S-72.423 Exercise 1.

Return your answer no later than on Tuesday 07.10.2003 at 16:00 into the course's P.O. box at the third floor of the E-wing.

Please, include the following information in your answers:
- Your name
- Your student number

It may be that you won't find answers to the questions straight from the lecture material. You may have to look for information from the textbooks and Internet. Good luck for information search!
To this exercise you may answer in English, Finnish or Swedish.

1. DESIBELS (once again...)

dBm and **dBμV** are defined by following formulas:

$$P(dBm) = 10 \cdot lg\left(\frac{P}{1\,mW}\right) \qquad U(dB\mu V) = 20 \cdot lg\left(\frac{U}{1\,\mu V}\right)$$

a) Sensitivity requirement of the GSM Base Station is –104 dBm. Calculate the corresponding power in watts. Calculate also the corresponding voltage when the nominal impedance of the system is 50 Ω. Represent the corresponding voltage in dBμV form.

b) In the system of 75 ohms dBm can be converted into dBμV without calculating watts and volts first. The equation will be as follows

A dBm = B dBμV - C and B dBμV = A dBm + C

Determine C and prove by using example calculation that the equation works.

2. SHANNON'S THEOREM & BITS and BAUDS OF MODEMS

[Reference: Voipio, Uusitupa: Tietoliikenneaapinen (in Finnish) or Internet]

a) Shannon's third and the most famous theorem 'information capacity theorem' determines a theoretical upper limit to an error-free transmission. Up to this limit it is possible to reduce amount of errors into arbitrarily small by choosing a suitable error coding.

$$C = B \cdot \log_2(1 + \frac{P}{N_0 B})\ \frac{bit}{s}$$

, where C is the highest possible bit rate, B is a bandwidth of the channel, P is an average received power and term N_0 is caused by a Gaussian distributed noise (additive white Gaussian noise, AWGN) whose one-sided power spectral density is N_0.

Calculate the smallest possible signal to noise ratio (SNR) of a telephone connection. Bandwidth of the connection is 3,1 kHz and wanted bit rate is 33000 bit/s.

b) According to a modem recommendation V.34 bit rate of the 512QAM modulation can be 28800 bit/s. Now the modem is able to transmit 512 different symbols to a telephone line. How many bits can be transmitted per one symbol when the information has not been compressed? What is the symbol rate (baud rate) at the time?

3. Write in full length the following acronyms:

- OSI
- PSTN
- N-ISDN
- GSM
- ATM
- WCDMA
- SS7
- IP
- IN
- SMS
- PLMN
- TCP
- UDP
- LAN
- SDH
- STM
- VPN
- EDGE

4. Pulse Code Modulation in PSTN

a) Please fill in the missing words:
Recommendation _____ specifies PCM (Pulse Coded Modulation) of voice frequencies. To generate a PCM signal, an analogue speech signal is sampled at _____ Hz and converted into a _____ bit code word.

b) Find out why A-law (or μ-law) is used?

5. Compare circuit switching and packet switching.