1. Derive \[ x_c(t) = A \sum_{n=-\infty}^{\infty} J_n(\beta) \cos(\omega_c + n\omega_m)t \] for tone modulation for frequency and phase modulation. (10 points)

2. Show that DSB(AM) modulation is a linear scheme where as the PM modulation scheme is nonlinear. (5 points)

3. An angle modulated signal is described by \[ x_c(t) = 1000\sin(1.0)\cos(10)(2\cos[10)( \pi \pi + 0.1\sin 1000\pi]) \]. If this signal is a PM signal with \( k_p = 10 \), then find \( m(t) \). If this signal is an FM signal with \( k_f = 10\pi \), then find \( m(t) \). (10 points)

4. In a tone modulated angle modulation, the modulated signal is \[ x_c(t) = A \cos(\omega_c t + \beta \sin \omega_mt) \]. Find the spectrum of this signal when \( \beta << 1 \), i.e. when we have an NB (narrow band) modulation. (5 points)

5. Show that for an FM signal demodulation using zero crossing detector \( \frac{\pi}{\Delta t} - \omega_c \) where \( \Delta t \) is the time between two zero crossing. (5 points)