BAŞKENT UNIVERSITY
ELECTRICAL & ELECTRONICS ENGINEERING DEPT.
EEM 441 Communication Systems I – Final Exam

Duration: 90 min 21/01/2002

1. The AM signal

$$s(t) = A_c[1 + k_a m(t)] \cos(2\pi f_c t)$$

is applied to the system shown in Fig.1. Assuming that $| k_a m(t) | < 1$ for all t and the message signal m(t) is limited to the interval $-W \leq f \leq W$ and that the carrier frequency $f_c > 2W$. Show that m(t) can be obtained from the square-rooter output $v_3(t)$.

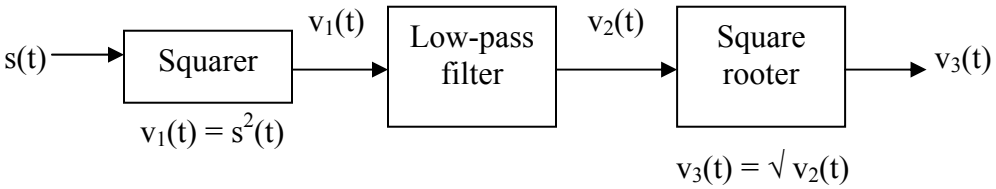

Fig.1

2. The normalized signal m(t) has a bandwidth of 10 kHz and its power content is 0.5 W. The carrier $A \cos(2\pi f_0 t)$ has a power content of 200 W.

a) If m(t) modulates the carrier using SSB amplitude modulation, what will be the bandwidth and power content of the modulated signal?
b) If the modulation scheme is DSB-SC, what will be the answer to part a) ?
c) If the modulation scheme is AM with modulation index of 0.6, what will be the answer to part a) ?
d) If the modulation is FM with $k_f = 50\,000$, what will be the answer to part a) ?

3. Assume that the first IF amplifier in the dual conversion receiver shown in Fig.2 passes all frequencies between $f_1 - W$ and f_1. Determine the receiver oscillator frequencies, f_0 and f_d, required to properly demodulate the following transmissions.

a) A SSB-USB transmission occupying the frequency range from f_c to $f_c + W$.
b) A SSB-LSB transmission occupying the frequency range from $f_c - W$ to f_c.
c) What happens if the receiver is set for receiving upper sideband and the actual received signal is lower sideband?

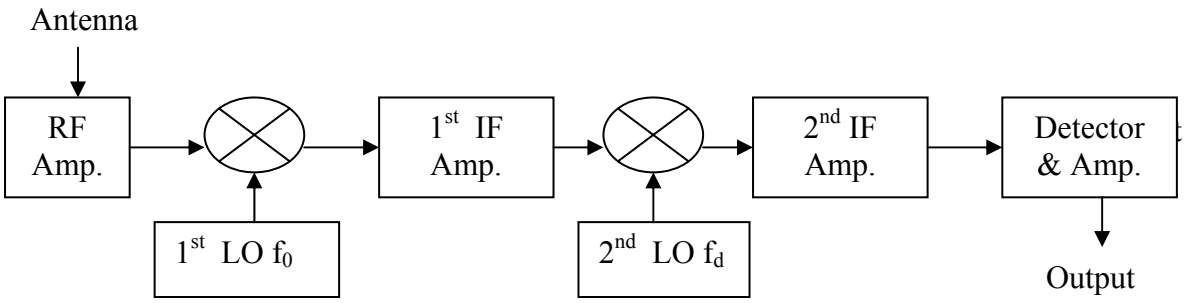

Fig.2

4. A certain sinusoid at a frequency of f_m Hz is used as the modulating signal in both an AM and a FM system. When modulated, the peak frequency deviation of the FM system is set to three times the bandwidth of the AM system. The magnitudes of those sidebands spaced at $\pm f_m$ Hz from the carrier in both systems are equal, and the total average powers are equal in both systems. Determine

a) The modulation index of the FM system
b) The modulation index of the AM system.

Useful Formulas:

$$u(t) = A_c \sum_{n=-\infty}^{\infty} J_n(\beta) \cos[2\pi(f_c + nf_m)t] \quad \{ \text{FM signal} \}$$

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

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

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

$\cos^2\beta = 0.5 [1 + \cos 2\beta]$

$J_1(6) = -0.28$