UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2003/2004
Second Semester Examination
2003/2004 Academic Session

Februari/Mac 2004
February/March 2004

ESA 484/3 – Rekabentuk Sistem Perhubungan Satelit

Satellite Communication System Design

Masa : 3 jam
Hour : [3 hours]

ARAHAN KEPADA CALON :
INSTRUCTION TO CANDIDATES:

Sila pastikan bahawa kertas soalan ini mengandungi **TIGA BELAS** mukasurat bercetak dan **ENAM** soalan sebelum anda memulakan peperiksaan.
*Please ensure that this paper contains **THIRTEEN** printed pages and **SIX** questions before you begin examination.*

Jawab **LIMA** soalan.
*Answer **FIVE** questions.*

Jawab semua soalan dalam Bahasa Malaysia
Answer all the questions in Bahasa Malaysia

Mesin kira bukan yang boleh diprogram boleh digunakan.
Non programmable calculator can be used.

Setiap soalan mestilah dimulakan pada mukasurat yang baru.
Each questions must begin from a new page.

1. (a) Dengan berpandukan gambarajah, tunjukkan definasi

(i) Sudut dongakan
(ii) Sudut Azimut
(iii) Sudut Zenit
(iv) Petunjuk Nadir
(v) Pusat Subsatelit

Using diagrams, show the look angles definition of
(i) Elevation angle
(ii) Azimuth angle
(iii) Zenith direction
(iv) *Nadir direction*
(v) Subsatellite point

(5 markah/*marks*)

(b) Pusat Subsatelit untuk stesen bumi di latitud utara 50^0N dan Longitude 0^o. Longitude satelit adalah di 70^oE.
Disertakan:

Subsatellite point for the earth station in the north latitude 52^oN and longitude of 0^o. The satellite's longitude (subsatellite point) is 66^o0 E.
Given that:

$$\cos(\gamma) = \cos(L_e)\cos(L_s)\cos c - \sin(L_e)\sin(L_s)$$

$$d = r_s\left[1+\left(\frac{r_e}{r_s}\right)^2 - 2\left(\frac{r_e}{r_s}\right)\cos(\gamma)\right]^{1/2}$$

Di mana r_s =42,164.17 km, r_e=6,378.137 km
where, r_s=42,164.17 km , r_e=6,378.137 km

$$\alpha = \tan^{-1}\left[\frac{\tan(l_s - l_e)}{\sin(L_e)}\right]$$

(i) Apakah yang dimaksudkan oleh L_e, L_s , l_e dan l_s?

What does L_e, L_s , l_e and l_s stands for?

(ii) Hitung nilai d

Calculate the value for d

(iii) Hitung sudut dongakan.

Calculate the Elevation angle

(iv) Untuk mengira sudut Azimut, nilai α perlu dikira terlebih dahulu. Hitung nilai α.

In calculating Azimuth angle, the intermediate α must be found. Find α.

(v) Apakah nilai sudut Azimut?

What is the Azimuth angle?

(10 markah/*marks*)

(c) Senaraikan EMPAT (4) kesan orbital dalam perlakuan sistem komunikasi satelit dan secara ringkasnya, terangkan perbezaan setiap kesan dan sertakan contoh-contoh yang sesuai.

List FOUR (4) different orbital effeets in satellite communication system performance and briefly explain each effects and giving example(s) where possible

(5 markah/*marks*)

2. (a) Terangkan asas teori penghantaran dengan berpandukan kepada informasi: Ketumpatan Fluxs, EIRP, Persamaan talian, kecekapan apertur dan jidar sistem.

Explain the basic transmission theory and include the following points: Flux density, EIRP, Line equation, aperture efficiency and system margin

(15 markah/*marks*)

(b) Satelit yang berjarak 36000 km dari permukaan bumi telah memancarkan P_t=10W dari G_t=17dB,

Given that a satellite distance at 36000 km from a point on earth surface radiating P_t=10W from G_t=17dB,

Hitungkan:
Calculate:

(i) Ketumpatan Fluxs (dalam dB)

Flux density F (in dB)

(ii) Kuasa yang diterima P_r (dalam dBW)

Power received P_r (in dBW)

(5 markah/*marks*)

3. Sebuah satelit geostatik menggunakan *bent pipe transponder* untuk menyalurkan isyarat digital TV dari stesen bumi ke pelbagai stesen penerima. Nilai minimum nisbah C/N adalah 9.5dB

A geostationary satellite with bent pipe transponder to distribute digital signal TV signals from an earth station to many receiving station. The minimum C/N ratio requires 9.5dB

(a) Mengapakah perlu kepada takat minimum nisbah C/N bernilai 9.5dB di penerima? Apakah faktor yang menyumbang kepada keperluan ini?

