BAŞKENT UNIVERSITY
ELECTRICAL & ELECTRONICS ENGINEERING DEPT.
EEM 441 – Communication Systems I 2^{nd} Midterm Exam.

Duration: 90 min **15/01/2002**

1. A DSB-SC signal is amplified before transmitting over a channel as shown in Fig.1. The amplifier is nonlinear with the following input-output relation.

$$s_0(t) = 100s_i(t) + 3s_i^2(t)$$

a) Assuming a rectangular spectrum bandlimited to W for the message signal, determine and sketch the spectra at points A,B and C.
b) Is it possible to recover the DSB-SC signal at the receiver without distortion? If so, is there a restriction on the value of the carrier?

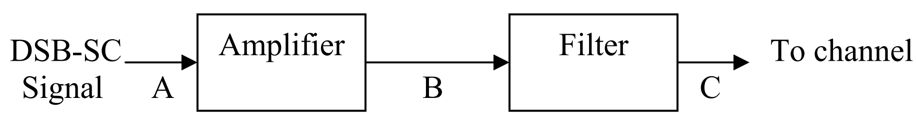

Fig.1

2. Consider the switching modulator in Fig.2a. In thıs system, the message signal x(t) is an arbitrary signal bandlimited to W and normalized such that $|x(t)|_{max} \leq 1$. Take the switching function as shown in Fig.2b. Assume $f_c >> W$.

a) Determine u(t) and the type of modulation when
(i) m(t) = x(t)
(ii) $m(t) = 0.5x(t) + \cos w_c t$

b) Determine the carrier level and the modulation index for the signal in part a) – (ii).

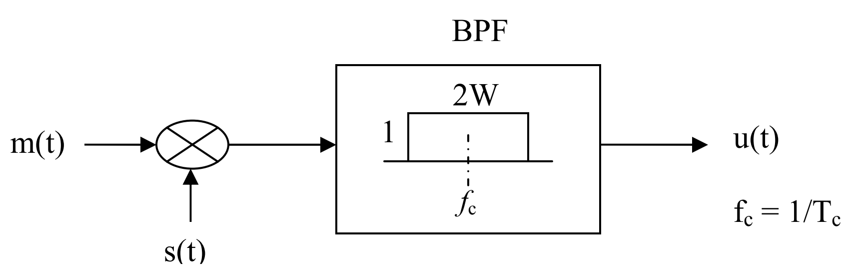

Fig.2a

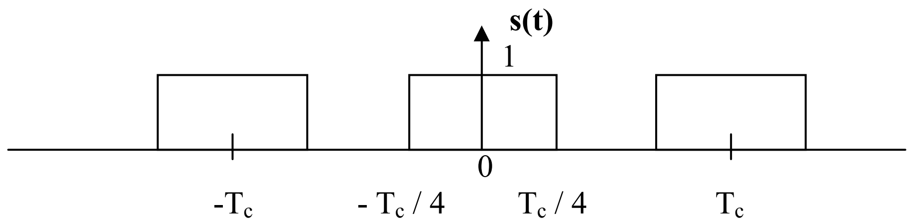

Fig.2b

3. The message signal m(t) is an arbitrary signal bandlimited to W. This signal is applied to the system shown in Fig.3.

a) Plot Y(f), the Fourier transform of y(t).
b) Plot Y(f) for the case where the frequency of the 2nd LO is f_c instead of $f_c + W$.

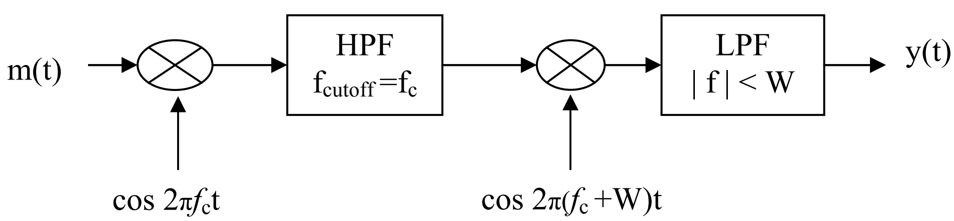

Fig.3

4. Consider the following modulated wave

$$s(t) = A_c \cos(2\pi f_c t) + m(t) \cos(2\pi f_c t) - \hat{m}(t) \sin(2\pi f_c t)$$

which represents a carrier plus an SSB signal, with m(t) denoting the message signal and $\hat{m}(t)$ its Hilbert transform. Determine the conditions for which an ideal envelope, with s(t) as input, would produce a good approximation to the message signal m(t).

Useful Formulas:

$x(t) \cos(w_0 t) \longleftrightarrow [X(f - f_0) + X(f + f_0)] / 2$

$s(t) = 0.5 + 2/\pi \sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2n-1} \cos[2\pi f_c t(2n-1)]$ { Switching function }

$2 \cos A \cos B = \cos(A-B) + \cos(A+B)$ $\quad$ $2 \sin A \cos B = \sin(A-B) + \sin(A+B)$

$2 \sin A \sin B = \cos(A-B) - \cos(A+B)$ $\quad$ $\cos^2\theta = 0.5 [1 + \cos 2\theta]$

$x_c(t) = 0.5 A_c [x(t) \cos w_c t + \hat{x}(t) \sin w_c t]$ { LS SSB signal }