

EE3101 Communication Engineering

Tutorial 10

(1) [Similar to Sklar's Problem 10.3]

A high-performance aircraft is transmitting an unmodulated carrier signal to a ground terminal. The ground terminal is initially in phase lock with the signal. The aircraft performs a maneuver whose dynamics are described by the equation for acceleration, $a(t) = At^2$, where A is a constant. Assuming that the linearized equations apply, determine the minimum order of the phase-locked loop required to maintain (a) frequency lock, and (b) phase lock, to the signal from this aircraft.

[Note: (i) the Doppler frequency caused by the relative velocity $v(t)$ between the transmitter and receiver is:

$$\delta\omega = \frac{\omega_0 v(t)}{c}$$
 where ω_0 is the nominal carrier frequency and c is the speed of light.

(ii) The Fourier transform of t^4 and t are $24/(j\omega)^5$ and $1/(j\omega)^2$ respectively.]

(2) If a very narrow band BPF with center frequency at symbol rate is added at the (a) NRZ-L and (b) AMI signal output, what is the output signal of the BPF?

(3) Find the power spectral density of $m(t)$ in Fig.7(b) of Chapter 3 of the lecture notes. Assuming that the input signal $r(t)$ is a random bipolar NRZ (i.e. NRZ-L) sequence. Show that the power spectral density of $m(t)$ has a peak at $\omega = \omega_T$, where ω_T is the angular frequency of the symbols.