SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electrical and Electronic Engineering
COMMUNICATION PRINCIPLES

**Assignment No. 6**

1. An FM modulator is followed by an ideal band-pass filter with centre frequency of 500 Hz and bandwidth of 72 Hz. The gain of the filter is 1 in the pass-band. The message signal $m(t) = 10\cos(20\pi t)$ and the carrier signal is $f(t)=10\cos(1000\pi t)$. The modulation frequency sensitivity $k_f = 7$ Hz/volt.
    a. Draw the amplitude spectra of the FM signal at the input and output of the band-pass filter, respectively.
    b. Determine the signal power at the input and output of the band-pass filter.

2. Show that unlike AM, the mean power of an FM signal in the form of $A_c \cos[\omega_c t + \beta \sin \omega_m t]$ is independent of modulation index, $\beta$ (Hint: make use of the property $\sum_{n=-\infty}^{\infty} J_n^2(\beta) = 1$).

3. For an FM signal $f_{FM}(t) = 6\cos(2\pi 10^9 t + 4\sin 2\pi 10^3 t)$, calculate the total mean power of the significant sideband components and the carrier component within the bandwidth, where
    a. the bandwidth is determined using 1% rule, and
    b. the bandwidth is determined using Carson's rule.

4. A message signal $m(t) = 5\sin(2000\pi t)$ phase modulates a cosine wave of 100 MHz. The PM signal has peak-phase deviation of $\pi/2$ and amplitude $A_c = 100$ volts.
    a. Determine the amplitude spectrum of the PM signal.
    b. Determine the approximate bandwidth which contains 99% of total power of the PM signal.
    c. Determine the approximate bandwidth using Carson's rule and compare the results with the analytical result obtained in part (b).

**Given:** $J_0(\pi/2)=0.4720$, $J_1(\pi/2)=0.5668$, $J_2(\pi/2)=0.2497$, $J_3(\pi/2)=0.0690$, $J_4(\pi/2)=0.0140$.