

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 (1999-2001 Catalog page 375). 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:

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

$$\cos(A)\cos(B) = \frac{1}{2}\cos(A - B) + \frac{1}{2}\cos(A + B)$$

$$e^{j\theta} = \cos(\theta) + j\sin(\theta)$$

$$\cos^2(A) = \frac{1}{2} + \frac{1}{2}\cos(2A)$$

2 Points Each (Circle the best answer)

1. The signal $\text{sinc}(t)$ is an energy signal.

(a) True

(b) False

2. The power P_y of a signal $R(\tau) = 2\text{sinc}^2(\tau)$ is

(a) 0

(b) $1/\pi\sqrt{2}$

(c) 2

(d) None above

3. For the same modulating signal, $m(t)$, the bandwidth of AM (DSB-LC) is always less than or equal to that of FM modulation.

(a) True

(b) False

4. The Hilbert transform of $\delta(t)$ is $1/(\pi t)$.

(a) True

(b) False

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

(a) True

(b) False

2 Points Each (Circle the best answer)

6. Find the maximum channel capacity in a 1 KHz bandwidth channel, assuming a signal power of 31 Watts and noise power of 1Watt.

- (a) 500bits/s (b) $5,000\text{bits/s}$ (c) $50,000\text{bits/s}$ (d) None above

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

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

8. The thermal noise of a resistor over a 10 MHz bandwidth is 0.001 Vrms at 300 degrees K. At 30 degrees K and 1 MHz bandwidth, the noise is:

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

9. The signal $\cos(1000t + 0.1\sin(20t))$ is narrowband FM.

- (a) True (b) False

10. A QAM modulator can be used to generate AM, PM, and FM modulations.

- (a) True (b) False

2 Points Each (Circle the best answer)

11. The signal $\cos(1000t + 20\sin(20t))$ is:
(a) Narrowband FM (b) Wideband FM (c) SSB (d) None above
12. 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
13. The peak instantaneous frequency ω_i of $\cos(1000t + \sin(2t) + \sin(3t))$ is:
(a) 1000 rad/s (b) 1002 rad/s (c) 1003 rad/s (d) None above
14. The modulation index β of $\cos(500t + 5\sin(2t))$ is
(a) 2 (b) 5 (c) 10 (d) None above
15. The Fourier transform of $y(t) = 2e^{j10t}\text{sinc}(t)$ is
(a) $\text{rect}(\omega - 10)$ (b) $\text{sinc}(t - 10)$
(c) $\delta(\omega)\text{rect}(\omega)$ (d) None above

2 Points Each (Circle the best answer)

21. 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
22. A valid Nyquist 1st criterion (zero ISI) pulse at a data rate of 10 bits/second could be $p(t) = \text{sinc}^2(10\pi t)$.
- (a) True (b) False
23. The bandwidth of a polar signal at 1000 baud using sinusoidal roll-off pulses with $r = .2$ is
- (a) 1200 Hz (b) 400 Hz (c) 600Hz (d) None above
24. The minimum sampling rate, without aliasing, for a signal with 10 KHz of bandwidth is
- (a) 5 KHz (b) 10 KHz (c) 20 KHz (d) None above
25. A 4-level signal (2 V, 1 V, -1 V, -2 V) at 1000 baud transmits data at a rate of
- (a) 1000 bits/s (b) 2000 bits/s (c) 4000 bits/s (d) None above

2 Points Each (Circle the best answer)

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

- (a) 1/5 (b) 1/2 (c) 12 (d) None above

27. The Nyquist rate for sampling the signal $g(t) = \cos(100\pi t) + 2$ 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 peak frequency deviation of 10 KHz. Using Carson's rule, the signal bandwidth is:

- (a) 1 KHz (b) 10 KHz (c) 22 MHz (d) None above

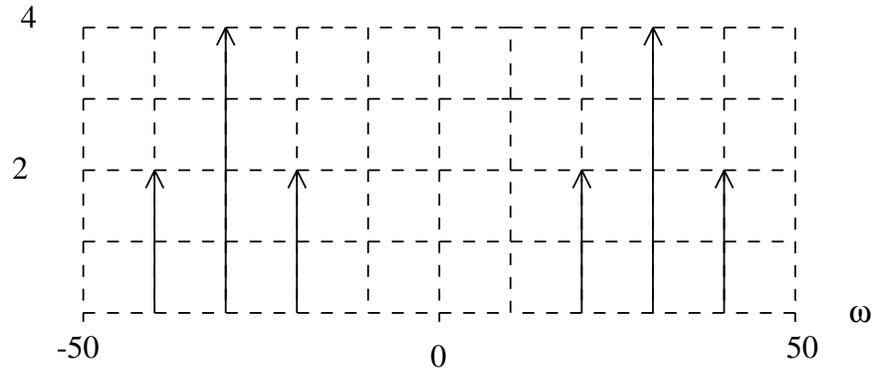
29. The second moment of a coin toss experiment, where heads=2 and tails=0 is equal to:

- (a) 0 (b) 1 (c) 2 (d) None above

30. A Gaussian random voltage has a second moment equal to 2 and mean equal to 1. The probability the voltage is less than zero is (to within +/- 0.010):

- (a) 0.158 (b) 0.080 (c) 0.023 (d) None above

For the following questions, a 30 rad/s carrier is AM (DSB-LC) modulated by sinusoidal signal $m(t)$ to generate a modulated signal with frequency spectrum $|Y(\omega)|$ shown below (weights of the delta functions are shown on the y-axis).



