PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester II — Academic Year: 2011
Date: March 1, 2012 — Time: 13.30-16.30
Subject: 210-463 Telecommunication Engineering — Room: Robot

Instructions:

- *Allow a student to bring one A4-size note into the room during the exam period.*
- *Allow a student to use his/her own calculator and dictionary.*

- Grading policy
  - There will be no credit for vague answers or unclear steps.
  - A grader should be able to understand what you were trying to do without your verbal explanation later.
  - Give all your assumptions for your answer if necessary.

Do all problems and try the last problem to get some bonus points for free! ☺

1. *Telephony*

Let's consider connecting 100 incoming trunks to 100 outgoing trunks using multiple stages of 10*10 switches.

(a) Find the total number of cross points for

i. a two-stage network

ii. a three-stage network

(5 points)

(b) Discuss the advantage and disadvantage of using a three-stage network compared to a two-stage network.

(5 points)

2. *Satellite communications*

Below is the link budget analysis for the uplink (6.175 GHz, C-band). Calculate this satellite link budget and answer Questions 2.1) to 2.6).

2.1) Transmit power (850W) ☐ dBW
What is the transmit power in dBW?

Transmit waveguide losses	2.0 dB
Transmit antenna gain (7m)	50.6 dBi

2.2) Uplink EIRP ☐ dBW
What is the uplink EIRP in dBW?

Atmospheric attenuation	0.1 dB
Free-space loss	200.4 dB
Receive antenna gain	26.3 dBi
Receive waveguide loss	0.5 dB

2.3) System noise temperature (450K) ☐ dB(K)
What is the system noise temperature in dB(K)?

2.4) Spacecraft G/T ☐ dB/K
What is the Spacecraft G/T in dB/K?

Boltmann's constant	–228.6 dBW/Hz/K

2.5) Bandwidth (25 MHz) ☐ dB Hz
What is the bandwidth in dB Hz?

2.6) Carrier-to-noise ratio ☐ dB
What is the carrier to noise ratio in dB?

(10 points)

3. *Fiber-optic communications*

Below is the list of parameters for the fiber-optic communication link operating at 1330 nm wavelength to support the data rate of 140 Mbps. The desired BER is $1*10^{-9}$.

- The light source is a laser diode with a −0.3 dBm output.
- The optical fiber amplifier gain is 40 dB.
- The receiver threshold of a PIN type is −46 dBm.

a) Find the power budget

(5 points)

Allocate the power budget in a) as follows:

- Connectors are used at the output of the source and at the input to the detector. The connector loss is at 0.5 dB each.
- Fusion splices every kilometer; allows 0.25 dB per splice
- Fiber attenuation loss at 0.25 dB/km
- A margin of 4 dB

b) What will be the maximum distance achievable without the use of repeaters? (5 points)

4. *Wireless communications*

4.1) Find the spectrum efficiency (unit: conversations/cell/MHz) of the IS-95 CDMA cellular system if it has the SIR requirement of 6 dB for the transmission rate of 9.6 kbps. Note that each IS-95 voice channel requires a transmission bandwidth of 1.23 MHz.

(10 points)

4.2) Discuss how to reduce the cost of deregistration in Figure 1.

(10 points)

