AV314 - Communication Systems I
(Analog Communication Systems)

Tutorial 1

most of the questions are from UM

Short questions

- What is the difference between analog and digital communications?
- What does one mean by communication between two points separated by time?
- What is Shannon's definition of the fundamental problem of communication?
- Why do you think the world is moving towards digital communication?
- Give examples of analog communication systems in use today.

- What is the definition of an LTI system?
- Why do we use LTI system models?

- Suggest an error function for calculating whether the reconstruction of an analog message signal is reasonable or not.

- Suggest a method of representing an effectively bandlimited and time limited continuous time signal as a vector

Question 1

What is the energy of the signal $s(t) = 2I_{[0,T]} + jI_{[T/2,2T]}$

Question 2

Show that the Fourier transform of $u(t) = \sin(\pi t) I_{[0,1]}(t)$ is $U(f) = \frac{2\cos(\pi f)}{\pi(1-4f^2)} e^{-j\pi f}$

Question 3

Problem 2.2 Find and sketch $y = x_1 * x_2$ for the following.

(a) $x_1(t) = e^{-t} I_{[0,\infty)}(t)$, $x_2(t) = x_1(-t)$.
(b) $x_1(t) = I_{[0,2]}(t) - 3I_{[1,4]}(t)$, $x_2(t) = I_{[0,1]}(t)$.

Question 4

Problem 2.4 Find and sketch the Fourier transforms for the following signals.

(a) $u(t) = (1 - |t|)I_{[-1,1]}(t)$.
(b) $v(t) = \text{sinc}(2t)\text{sinc}(4t)$.
(c) $s(t) = v(t)\cos(200\pi t)$.
(d) Classify each of the signals in (a)–(c) as baseband or passband.

Question 5

Problem 2.7 The signal $s(t) = \text{sinc}(4t)$ is passed through a filter with impulse response $h(t) = \text{sinc}^2 t \cos(4\pi t)$ to obtain output $y(t)$. Find and sketch the Fourier transform $Y(f)$ of the output (sketch the real and imaginary parts separately if the spectrum is complex-valued).

Question 6

Suppose a baseband signal $m(t) = 5\cos(2\pi 50 t) + 2\sin(2\pi 60 t)$ is AM modulated using a carrier signal of frequency 1000 Hz. Find out the spectrum of the AM modulated signal - note that you should specify both the magnitude and phase spectra.

Question 7

Suppose a baseband signal $m(t) = 5\cos(2\pi 50\, t) + 2\sin(2\pi 60\, t)$ is AM modulated using a carrier signal of frequency 1000 Hz. Derive the condition on the modulator sensitivity so that there is no overmodulation or modulation distortion

Question 8

Suppose a baseband signal $m(t) = 5\cos(2\pi 50\, t) + 2\sin(2\pi 60\, t)$ is AM modulated using a carrier signal of frequency 1000 Hz. At the demodulator, a local oscillator (which is not correctly designed) produces a carrier signal of frequency 1010 Hz. Discuss with proper mathematical justification what is obtained at the output of the demodulator.

Question 9

Suppose a baseband signal $m(t) = 5\cos(2\pi 50\, t) + 2\sin(2\pi 60\, t)$ is AM modulated using a carrier signal of frequency 1000 Hz. Suppose the modulated signal is not over-modulated.

(a) Discuss a scheme by which the signal m(t) can be recovered non-coherently.

(b) Assuming that diodes used in the full-wave rectifier block are ideal - do you think the following system can be used in any way to recover m(t)?