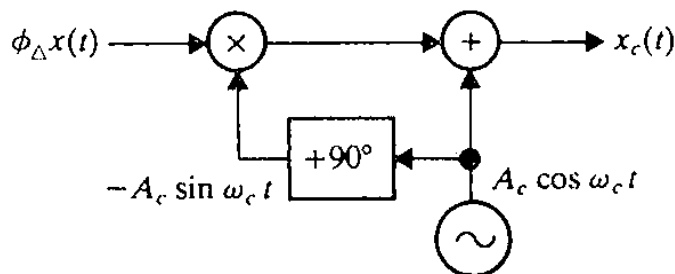


S-72.245 TRANSMISSION METHODS IN TELECOMMUNICATION SYSTEMS (4 cr)

Exam 5.4.04, 12-15, halls BDELG

This is an open-book exam, hence all handouts and other references can be present.

1. A tone modulated AM-signal with the modulation index $\mu = 2/5$ is applied to a non-linear channel whose output voltage in terms of input voltage is $v_{out}(t) = v_{in}^2(t)$. Determine the second order distortion $D_2[\%]$ of the detected AM-wave. The AM-detector operates at the frequency that is twice the applied AM-carrier frequency.



2. Consider the narrow band phase modulator shown in the figure that is used with the modulating signal $x(t) = \text{sinc}^2 2Wt$. Determine the respective spectra for (a) PM. (b) How would you use the device for generating an FM signal? (c) Determine the respective FM spectra.

3. A binary PCM system, using NRZ signalling, operates just above threshold ($E_b / N_0 = 11\text{dB}$) with an average probability of error equal to 10^{-6} . Suppose that the signalling rate is halved. Find the new value of the average probability of error.

4. The purpose of a radar system is basically to detect the presence of a target and to extract useful information about the target. Suppose that in a such system, hypothesis H_0 is that there is no target present, so that the received signal $x(t) = w(t)$, where $w(t)$ is white Gaussian noise of zero mean and power spectral density of $N_0/2$. For hypothesis H_1 , a target is present, and $x(t) = w(t) + s(t)$, where $s(t)$ is the echo produced by the target. Assume that $s(t)$ is completely known. Evaluate: (a) The probability of false alarm (PFA) defined as the probability that the receiver decides that a target is present when it is not. (b) The probability of detection (PD) defined as the probability that the receiver decides that a target is present when it is.

5. Internal impedance of a signal generator (whose open circuit RMS voltage is 1 V) consists of a series connected resistance of $R = 50\Omega$ and inductor of $L = 100\text{nH}$. (a) Synthesize a perfectly matched load (by using resistors, capacitors and/or inductors) at the frequency 1 MHz. (b) Assume then, that an unknown load impedance Z_o is connected to the generator and the voltage of $0.2+0.3$ I V is measured at the frequency of 2 MHz across the load. Synthesize the respective load by using a combination of R,L,C components.