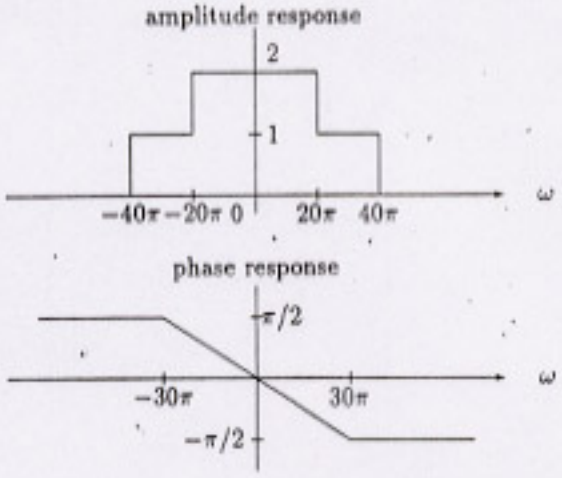
國立交通大學八十五學年度碩士班入學考試試題

1. (8%) Find and plot the Fourier transform of

$$x(t) = \begin{cases} A\cos 2\pi f_0 t, & nT - \frac{\tau}{2} \le t \le nT + \frac{\tau}{2}, \quad n = 0, \pm 1, \pm 2, \ldots \\ 0, & \text{otherwise} \end{cases} \qquad (T = 2\tau = 5/f_0)$$

using the multiplication and convolutional properties of the Fourier transform (without mathematically derivation).

2. Consider a linear time-invariant (LTI) system with amplitude and phase responses given as follow:



(a) (3%) Suppose $x(t) = 4\cos 10\pi t \cdot \sin^2 20\pi t$, find its average power P_x.

Note:
$$\sin u \sin v = \tfrac{1}{2}[\cos(u-v) - \cos(u+v)]$$
$$\cos u \cos v = \tfrac{1}{2}[\cos(u-v) + \cos(u+v)]$$
$$\sin u \cos v = \tfrac{1}{2}[\sin(u-v) + \sin(u+v)]$$

(b) (4%) Let $x(t)$ be the input to the LTI system, find the corresponding output signal $y(t)$.

(c) (2%) Find the output power P_y.

(d) (8%) If the input $x(t)$ is perturbed by an additive bandlimited white Gaussian noise (bandlimited to $\pm 20\pi$) $n(t)$ with unity power, find the joint p.d.f. of the noisy outputs at time $t = 0$ and $t = 1/15$ sec.

3. (a) (4%) Give the mathematical expression of an upper sideband SSB signal, if the baseband message signal is $m(t)$.

(b) (6%) Suggest two ways of generating an upper sideband SSB signal (draw the associated block diagrams).

4. Draw block diagrams of an FM demodulator using

   (a) (3%) a discriminator,

   (b) (4%) a phase-locked loop,

   (c) (4%) a frequency-compressive feedback loop,

   and indicate the place where the demodulated output is obtained.

   (d) (4%) What is the advantage of using the latter two implementations?

5. (a) (4%) Describe the Nyquist pulse-shaping criterion.

   (b) (4%) Prove it mathematically.

   (c) (4%) Explain how this criterion is used in digital communication.

6. Consider BPSK modulation:

   (a) (5%) Draw the block diagram of a BPSK transmitter and the block diagram of an optimum BPSK correlator receiver.

   (b) (5%) Derive the probability of error for BPSK transmission in AWGN.

   (c) (4%) Redo (b) when the regenerated local carrier at receiver has a phase error Φ_e.

   (d) (4%) Draw the block diagram of the carrier frequency synchronization subsystem in the receiver. Discuss its performance.

7. (a) (3%) What is channel capacity and what is the capacity of a binary symmetric channel?

   (b) (3%) State the Shannon-Hartley law for an AWGN channel.

   (c) (3%) Discuss the bandwidth-SNR trade off in (b).

   (d) (2%) Is it theoretically possible to reliably transmit a signal of bandwidth of 100 MHz through a channel with bandwidth of only 10 Hz? Why?

8. A TV set with a noise figure of 20 dB is connected to an antenna through a 30 m cable with 0.1 dB/m loss. Evaluate

   (a) (3%) the overall noise figure.

   (b) (3%) the overall noise figure if an RF preamplifier with 20 dB gain and 3 dB noise figure is inserted between the cable and the TV set.

   (c) (3%) the overall noise figure if the same preamplifier is inserted between the antenna and the cable.