EEGR4123 **FINAL EXAM** **FALL 1999**

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 $e^{|t|}$ is an energy signal.

   (a) True (b) False

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

   (a) 5 (b) $5\sqrt{2}$ (c) 6.5 (d) None above

3. A phase-locked loop can be used to demodulate FM signals.

   (a) True (b) False

4. The bandwidth of a SSB signal is twice the bandwidth of a DSB-LC signal.

   (a) True (b)False

5. An ideal Butterworth filter is distortionless.

   (a) True (b)False

2 Points Each (Circle the best answer)

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

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

7. The frequency of the signal $sin(\pi t)$ is

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

8. $e^{-j5\pi/2} =$

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

9. Television broadcast signals can best be described as

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

10. A QAM modulator can be used to generate a phase modulated signal.

    (a) True (b)False

2 Points Each (Circle the best answer)

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

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

12. The carrier frequency of $2cos(1000t + sin(200t))$ is

    (a) 1000 rad/s (b) 1002 rad/s (c) 200 rad/s (d) None above

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

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

14. The modulation index β of $cos(500t + sin(2t))$ is

    (a) 1 (b) 2 (c) 500 (d) None above

15. The Fourier transform of $y(t) = rect(2t)\ rect(4t)$ is

    (a) $0.25sinc(\omega/8)$ (b) $4sinc(4\omega)sinc(2\omega)$

    (c) $rect(2) + rect(4)$ (d) None above

2 Points Each (Circle the best answer)

16. Polar binary pulses of amplitude $A_P = 10$ V are received in the presence of 2 Volts rms noise. For random data, the error probability is (within +/- 50 % accuracy)

    (a) 0.001 (b) 0.01 (c) 0.99 (d) None above

17. A 15 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) 1.5 volts (c) 2.3 volts (d) None above

18. The pulse shape of a digital signal affects the power spectral density of the signal.

    (a) True (b)False

19. 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

20. The power spectral density of a baseband bipolar coded signal is always zero at $\omega = 0$, for any pulse shape $p(t)$.

    (a) True (b)False

2 Points Each (Circle the best answer)

21. A valid Nyquist 1st criterion (zero ISI) pulse at a data rate of 10 bits/second could be $p(t) = sinc(\pi t)$.

    (a) True (b)False

22. The bandwidth of a bipolar signal at 1000 baud using sinusoidal roll-off pulses with $r = .25$ is

    (a) 250 Hz (b) 750 Hz (c) 1250Hz (d) None above

23. 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

24. A binary 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

25. For a given bandwidth and pulse shape, a greater number of bits/second can be transmitted with bipolar-RZ than using polar-RZ.

    (a) True (b)False

2 Points Each (Circle the best answer)

26. The modulation index μ of $g(t) = [10 + 2cos(4t)]sin(10000t)$ is:

    (a) 1/5 (b) 4/5 (c) 12 (d) None above

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

    (a) 50 samples/s (b) 100 samples/s (c) 200 samples/s (d) None above

28. An FM carrier at 1 MHz is FM modulated by a 1 KHz sine wave with $\beta = 10$. Using Carson's rule, the signal bandwidth is:

    (a) 11 KHz (b) 22 KHz (c) 1.001 MHz (d) None above

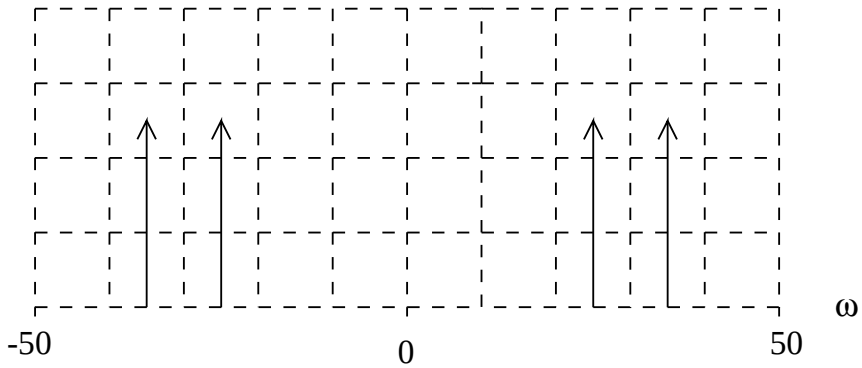
29. The signal $cos(1000t + 20sin(20t))$is narrowband FM.

