

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

(a) True

(b) False

2. Signal $\text{sinc}(2t)$ requires less bandwidth than signal $\text{sinc}(t)$.

(a) True

(b) False

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

(a) 0.25

(b) 0.5

(c) 1

(d) None above

4. The signal $\text{sinc}^2(3t)$ is a power signal.

(a) True

(b) False

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

(a) 1 Hz

(b) 2 Hz

(c) 4π rad/s

(d) None above

5 Points Each (Circle the best answer)

6. Let the autocorrelation function of signal $y(t)$ be given as $R_y(\tau) = \Delta(5\tau)$. The power P_y of this signal is then:

- (a) 0.5 (b) 1 (c) 5τ (d) None above

7. A ring modulator can be used to frequency shift a signal $m(t)$ to a higher frequency.

- (a) True (b) False

8. Let $x(t) = 2\sin^2(20\pi t)$. 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

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

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

10. Assume a DSB-SC signal $y(t) = m(t)\cos(100\pi t)$, with $m(t) = \cos(10\pi t)$. The carrier frequency of the signal $y(t)$ is

- (a) 50 Hz (b) 100 rad/s (c) 100 Hz (d) None above

5 Points Each (Circle the best answer)

11. The double convolution, $[\delta(t - 1) * \text{rect}(t)] * \delta(t - 2) =$
(a) $\delta(t - 3)\text{rect}(t)$ (b) $\text{rect}(t - 1) + \text{rect}(t - 2)$ (c) $\text{rect}(t - 3)$ (d) None above
12. The Hilbert transform of e^{-j2t} is
(a) $-j e^{-j2t}$ (b) $1/(\pi t)$ (c) $-j\text{sgn}(t)$ (d) None above
13. A filter has an output $y(t) = \sin(x(t))$, where $x(t)$ is the input. The filter is linear.
(a) True (b) False
14. The impulse response of an ideal lowpass filter with 10 rad/s bandwidth is $10\text{sinc}(10t)/\pi$.
(a) True (b) False
15. The inner product $(x(t), y(t))$ over an interval $T = 1$ second, with $x(t) = \cos(20t)$ and $y(t) = \cos(21t)$, is
(a) 0 (b) 1/2 (c) $\cos(20t)\cos(21t)$ (d) None above

5 Points Each (Circle the best answer)

16. A cube root of j is

- (a) $j/3$ (b) $e^{j\pi/6}$ (c) $e^{j\pi/9}$ (d) None above

17. Random signals $x(t)$ cannot have autocorrelation functions, $R_x(\tau)$, because of their randomness.

- (a) True (b) False

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

- (a) True (b) False

19. The positive pre-envelope $m_+(t)$ of $m(t) = 2\cos(t)$ is:

- (a) $-je^{jt}\pi$ (b) $e^{-j\omega t}\pi$ (c) j/π (d) None above

20. The output $y(t)$ of a system is $y(t) = x^3(t)$. If the input signal is $x(t) = 2 + \cos(10\pi t)$, the highest frequency component in the output $y(t)$ is:

- (a) 15 rad/s (b) 15 Hz (c) 20 Hz (d) None above

21. For the following questions, let $y(t) = 10x(t)\sin(15t) + 2\cos(30t)$, where $X(\omega) = \mathcal{F}\{x(t)\} = \text{rect}(\omega/10)$.

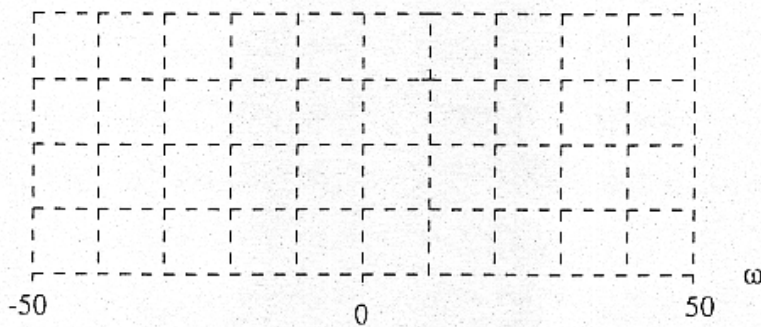
Show all work on this page.

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.

