UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	SATELLITE COMMUNICATION SYSTEM
COURSE CODE	:	BEP 4243 / BEX 43603
PROGRAMME	:	BEE
EXAMINATION DATE	:	JANUARY 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) There are seven elements which could determine the orbit of a spacecraft around the Earth. They are termed as Keplerian elements. With the aid of diagrams, describe the meaning of THREE (3) Keplerian elements as given below:

(i) orbital inclination, i,

(2 marks)

(ii) right ascession of the ascending node, Ω and

(3 marks)

(iii) argument of perigee, ω.

(3 marks)

(b) A satellite is orbiting above the Earth with an inclination, i, of 23.63°, eccentricity, e, of 0.001109, mean motion (rev/day), NN, of 14.23300431 and semi major axis, a, of 7192km. K_1 is given as 66063.1704 km^2. Using those information given, calculate:-

(i) rate of regression of the nodes, and

(8 marks)

(ii) rate of rotation of the line of apsides.

(4 marks)

Q2 (a) The 2-line elements for satellite NOAA 45 are as follows;

```
NOAA    45
1 28654U 05018A   05154.51654998  .00000093  00000-0  28161-4  0  189
2 28654   98.7443 101.8853 0013815 210.8695 149.1647 14.10848892 1982
```

By referring to Table Q2, evaluate:-

(i) epoch day in Julian, and

(3 marks)

(ii) Greenwich Sidereal Time, GST, where it is given as,

$$GST = 99.6910^\circ + 36\,000.7689^\circ \times T + 0.0004^\circ \times T^2 + UT^\circ$$

(7 marks)

(b) The following elements applied to a satellite in inclined orbit; n = 0.000146 rad/s, M_o = 295°, i = 21°, e = 0.008182, Ω = 285°, ω = 45° and a = 7130 km. Assuming a perfectly spherical Earth of uniform mass and radius of 6371 km, and given that the epoch corresponds to 10s, estimate:

(i) true anamoly, ν,

(4 marks)

(ii) radius vector, r, and

(3 marks)

(iii) position vector of the satellite in **PQW** frame.

(3 marks)

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TABLE Q2

January 0.0	Julian days
1999	2451178.5
2000	2451543.5
2001	2451909.5
2002	2452274.5
2003	2452639.5
2004	2453004.5
2005	2453370.5
2006	2453735.5
2007	2454100.5
2008	2454465.5
2009	2454831.5
2010	2455196.5

Q3 (a) Compare the rain attenuation which exceeded 0.1% of the time in any year for horizontal, vertical and circular polarizations when the rain height and rain rate is 5.6 km and 11.2 mm/h, respectively. The altitude of the Earth station is 500 m above the mean sea level with the elevation angle of the antenna is 27°. Those signals are apolarized at 15 GHz.

(14 marks)

(b) Radio waves travelling between satellites and Earth stations must pass through the atmosphere. They faces few effects such as scintillation, misalignment loss, multipath, dispersion, depolarization, attenuatuion etc. Differentiate between the scintillation, attenuation and depolarization.

(6 marks)

Q4 (a) List down the losses that take place in free space losses calculation and formulate them, as in the Error Budget calculation.

(6 marks)

(b) Sketch a satellite link consist Earth stations at both end with satellite transponder in the centre of the link. Then, prove that :

$$\left(\frac{C}{N_O}\right)=\left(\frac{P_R}{(\gamma P_{NU}+P_{ND})}\right)$$

(8 marks)

(c) For an individual satellite link, the Carrier-to-Noise Spectral Density Ratios, C/N_0, for uplink and downlink are 100 dBHz and 87 dBHz, respectively. Calculate the total C/N_0.

(6 marks)

Q5 (a) The desired carrier [EIRP] from a satellite is given as 36 dBW. The ground station receiving antenna gain is 42.27 dB in the desired direction and 21.63 dB towards the interfering satellite. The interfering satellite also radiates an [EIRP] of 30 dBW. The polarization discrimination is 4 dB. Calculate the Carrier-to-Interference [C/I] ratio at the ground receiving antenna.

(6 marks)

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TABLE Q3

For p = 0.001%	$r_{0.001} = \frac{10}{10 + L_G}$
For p = 0.01%	$r_{0.01} = \frac{90}{90 + 4L_G}$
For p = 0.1%	$r_{0.1} = \frac{180}{180 + L_G}$
For p = 1%	$r_1 = 1$

TABLE Q3

Frequency, GHz	a_h	a_v	b_h	b_v
8	0.00454	0.00395	1.327	1.31
10	0.0101	0.00887	1.276	1.264
12	0.0188	0.0168	1.217	1.2
15	0.0367	0.0335	1.154	1.128
20	0.0751	0.0691	1.099	1.065
25	0.124	0.113	1.061	1.03
30	0.187	0.167	1.021	1

(b) The value for the parameters of satellite and Earth station (in unit dB) are given in Table Q5 below.

Table Q5

Satellite and Earth Station parameters	Value (in dB)
L_U	200
L_D	196
$G_E = G'_E$	25
$G_S = G'_S$	9
$G_{TE} = G_{RE}$	48
$G_{RS} = G_{TS}$	19
$U_S = U'_S$	1 μJ
$U_E = U'_E$	10 μJ
k	-228.6

By using appropriate formula and method, calculate:

(i) transmission gain, γ, and

(4 marks)

(ii) the equivalent temperature rise.

(10 marks)

Q6 (a) Navigation system is a Global Positioning Satellites (GPS) system that can be used to determine the location of a human being or anything on any part of the world. However, ionosphere and troposphere always give effect to the overall performance of GPS positioning.

(i) Assess the statement above by analyzing the equatorial ionospheric and tropospheric effect to Navigation in GPS application.

(8 marks)

(ii) Propose FOUR (4) methods that can be implemented in order to mitigate the ionospheric error and to improve the GPS positioning.

(8 marks)

(b) When it is raining heavily, suddenly the TV signals that are being broadcasted using the geostationary satellites were distorted. There are few reasons for the occurance of this problem. Name and explain TWO (2) main reasons for this distortion to take place.

(4 marks)

- END OF QUESTION -