ECGR4123 Analog and Digital Communication Final Fall 2010

Name: _____

Last 4 digits of student Number: _____

Do NOT begin until told to do so
Make sure that you have all pages before starting
Open book, 2 sheet front/back notes, NO CALCULATOR
DO ***ALL WORK*** IN THE SPACE GIVEN
Do **NOT** use the back of the pages, do **NOT** turn in extra sheets of work/paper
Multiple-choice answers should be within 5% of correct value
Show ALL work, even for multiple choice

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:
$F\{\}$ denotes Fourier transform { *or Fourier series, as implied in problem}*
$F^{-1}\{\}$ denotes inverse Fourier transform
ω denotes frequency in rad/second, f denotes frequency in Hz
$*$ denotes convolution
x*(t) denotes the conjugate of x(t)

Useful constants, etc:

$e \approx 2.72$	$\pi \approx 3.14$
$1/e \approx 0.37$	$\sqrt{2} \approx 1.41$
$\sqrt{3} \approx 1.73$	$\sqrt{5} \approx 2.22$
$\sqrt{7} \approx 2.65$	$\sqrt{10} \approx 3.16$
$\ln(2) \approx 0.69$	$\ln(4) \approx 1.38$
$\log_{10}(2) \approx 0.30$	$\log_{10}(3) \approx 0.48$
$\log_{10}(10) \approx 1.0$	$\log_{10}(0.1) \approx -1$
$\log_{10}(e) \approx 0.43$	$\cos(\pi / 4) \approx 0.71$
$\log_2(2) = 1$	$\log_2(256) = 8$
$\log_{10}(1.5) \approx 0.18$	

$\cos(A) \cos (B) = 0.5 \cos(A - B) + 0.5 \cos(A + B)$
$e^{j\theta} = \cos(\theta) + j \sin(\theta)$

5 Points Each, circle the best answer

1. The signal g(t) = $\Pi(2t)$ is an energy signal.

   a) True b) False

2. The dc response of a system with impulse response h(t) = $\Delta(2t)$ is $H(f)|_{f=0}$ =

   a) 1/2 b) 1 c) 2 d) none above

3. The power of a signal g(t) with autocorrelation $R_g(\tau)$ = $\Delta(\tau) + \Delta(\tau/2)$ is

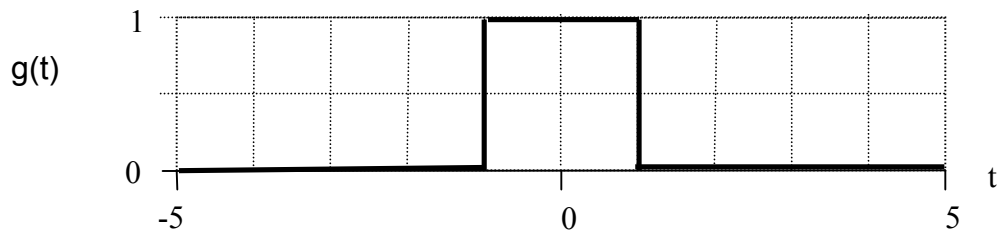
   a) 1 b) 1.5 c) 2 d) none above

4. A power level 9 dB above 1 W would equal

   a) 2 W b) 4 W c) 8W d) none above

5. For signal g(t) shown below, the Fourier transform is G(f)=

   a) $2\text{sinc}(2\pi f)$ b) $2\text{sinc}^2(f/2)$ c) $0.5\ \text{sinc}(\pi f/2)$ d) none above



5 Points Each, circle the best answer

6. An envelope detector can be used to demodulate a SSB signal.

a) True b) False

7. The bandwidth of the DSB-LC signal $g(t) = \{ 5 + \cos(10\pi t) \} \cos(2000\pi t)$ is

a) 10 Hz b) 20 Hz c) 1020 Hz d) none above

8. A signal $g(t) = \cos(40\pi t) \cos(10{,}000\pi t)$ is best described as

a) DSB-LC b) SSB c) FM d) DSB-SC

9. Given a phase modulated signal $g(t) = 3 \cos(2\pi f_0 t + 4 \cos(2\pi f_m t))$ with carrier frequency f_o=10,000 and modulation frequency f_m=10, the bandwidth using Carson's rule is

a) 40 Hz b) 50 Hz c) 100 Hz d) none above

10. The instantaneous frequency of $\cos(t^3)$ at t=2 is

a) 6 rad/s b) 6π rad/s c) 12 rad/s d) none above

5 Points Each, circle the best answer

11. A duobinary voltage sequence of { 4, 0, -4, -4 } would correspond to a data sequence of

a) {1,0,0,0} b) {0,0,1,0} c) {1,0,1,1} d) none above

12. If a full-scale sinusoid of 1 KHz is sampled by a 10-bit analog-to-digital-converter at a rate of 10,000 samples/second, the signal-to-quantization-noise ratio is.

