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Question Paper Code: U4401

B.E. / B.Tech. DEGREE EXAMINATION, APRIL / MAY 2025

Professional Elective

Electronics and Communication Engineering

21ECV401- GLOBAL POSITIONING AND NAVIGATION SYSTEM

(Regulations 2021)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (5 x 1 = 5 Marks)

1. A minimum of ——— satellites is required for determining a precise 3D location using GPS CO1-U

   (a) 2 (b) 3 (c) 4 (d) 5

2. ___________ does the Time of Clock (Toc) parameter in Sub frame 1 represent CO1-U

   (a) The satellite's orbital start time

   (b) The reference time for satellite clock corrections

   (c) The time required for satellite signal propagation

   (d) The time to reach UTC

3. Navigation payloads require signals to be broadcast in _____spectrum band CO1-U

   (a) X-band (b) L-band (c) Ka-band (d) V-band

4. GPS receivers rely on _______ for calculating position and velocity information. CO1-U

   (a) Pseudo-random codes (b) High-frequency oscillators

   (c) Multipath signals (d) Frequency multiplexing

5. The primary function of the RF section in a generic GPS receiver is to ______ CO1-U

   (a) Amplify received signals and convert them to baseband

   (b) Decode navigation data from the satellite signal

   (c) Perform trilateration using pseudo-ranges

   (d) Synchronize the receiver clock with the satellite clock

PART – B (5 x 3= 15 Marks)

6. Outline the testing procedures for GPS satellites, focusing on vibration and thermal testing. Why are these tests critical? CO1-U

7. Calculate the Tgd (Group Delay Differential) value for the bits 1000000 and explain its significance in improving positioning accuracy. CO2-App

8. Outline the main components of a GPS navigation payload. CO1-U

9. Classify the types of signals processed by vector delay lock loops in GPS receivers. CO1-U

10. If a navigation receiver synchronizes with a bit stream at 50 bps, calculate the duration of one bit. CO2-App

PART – C (5 x 16= 80 Marks)

11. (a) Explain the basic principles of GPS operation and how it determines the user's position. CO1-U (16)

Or

(b) Illustrate the transformative impact of GPS technology on modern-day activities by highlighting its diverse applications. and significance. CO1-U (16)

12. (a) Apply the concept of satellite orbits to evaluate how the Medium Earth Orbit (MEO) used by GPS satellites enhances the system's accuracy and reliability in real-world applications, particularly in urban environments or areas with challenging terrain. CO2-App (16)

Or

(b) Given the clock correction dataΔt_0=-2.34ns,Δt_1=4.56ns/s, Δt_2=-0.002ns/$s^2$and the ephemeris data (T_{oe}=43,000 s, with the satellite position at T_{oe} being (12,500km,7,300km,20,200km)and an orbital velocity of 3.9 km/s), calculate the clock error (Δt) and determine the satellite's position at the current time t=43,500 s. CO2-App (16)

13. (a) Explain the key requirements for navigation payloads in spacecraft, focusing on the essential components and functionalities needed for accurate positioning and timing in global navigation systems. CO1-U (16)

Or

(b) Describe the configuration of the Block IIR space vehicle and how its design addresses the specific needs of navigation payloads to provide reliable and precise signals for global navigation systems. CO1-U (16)

14. (a) Analyze how the GPS signal processing chain adapts to weak signals in indoor or obstructed environments, using techniques like advanced filtering, signal tracking, and error correction to ensure reliable position estimates. CO4-Ana (16)

Or

(b) Examine how quasi-optimal processing in GPS signal tracking improves the signal-to-noise ratio (SNR) and enhances positioning accuracy, and include its impact on signal integrity and computational efficiency. CO4-Ana (16)

15. (a) Apply the computational model to calculate the noise figure and noise temperature of a GPS receiver. Given the system gain of 40 dB, a noise power density of -174 dBm/Hz, and an input noise of 1.5 dB, determines the noise figure and noise temperature. Provide the necessary steps and explain how these parameters influence the receiver's performance. CO3-App (16)

Or

(b) Calculate the received signal noise in terms of both time domain and frequency domain. Consider a GPS signal with a received power of 10 μW and a noise power density of -174 dBm/Hz over a bandwidth of 2 MHz. Compute the noise in both the time domain and the frequency domain. Provide the necessary steps and calculations. CO3-App (16)