EEGR4123 **FINAL EXAM** **FALL 1998**

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 (1997-99 Catalog page 336). 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:

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

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

2 Points Each (Circle the best answer)

1. The signal $cos(3\pi t)$ is an energy signal.

   (a) True (b) False

2. The frequency of the signal $sin(t)$ is

   (a) t rad/s (b) 1 rad/s (c) 2π Hz (d) None above

3. $(e^{j\pi/4})^2 =$

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

4. The output $y(t)$ of a linear system for an input $x(t)$ is $y(t) = x(t-1)$. The magnitude of the frequency response of this system is $|H(\omega)| =$:

   (a) 1 (b) $rect(\omega)$ (c) $sinc(t-1)$ (d) None above

5. The Fourier transform of $rect(t/2)cos(10t)$ is

   (a) $sinc(\omega - \omega_0)$ (b) $sinc(\omega - 10) + sinc(\omega + 10)$

   (c) $sinc(\omega)\delta(\omega)$ (d) None above

2 Points Each (Circle the best answer)

6. The Hilbert transform of the Hilbert transform of $\cos(t)$ is

   (a) $\cos(t)$ (b) $-\cos(t)$ (c) $j\ \sin(t)$ (d) None above

7. Television broadcast signals can best be described as

   (a) DSB-LC (b) SSB (c) VSB (d) None above

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

   (a) True (b)False

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

   (a) True (b)False

10. Distortionless signal transmission requires constant group delay over the transmission bandwidth.

    (a) True (b)False

2 Points Each (Circle the best answer)

11. The signal $cos(1000t + 2sin(20t))$ is:

(a) FM (b) PM (c) FM and PM (d) None above

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

(a) 1000 rad/s (b) 1002 rad/s (c) 2000π rad/s (d) None above

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

(a) 1002 rad/s (b) 1020 rad/s (c) 1040 rad/s (d) None above

14. The modulation index β of $cos(1000t + 2sin(20t))$ is

(a) 1 (b) 2 (c) 10 (d) None above

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

(a) 1/2 (b) 2 (c) 20 (d) None above

2 Points Each (Circle the best answer)

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

(a) 6 rad/s (b) 40 rad/s (c) 120 rad/s (d) None above

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

(a) 2 rad (b) 40 rad (c) 1002 rad (d) None above

18. The Nyquist rate for sampling the signal $g(t) = cos(50\pi t) + cos(200\pi t)$ is :

(a) 100π samples/s (b) 200 samples/s (c) 250 samples/s (d) None above

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

(a) True (b)False

20. The Fourier transform of the autocorrelation of a power signal is power spectral density.

(a) True (b)False

2 Points Each (Circle the best answer)

21. A 50 volt peak-peak signal is quantized in a uniform quantizer with stepsize $\Delta v = 3$ volts. The mean square quantization noise (or equivalently, quantization noise power) is

(a) 0.06 volts^2 (b) 0.75 volts^2 (c) 9 volts^2 (d) None above

22. A compandor can be used to reduce the effects of quantization noise on weak signals.

(a) True (b)False

23. The number of voice channels carried by a T1 carrier system is typically

(a) 19 (b) 24 (c) 193 (d) None above

24. The typical bit rate of a single PCM voice channel is

(a) 4000 bits/s (b) 8000 bits/s (c) 64000 bits/s (d) None above

25. The power spectral density of a line code depends on the statistics of the data and pulse shape.

(a) True (b)False

2 Points Each (Circle the best answer)

26. A valid Nyquist 1st criterion (zero ISI) pulse at a data rate of 100 bits/second could be $p(t) = sinc^3(100\pi t)$.

    (a) True (b)False

27. An 8-ary signal at 1000 baud transmits data at a rate of

    (a) 1000 bits/s (b) 3000 bits/s (c) 8000 bits/s (d) None above

28. Duobinary pulses exhibit zero ISI.

    (a) True (b)False

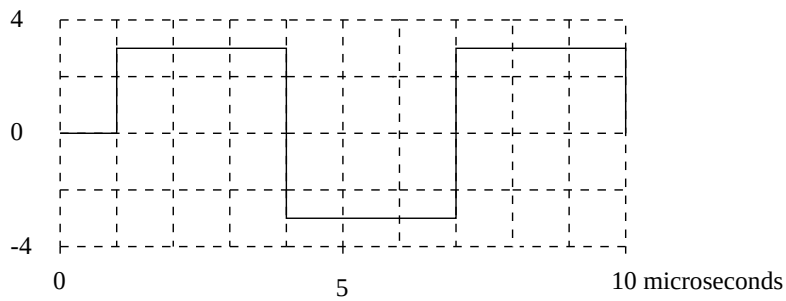
29. The bandwidth of a bipolar signal at 1000 baud using sinusoidal roll-off pulses with $r = .5$ is