a) 49.8 dB b) $\log_2 e^{10}$ dB c) 61.8 dB d) none above

13. The power spectral density of a line code is affected by the statistics of the data being transmitted.

a) True b) False

14. If a channel has a bandwidth of 2 MHz, and a signal to noise power ratio of S/N=15, then the channel capacity is C=

a) 2 Megabit/s b) 4 Megabit/s c) 8 Megabit/s b) none above

15. To avoid aliasing, the signal $g(t) = \cos(500\pi t) + \cos(2000\pi t)$ should be sampled at a rate greater than

a) 1.25 KHz b) 2 KHz c) 2.5 KHz d) none above

5 Points Each, circle the best answer

16. A binary 1000 bit/s bipolar line code uses Nyquist-1 pulses with roll-off factor r = 0.5. The bandwidth of the of the line-code is:

a) 750 Hz b) 1250 Hz c) 1500 Hz d) None above

17. Given a phase modulated signal $g(t) = 7 \cos(\omega_c t + 2 \cos(\omega_m t))$ with carrier frequency ω_c=1000 and modulation frequency ω_m=20, the peak phase deviation $\Delta\varphi$=

a) 2 rad b) 20 rad c) 40 rad d) none above

18. Given a phase modulated signal $g(t) = 5 \cos(2\pi f_c t + 3 \cos(2\pi f_m t))$ with carrier frequency f_c=500 and modulation frequency f_m=20, the peak frequency deviation Δf=

a) 3 Hz b) 20 Hz c) 60 Hz d) none above

19. The frequency modulated signal $g(t) = 5 \cos(2000\pi t + 5 \cos(2\pi t))$ is a wideband FM signal.

a) True b) False

20. The Fourier transform of $\frac{-1}{\pi t}$ is

a) $-2/(j\pi\omega)$ b) j sgn (ω) c) $\Delta(\omega/2) + j\,\Delta(-\omega/2)$ d) none above

5 Points Each, circle the best answer

21. A QAM modulator can be used as a phase modulator.

a) True b) False

22. A polar line code with peak signal voltage of A=1 volt in the presence of 1 volt rms noise would have an error rate of (to within +/- 0.005)

a) 0.317 b) 0.159 c) 0.022 d) none above

23. The data rate of a T1 carrier system is.

a) 8 kbit/s b) 64 kbit/s c) 1544 kbit/s e) none above

24. A line code g(t) is given as

$$g(t) = \sum_{n=-\infty}^{\infty} a_n \Pi\left(\frac{t - 0.001n}{0.0001}\right),$$

where a_n=1 or -1 is the random binary data being transmitted.
The line code g(t) is best described as

