

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  
 $\omega$  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. The signal  $e^t \text{rect}(10t) \text{rect}(30t)$  is an energy signal.

(a) True

(b) False

2. Single sideband (SSB) requires less bandwidth than double- sideband suppressed carrier for a given modulating signal  $m(t)$ .

(a) True

(b) False

3. Let the energy spectral density of signal  $y(t)$  be given as  $\Psi_y(\omega) = \pi \text{rect}(\frac{\omega}{20\pi})$ . The essential bandwidth containing 90% of the energy is:

(a) 9 Hz

(b) 10 Hz

(c) 20 Hz

(d) None above

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

(a) 0.2

(b) 0.5

(c) 2

(d) None above

5 Points Each (Circle the best answer)

5. Let  $x(t) = 2\cos^2(10\pi t)$ .  $D_0$  in the exponential Fourier series expansion of  $x(t)$  is  $D_0 =$

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

6. If  $h(t) = 2000 \sin(100t)\text{sinc}(2t)$  is the impulse response of a system, the bandwidth of the system is

- (a) 2 Hz                      (b) 4 rad/s                      (c)  $2\pi$  rad/s                      (d) None above

7. Let the autocorrelation function of signal  $y(t)$  be given as  $R_y(\tau) = (1 - |2\tau|) \text{rect}(\tau)$ . The power  $P_y$  of this signal is then:

- (a) 0.5                      (b) 1                      (c)  $2\tau$                       (d) None above

8. Let the power spectral density of signal  $y(t)$  be given as  $S_y(\omega) = \pi \text{rect}(2\omega - 5) + \pi \text{rect}(2\omega + 5)$ . The power  $P_y$  of this signal is then:

- (a) 0.5                      (b) 1                      (c)  $2\pi$                       (d) None above

5 Points Each (Circle the best answer)

9. A filter with impulse response  $7\delta(t - 1) + \delta(t - 3)$  is distortionless.

(a) True

(b) False

10. The frequency response of a filter is  $H(\omega) = \pi$ . The time delay through the filter is:

(a)  $\pi$  radian/second

(b) 1 seconds

(c)  $-1$  seconds

(d) None above

11. The double convolution,  $[\delta(t - 2) * \text{rect}^2(t/3)] * \delta(t - 1) =$

(a)  $\delta(\text{rect}^2(\frac{t-3}{3}))$

(b)  $\text{sinc}^2(t/3 - 2)$

(c)  $\delta(t - 1)\text{rect}^2(\frac{t-2}{3})$

(d) None above

12. The Hilbert transform of  $e^{jt}$  is

(a)  $\delta(2\omega t)$

(b)  $1/(\pi t)$

(c)  $-j e^{jt}$

(d) None above

5 Points Each (Circle the best answer)

13. The power spectral density  $R_x(\tau)$  of a signal  $x(t)$  can *not* be determined if  $x(t)$  consists of random data (i.e., a binary pulse train transmitting random bits).

(a) True

(b) False

14. The output of a system is given as  $y(t) = \pi x(t)$  where  $x(t)$  is the input. This system is linear.

(a) True

(b) False

15. A cube root of  $j$  is

(a)  $j$

(b)  $e^{-j\pi/3}$

(c)  $e^{j\pi/6}$

(d) None above

16. The output  $y(t)$  of a system is  $y(t) = x^3(t)$ . 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:

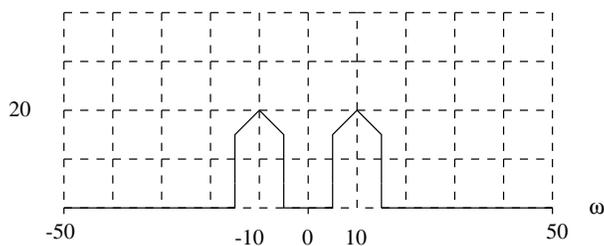
(a) 15 Hz

(b) 30 Hz

(c) 45 Hz

(d) None above

17. For the following questions, let  $y(t) = [20 + x(t)] \sin(25t)$ , where  $X(\omega) = \mathcal{F}\{x(t)\}$  is given below.

