**EECS 307 Midterm 2**

Feb. 26, 2020

(open book and notes)

1. For the bandpass frequency response

$$X(f) = \begin{cases} 1 & 700 \le |f| \le 1100 \\ 0 & otherwise \end{cases}$$

with carrier frequency $f_c = 1000$, sketch the baseband signal in the frequency domain and find the complex envelope $\tilde{x}(t)$, the in-phase and quadrature components $x_R(t)$ and $x_I(t)$, and the envelope of the signal $A(t)$. Sketch the envelope and label the zero-crossings.

2. An AM modulator operates with the message signal

$$m(t) = 20\cos(40\pi t) + 30\cos(80\pi t)$$

The unmodulated carrier is given by $100\cos 200\pi t$, and the system operates with a modulation index of 3/4.

(a) What is the normalized message $m_n(t)$? What is the power of $m_n(t)$? You can assume that $|\max m(t)| = |\min m(t)| = 50$.

(b) Determine the power efficiency of the modulator.

(c) Sketch the double-sided amplitude spectrum of $x_c(t)$, the modulator output, giving the weights and frequencies of all components.

3. A lower sideband Single-Sideband (SSB) signal is generated by modulating a 1600 kHz carrier by the signal $m(t) = 2\cos 4000\pi t + \sin 4000\pi t$. The amplitude of the carrier is $A_c = 1$.

(a) Determine the magnitude spectrum of the lower sideband SSB signal.

(b) Determine the (time domain) expression for the modulated signal $x_c(t)$.
(Hint: use your answer to part (a).)

(c) Suppose now that the signal $m(t)$ frequency modulates the carrier. Given $f_d =$ 50 kHz, (i) write an expression for the modulated signal $x_c(t)$, (ii) determine the modulation index, and (iii) estimate the bandwidth of the modulated signal.