a) Polar RZ b) Bipolar RZ c) On-off NRZ d) none above

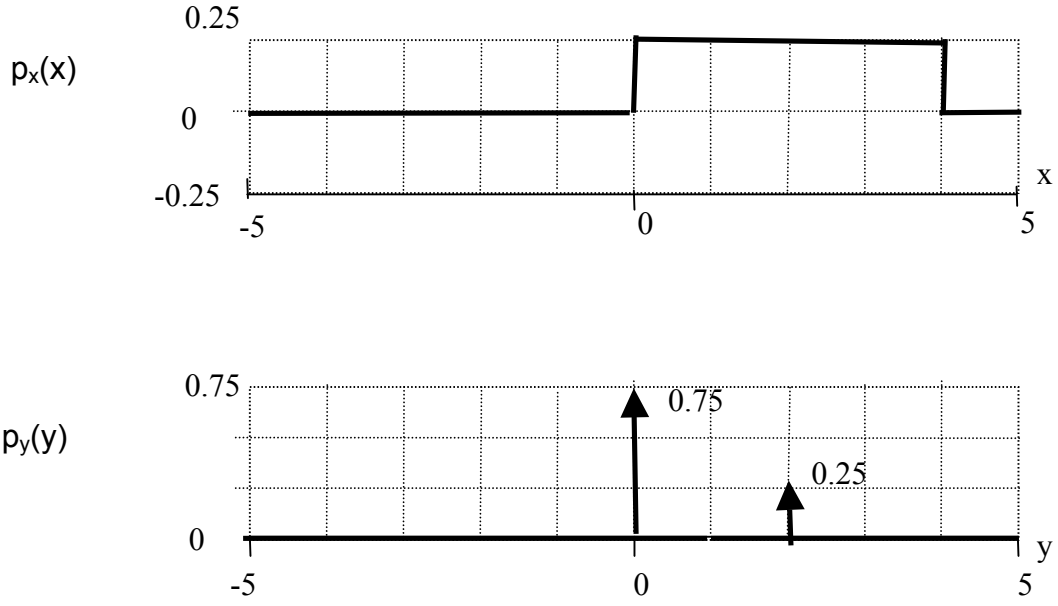
25. A polar RZ system consists of a cascaded pair of regenerative repeaters, each one having an error rate of 0.020. The total error rate for the system is

a) 0.020 b) 0.040 c) 0.080 d) none above

26. A minimum-bandwidth Nyquist-1 pulse has zero ISI.

a) True b) False

The following questions refer to the pdf's below.



5 Points Each, circle the best answer

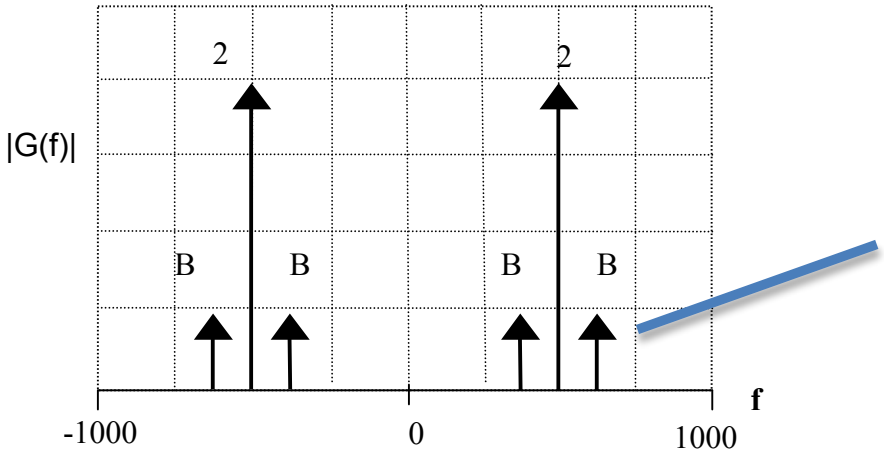
27. The mean of the random variable with pdf $p_x(x)$ is

a) 2 b) 1 c) 0.5 d) none above

28. The second moment of the variable described by the pdf $p_y(y)$ equals

a) 4 b) 2 c) 1 d) none above

5 Points Each, circle the best answer
The following questions refer to the FM signal $g(t) = A\cos(2\pi f_c t + 0.25\cos(2\pi f_m t))$ with magnitude spectrum |G(f)| given below.