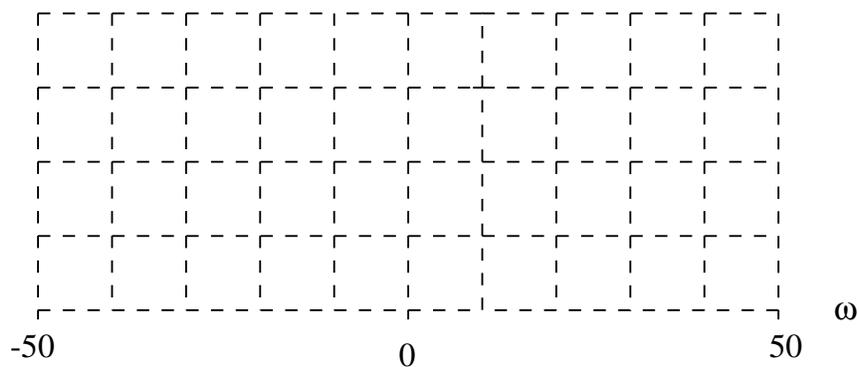


10 points

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

10 points

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



5 points

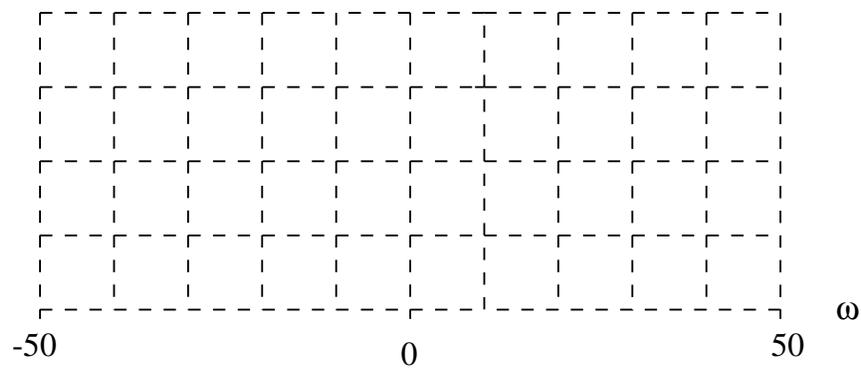
18. The modulation of  $y(t)$  is best described as:

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

19. For the following questions, signal is given as  $y(t) = [2 + \cos(5t)] \cos(35t)$ .

10 points

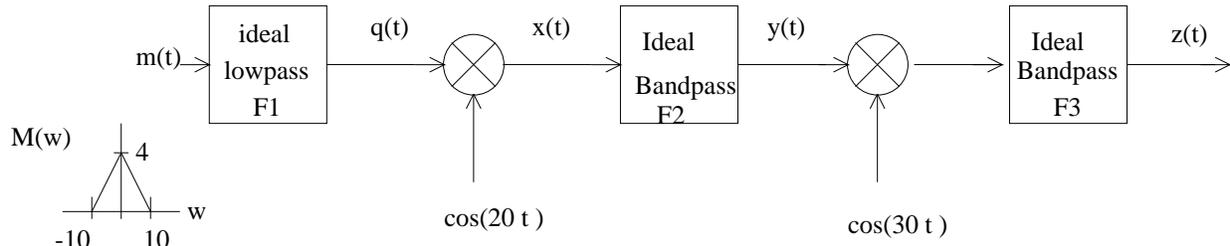
Plot  $|Y(\omega)|$  below. Be sure to label the axes.



10 points

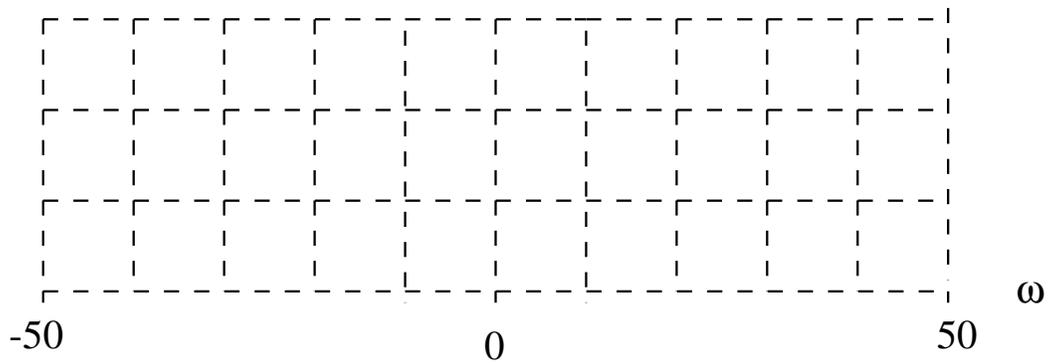
Sketch the block diagram of a demodulator for  $y(t)$ . Be sure to indicate the bandwidth of any ideal filters you use in the block diagram.

20. 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, and ideal bandpass filter F3 has a bandwidth of 10 rad/s at a center frequency of 10 rad/s.



