註:本次考試不可以參考自己的書籍及筆記;　不可以使用字典;　可以使用計算器。
※每題10分

1. For wireless transmission, why we need modulation? State the reasons of necessity as best as you can.

2. A system is said to be distortionless if it introduces the same attenuation and time delay to all spectral components of the input, for then the output looks like the input.
   (a) Give the transfer function of a distortionless system.
   (b) A system has the transfer function: $H(f)=(1-j2\pi f)/(1+j2\pi f)$.
       Is this system transmission distortionless? Give the calculation to support your answer.

3. A DSB-SC (double sideband suppressed carrier) wave is demodulated by applying it to a coherent detector. Evaluate the effect of a frequency error Δf in the local carrier frequency of the detector, measured with respect to the carrier frequency of the incoming DSB-SC wave.

4. If $m(t), f_c$, and k_f denote the message signal, carrier frequency, and frequency-sensitivity factor, respectively. Please give (a) the frequency-modulated wave $s(t)$ of $m(t)$, (b) the instantaneous phase $\theta_i(t)$ and instantaneous frequency $f_i(t)$ of $s(t)$.

5. Consider a compact disc (CD)that uses pulse-code modulation to record audio signals whose bandwidth W=15 kHz. Assume that the signal is uniformly quantized to 512 levels. Determine
   (a) the Nyquist rate, and
   (b) the minimum permissible bit rate.

6. An M-ary communication system transmits at a rate of 2000 symbols per second. What is the equivalent bit rate in bits per second for $M=8$ and 64?

7. (a) Calculate the minimum required bandwidth for a coherently detected orthogonal binary FSK system. The higher-frequency signaling is 1 MHz and the symbol duration is 1 ms.
   (b) What is the minimum required bandwidth for a coherently MFSK system having the same symbol duration?

8. The figure shown in right is bit error probability for several types of binary systems. Which one is the best? Which one is the worst? If we want to have a bit error probability better than 10^{-4} but the bit energy to noise ratio can not be over 12 dB, then what systems are available? If error-performance improves, what price must we pay? And what is the physical meaning of Shannon limit (-1.6 dB)?

Figure for Prob.8

9. Consider the signal constellation of three points lying on the locations (0, 0), (2, 0) and (1, $\sqrt{3}$). Assume that the signals are equally probable. The peak and average energies required to achieve a given probability of error can be minimized through appropriate translation of the coordinate system. Find the way to translate the coordinate system such that the average energy is minimized and calculate the average energies before and after the translation.
   Hint: The average energy can be minimized by subtracting a constant vector $\bar{a}$ from each signal point. So you have to find $\bar{a}$ firstly.
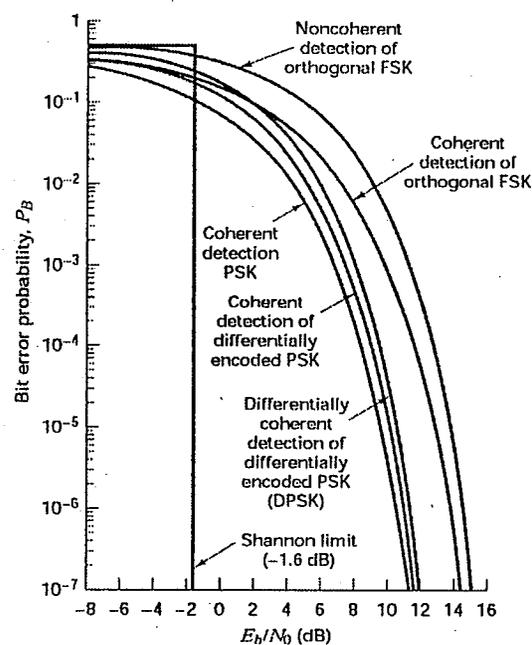
10. A 1 Mbps bit stream is to be transmitted using QPSK.
    (a) What is the symbol rate?
    (b) What is the required channel bandwidth if only the main lobe of the signal spectrum is to be passed?

The Complete Smith Chart

Black Magic Design

RADIALLY SCALED PARAMETERS