1. A sinusoidal signal of frequency 1 Hz is to be sampled periodically.
   (a) Find the maximum allowable time interval between samples.(5%)
   (b) The samples are spaced $\frac{2}{3}$ sec apart. Show graphically the spectrum of the sampled signal.(5%)

2. For a signal $f(t)=A\cos(w_o t+\theta)$
   (a) Find the autocorrelation function of $f(t)$.(5%)
   (b) Find the power spectral density of $f(t)$.(5%)
   (c) Find the power of $f(t)$. (5%)

3. A system has the transfer function

   $$H(f) = \frac{3+j2\pi f}{10+j2\pi f}.$$

   Determine whether the system is distortionless or not.(10%)

4. Consider an FM modulator with output

   $$y(t) = 50\cos[2\pi(1000)t + 2\pi f_d \int m(\tau)d\tau]$$

   The modulator operates with $f_d=6$ and has the input message signal
   $$m(t) = 5\cos(12\pi t)$$
   The modulator is followed by a bandpass filter with a center frequency of 1000 Hz and a bandwidth of 56 Hz.
   (a) Determine the peak frequency deviation and modulation index.(5%)
   (b) Determine the power at the filter output.(10%)

   Table of Bessel Function $J_n(\beta)$

n	$\beta=3.0$	$\beta=5.0$	$\beta=7.0$	$\beta=8.0$
0	-0.260	-0.178	0.300	0.172
1	0.339	-0.328	-0.005	0.235
2	0.486	0.047	-0.301	-0.113
3	0.309	0.365	-0.168	-0.291
4	0.132	0.391	0.158	-0.105

5. A delta modulator has the message signal
   $$m(t) = 9\sin(20\pi t) + 5\sin(40\pi t)$$
   Determine the minimum sampling frequency required to prevent slope overload, assuming that the impulse weights δ are 0.05π.(10%)

6. Please calculate the information capacity (in bits) of a 450-page book, assuming 500 words per page, each word containing five symbols chosen at random from a 37-ary alphabet (26 letters, 10 digits, and a blank space).(10%)

7. An M-ary communication system transmits at a rate of 1000 symbols per second.
   (a) What is the baud rate ?(5%)
   (b) What is the equivalent bit rate in bits per second for $M=64$?(5%)
   (c) If $M=2$, what kinds of modulation can achieve the best performance (error probabilities), PSK, ASK, or FSK ?(5%)

8. Let $x_m = (x_{m1}, x_{m2}, ..., x_{mN})$, $m=1,2,..., M$, be a set of M binary sequences each of length N. Message m is represented by sequence x_m. One of the sequences is transmitted over the binary symmetric channel. Let $y = (y_1, y_2, ..., y_N)$ represent the received binary sequence. For a binary symmetric channel, the conditional error probability for the nth symbol is p if $y_n \neq x_{mn}$ and is (1-p) if $y_n = x_{mn}$. Let d_m be the number of places x_m differs from y. The receiver determines which message was transmitted by observing y. What is the maximum likelihood decision rule ?(15%)