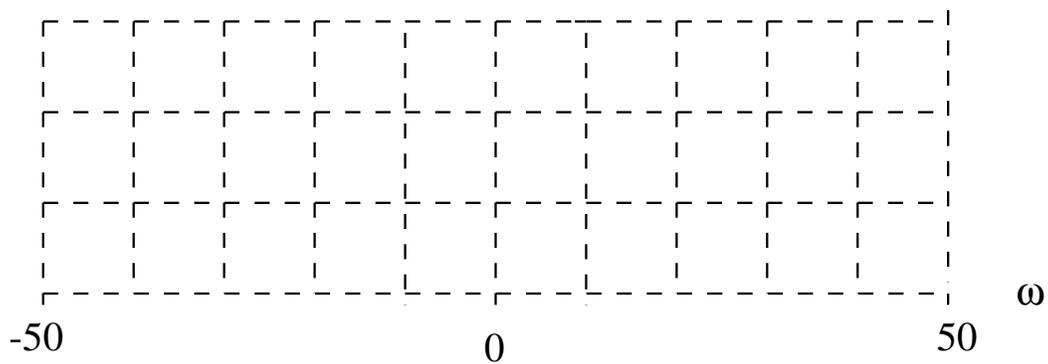
10 points

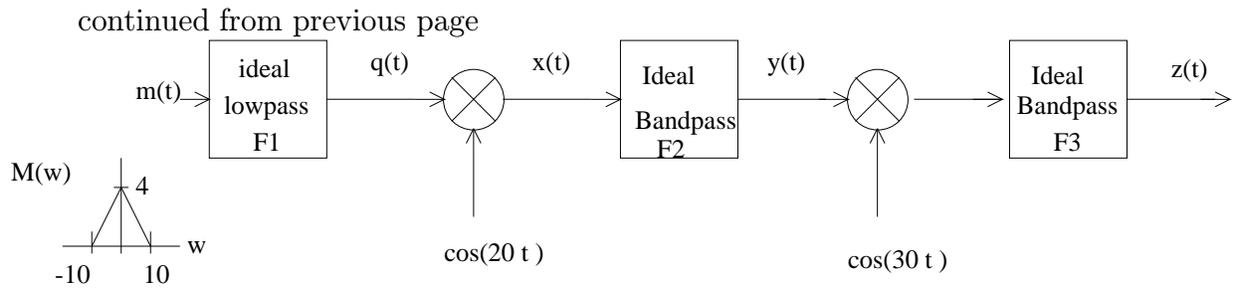
Plot  $|Q(\omega)|$  below. Be sure to label the axes.



10 points

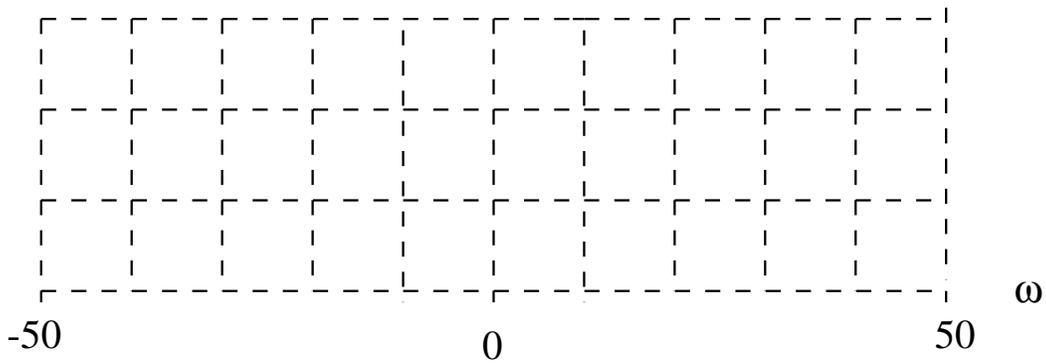
Plot  $|X(\omega)|$  below. Be sure to label the axes.





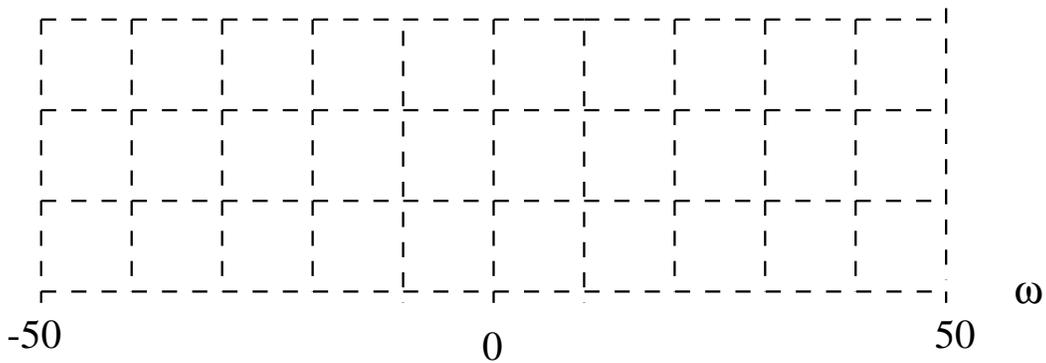
10 points

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



10 points

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



5 points

21. The modulation at the output  $z(t)$  is best described as:

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