29. The carrier frequency is f_c =

a) 500 Hz b) 750 Hz c) 1000 Hz d) None above

30. The modulation frequency is f_m =

a) 125 Hz b) 250 Hz c) 500 Hz d) None above

31. The magnitude of amplitude A in the equation for g(t) above is A=

a) 0.5 b) 2 c) 4 d) None above

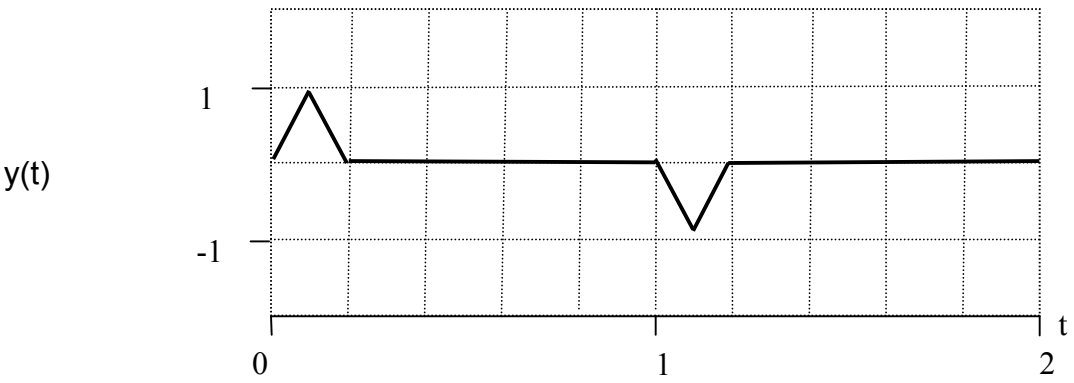
32. The magnitude of the spectral component B in the figure is B=

a) 0.25 b) 0.5 c) 1 d) None above

33. The modulation index β is

a) 0.25 b) 0.75 c) 4 d) None above

The following questions refer to a binary polar line code signal y(t) shown below, with pulse shape $p(t)=\Delta(5(t-0.1))$ and with bit rate of 1 bit/s.



