1. (25%)
Find the approximate band of frequencies occupied by an FM wave with carrier frequency of 5 kHz, frequency sensitivity $k_f = 10$ Hz/v, and
(a) $s(t) = 10\cos(10\pi t) \text{ volts}$ (12%)
(b) $s(t) = 5\cos(20\pi t) \text{ volts}$ (13%)
by using Carson's rule.

2. (25%)
Using the message signal
$m(t) = \frac{1}{1+t^2}$
and a carrier wave $c(t) = A_c \cos(2\pi f_c t)$, write down the modulated signals for the following methods of modulation.
(a) Amplitude modulation with 50 percent modulation. (10%)
(b) Single sideband modulation with only the upper sideband transmitted. (15%)

3. (25%)
Consider the signal
$g(t) = \cos(2\pi t + 25^\circ) + \cos(4\pi t + 53^\circ) + \cos(6\pi t + 84^\circ) + \cos(8\pi t + 176^\circ) + \cos(10\pi t + 9^\circ)$
(a) Determine the autocorrelation function of $g(t)$ (10%)
(b) Find the power spectrum density of $g(t)$ (10%)
Find the power of $g(t)$ (5%)

4. (25%)
Given a value of $N_0$ and the two input pulse signals
$p_1(t) = A \cdot \Pi\left(\frac{t-t_0}{\tau_0}\right)$
$p_2(t) = B \cdot \cos\left[\frac{2\pi(t-t_0)}{\tau_0}\right] \Pi\left(\frac{t-t_0}{\tau_0}\right)$
(a) Find the signal-to-noise ratio at the matched filter output for the input pulse $p_2(t)$. (15%)
(b) Relate $A$ and $B$ such that both pulses provide the same signal-to-noise ratio at the matched filter output. (10%)