UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER II
SESI 2008/2009

NAMA MATA PELAJARAN	:	SISTEM KOMUNIKASI SATELIT
KOD MATA PELAJARAN	:	BEP 4243
KURSUS	:	4 BEP
TARIKH PEPERIKSAAN	:	APRIL 2009
JANGKA MASA	:	3 JAM
ARAHAN	:	JAWAB **LIMA** (5) SOALAN SAHAJA DARIPADA ENAM (6) SOALAN.

KERTAS SOALAN INI MENGANDUNGI 8 MUKA SURAT

SOALAN DALAM BAHASA INGGERIS

Q1 (a) A spacecraft is launched into Geostationary Transfer Orbit (GTO) on an Arianne IV launch vehicle from the Guaina Space Centre near Kourou, French Guaiana. The Arianne manages to inject the satellite directly into GTO with a perigee altitude of 200 km at an inclination of 0°. Calculate:

(i) velocit y at 200 km altitude,

(2 marks)

(ii) the transfer orbit velocity at perigee,

(2 marks)

(iii) velocity increment at perigee,

(1 mark)

(iv) the transfer orbit velocity at apogee and

(2 marks)

(v) the velocity increment at apogee that must be provide by the spacecraft to circularize the orbit.

(3 marks)

(b) IntelSat 4 is a geostationary satellite located at longitude 72^{0}E. An Earth station at longitude 101^{0}E and latitude 5^{0}N receives satellite signal from the satellite. By referring to Figure 1(b), estimate:

(i) distance between the satellite and the Earth station,

(5 marks)

(ii) azimuth angle and

(3 marks)

(iii) elevation angle.

(2 marks)

Q2 (a) Using a suitable figure, explain the perifocal coordinate system in **P,Q** and **W** frames (or **PQW** frame), where **P**, **Q** and **W** are unit vectors.

(4 marks)

(b) The following are Two Line Element (TLE) set for a particular satellite.

```
NOAA    14
1 23455U 94089A   97320.90946019 .00000140  00000-0  10191-3  0  2621
2 23455 99.0090  272.6745 0008546 223.1686 136.8816 14.11711747148495
```

Calculate:

(i) Epoch day in Julian day.

(2 marks)

(ii) time in Julian century with JD_{ref} is reference time of January 0.5, 1900 = 2415020 Julian days,

(2 marks)

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

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

(3 marks)

(iv) semi-major axis, a.

(4 marks)

(v) true anomaly using approximated equation for near circular orbit and

$$v \cong M + 2e \sin M + \frac{5}{4}e^2 \sin 2M$$

(2 marks)

(vi) orbital radius vector, **r**, in the **PQW** frame (**P**, **Q** and **W** are unit vectors in perifocal coordinate system), where **r** is given as,

$$\mathbf{r} = (r\cos v)\mathbf{P} + (r\sin v)\mathbf{Q} \text{ and } r = \frac{a(1-e^2)}{1+e\cos v}.$$

(3 marks)

Q3 (a) For a point rain rate of 10 mm/h, the rain attenuation exceeded 0.01% of the time in any year. The altitude of the Earth station and the antenna elevation angle at the Earth station is given as 600m and 50°, respectively. For a frequency of 12 GHz and a rain height of 3 km, calculate:

(i) vertical polarization.

(4 marks)

(ii) horizontal polarization and

(3 marks)

(iii) circular pol arization.

(5 marks)

(b) By using the rain attenuation for the circular polarization above, distinguish the cross-polar discrimination, XPD, in unit dB. Given;

$$V = \begin{cases} 20 & for\ 8 \le f \le 15GHz \\ 23 & for\ 15 \le f \le 35GHz \end{cases}$$

$$U = 30\log f - 10\log(0.5 - 0.4697\cos 4\tau) - 40\log(\cos\theta)$$

(8 marks)

Q4 (a) Compare linear (horizontal and vertical) and circular polarizations. Use mathematical equations, whenever necessary, to enhance the explanation.

(7 marks)

(b) A geostationary satellite is stationed at 105° W and transmits a vertically polarized wave. Estimate the angle of polarization at an Earth station at latitude of 18° N and longitude 73° W. Given a_{GSO} = 42164 km and the mean radius of spherical Earth, R = 6371 km.

(13 marks)

Q5 (a) The performance measurement of a satellite link is the ratio of a carrier power to noise power at the receiver input. Normally, link-budget calculations are often concerned to determine this ratio. Formulate the Carrier-to-Noise ratio by taking into consideration all the possible errors or losses in a typical satellite link.

