Course Title: Satellite Comm. Systems	Course Code: EEC 4122	Year: 4th Year
Date: First Term 13 /1/ 2016	Allowed Time: 3 Hours	Number of Pages: (7)

Answer the following questions

Question No 1

[25 Marks]

Select the correct answer that best matches the following statements. More than one answer is prohibited and mistaken choices is deducted from correct choices:

[1] Kepler's laws are made to:

a. Express the planetary motion.
b. Control the satellite Attitude.
c. Ensure station keeping.
d. Control the antenna reception.

[2] Barycenter is the:

a. Center at any foci of the ellipse.
b. Center of earth.
c. Center of satellite.
d. Center of two bodies in space that interacts through gravitation.

[3] According the Kepler's second law with elliptical orbit, for equal time intervals:

a. Satellite has a constant velocity.
b. Earth has linearly increase velocity.
c. Satellite travels equal distances.
d. Satellite travels non equal distances.

[4] Kepler's second law is very useful:

a. To control the length of time a satellite is seen from a particular region
b. To control the satellite Attitude.
c. To control the semi major axis.
d. To control the inclination angle.

[5] The third Kepler's law indicates that:

a. There is a fixed relationship between the period and size of orbit.
b. The mean motion of the satellite is given by $\frac{P_o}{2\pi}$ [P_o is the mean solar day]

Use only black or blue pens or pencil in your answer

Do not make any mark in your booklet

Answer only the required questions (Extra answers will not be considered)

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c. The mean distance between the satellite and Earth is given by $AP_o^{3/2}$.

d. Argument of perigee is identical to the right ascension of ascending nodes.

[6] Inclination,

a. Is the angle between the line of upsides and the equatorial plane.

b. Is the angle from the ascending node to the perigee.

c. Is the angle from the line A to the ascending node in the equatorial plane.

d. Is the slope between the orbital and equatorial planes.

[7] Aries,

a. Is the point at which the orbit intersects equatorial plane from south to north.

b. Is the point at which sun crosses equator when going from south to north.

c. Is the point at which sun crosses equator when going from north to south.

d. Is the line when the ascending and the descending nodes are jointed together through the Earth center.

[8] Atmospheric drag,

a. Is greatest at the apogee.

b. Is greatest at the perigee.

c. Is greatest for high orbit satellites over 1000 km.

d. Is negligible for low orbit satellites below 200 km.

[9] Atmospheric drag,

a. Decreases the velocity at the perigee point.

b. Increases the velocity at the perigee point.

c. Increases the velocity at the apogee point.

d. Decreases the velocity at the apogee point.

[10] Gravitational pulls of the sun and moon,

a. Have a negligible effect on high orbit satellites.

b. Have a negligible effect on low orbit satellites.

c. Increases the velocity at the perigee point.

d. Increases the velocity at the apogee point.

[11] The orbit that has been specified by Kepler's laws is an ideal orbit because:

a. It assumes that satellite will rotate on an elliptical orbit.

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b. The satellite is usually launched in two main steps through the Hohmann transfer orbit.
c. The oblateness of the Earth.
d. Its only applicable for geostationary satellites.

[12] It is possible to have a constant mean motion against all possible perturbations of orbits by controlling:
a. The angle between the orbital and the equatorial planes.
b. The angle from the ascending node to perigee.
c. The angle from the line A to the ascending node.
d. The average value of the angular position of the satellite with respect to the perigee.

[13] Rotation of the line of apsides,
a. Affects the anomalistic period.
b. Changes the oblateness of the Earth.
c. Changes the right ascension of ascending node.
d. Changes the angle from the ascending node to perigee.

[14] Advantages of using Ku band over C band is due to:
a. High power signal can be transmitted without causing problem on ground.
b. Low power signal can be transmitted without interference.
c. Commercial satellite systems have made use of C band.
d. Commercial satellite systems have made use of K_U band.

[15] The regression is zero
a. For geostationary satellites.
b. For polar orbits.
c. For orbits having very low values of inclination angles.
d. When the argument of perigee is identical to the right ascension of ascending nodes.

[16] Movement across the roll axis:
a. Changes the antenna footprint, north and south.
b. Changes the antenna footprint, east and west.
c. Changes the antenna footprint, east to west.

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d. Just rotates the antenna footprint.

[17] Station keeping:

a. Is equivalent to attitude control.
b. Just rotates the antenna footprint.
c. Means geostationary satellite should remain in its correct orbital slot.
d. Means geostationary satellite should remain in its correct orientation.

[18] A satellite in the 6/4 GHz must be kept

a. Within 0.5 degrees of its designated altitude.
b. Within 0.1 degrees of its designated longitude.
c. Within 0.05 degrees of its designated attitude.
d. Within 0.1 degrees of its designated attitude.

[19] Telemetry functions include:

a. Attitude change
b. The frequency of meteorite impact.
c. Beacon signals from the satellite.
d. Transponder switched in or out of service.

