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EEGR4123 **FINAL EXAM** **FALL 2002**

Name: _____

Student Number: _____

Do NOT begin until told to do so
Make sure that you have all pages before starting
You may not leave the room during the exam
No *calculators, open book, 2 page notes*

ACADEMIC INTEGRITY:
Students have the responsibility to know and observe the requirements of The UNCC Code of Student Academic Integrity as given in the UNCC Catalog. This code forbids cheating, fabrication or falsification of information, multiple submission of academic work, plagiarism, abuse of academic materials, and complicity in academic dishonesty.

Unless otherwise noted:

Show all work, even for multiple choice
Multiple choice answers should be within 5% of correct value
$\mathcal{F}\{\}$ denotes either continuous Fourier transform
$\mathcal{F}^{-1}\{\}$ denotes inverse Fourier transform
ω denotes the continuous-time frequency variable
$*$ denotes linear convolution
$x^*(t)$ denotes the conjugate of x(t)

Useful constants, etc:

$$\begin{array}{cccc} e \approx 2.72 & \pi \approx 3.14 & 1/e \approx 0.37 & \sqrt{2} \approx 1.41 \\ \sqrt{3} \approx 1.73 & \sqrt{5} \approx 2.22 & \sqrt{7} \approx 2.64 & \sqrt{10} \approx 3.16 \\ ln[2] \approx 0.69 & ln[4] \approx 1.38 & ln[55] \approx 4.0 & ln[256] \approx 5.6 \\ log_{10}[2] \approx 0.30 & log_{10}[3] \approx 0.48 & log_{10}[55] \approx 4.0 & log_{10}[10] \approx 1.0 \\ log_{10}[0.1] \approx -1.0 & log_{10}[0.5] \approx -0.3 & log_{10}[e] \approx 0.43 & cos(\pi/4) \approx 0.71 \end{array} \quad (1)$$

$cos(A)cos(B) = \frac{1}{2}cos(A-B) + \frac{1}{2}cos(A+B)$
$e^{j\theta} = cos(\theta) + jsin(\theta)$
$cos^2(A) = \frac{1}{2} + \frac{1}{2}cos(2A)$

5 Points Each (Circle the best answer)

1. $(e^{j\pi/2})^2 =$

   (a) $2j$ (b) $j+1$ (c) -1 (d) None above

2. The modulation index β of $cos(2000t + 5sin(10t))$ is

   (a) 0.5 (b) 5 (c) 15 (d) None above

3. The Fourier transform of $y(t) = 2sinc(2t)$ is

   (a) $\pi\ rect(\omega/4)$ (b) $\delta(\omega)sinc(2\omega)$

   (c) $2\ rect(2\omega)$ (d) None above

4. A bandlimited signal can be recovered exactly from its samples when the sampling rate is greater than the Nyquist rate.

   (a) True (b)False

5. The power P_y of a signal $y(t) = sin(3t) + 4sin(2t)$ is

   (a) $5sin(5t)$ (b) $\sqrt{5}$ (c) 8.5 (d) None above

5 Points Each (Circle the best answer)

6. The output $y(t)$ of a linear system for an input $x(t)$ is $y(t) = x(t-3)$. The magnitude of the frequency response of this system is $|H(\omega)| =$:

   (a) 1 (b) $rect(3\omega)$ (c) $X(\omega - 3)$ (d) None above

7. The power P_y of a signal with autocorrelation $R(\tau) = 3^{-2|\tau|}$ is

   (a) $sinc(\omega)$ (b) $3^{-2\omega}$ (c) 9 (d) None above

8. The statistics of the data being transmitted does not affect the power spectral density of a digital signal.

   (a) True (b)False

9. The thermal noise of a resistor over a 10 MHz bandwidth is 0.001 Vrms at 300 degrees K. At 30 degrees K and 100 MHz bandwidth, the noise is:

   (a) $0.0001Vrms$ (b) $0.001Vrms$ (c) $0.01Vrms$ (d) None above

10. A duobinary (Nyquist 2nd criterion) signal [1, 1, 0, 0] is received. This corresponds to a binary data sequence of (ignoring the first bit):

    (a) [1, 1, 0] (b) [1, 0, 0] (c) [1, 0, 1] (d) None above

5 Points Each (Circle the best answer)

11. The I and Q channels in QAM can carry independent signals that can both be recovered after demodulation.

    (a) True (b)False

12. The bandwidth of an FM signal is independent of the modulation index β.

    (a) True (b)False

13. The bandwidth of an AM signal is independent of the modulation index μ.

    (a) True (b)False

14. The bandwidth of a PM signal is independent of the amplitude of the modulating signal $m(t)$.

    (a) True (b)False

15. The carrier frequency of $cos(1000t + 2sin(20t))$ is

    (a) 1000 rad/s (b) 1002 rad/s (c) 1022 rad/s (d) None above

5 Points Each (Circle the best answer)

16. The signal $cos(1000t + 0.03sin(100t))$ is:

    (a) Narrowband FM (b) Wideband FM (c) SSB (d) None above

17. Which of the following line codes have built-in error detection capability.

    (a) Bipolar RZ (b) Polar RZ (c) On-Off NRZ (d) None above

18. The peak instantaneous frequency ω_i of $cos(1000t + 2sin(20t))$ is:

    (a) 1002 rad/s (b) 1022 rad/s (c) 1040 rad/s (d) None above

19. Bipolar linecode of peak amplitude $A_P = 6$ V is received in the presence of 3 Volts rms noise. For random data, the error probability is (to within +/- 0.05)

    (a) 0.01 (b) 0.25 (c) 0.67 (d) None above

20. Find the maximum channel capacity in a 1 KHz bandwidth channel, assuming a signal power of 255 Watts and noise power of 1Watt.

