# Winter 2008 ELG3170 Midterm

30 Points Total, 90 Minutes, Close-Book

March 1st, 2008

## Warning: Any error in unnecessarily included explanations in your solutions will be penalized!

1. (3 points) Which one of the following AM modulation schemes allows the use of a simpler receiver primarily based on an envelop detector?
   (a) DSB-SC
   (b) DSB-TC

2. (3 points) Suppose that the message signal $m(t)$ is low-pass with spectrum occupying precisely frequency band $[-3kHz, +3kHz]$. An AM modulation scheme generates signal

$$u(t) = A_c m(t)\cos(2\pi \cdot 700000 \cdot t) + A_c \hat{m}(t)\sin(2\pi \cdot 700000 \cdot t) \qquad (1)$$

   for some chosen positive value of $A_c$, where $\hat{m}(t)$ is the Hilbert Transform of $m(t)$. What is this modulation scheme?

**From here on, $u(t)$ is taken as that defined in Equation (1).**

3. (5 points) Suppose that $u(t)$ is transmitted and received (perfectly). Now consider the following demodulation scheme of signal $u(t)$ so as to recover $m(t)$.
   (a) Generate $y(t) = u(t)\cos(2\pi \cdot 700000 \cdot t + \theta)$.
   (b) Pass $y(t)$ through an ideal low-pass filter with pass-band $[-3kHz, +3kHz]$.

   Express $y(t)$ in terms of $m(t)$ and $\theta$. Determine the choice of $\theta$ for which the low-pass filter outputs $m(t)$ up to scale.

**From here on, we consider $m(t)$ is such that the Fourier Transform of $m(t)$ is $M(f) = \Pi(f/300)$, where $\Pi(f) = 1$ for $f \in [-1, 1]$ and $\Pi(f) = 0$ for $f \notin [-1, 1]$.**

4. (5 points) Determine the Fourier Transform $U(f)$ of $u(t)$.

5. (3 points) What is the bandwidth of signal $u(t)$ above?

6. (3 points) Is $u(t)$ power-type signal or energy-type signal?

7. (3 points) If $u(t)$ is power-type, determine its power. If $u(t)$ is energy-type, determine its energy.

8. (5 points) Determine the low-pass equivalent of $u(t)$, with respect to carrier frequency $700kHz$.