Why must we have a minimum C/N ratio of 9.5dB be met at the receiver? What are the factors contributing to this requirement?

(2 markah/*marks*)

(b) Apakah jidar kait?

What is link margin?

(2 markah/*marks*)

(c) Apakah Perhubungan Kait Ke atas dan Perhubungan Kait Ke bawah? Lukiskan gambarajahnya

*What is the **Uplink** and **Downlink**? Draw the diagram.*

(2 markah/*marks*)

(d) Dengan **Jadual A** yang diberikan, hitung nilai-nilai tersebut untuk PERHUBUNGAN KAIT KEATAS:

*Using **Table A**, calculate the following values for an UPLINK COMMUNICATION.*

(i) Hitung N di tranponder

Calculate N at the transponder

Baltzman constant

(ii) Hitung P_r (kuasa di masukan tranponder)

Calculate P_r (power at transponder input)

(iii) Hitung P_t jika $(C/N)_{up} = 30dB$

Calculate P_t if $(C/N)_{up} = 30dB$

(iv) Apakah yang dapat dilakukan untuk mengurangkan penghantaran kuasa?

What can be done to reduce the transmitting power?

(14 markah/*marks*)

Satellite parameters	
Geostationary at 73° W longitude, 28 Ku-band transponders	
Total RF output power	2.24KW
Antenna gain, on axis (transmit and receive)	31dB
Receive system noise temperature	500K
Transponder saturated output power: Ku band	80W
Transponder bandwidth: Ku band	54MHz
Signal	
Compressed digital video signals with transmitted symbol rate of 43.2 Msps Minimum permitted overall $(C/N)_0$ in receiver	9.5dB
Transmitting Ku-band earth station	
Antenna diameter	5m
Aperture efficiency	68%
Uplink frequency	14.15GHz
Required C/N in Ku-band transponder	30dB
Transponder HPA output backoff	1dB
Miscellaneous uplink losses	0.3dB
Location: -2 dB contour of satellite receiving antenna	
Receiving Ku-band earth station	
Downlink frequency	11.45GHz
Receiver IF noise bandwidth	43.2MHz
Antenna noise temperature	30K
LNA noise temperature	110K
Required overall $(C/N)_0$ in clear air	17dB
Miscellaneous downlink losses	0.2dB
Location: -3 dB contour of satellite transmitting antenna	
Rain attenuation and propagation factors	
Ku-band clear air attenuation	
Uplink 14.15 GHz	0.7dB
Downlink 11.45 GHz	0.5dB
Rain attenuation	
Uplink 0.01% of year	6.0dB
Downlink 0.01% of year	5.0dB

Table A : System and Satellite Specification

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5. Dalam keadaan cuaca cerah, C/N = 14.dB. Turas $N_{bandwidth}$ = 1.0MHz, roll-off faktor = 0.3. Dengan menggunakan sekaitan ideal pengesanan BPSK dan QPSK nyahmodulator.

Under the clear condition (C/N) = 14.0dB. The filter $N_{bandwidth}$ =1.0MHz, roll- off factor=0.3. Using ideal correlation detection BPSK and QPSK demodulators.

Kadar ralat bit untuk BPSK adalah
Bit error rate for the BPSK is given as

$$P_{e\ BPSK} = Q\left[\sqrt{\frac{2C}{N}}\right] = \frac{1}{2}erfc\left[\sqrt{C/N}\right]$$

Kadar ralat bit untuk QPSK adalah
Bit error rate for the QPSK is given as

$$P_{e\ QPSK} = Q\left[\sqrt{\frac{C}{N}}\right]$$

Jadual Ralat barangkali terdapat di jadual **TABLE B**
*Probability of error can be found using **TABLE B***

(a) Apakah **roll factor**?
*What is **roll factor**?*

Terangkan perbezaan di antara BPSK and QPSK
Explain the difference between BPSK and QPSK

(6 markah/*marks*)

(b) Hitung kadar bit, kadar simbol, lebar jalur kaitan, dan BER bila kaitan tersebut beroperasi:

Calculate the bit rate, symbol rate, occupied (absolute) bandwidth of the link, and BER when the link is operated.

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(i) Dengan modulasi BPSK

With BPSK modulation

(ii) Dengan modulasi QPSK
With QPSK modulation

(9 markah/*marks*)

(c) Bagaimanakah mengekalkan tahap BER yang bersesuian dalam kaitan QPSK?

How to maintain acceptable BER inside the QPSK link

(1 markah/*marks*)

(d) Jika perlemahan hujan mengurangkan P_r sebanyak 3dB, C/N = 11dB. Apakah nilai BER untuk

If the rain attenuation reduces P_r by 3d,B C/N=11dB. What is the resulting BER for

(i) BPSK
(ii) QPSK

(4 markah/*marks*)

6. (a) Bagaimanakah anda menerangkan konsep VSAT? Berikan jawapan berpandukan sistemnya.