    (a) 500 Hz (b) 750 Hz (c) 1500Hz (d) None above

30. The bandwidth of a polar signal at 1000 baud using sinusoidal roll-off pulses with $r = .5$ is

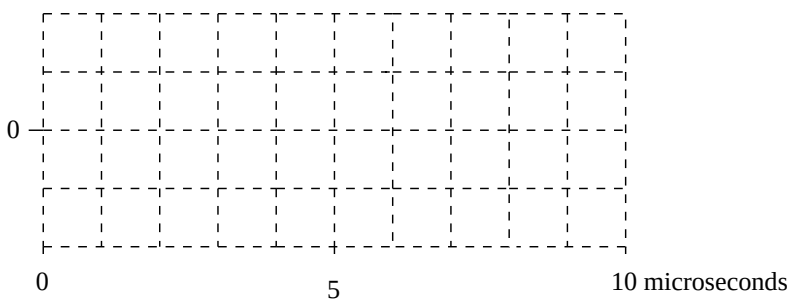
    (a) 500 Hz (b) 750 Hz (c) 1500Hz (d) None above

31. For the following questions, let the modulating signal be $m(t)$ given below.



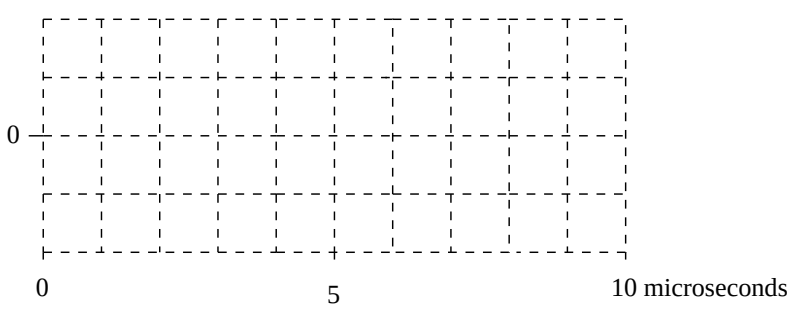
5 points

(a) Sketch the signal that results when $m(t)$ is used to modulate a 1 volt peak-peak 0.5 MHz carrier using DSB-SC modulation.



5 points

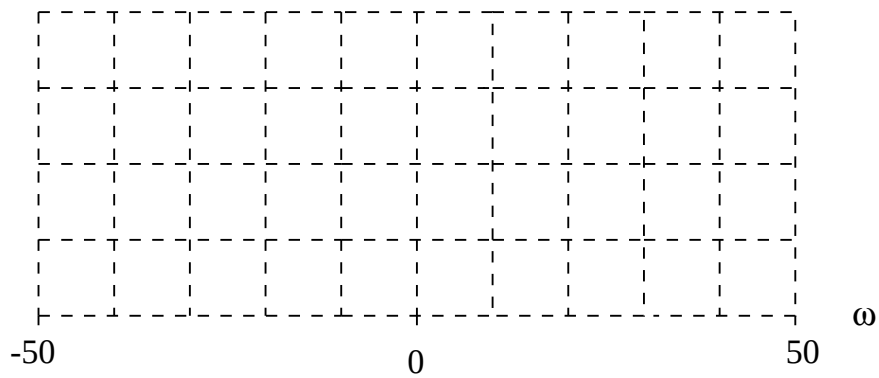
(b) Sketch the signal that results when $m(t)$ is used to modulate a 1 volt peak-peak 0.5 MHz carrier using DSB-LC modulation, given that the modulation level is adjusted so that the modulation index of the final modulation is $\mu = 0.5$. (You may assume that $m(t)$ is multiplied by some constant to result in the desired value of μ.)



32. For the following questions, A PM signal is given as $y(t) = cos(25t + 0.2cos(10t))$.

10 points

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

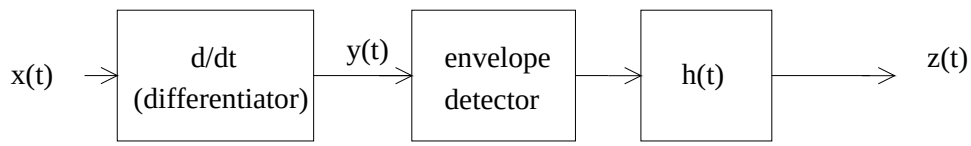


33. A polar line code at $1/T_0$ bits/s is formed using a pulse shape of $p(t) = sinc^2(\pi t/T_0)$ instead of the usual square pulse of width $T_0/2$ used in a polar-RZ line code.

10 points

Find the power spectral density $S_y(\omega)$ of this new line code. Show the intermediate results for $S_x(\omega)$ and $P(\omega)$ used in finding $S_y(\omega)$.

34. The block diagram of a communications system is shown below. The input to the system is $x(t) = 4sin(20000\pi t + 3cos(20\pi t))$, and the impulse response of the filter is $h(t) = sinc(t)$



5 points

(a) Find y(t).

5 points

(b) Find z(t). (Hint: this is not a well-designed demodulator.)