

Total Marks: 125 Marks



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Course Title: Satellite Comm. Systems
Date: First Term 13 /1/ 2016

Course Code: EEC 4122 Allowed Time: 3 Hours Year: 4th Year 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]

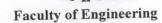
Use only black or blue pens or pencil in your answer

Do not make any mark in your booklet

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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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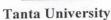
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- b. The satellite is usually launched in two main steps through the Hohmann transfer orbit.
- c. The oblateness of the Earth.
- d. Its only applicable for geostationary satellites.
- [12] It is possible to have a constant mean motion against all possible 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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Ouestion 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 81.16150 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 <u>in dBm</u>. (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 10⁵ 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.
 - 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 <u>three</u> satellite systems that are used to provide satellite mobile services. Compare between these systems in terms of: <u>number of satellites</u> used, <u>satellite orbit type</u>, <u>geographic zone served</u>. (10) Marks

With Best Wishes

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Course Coordinator:

Assistant Prof. Mahmoud A. A. Ali

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