IT3031: Communication Systems Midterm Exam Date: April 27, 2011

The following formulae may be needed in these examination questions.
(1) $C = B\log_2(1+\text{SNR})$, (2) $R = 2B\log_2 L$, (3) $S = cN\frac{1}{r}$, and (4) $\text{dB} = 10\log_{10}\frac{P_2}{P_1}$

1. Explain the following terms. (20 pts)
   (a) Baseband transmission Sending a digital signal over a channel without changing the digital signal to an analog signal.
   (b) Line coding The process of converting digital data to digital signals.
   (c) Baud rate The number of signals per second.
   (d) Attenuation A loss of energy
   (e) Distortion The signal changes its form or shape
   (f) Baseline wandering A long string of 0s or 1s can cause a drift in the baseline (baseline wandering) and make it difficult for the receiver to decode correctly.
   (g) DC components When the voltage level in a digital signal is constant for a while, the spectrum creates very low frequencies (results of Fourier analysis). These frequencies around zero, called DC (direct-current) components.
   (h) Self-synchronization The receiver's clock is faster or slower, the bit intervals are not matched and the receiver might misinterpret the signals.
   (i) Multiplexing The set of techniques that allows the simultaneous transmission of multiple signals across a single data link.
   (j) Direct Sequence Spread Spectrum

2. HDTV uses digital signals to broadcast high quality video signals. The HDTV screen is normally a ratio of 16:9 (in contrast to 4:3 for regular TV), which means the screen is wider. There are 1920 by 1080 pixels per screen, and the screen is renewed 30 times per second. Twenty-four bits represents one color pixel. What is the bit rate for the HDTV? (5 pts)

   ANS: $1920 \times 1080 \times 30 \times 24 = 1,492,992,000$ or 1.5 Gbps.

3. What are the propagation time and the transmission time for a 2.5-kbyte message (a text file) if the bandwidth of the network is 1 Gbps? Assume that the distance between the sender and the receiver is 12,000 km and that light travels at 2.4×10^8 m/s. (10 pts)

   ANS: Propagation time $= \frac{12000\times1000}{2.4\times10^8} = 50$ ms
   Transmission time $= \frac{2500\times8}{10^9} = 0.020$ ms.

   算延遲

4. We need to send 640 kbps over a noiseless channel with a bandwidth 40 kHz. How many signal levels do we need? (5 pts)

   640/40/2(兩倍頻率紀錄)

   ANS: $640,000 = 2 \times 40,000 \times \log_2 L \Rightarrow \log_2 L = 8 \Rightarrow L = 2^8 = 256$.

5. A telephone normally has a bandwidth of 3000 Hz (300 to 3300 Hz) assigned for data communications. The signal-to-noise is usually 4095. What is the theoretical highest bit rate of the regular telephone line? (10 pts)

   SNR

   ANS: $C = B\log_2(1+\text{SNR}) = 3000\log_2(1+4095) = 3000\log_2 4096 = 3000 \times 12 = 36,000$ bps.

6. A signal is carrying data in which one data element is encoded as one signal element ($r = 1$). If the bit rate is 100 kbps, what is the average value of the baud rate if c is assumed as 1/2? (5 pts)

   ANS: $S = c \times N \times \frac{1}{r} = \frac{1}{2} \times 100000 \times \frac{1}{1} = 50000 = 50$ kbaud.

7. The attenuation of a signal is -10dB. What is the final signal power if it was originally 5W? (5 pts)

   ANS: $-10 = 10 \log_{10}(P_2/5) \rightarrow \log_{10}(P_2/5) = -1 \rightarrow (P_2/5) = 10^{-1} \rightarrow P_2 = 0.5$W.

8. Draw the data stream 0011001110111101 with graph of following schemes. (40 pts)

   (a) NRZ
   (b) NRZ-I
   (c) NRZ-L
   (d) RZ
   (e) Manchester
   (f) Differential Manchester
   (g) AMI
   (h) Pseudoternary