-loop control system is accurate than an open-loop system with disturbances.

   Reason (R): A system's response is analyzed only from its closed-loop behavior. CO4 [K_2]

   a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A

   c) A is true but R is false d) A is false but R is true

5. Which one of the following sensors measures the angular rates of rotation of a vehicle about its roll, pitch, and yaw axes? CO4 [K_1]

a) Rate gyros b) Rate integrating gyros

c) Linear accelerometers d) Rotary encoders

6. Which one of the following is a hyperbolic navigation system? CO1 [K_1]

a) VOR b) Inertial navigation

c) GPS d) LORAN

7. Which one of the following is not a valid assumption in the derivation of ballistic missiles equations of motion? CO5 [K_2]

a) Axis origin located at missile's cg b) Rotating earth

c) Rigid body d) Constant mass

8. A command guidance computer generates an acceleration command proportional to CO2 [K_1]

a) LOS range b) LOS angle

c) LOS rate d) Cross range error

9. Match the given closed-loop poles in List I with its corresponding second-order system given in List II. CO4 [K_2]

List I	**List II**
(A) –2, –1	(i) Undamped
(B) ±2*j*	(ii) Underdamped
(C) –2 ± 2*j*	(iii) Critically damped
(D) –2, –2	(iv) Overdamped

a) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii) b) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)

c) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii) d) (A)-(iv), (B)-(iii), (C)-(ii), (D)-(i)

10. In a feedback control system, which one of the following represents a 'desired output'? CO4 [K_2]

a) Reference input b) Controller input

c) Controller output d) Actual system response

PART B (10 x 2 = 20 Marks)

11. Define the terms "guidance" and "control". CO2 [K_2]

12. Show the block diagram of the missile guidance and control model. CO2 [K_2]

13. What is the **guidance law** for a missile and what is its primary function? CO3 [K_2]

14. What is the principle of LOS guidance? CO2 [K_2]

15. What is the concept of **position fixing** in VOR radio navigation system? CO1 [K_2]

16. A Loran chain consists of a master station and a slave station separated by 1200 km.

The slave station has a constant coding delay of 1000 microseconds. There is a receiver (missile) located along the baseline connecting the master and slave stations, and the receiver was positioned 800 km from the master station and 400 km from the slave station. Find the time difference between the arrival of master and slave pulse signals at the receiver. (Assume the speed of light is 3×10^8 m/s.) CO1 [K_3]

17. Define 'LOS rate', 'closing velocity' and 'miss distance' in missile guidance. CO2 [K_2]
18. What is the objective of a missile control system? CO6 [K_2]
19. Draw the block diagram of a missile autopilot system. CO4 [K_2]
20. What is the function of a servo in a missile control system? CO4 [K_2]

PART C (6 x 5 = 30 Marks)

21. Mention the complete specifications of all the signals transmitted by a VOR ground station and explain the basic principles and operation of the VOR navigation system. (5) CO1 [K_2]

22. With the help of missile-target intercept geometry, derive the guidance law equations for CLOS guidance in order for a missile to stay on the beam of a ground-based tracking radar. (5) CO3 [K_3]

23. Derive the expressions for the missile lateral acceleration terms in pure proportional navigation guidance in terms of the relative velocity between a missile and target. (5) CO3 [K_3]

24. Explain the missile guidance and control processes. Also, show the guidance and control loops. (5) CO1 [K_2]

25. With a neat block diagram, explain the operation of a roll stabilization control system for a missile. (5) CO4 [K_2]

26. Mention any FIVE functions of a missile seeker. (5) CO2 [K_2]

Answer any FOUR Questions

PART D (4 x 10 = 40 Marks)

27.	Explain the principles of the following guidance methods for missiles: (i) Beam rider guidance (ii) Command guidance (iii) Active and passive homing guidance (iv) Inertial guidance (v) Pure pursuit guidance	10	CO2	[K_2]
28.	Derive the 6-DOF equations of motion for a missile.	10	CO5	[K_3]
29.	With a neat block diagram explain the acceleration control system and roll angle control system for a bank-to-turn missile.	10	CO4	[K_2]
30.	With a neat block diagram explain the Vanguard control system for a rigid missile.	10	CO4	[K_2]
31.	With a neat block diagram explain the controlled guidance model for a roll-stabilized missile.	10	CO2	[K_2]

****