    (a) 8000 bits/s (b) 255,000 bits/s (c) 256,000 bits/s (d) None above

5 Points Each (Circle the best answer)

21. The Hilbert transform of the Hilbert transform of $x(t)$ is . (i.e., the Hilbert transform taken twice)

(a) $-x(t)$ (b) $-jX(\omega)$ (c) $jX(\omega)$ (d) None above

22. The bandwidth of the signal $cos(1000t + 2sin(20t))$ using Carson's rule is:

(a) 20 rad/s (b) 44 rad/s (c) 120 rad/s (d) None above

23. The peak phase deviation $\Delta\phi$ of $cos(1000t + 20sin(2t))$ is:

(a) 20 rad (b) 22 rad (c) 44 rad (d) None above

24. A 20 volt peak-peak signal is quantized in a uniform quantizer with stepsize $\Delta v = .1$ volts. The root mean square quantization noise is

(a) 1 volt (b) $\sqrt{2}$ volts (c) $\frac{20}{\sqrt{12}}$ volts (d) None above

25. The Fourier transform of the autocorrelation $R_y(\tau)$ of a random signal $y(t)$ is the power spectral density $S_y(\omega)$.

(a) True (b)False

5 Points Each (Circle the best answer)

26. The expected value of a coin toss experiment, where heads=4 and tails=0 is equal to:

(a) 0 (b) 2 (c) 4 (d) None above

27. The mean of a coin toss experiment, where heads=4 and tails=0 is equal to:

(a) 0 (b) 2 (c) 4 (d) None above

28. The second moment of a coin toss experiment, where heads=4 and tails=0 is equal to:

(a) 0 (b) 2 (c) 4 (d) None above

29. The Nyquist rate for sampling the signal $g(t) = cos(100\pi t) + cos(10\pi t)$ is :

(a) 100 samples/s (b) 110 samples/s (c) 220 samples/s (d) None above

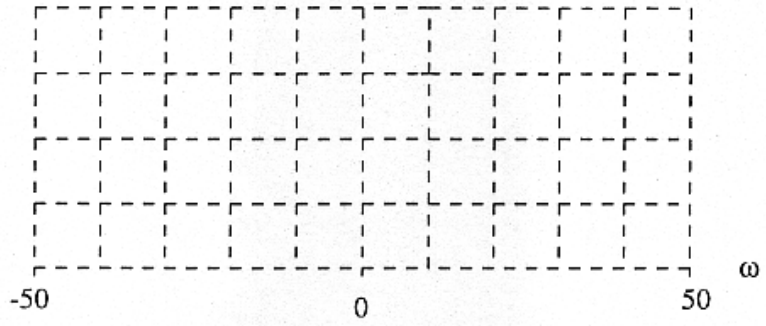
30. A delay line discriminator can be used to demodulate FM.

(a) True (b)False

For the following questions, a 30 rad/s carrier is phase modulated to give a modulated signal $y(t) = 2cos(30t + 0.1sin(10t))$, where the modulating signal was $m(t) = 0.1sin(10t)$.

10 points

31. For this signal, sketch the frequency spectrum $|Y(\omega)|$ below. Be sure to label the vertical axis.



5 points each

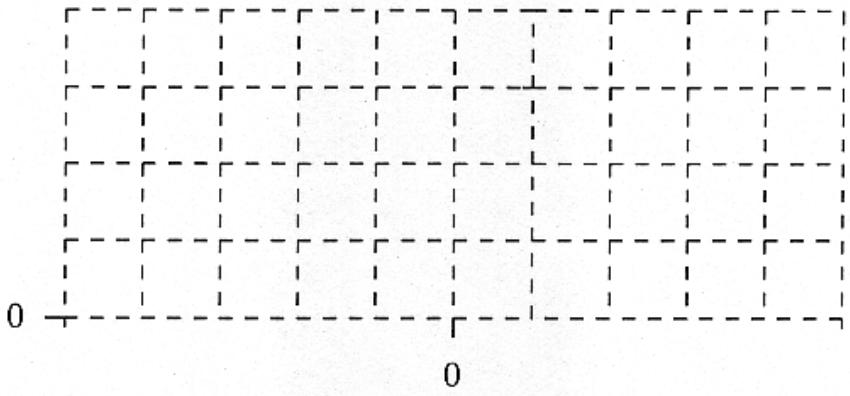
32. The signal $m(t)$ could be recovered from the above modulated signal using an envelope detector.
(a) True (b)False

33. If the signal $y(t)$ was squared, i.e., $y^2(t)$, then the modulation index would double.
(a) True (b)False

For the following questions, consider the experiment of tossing two coins. Then, define the random variable X where X is the number of heads, i.e., $X = 2$ if both coins have heads.

