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Only the faculty's own calculators are allowed in the exam.

Answer **only five (5)** questions out of the following six questions. (The grade of this exam is based on the five answers that yield the lowest number of points).

1. a) What capabilities does a multi-system & multi-frequency GNSS receiver have?   (2p)

    b) What is meant by "satellite constellation"?   (1p)

    c) What is meant by "satellite geometry"?   (1p)

    d) What is the difference between ephemeris data and almanac data in GNSS?   (1p)

    e) What is meant by the concept of "integer ambiguity"?   (1p)

2. a)   (2p)
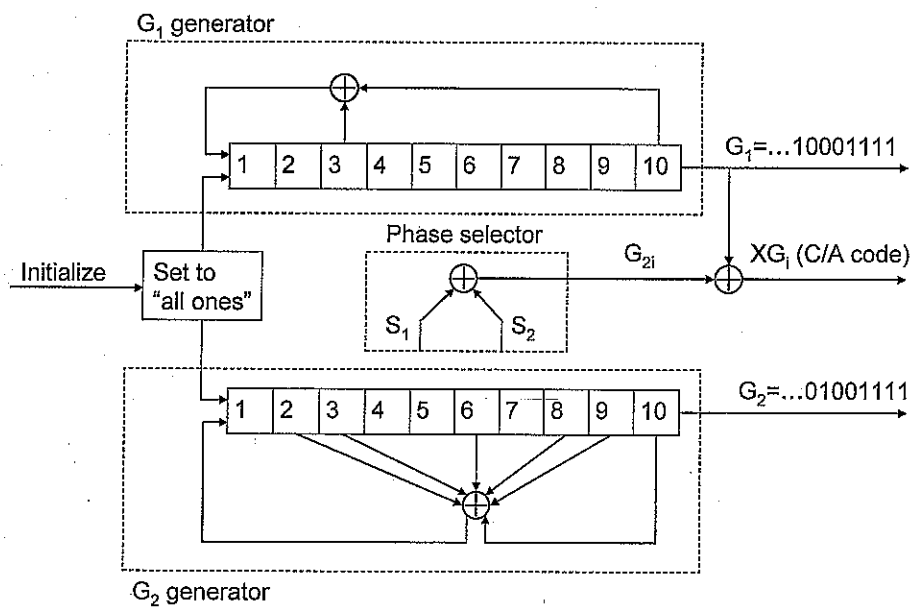
The block diagram above describes the generation of the GPS C/A code. Explain how the C/A code generation works.

    b) In the beginning of the epoch 10, the contents of the registers G1 and G2 are the following: (2p)

    G1 =   0 0 0 1 1 1 0 0 0 1
    G2 =   0 1 0 1 1 0 1 0 0 1.
    Generate the C/A-code output for the GPS satellite number **2 (PRN = 2)** for epochs 10 and 11, and the contents of the registers G1 and G2 for epoch 11. For further information, see Appendix B.

    c) Describe the correlation properties of the C/A-code in GPS. What benefits do these properties bring?   (2p)

3. a) Two GNSS receivers, Receiver 1 and Receiver 2 are connected to one   (3p)
        antenna, as shown in the figure below. The cable between the antenna and
        Receiver 1 is 2 m long whereas the length of the cable to Receiver 2 is 10 m.

    - Which error sources of positioning have the same effect in both
      receivers, and which error sources have different effects?

    - How do the cables affect the PVT estimate?
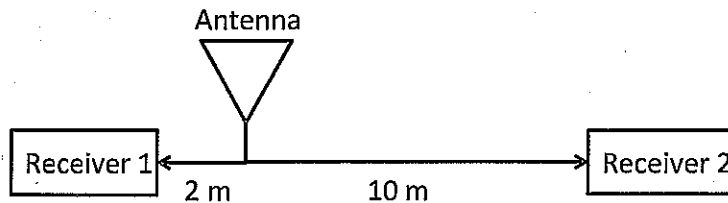
    b) What is ionospheric error? Which methods can be used in GNSS positioning   (3p)
        to decrease the effect of ionospheric error?

4. a) Carrier-Smoothing of the code measurements: What does it mean? How is it   (3p)
        done? What are the benefits of it?

    b) The latitude of the user is 57° (North), longitude is 15° (East), and height is 0   (3p)
        m. How large in meters is the positioning error caused by an error of a half
        degree (0.5°) in the user longitude?

        Use the WGS 84 ellipsoidal model.

        (Writing down all the equations / algorithm for solving this problem is
        enough, if you do not want to touch the calculator)

5. Essay: GPS signals. Frequencies, codes, signal structure.   (6p)

6. Essay: Orbits of GNSS satellites and their orbital parameters.   (6p)