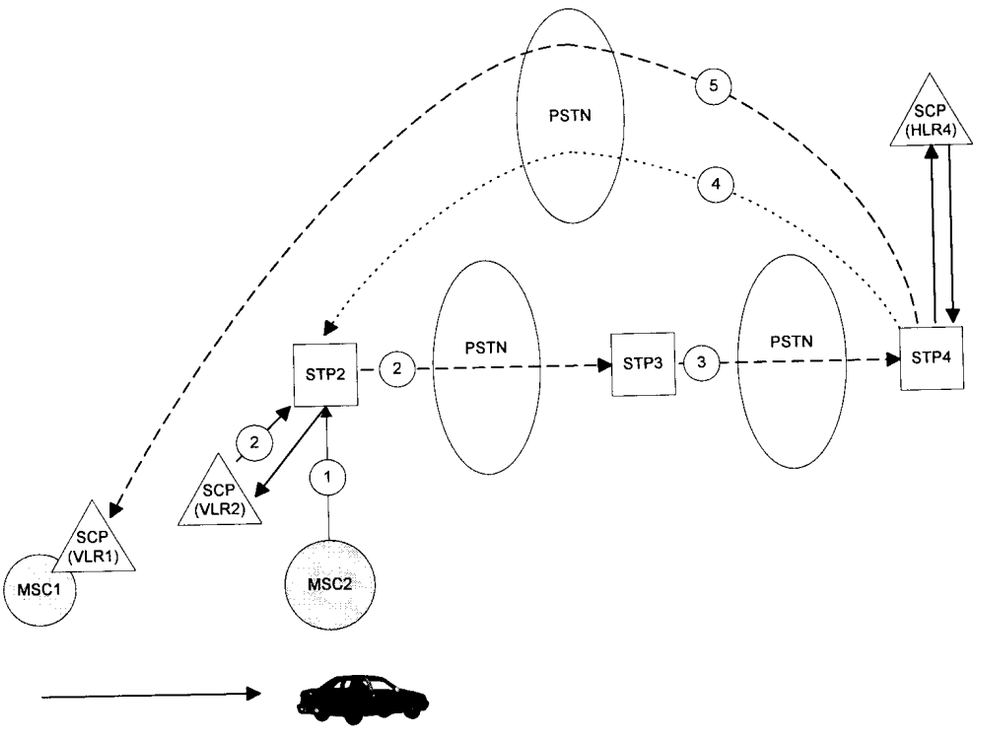

Figure 1 Registration through SS7

4.3) Simple CDMA

Let data bits "0" and "1" be represented by the signals shown in Figures 2 and 3. Assume there are two users in this system and both users have different spreading codes as shown in Figures 4 and 5. The simple CDMA transmitter and receiver are shown in Figures 6 and 7. If the message m(t) before despreading at the receiver in Figure 7 is given as shown in Figure 8, determine the "data in" at the CDMA transmitter in Figure 6 of both users.

(10 points)

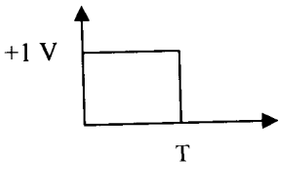

Figure 2 Data bit "0" before spreading

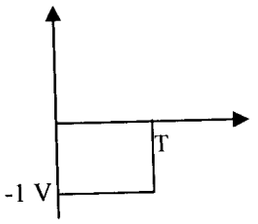

Figure 3 Data bit "1" before spreading

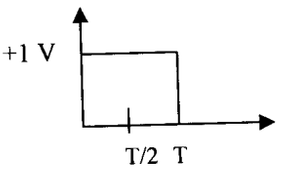

Figure 4 User 1's spreading code

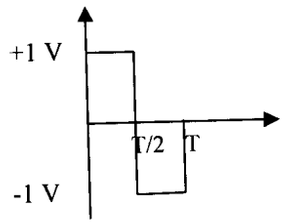

Figure 5 User 2's spreading code

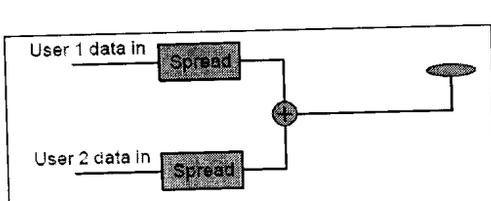

Figure 6 Simple CDMA transmitter

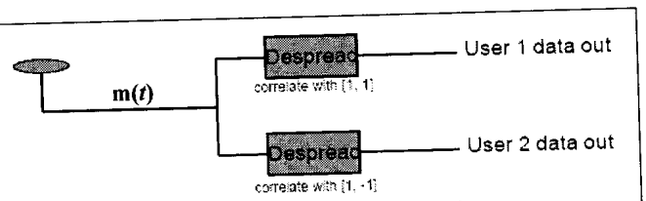

Figure 7 Simple CDMA receiver

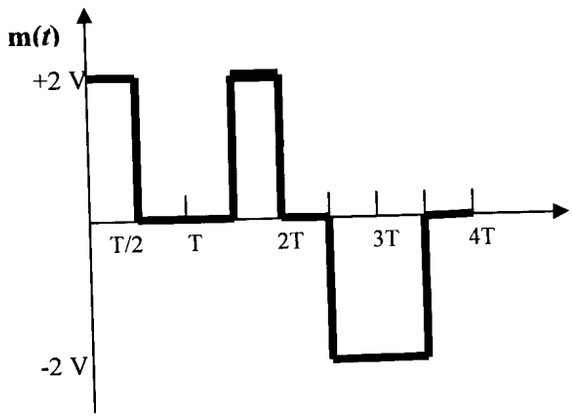

Figure 8 Message m(*t*) at a simple CDMA receiver

- **Bonus problem**
  - Why is there a guard time in uplink NA-TDMA transmissions but not in downlink transmissions? What considerations determine the length of the guard time? What are the disadvantages of making the guard time too short or too long?

    Note: You don't have to know details of NA-TDMA to answer this question.

    (10 points)