[20] Command examples include:

a. Attitude change.
b. The frequency of meteorite impact.
c. Beacon signals from the satellite.
d. Altitude control.

[21] Beacon signals

a. Strong light that can be seen far away.
b. Pilot carriers at frequencies in one of communication channels.
c. Considered as one of the command functions.
d. Considered as one of the telemetry functions.

[22] Splitting the gain between preamplifier at 6GHz and second amplifier at 4GHz

a. Duplicates oscillation which might occur if all the gain is made at the same frequency.
b. Avoids possible oscillations.
c. Decreases the overall gain.

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d. Increases the overall gain on the expense of complexity of demultiplexer.

[23] PM modulation can occur after TWTA because:

a. AM modulation could occur from filtering prior to TWTA.
b. AM modulation could occur from filtering prior to TWTA.
c. FM/PM conversion prior to TWTA.
d. The nature of TWTA phase characteristics.

[24] To reduce intermodulation distortion of TWTA,

a. The transponder could be used as a multi carrier.
b. TWTA is used at the linear portion of the phase characteristics.
c. Hard-limiter could be used before TWTA.
d. Reduce the input of multicarrier than the single carrier case.

[25] Variable attenuation in a transponder is needed

a. To balance out variations in the input.
b. So that each transponder channel has the same nominal attenuation.
c. To be suitable for different ground stations.
d. To be suitable for different services.

Question No 2

[25 Marks]

a. Explain with aid of drawing the SPADE system including the following:
   1. SPADE definition and dimensions. (2) Marks
   2. SPADE operation. (4) Marks
   3. Operation of common signaling channel (4) Marks
b. Explain with the aid of drawing the relative levels at the different stages of the transponder. (4) Marks
c. Draw and explain in details the function of each stage in the block diagram of indoor unit in DBS. (6) Marks
d. Comment on the following words: Aries, Celestial equator, Vernal equinox, ecliptic plane, mean anomaly, true anomaly. (5) Marks

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Question No 3 [25 Marks]

a. A satellite in orbit has an apogee height of 35795km and a perigee height of 35779km. Assume the Earth's equatorial radius 6371 km, the inclination angle is given as 81.1615o whereas the mean motion was 14.2171404 rev/day. If the constant K_2 equals 65915.3446 calculate:
   1. The regression of the nodes. (4) Marks
   2. The rotation of the line of apsides. (2) Marks
   3. From your study what controls that could be used to compensate for the changes given in 1 and 2. (2) Marks

b. Explain in details the gain and phase characteristics of TWTA. (4) Marks

c. Your earth station is at 84° W longitude and 30° N latitude. At a given moment, your dish antenna is pointed to azimuth 180° (due South) and 30° of elevation to receive a signal from a satellite in an equatorial orbit. Determine the following:
   1. The **three** conditions for an orbit to be geostationary. (3) Marks
   2. The latitude and longitude of the satellite sub-point at this moment. (4) Marks
   3. The east and west limits of visibility for your earth station assuming a minimum angle of elevation of 5°. (6) Marks

Question No 4 [25 Marks]

a. A satellite on a range of 42,000 km from a ground station is operating at 6 GHz and has receiver feeder losses of 1.5 dB, atmospheric absorption loss of 0.5 dB, antenna pointing loss of 0.5 dB, and depolarization loss due to a Faraday rotation angle of 4°.
   1. Calculate the total link loss in dB. (6) Marks
   2. If a 3-m parabolic antenna is used at the receiver with an aperture efficiency of $\eta = 0.55$ and an EIRP of 56 dBW is used at the transmitter. Calculate the received power **in dBm**. (4) Marks

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3. Calculate carrier to noise spectral density ratio at receiver if the noise temperature is 185 K (State its unit) (4) Marks

b. You are given the following components: antenna with a noise temperature of 35 K, LNA with a gain of 10^5 and a noise temperature of 150 K, a cable with a loss of 5 dB and a receiver with noise factor of 12 dB.
   1. Define the noise factor (F) and explain aided with equations how it is related to noise temperature. (3) Marks
   2. Connect the above components for adequate reception with minimal noise (Sketch your answer). (4) Marks
   3. Calculate the noise temperature referred to the system input. (4) Marks

Question No 5

[25 Marks]

a. Suppose that you can observe, at a given moment and location in Egypt, six GPS satellites, namely, RPN23, RPN03, RPN06, RPN16, RPN09, RPN07, such that the timing measurements obtained from them are: 70.87, 71.59, 74.57, 77.23, 70.57 and 71.85 msec respectively.
   1. How many timing measurements are needed to determine your location? (Explain your answer) (6) Marks
   2. Calculate the corresponding distances from different satellites assuming 1 msec offset due to different timing inaccuracies. (9) Marks

b. Mention **three** satellite systems that are used to provide satellite mobile services. Compare between these systems in terms of: number of satellites used, satellite orbit type, geographic zone served. (10) Marks

With Best Wishes

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