How do you explain the concept of VSAT? Give an overview of the system.

(6 markah/*marks*)

(b) Terdapat TIGA (3) asas implemantasi dalam setiap servis telekomunikasi. Terangkan setiap implemantasi.

There are THREE (3) basic implementation of any telecommunications service. Explain each implementation

(i) Satu hala/*One way*
(ii) Dua hala/*Two way*
(iii) Pelaksanaan pengasingan IP/*Split IP implementation*

(14 markah/*marks*)

Table of Q Function Q(z)

z	Q(z)	z	Q(z)
0	0.5	5.0	2.872 E−7
2.0	2.280 E−2	5.1	1.701 E−7
2.1	1.791 E−2	5.2	9.981 E−8
2.2	1.394 E−2	5.3	5.799 E−8
2.3	1.075 E−2	5.4	3.372 E−8
2.4	8.220 E−3	5.5	1.902 E−8
2.5	6.227 E−3	5.6	1.073 E−8
2.6	4.674 E−3	5.7	6.000 E−9
2.7	3.476 E−3	5.8	3.320 E−9
2.8	2.562 E−3	5.9	1.820 E−9
2.9	1.871 E−3	6.0	9.979 E−10
3.0	1.354 E−3	6.1	5.310 E−10
3.1	9.702 E−4	6.2	2.827 E−10
3.2	6.889 E−4	6.3	1.490 E−10
3.3	4.847 E−4	6.4	7.778 E−11
3.4	3.378 E−4	6.5	4.021 E−11
3.5	2.332 E−4	6.6	2.058 E−11
3.6	1.595 E−4	6.7	1.043 E−12
3.7	1.081 E−4	6.8	5.236 E−12
3.8	7.252 E−5	6.9	2.603 E−12
3.9	4.821 E−5	7.0	1.281 E−12
4.0	3.174 E−5	7.1	6.244 E−13
4.1	2.070 E−5	7.2	3.014 E−13
4.2	1.337 E−5	7.3	1.440 E−13
4.3	8.558 E−6	7.4	6.816 E−14
4.4	5.423 E−6	7.5	3.194 E−14
4.5	3.404 E−6	7.6	1.482 E−14
4.6	2.117 E−6	7.7	6.810 E−15
4.7	1.303 E−6	7.8	3.098 E−15
4.8	7.948 E−7	7.9	2.398 E−15
4.9	4.800 E−7	8.0	6.226 E−16

Table B (i): Table of Q Function Q(z)

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Table of Function erfc(x)

x	erfc(x)	x	erfc(x)
0.0	1.00000	2.0	5.167 E−3
0.05	0.94363	2.1	3.267 E−3
0.10	0.88754	2.2	2.029 E−3
0.15	0.83200	2.3	1.237 E−3
0.20	0.77730	2.4	7.408 E−4
0.25	0.72367	2.5	4.357 E−4
0.30	0.67137	2.6	2.515 E−4
0.35	0.62062	2.7	1.426 E−4
0.40	0.57161	2.8	7.932 E−5
0.45	0.52452	2.9	4.331 E−5
0.50	0.47950	3.0	2.321 E−5
0.55	0.43668	3.1	1.220 E−5
0.60	0.39614	3.2	6.297 E−6
0.65	0.35797	3.3	3.187 E−6
0.70	0.32220	3.4	1.583 E−6
0.75	0.28884	3.5	7.713 E−7
0.80	0.25790	3.6	3.687 E−7
0.85	0.22933	3.7	1.729 E−7
0.90	0.20309	3.8	7.951 E−8
0.95	0.17911	3.9	3.587 E−8
1.00	0.15730	4.0	1.587 E−8
1.05	0.13776	4.1	6.889 E−9
1.10	0.11979	4.2	2.932 E−9
1.15	0.10388	4.3	1.224 E−9
1.20	0.08969	4.4	5.012 E−10
1.25	0.07710	4.5	2.013 E−10
1.30	0.06599	4.6	7.925 E−11
1.35	0.05624	4.7	3.060 E−11
1.40	0.04771	4.8	1.159 E−11
1.45	0.04030	4.9	4.303 E−12
1.50	0.03389	5.0	1.567 E−12
1.55	0.02838	5.1	5.596 E−13
1.60	0.02363	5.2	1.959 E−13
1.65	0.01962	5.3	6.727 E−14
1.70	0.01621	5.4	2.265 E−14
1.75	0.01333	5.5	7.476 E−15
1.80	0.01091	5.6	2.420 E−15
1.85	0.00889	5.7	7.680 E−16
1.90	0.00721	5.8	2.390 E−16
1.95	0.00582	5.9	7.291 E−17

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