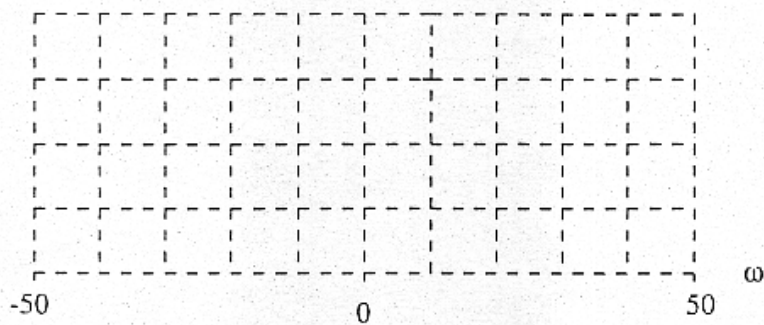


22. For the following question, let $y(t) = (2 \cos(5t) + 4 \cos(20t))^2$. (Note that the right hand side is squared.)

Show all work on this page.

10 points

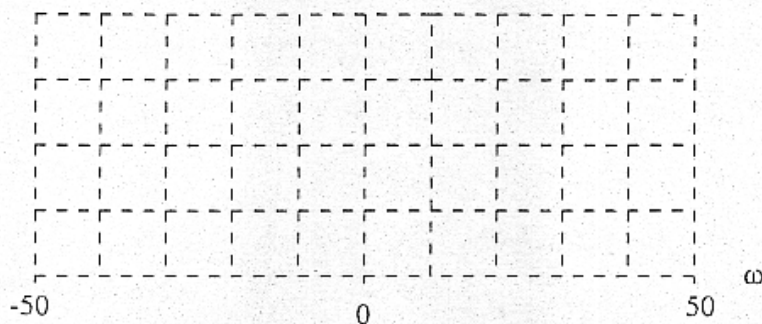
Plot $|Y(\omega)|$ below. Be sure to label the axes.



23. For the following question, let the autocorrelation of $y(t)$ be $R_y(\tau) = \text{sinc}^2(10\tau)/\pi$.

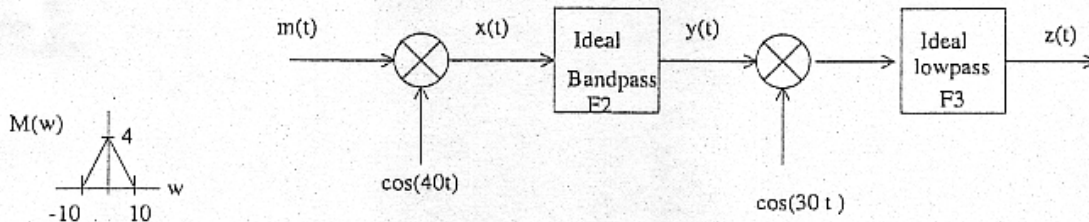
10 points

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



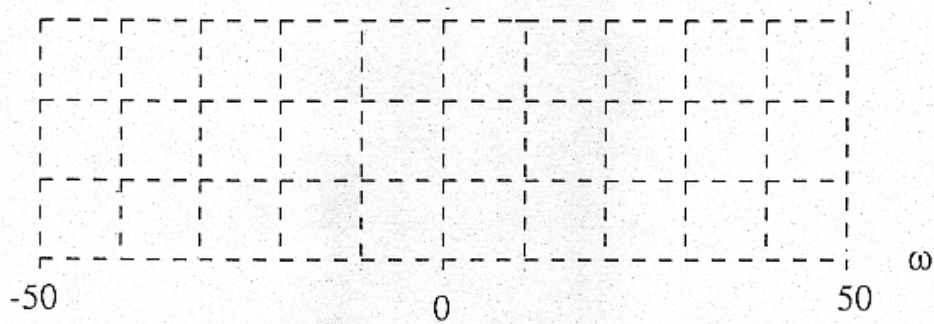
24. For the following questions, the block diagram and input spectrum $M(\omega)$ are given below. Assume that ideal bandpass filter F2 has a bandwidth of 10 rad/s at a center frequency of 40 rad/s, and ideal lowpass filter F3 has a bandwidth of 20 rad/s.

Show all work on this page.



10 points

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



10 points

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