    (a) True (b) False

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

    (a) True (b)False

For the following questions, a carrier is modulated by a purely sinusoidal signal $m(t) = cos(5t)$ to generate a modulated signal with frequency spectrum $|Y(\omega)|$ shown below.



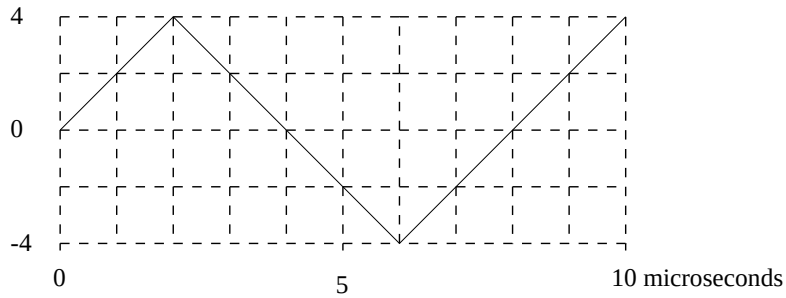
5 points each

31. $y(t)$ could be a DSB-LC signal.
(a) True (b)False

32. $y(t)$ could be a DSB-SC signal.
(a) True (b)False

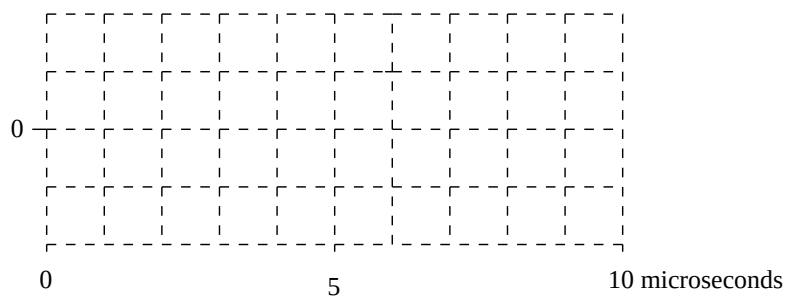
33. $y(t)$ could be an SSB signal.
(a) True (b)False

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



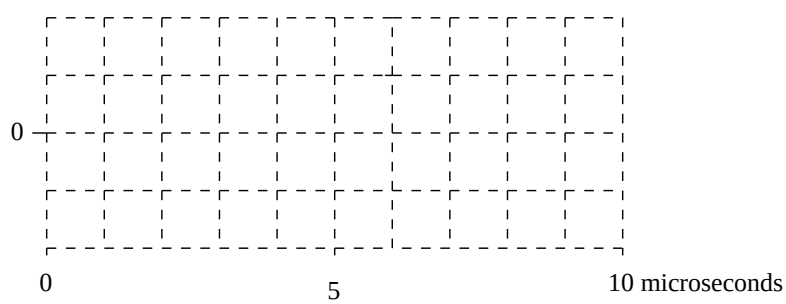
10 points

(a) Sketch the signal that results when $m(t)$ is used to modulate a 0.5 MHz carrier using DSB-LC modulation with modulation index of $\mu = 1$. Assume the peak value of the modulated signal is 1 V.

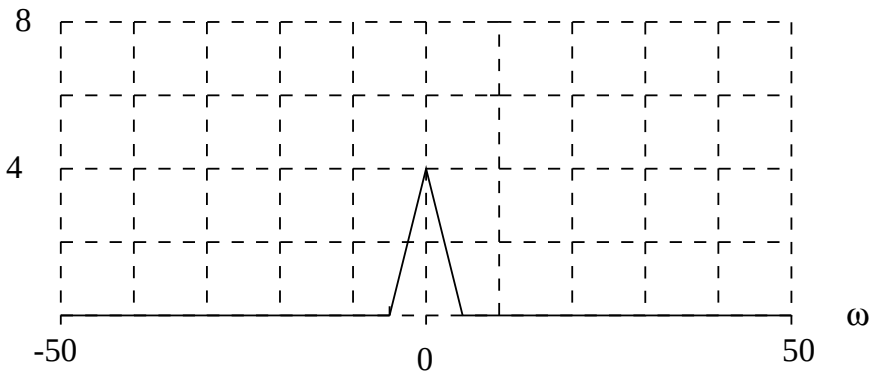


10 points

(b) Sketch the signal that results when $m(t)$ is used to modulate 0.5 MHz carrier using DSB-SC modulation. Assume the peak value of the modulated signal is 1 V.