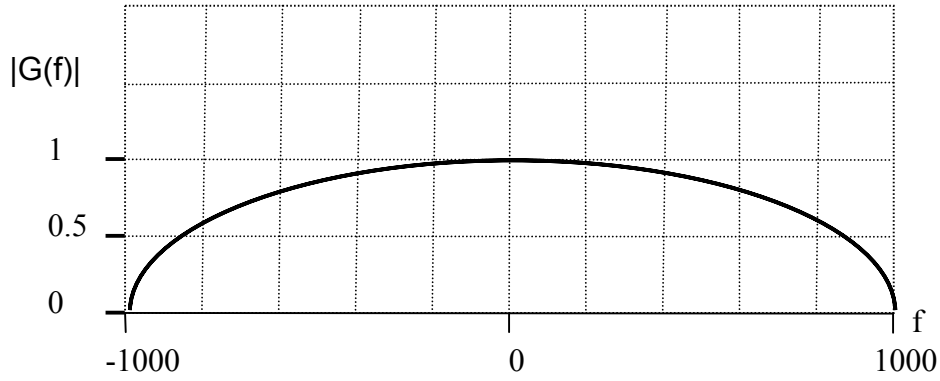
5 Points Each, circle the best answer

34. The first two bits of data communicated by the signal y(t) above are

a) {0,0} b) {0,1} c) {1,0} d) none above

35. The magnitude of the power spectral density $S_y(f)$ at the frequency f=0 is

a) 1 b) 2 c) 4 d) none above

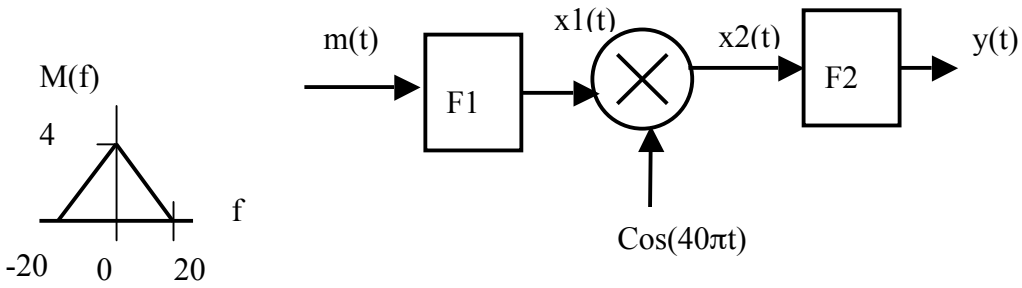


5 Points Each, circle the best answer

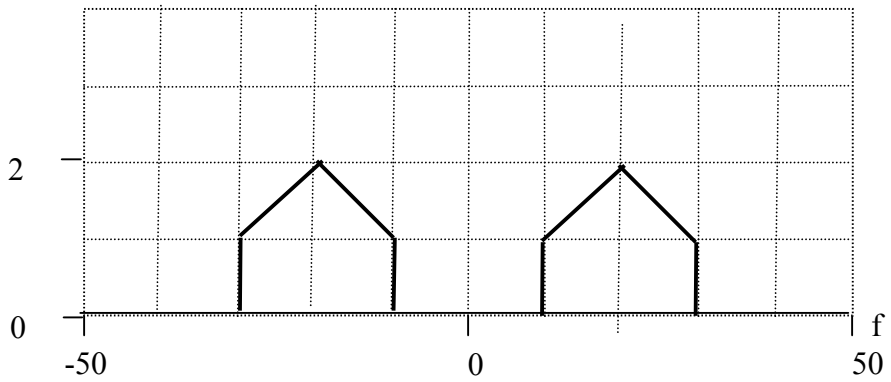
36. For the *minimum-bandwidth* Nyquist-2 pulse g(t) with spectrum |G(f)| shown above, the data rate of the binary line code is

a) 500 bits/s b) 1000 bits/s c) 2000 bits/s d) none above

5 Points Each, circle the best answer



The following questions refer to the above modulator which has ideal lowpass filter F1 with bandwidth 10 Hz and ideal bandpass filter F2 with bandwidth 20 Hz at a center frequency of 40 Hz.



37. The above spectrum is |X2(f)| .

a) True b) False

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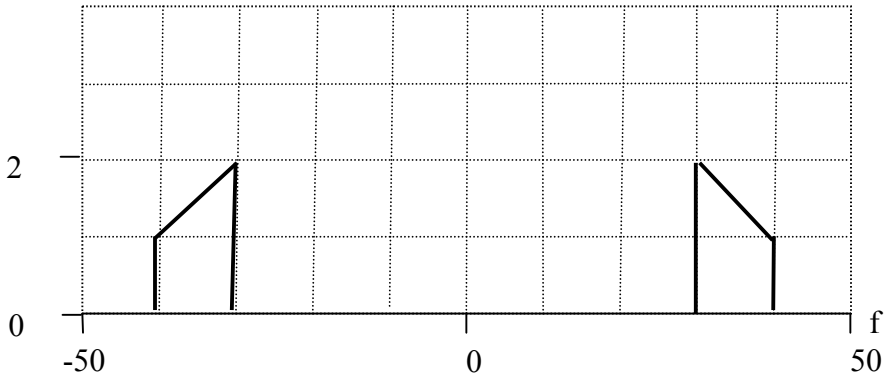
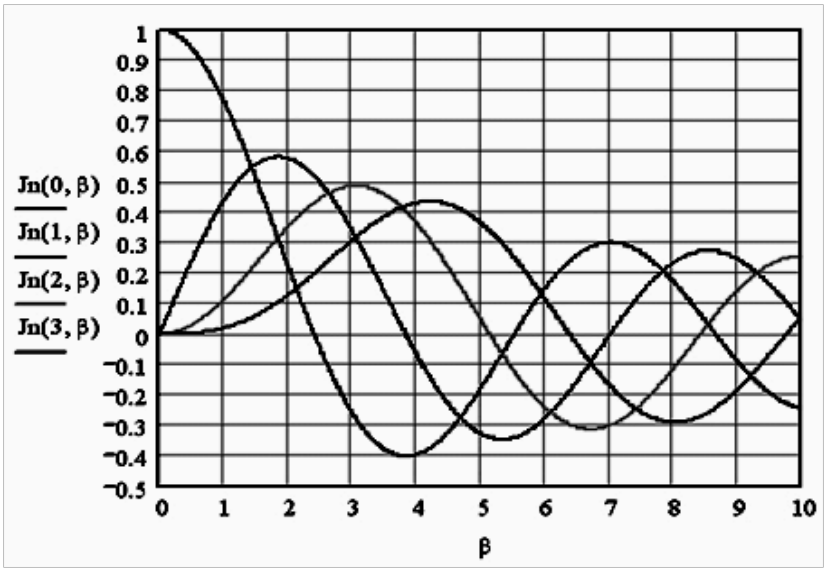


38. The above spectrum is |Y(f)| .

a) True b) False



5 Points Each, circle the best answer

39. For a wideband FM signal g(t) with a modulation frequency of f_m=1000 Hz, the first carrier null occurs at a modulation index of β =

a) 2.4 b) 3.9 c) 5.5 d) 7

40. For a wideband FM signal g(t) with a modulation frequency of f_m=100 Hz, the first sideband null occurs when the first sideband (f_c+/- f_m) passes through zero at a modulation index β=

a) 2.4 b) 3.9 c) 5.5 d) 7