

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, 1 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:

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

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

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

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

5 Points Each (Circle the best answer)

1. Vestigial sideband (VSB) requires less bandwidth than double- sideband suppressed carrier for a given modulating signal $m(t)$.

(a) True

(b) False

2. Given DSB-LC signal $y(t) = 4(1 + \cos(10t))\cos(10000t)$, the modulation index is $\mu =$

(a) 0.25

(b) 0.5

(c) 1

(d) None above

3. The signal $\text{rect}(10t) * \text{rect}(30t)$ is an energy signal.

(a) True

(b) False

4. If $h(t) = 2000 \sin(100t)\text{sinc}(t)$ is the impulse response of a system, the bandwidth of the system is

(a) 1 Hz

(b) 2 rad/s

(c) 2π rad/s

(d) None above

5 Points Each (Circle the best answer)

5. Let the autocorrelation function of signal $y(t)$ be given as $R_y(\tau) = \text{sinc}^3(\tau)$. The power P_y of this signal is then:

- (a) 0.5 (b) 1 (c) 2τ (d) None above

6. Let $x(t) = 2\cos^3(2\pi t)$. D_0 in the exponential Fourier series expansion of $x(t)$ is $D_0 =$

- (a) 0 (b) $1/2$ (c) $1/4$ (d) None above

7. Let the power spectral density of signal $y(t)$ be given as $S_y(\omega) = \pi \text{rect}(\omega/3) + \pi \text{rect}(\omega)$. The power P_y of this signal is then:

- (a) 1.2 (b) $4/3\pi$ (c) 2 (d) None above

8. Assume a DSB-SC signal $y(t) = m(t)\cos(1000t)$, with $m(t) = \cos(100t)$. The carrier frequency of the signal $y(t)$ is

- (a) 100 Hz (b) 100 rad/s (c) 1000 Hz (d) None above

5 Points Each (Circle the best answer)

9. The double convolution, $[\delta(t + 1) * \text{rect}(t)] * \delta(t - 1) =$

- (a) $\delta(\text{rect}(t - 1))$ (b) $\text{rect}(t - 1) + \text{rect}(t + 1)$ (c) $\text{rect}(t)$ (d) None above

10. The Hilbert transform of e^{j2t} is

- (a) $\delta(2\omega t)$ (b) $1/(\pi t)$ (c) $-j e^{j2t}$ (d) None above

11. A filter with impulse response $h(t) = e^{-0.5t}$ is distortionless.

- (a) True (b) False

12. The impulse response of a filter is $\delta(t - 1)$. The time delay through the filter is:

- (a) π radian/second (b) 1 seconds (c) -1 seconds (d) None above

5 Points Each (Circle the best answer)

13. A fourth root of j is

- (a) $j/4$ (b) $e^{-j\pi/8}$ (c) $e^{j\pi/4}$ (d) None above

14. Random signals $x(t)$ cannot have power spectral density functions, $S_x(\omega)$, because of their randomness.

- (a) True (b) False

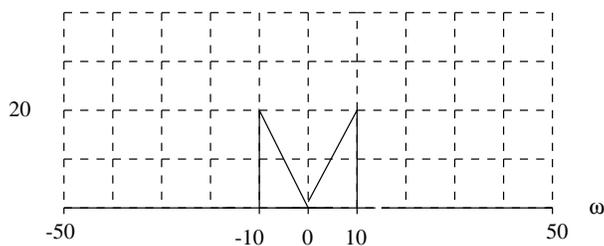
15. The output of a system is given as $y(t) = x(t - 2) + 7x(t - 1)$ where $x(t)$ is the input. This system is linear.

- (a) True (b) False

16. The output $y(t)$ of a system is $y(t) = x^2(t)$. If the input signal is $x(t) = \cos(5\pi t) + \cos(10\pi t)$, the highest frequency component in the output $y(t)$ is:

- (a) 10 Hz (b) 15π Hz (c) 15 Hz (d) None above

17. For the following questions, let $y(t) = x(t) \sin(30t) + x(t)$, where $X(\omega) = \mathcal{F}\{x(t)\}$ is given below.

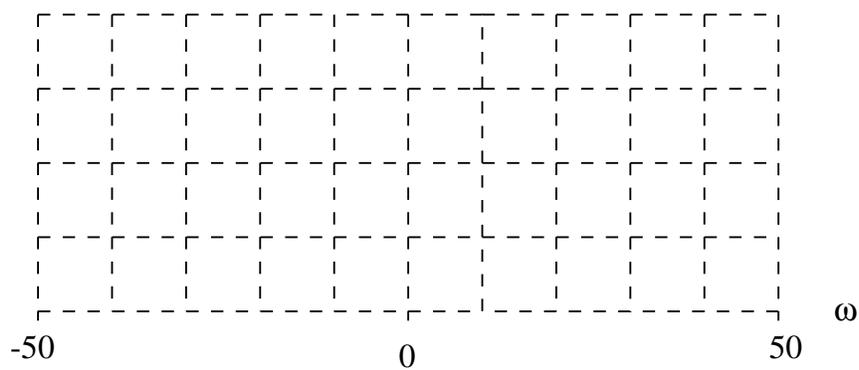


10 points

Find $Y(\omega) = \mathcal{F}\{y(t)\}$ in terms of $X(\omega)$.