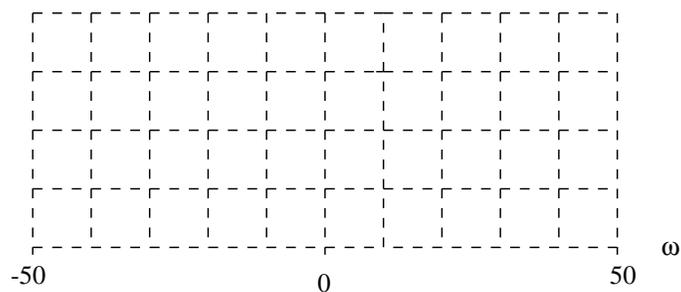
5 points each

31. The modulation index μ is.
 (a) 0.25 (b) 0.5 (c) 1 (d) None above
32. The frequency of the sinusoidal modulation $m(t)$ is
 (a) 10 rad/s (b) 20 rad/s (c) 30 rad/s (d) None above
33. If the signal was a narrowband FM signal instead of an AM signal, the frequency of the sinusoidal modulation $m(t)$ would be
 (a) 10 rad/s (b) 20 rad/s (c) 30 rad/s (d) None above

34. For the following questions, let the PM signal be $y(t) = 2\cos(40t + 0.2\sin(5t))$. The

20 points

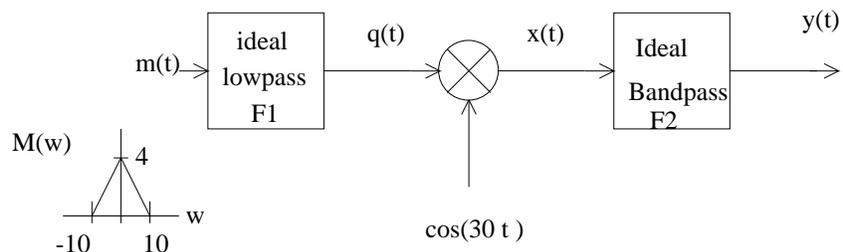
(a) Sketch the frequency spectrum $|Y(\omega)|$ below. Show all of your work!



10 points

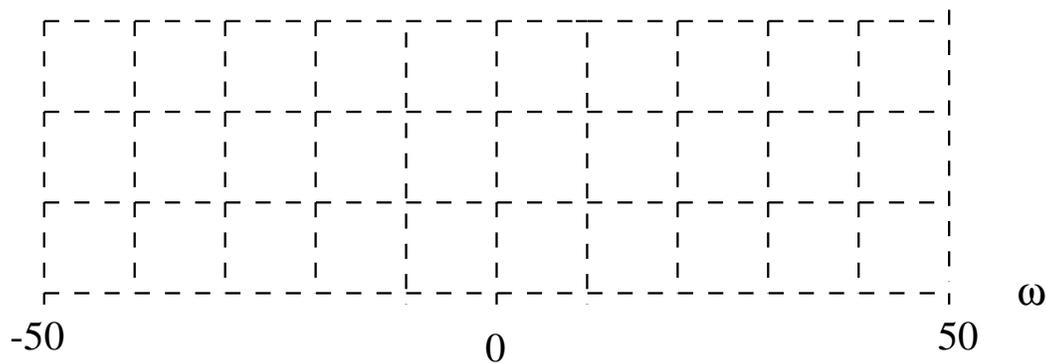
(b) Sketch the block diagram of a *differentiator-type* demodulator for this signal. Use ideal filters where needed, and indicate bandwidths.

35. For the following questions, the block diagram and input spectrum $M(\omega)$ are given below. Assume that the ideal lowpass filter F1 cuts off at 5 rad/s, ideal bandpass filter F2 has a bandwidth of 10 rad/s at a center frequency of 25 rad/s.



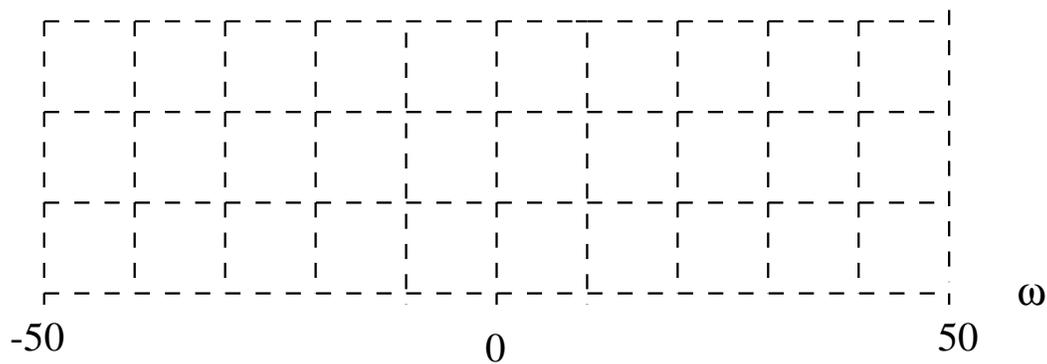
10 points

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



10 points

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



36. A polar line code at $1/T_0$ bits/s is formed using a triangular pulse of width $T_0/2$ and peak value of 1 volt 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.

