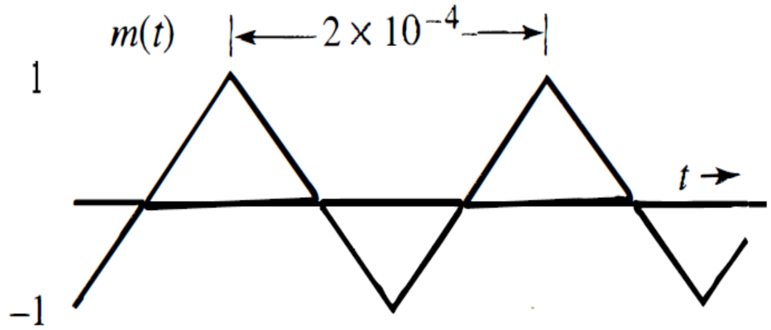
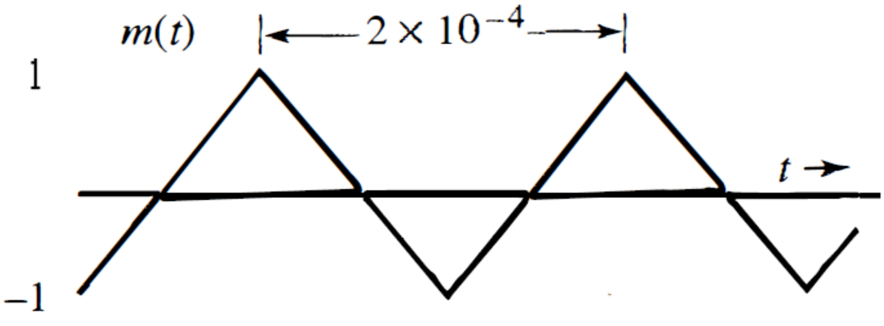
Name	FM	PM
Instantaneous Angular Frequency $w_i(t)$ $f_i(t)$	$w_i(t) = w_c + k_f m(t)$ $f_i(t) = f_c + \frac{k_f}{2\pi} m(t)$	$w_i(t) = \frac{d\theta}{dt} = w_c + k_p \dot{m}(t)$ $f_i(t) = \frac{d\theta}{dt} = f_c + \frac{k_p}{2\pi} \dot{m}(t)$
Main Equation φ	$\varphi_{FM}(t) = A\cos(w_c t + k_f \int_{-\infty}^{t} m(\alpha) d\alpha)$	$\varphi_{PM}(t) = A\cos(w_c t + k_p m(t))$
Frequency Deviation Δf	$\Delta f = k_f \frac{m_p}{2\pi}$ $\Delta W = k_f m_p$	$\Delta f = k_p \frac{\dot{m}_p}{2\pi}$ $\Delta W = k_p \dot{m}_p$
Deviation Ratio(Modulation Index) β	$\beta = \frac{\Delta f}{B}$	
Bandwidth $NBFM/NBPM$	$NBFM = NBPM = B.W = 2B$	
Bandwidth Carson's rule	$B_{FM} \approx 2(\Delta f + B)\ Hz$ $B_{Fm} \approx 2B(\beta + 1)$	
Bandwidth	$B_{Fm} \approx 2\Delta f\ Hz$	
Carrier Swing	$2\Delta f$	

No.	Examples
1	A signal tone FM signal is $\varphi_{FM}(t) = 10[cos(2\pi 10^6 t + 8\sin 2\pi 10^3 t)$ Determine 1. The carrier frequency f_c 2. Modulating frequency 3. The modulation index β 4. The peak frequency deviation Δf 5. The bandwidth of $\varphi_{FM}(t)$
2	What is the modulation index of an FM signal have a carrier swing of $100KHz$ when the modulating signal has a frequency of $8\ KHz$
3	107.6MHz carrier signal is frequency modulated 7KHz since wave. The resultant FM signal has a frequency deviation of 50KHz . determine the following a- the carrier swing of the FM signal b- the highest and lowest frequencies attained by the modulated c- the modulation index of the FM wave.
4	for the angle modulation signal $X_c(t) = 10\,cos[2\pi 10^6 t + 10\,sin(2\pi 10^3 t)]$ find $m(t)$ if 1- X_c is a PM signal with $k_p = 10$ 2- X_c is a FM signal with $k_F = 10\pi$
5	Sketch FM and PM waves for the modulating signal m(t) shown in figure below. The constants k_f and k_p are $2\pi 10^5$ and 10π respectively, and the carrier frequency f_c is 100 MHz 

6	*(a) Estimate B_{FM} and B_{PM} for the modulating signal m(t) in Figure below for $k_F = 2\pi * 10^5$ and $k_P = 5\pi$. Assume the essential bandwidth of the periodic $m(t)$ as the frequency of its third harmonic.* *(b)*** Repeat the problem if the amplitude of $m(t)$ is doubled [if $m(t)$ is multiplied by 2].* 
7	****A signal $S(t)$ is measured and found to be described by* $S(t) = A\cos(2\pi f_b t + \propto \sin(2\pi f_a t))$ *Let $S(t)$ let an angle modulation with k_P sensitivity what is the information signal $m(t)$?* *If $S(t)$ now is FM signal with k_F find $m(t)$ and $f_i(t)$*
8	*Design an Armstrong indirect FM modulator to generate an FM signal with carrier frequency 97.3 MHz and $\Delta f = 10.24\ kHz$. A NBFM generator of $f_{c1} = 20\ kHz$ and $\Delta f = 5\ Hz$ is available. Only frequency doublers can be used as multipliers. Additionally, a local oscillator (LO) with adjustable frequency between 400 and 500 kHz is readily available for frequency mixing.*