10 points

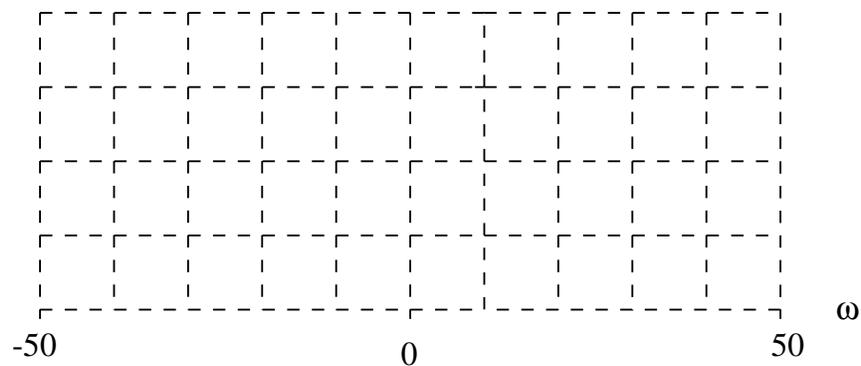
Plot $|Y(\omega)|$ below. Be sure to label the axes.



18. For the following questions, let $y(t) = \cos(20t) + 2\cos(30t) + \cos(40t)$.

10 points

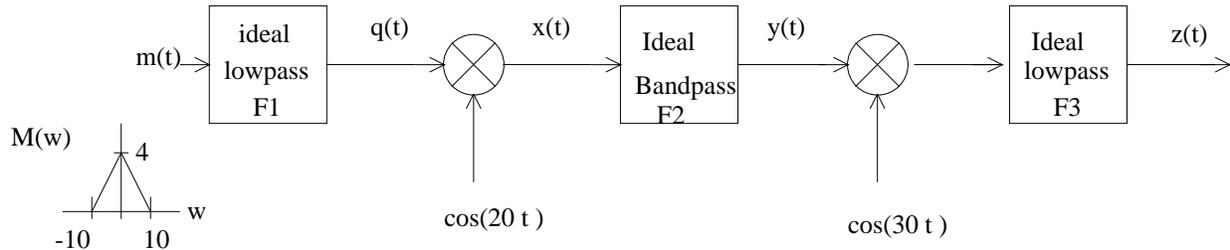
Plot $|Y(\omega)|$ below. Be sure to label the axes.



10 points

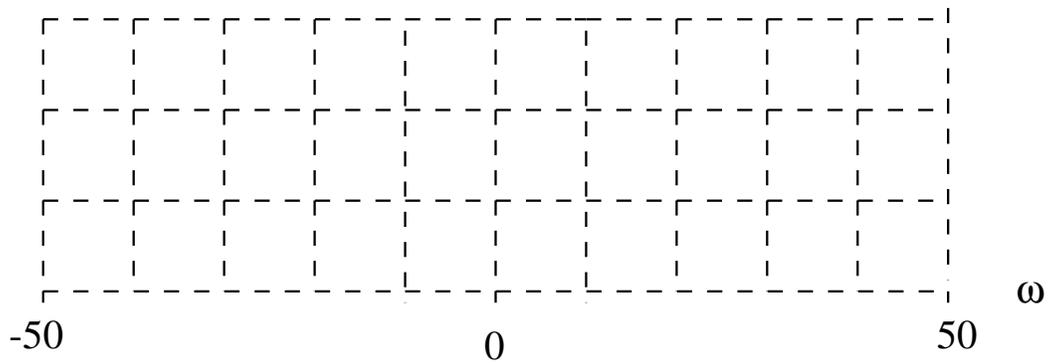
The above signal $y(t)$ is first applied to an envelope detector, and then filtered by a 10 Hz ideal lowpass filter. What is the output of the lowpass filter? (You may ignore constant factors of gain.)

19. 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 15 rad/s, ideal bandpass filter F2 has a bandwidth of 10 rad/s at a center frequency of 25 rad/s, and ideal lowpass filter F3 has a bandwidth of 10 rad/s.



