1. Determine the transmission pulse rate of a telephone system. In this system, 24 voice channels are converted to binary PCM and then time-division multiplexed. Each telephone signal, with a nomial bandwidth of 3.4 kHz, is sampled at a rate of 8000 samples/second. The number of quantizing levels is 256. (10%)

2. A zero-memory source emits six messages with probabilities 0.3, 0.25, 0.15, 0.12, 0.1, and 0.08, respectively. If a coding system with the average information 2.8 bits/message is adopted, determine the efficiency and the redundancy. (10%)

3. Estimating the bandwidth (B_{FM} and B_{PM}) of frequency and phase modulation for the modulating signal $m(t)$ for $k_f=\pi \times 10^4$ and $k_p=\pi/4$. Assume that the essential bandwidth of $m(t)$ is 15 kHz. (20%)
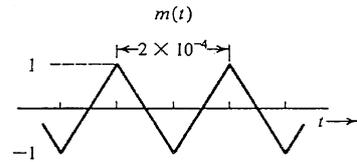
4. Consider the signal $x(t)=\cos(20\pi t)$, which is sampled at the following rates: (a) 30 samples/second; (b) $f_s=15$ Hz. Recovery is accomplished in both cases by an ideal lowpass filter with the cutoff frequency 30 Hz. Determine the output in both cases. (20%)

5. A 2 Mbps bit stream is to be transmitted using QPSK. Even- and odd-indexed bits are associated with $d_1(t)$ and $d_2(t)$, respectively. (20%)
   (a) What is the symbol rate?
   (b) What is the symbol error probability if the carrier power is 4 mW and $N_o=10^{-9}$ W/Hz?
      Hint: The symbol error probability $P_s \approx 2Q\left(\sqrt{E_s / N_o}\right)$.

6. The shown figure is a simple RC lowpass filter, where $R=10^3$ Ω and $C=10^{-9}$ F.
   (a) Determine the transfer function $H(w)$ and give the magnitude and phase responses. (5%)
   (b) What is the condition on the bandwidth of $g(t)$ so that the system can perform approximately transmission distortionless? (5%)
   (c) What is the transmission delay of this approximately transmission distortionless system? (5%)
   (d) Find $r(t)$ when $g(t)=A\cos(100t)$. (5%)