(4 marks)

(b) In a link-budget calculation at 12 GHz, the free-space loss is 206 dB, the antenna pointing loss is 1 dB and the atmospheric absorption is 2 dB. The receiver [G/T] is 19.5 dB/K and the receiver feeder losses are 1 dB. The EIRP is 48 dBW. Calculate the Carrier-to-Noise spectral density (C/N_0) ratio. Boltzmann's constant is given as $k = 1.38 \times 10^{-23}$ J/K

(8 marks)

(c) Illustrate a complete satellite circuit using both uplink and downlink. From the design, prove that C/N_0 at the groud receiver is:

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

Define the meaning of each parameters in the equation, whenever necessary.

(8 marks)

Q6 (a) Global Positioning Satellites (GPS) is a system that can be used for so many applications on the Earth. To name few of the applications are such as Navigation, Surveying, Tracking, Construction, Machine Control and Mining. However, the ionosphere becomes as a major source of error in the performance of GPS.

(i) Defend the fact above by referring to the contents of the electron density in the ionosphere, variation of refractive index in the ionospheric layer and ionospheric depolarization.

(8 marks)

(ii) Propose 2 methods that can be implemented in order to 'remove' the ionospheric error and to improve the performance of the GPS system.

(4 marks)

(iii) Troposphere is another layer in the atmosphere. However, it's effect to GPS system is just one tenth (~ 10%) of the total ionospheric effect. Analyse why there is different (reduction) in the the error measurement from the tropospheric layer to GPS system though it is another atmospheric layer like ionosphere.

(6 marks)

(b) At some time in a day (especially during raining time at tropical countries), the transmission of satellite TV signals will be distorted. They are few reasons for the occurance of this problem. Name 2 main reasons for this distortion to take place.

(2 marks)

Lampiran I

PEPERIKSAAN AKHIR

SEMESTER/SESI : SEMESTER 2/2008/09
MATA PELAJARAN : SISTEM KOMUNIKASI SATELIT

KURSUS : 4 BEP
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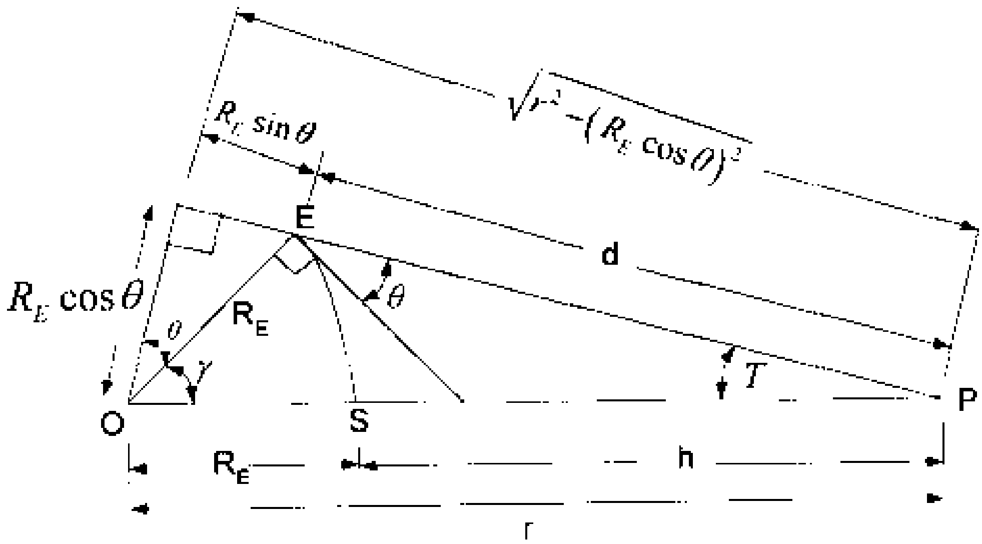

Figure 1(b)

Table 1 : Reduction Factors

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 2 : Specific Attenuation Coeficients

Frequency, GHz	a_h	a_v	b_h	b_v
1	0.0000387	0.0000352	0.912	0.88
2	0.000154	0.000138	0.963	0.923
4	0.00065	0.000591	1.121	1.075
6	0.00175	0.00155	1.308	1.265
7	0.00301	0.00265	1.332	1.312
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

Table 3: Julian Dates at the beginning of each year (Jan 0.0 UT) for the years 1986 - 2000

Year	Julian date (days)
	2 400 000.+
1986	46 430.5
1987	46 795.5
1988	47 160.5
1989	47 526.5
1990	47 891.5
1991	48 256.5
1992	48 621.5
1993	48 987.5
1994	49 352.5
1995	49 717.5
1996	50 082.5
1997	50 448.5
1998	50 813.5
1999	51 178.5
2000	51 543.5