

Advanced Communication Systems- ASSIGNMENT 2

Due Date: Before 3:20pm, 9 Jan,2009.CR to bring to my office after collection

- 1.** Explain what the terms centrifugal and centripetal mean with regard to a satellite in orbit around the earth.

A satellite is in a circular orbit around the earth. The altitude of the satellite's orbit above the surface of the earth is 1400km. (i) What are the centripetal and centrifugal accelerations acting on the satellite in its orbit? Give your answers in m/s. (ii) What is the velocity of the satellite in this orbit? Give your answer in km/s. (iii) What is the orbital period of the satellite in this orbit? Give your answers in hours, minutes, and seconds. Note: Assume the average radius of the earth is 6378.137 km and Kepler's constant has the value $3.986004418 \times 10^5 \text{ km}^3/\text{s}^2$.

- 2.** A satellite is in a 322-km high circular orbit. Determine:
- The orbital angular velocity in radians per second;
 - The orbital period in minutes; and
 - The orbital velocity in meters per second.

Assume the average radius of the earth is 6378.137 km and Kepler's constant has the value $3.986004418 \times 10^5 \text{ km}^3/\text{s}^2$.

- 3.** The same satellite in Problem 2 above (322-km circular orbit) carries a 300 MHz transmitter. Determine the maximum frequency range over which the received signal would shift due to Doppler effects if received by a stationary observer suitably located in space. Note: The frequency can be shifted both up and down, depending on whether the satellite is moving towards or away from the observer. You need to determine the *maximum* possible change in frequency due to Doppler (i.e., $2\Delta f$).

- 4.** An observation satellite is to be placed into a circular equatorial orbit so that it moves in the same direction as the earth's rotation. Using a synthetic aperture radar system, the satellite will store data on surface barometric pressure, and other weather related parameters, as it flies overhead. These data will later be played back to a controlling earth station after each trip around the world. The orbit is to be designed so that the satellite is directly above the controlling earth station, which is located on the equator, once every 4 h. The controlling earth station's antenna is unable to operate below an elevation angle of 10° to the horizontal in any direction. Taking the earth's rotational period to be exactly 24 h, find the following quantities:

- The satellite's angular velocity in radians per second.
- The orbital period in hours.

- c. The orbital radius in kilometers.
- d. The orbital height in kilometers.
- e. The satellite's linear velocity in meters per second.

5. What is the difference, or are the differences, between a *geosynchronous* satellite and a *geostationary* satellite orbit? What is the period of a geostationary satellite? What is the name given to this orbital period? What is the velocity of a geostationary satellite in its orbit? Give your answers in km/s.

A particular shuttle mission released a TDRSS satellite into a circular low orbit, with an orbital height of 270 km. The shuttle orbit was inclined to the earth's equator by approximately 28° . The TDRSS satellite needed to be placed into a geostationary transfer orbit (GTO) once released from the shuttle cargo bay, with the apogee of the GTO at geostationary altitude and the perigee at the height of the shuttle's orbit. (i) What was the period of the GTO? (ii) What was the difference in velocity of the satellite in GTO between when it was at apogee and when it was at perigee? Assume the average radius of the earth is 6378.137 km and Kepler's constant has the value $3.986004418 \times 10^5 \text{ km}^3/\text{s}^2$.