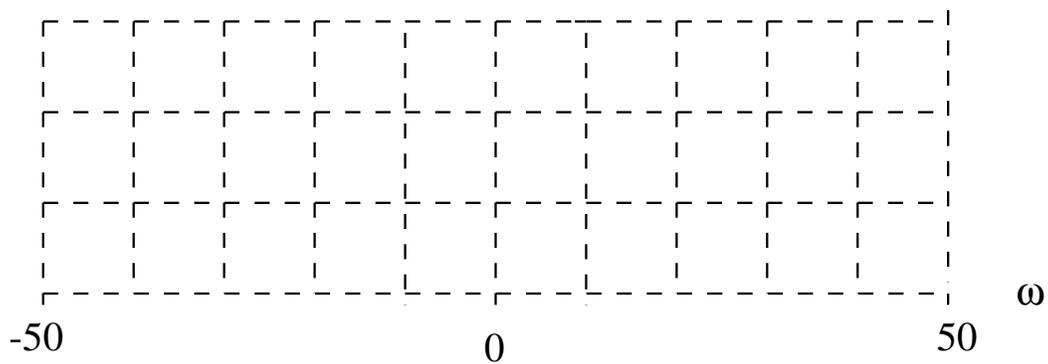
10 points

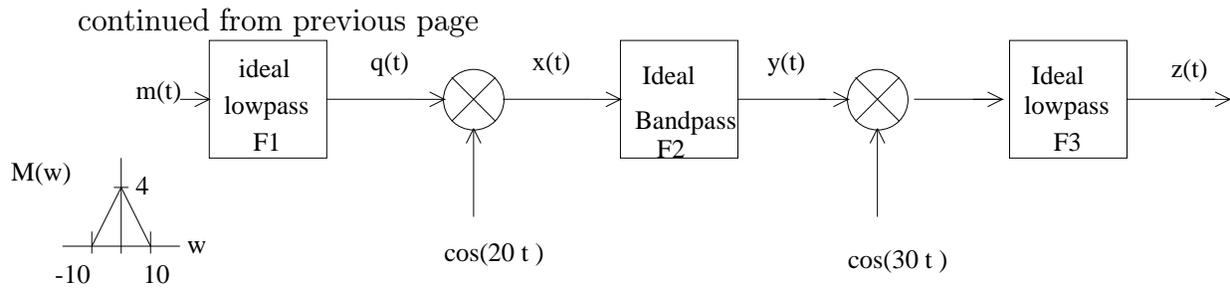
Plot $|Q(\omega)|$ below. Be sure to label the axes.



10 points

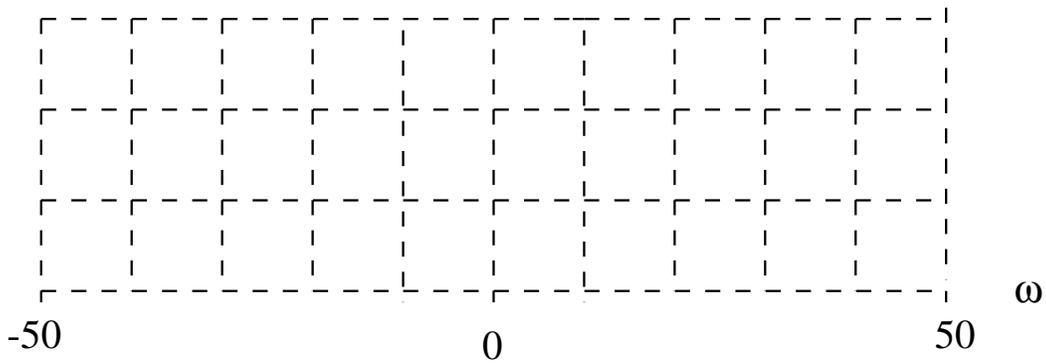
Plot $|X(\omega)|$ below. Be sure to label the axes.





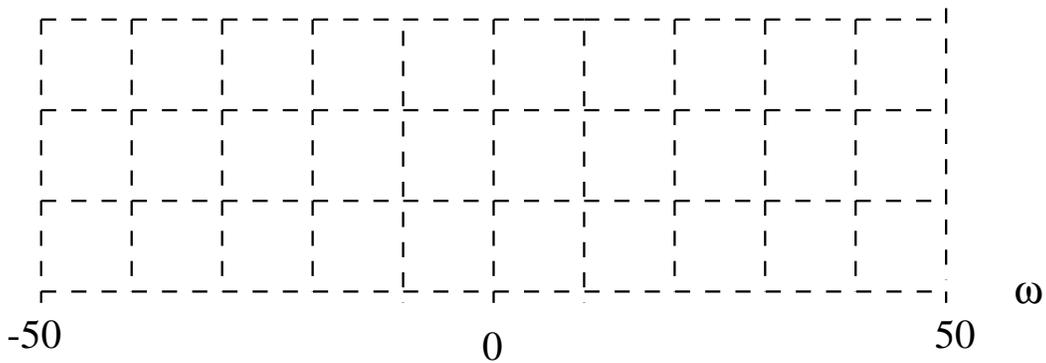
10 points

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



10 points

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



5 points

20. The modulation at signal $x(t)$ in the above system is best described as:

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