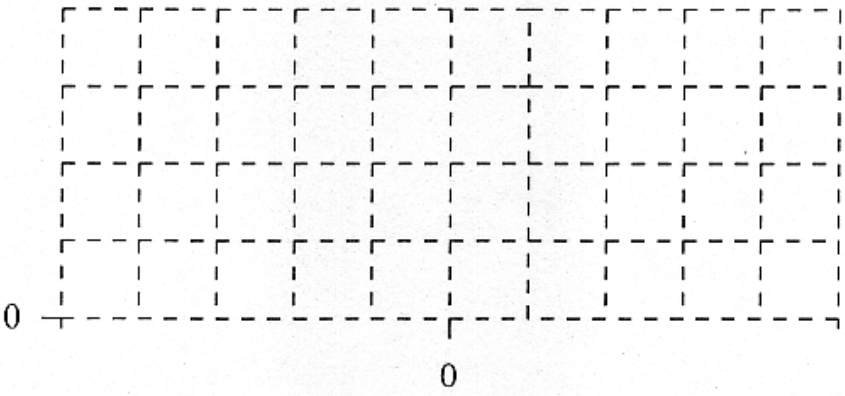
10 points

34. Plot the probability density function of X, $p_x(x)$.

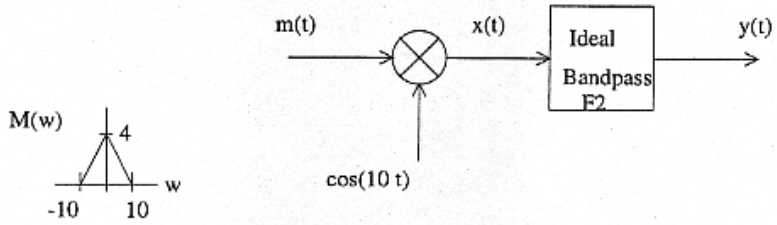


10 points

35. Plot the Cumulative Distribution Function of X, $F_x(x)$.

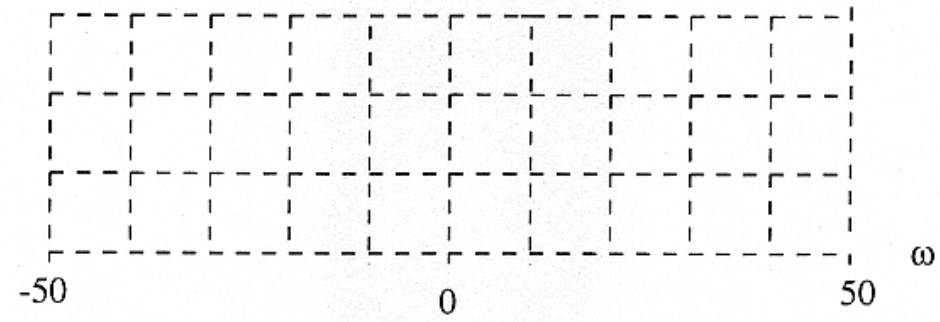


For the following questions, the block diagram and input spectrum $M(\omega)$ are given below. Assume that the ideal bandpass filter F2 has a bandwidth of 10 rad/s at a center frequency of 15 rad/s.
Explain why, or show derivation for your results below.



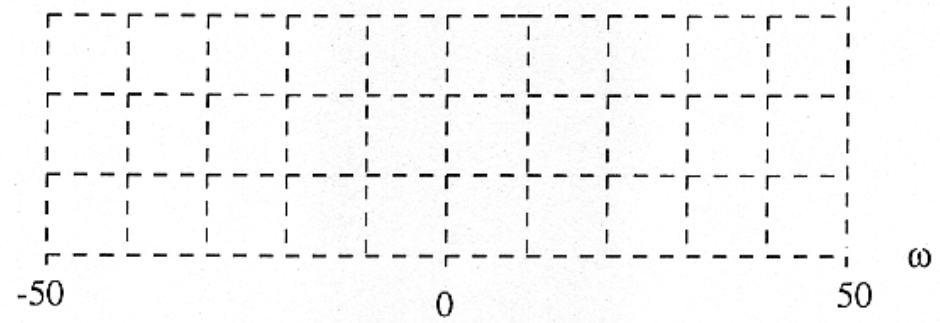
10 points

36. Plot $|X(\omega)|$ below. Be sure to label the axes.



10 points

37. Plot $|Y(\omega)|$ below. Be sure to label the axes.



38. Sketch the frequency response $|P(\omega)|$ of a Nyquist 2 (Nyquist second method) filter with a baud rate of $40/\pi$ baud.

Be sure to label the vertical axis.

10 points