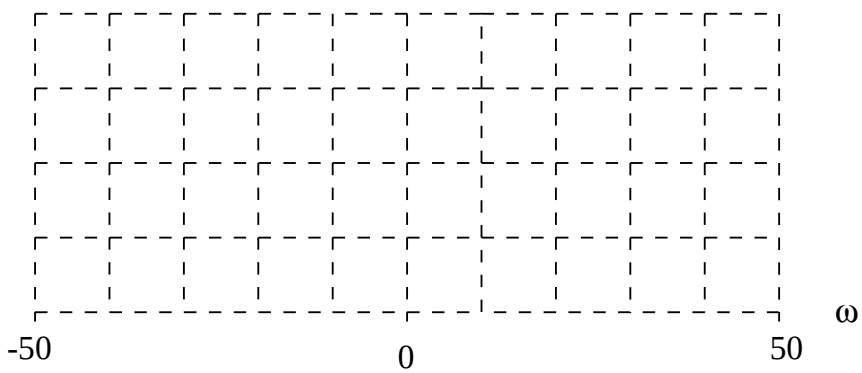
35. For the following questions, A signal is given as $y(t) = m(t)\ cos(30t)\ cos(10t)$. The spectrum $M(\omega)$ of $m(t)$ is given below.



10 points

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

Explain why, or show derivation for your result.

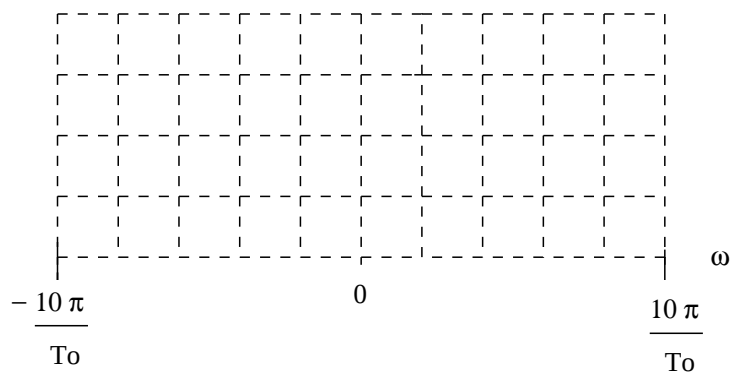


36. A polar line code at $1/T_0$ bits/s is formed using a rectangular pulse of width $T_0/4$ instead of the usual square pulse of width $T_0/2$ used in a polar-RZ line code.

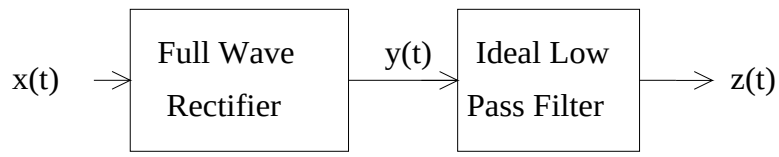
10 points

Sketch the power spectral density $S_y(\omega)$ of this new line code.

Explain why, or show derivation for your result.

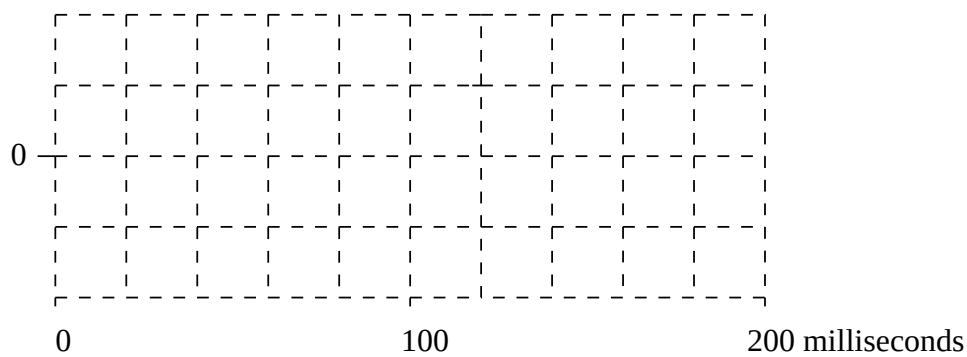


37. The block diagram of a communications system is shown below. The input to the system is $x(t) = sin(100\pi t)[2 + cos(20\pi t)]$, and the cutoff frequency the filter is 20 Hz.



5 points

(a) Sketch y(t).



5 points

(b) Find z(t).