Please note the following:
1) This is the 12-week exam that was given for EC312 in Spring 2013.
2) The course has evolved since Spring 2013, and there may be topics that we have covered in more detail this semester than you’ll see tested here in the practice exam.
3) There is NO guarantee that the 12-week exam for this semester will resemble this practice exam. Working through this practice exam should not be deemed as sufficient preparation for the upcoming 12-week exam.
12 WEEK EXAM Practice

NAME: _________________

ALPHA: _________________

SECTION: _________________

1. This is individual work.
2. SHOW ALL WORK!
3. Write legibly to receive credit.
4. Turn in your equation sheet.

SCORE: _______/100

SCALE
>89.5%: 31337
79.5 - 89.5%: H@XX0R
69.5 - 79.5%: G33K
59.5 - 69.5%: $€RiPt K1DD13
<59.5%: WannaB
Lesson 11 – Intro to Communications Systems

1. Describe the main purpose of any communication system.

2. Provide the names and approximate frequencies and applications for 3 bands that the FCC allocates for the Electromagnetic Spectrum.

3. In music, a pure C6 tone is defined as having a frequency of 1046.50Hz. Assuming that it has zero phase offset and an amplitude of 2volts:
   a) Write the mathematical formula for the sinusoid of this tone.
   b) Sketch the time domain diagram for this tone, labeling all significant parts.
   c) Sketch the frequency domain diagram for this tone.
Lesson 12 – Intro to Modulation

4. From the pictured AM Radio Signal in which $V_{\text{max}}$ is 10V, $V_{\text{min}}$ is 2V, $f_c$ is 1000KHz, and $f_m$ is 5KHz, determine:

(a) $V_m$ _________
(b) $V_c$ _________
(c) $m$, the modulation index _________
(d) $f_{\text{lsb}}$ ______________
(e) $f_{\text{usb}}$ ______________
(f) $V_{\text{lsb}}$ ______________
(g) $V_{\text{usb}}$ ______________
(h) $BW_{\text{AM}}$ ______________

(i) If the antenna resistance is 50 $\Omega$, what is the

(j) $P_c$ ___________ and $P_{\text{LSB}}$ ___________
5. In the United States, AM broadcasts are afforded 10KHz of bandwidth, while FM broadcasts may use up to 250KHZ of bandwidth. (T/F)

6. An Emergency Action Message must be sent to a submarine at sea at a frequency of 30KHz. How long of a quarter-wavelength wire must the submarine stream behind it in order to best receive the message? Include units!

Lesson 13 – Signal Gain and dB

7. An amplifier has an output of 25W. What is its gain both in dBm and dBW?

8. Given the following system, what is the minimum required signal power ($P_{in}$) to achieve the desired Signal to Noise ratio?

![Diagram]

\[ \text{SNR} = 29\text{dB} \]
\[ P_n = 7\text{nW} \]

9. The SNR of a system is 20dB and signal power is 4.5W, determine noise power.

10. Is noise present across all frequencies, in what band of frequencies is it the largest?
Lesson 14 – Fourier and Filters

11. For the circuit below, answer the following questions:

\[ V_o = \frac{R}{R + Z_L} V_s \]

\[ \frac{V_o}{V_s} = \frac{R}{R + j2\pi fL} \]

\[ X_L = X_R \rightarrow f_B = \frac{R}{2\pi L} \]

a) What type of filter does this circuit represent? (Remember to substitute values for frequency of 0 and infinity to analyze the transfer function \( V_o/V_s \) vs frequency.)

b) The filter cut-off frequency, \( f_B \) is defined to be what value in (power) dB, and in voltage?

c) Show a plot of \( V_o/V_s \) vs frequency indicating any specific values (especially \( f_B \))

12. Using the same circuit analysis as above, determine what type of filter this circuit is?

\[ V_o = \frac{R}{R + \frac{1}{j2\pi fC}} = \frac{j(f/f_B)}{[j(f/f_B) + 1]} \]

\[ \left| \frac{V_o}{V_s} \right| = \frac{(f/f_B)}{\sqrt{1+(f/f_B)^2}} \]

13. Draw a magnitude vs frequency plot for a tuned circuit and indicated all the important characteristics and variables.
14. What are the advantage(s) of a directional antenna vs a (theoretical) isotropic radiator? Check any that apply.
   a) For the same power, directional allows communication over longer distances vs isotropic.
   b) With less power, directional can communicate same distance as isotropic.
   c) Directional antennas require fewer parts than an isotropic antenna.
   d) Directional antennas fit more easily onto Humvees than isotropic antennas.

15. Use the radiation pattern to answer the follow-on questions about this antenna:

   a. What is the beamwidth of this antenna?

   b. What is the Side Lobe Level with respect to the side lobe positioned at 90°?

   c. If this antenna has a gain of 9dBi and is transmitting at a power of 10W, what is the EIRP for this antenna?

   d. For the yagi antenna associated with this radiation pattern, the center frequency is 400Mhz. What is the physical size of the driven element of the yagi antenna?
16. a) Describe the purpose of a director as it pertains to the parasitic element of a yagi antenna.

b) Would additional directors enhance these effects or provide no further benefit?

Lesson 16 – Propagation

17. If electromagnetic waves with low frequencies come into contact with a relatively large and smooth surface (reflection / scattering) is more likely to occur, whereas high frequency waves coming into contact with relatively smaller and rougher surfaces will tend to undergo (reflection / scattering).

18. a) What type of propagation will occur for communications in the Very High Frequency (VHF) band?

b) If someone is standing in a life raft with a hand-held VHF radio (assume antenna height of 6 ft), what is the maximum range from which they could contact a search and rescue helicopter flying 100 ft above the surface?

19. Your cell phone transmits at a power level of 500 mW, and an antenna gain of 2.0 dB. The cell tower has an antenna gain of 8.0 dB, and for LTE, you’re transmitting at 700 MHz.
   How far from the tower could you be while maintaining the capability to communicate? (Cellular “dead zone” occurs when $P_r < -110$dBm.)
Lesson 17 – Analog to Digital Conversion

20. For the signal given by the formula
   \[ v(t) = 10\sin(2 \pi 450t) + 3\sin(2 \pi 600t + 300^\circ) + 7\sin(2\pi 1100t) \):

   a. What is the minimum sampling rate that could be used to transmit this signal
digitally such that a receiver could accurately reconstruct the signal?

   b. If the signal were mapped by a 5-bit quantizer with a resolution of 1V, what
   would this imply is the minimum voltage found in the waveform?

   c. Given your above answer, what bitstream would be generated by the
   sampled point (2.5s, -11.6V)?

   d. If a receiver was decoding the incoming bitstream of 10100, what voltage
   level would be recovered?

21. Which action below will reduce the effects of quantization error?

   a. Use AM instead of FM
   b. Use less bits per sample in your A/D converter
   c. Increase the size of the quantization intervals
   d. Use more bits in your A/D converter
Lesson 18 – Bandwidth and Multiplexing

22. What dictates the bandwidth requirements of a channel for a communication system? (Provide as many as you can and state their applications)

23. What are 4 ways that a channel can be shared?

24. Which multiplexing techniques are better for analog and which are better for digital, or both?

25. What bandwidth would be correct for 12 TV stations to share a UHF band of 540MHz, what form of multiplexing is this?
Lesson 19 – Digital Modulation

26. What Modulation Techniques are combined in Quadrature Amplitude Modulation?

27. Given the following time domain graph of an FSK signal:

![Time Domain Graph](image_url)

a) Using your best guesstimate- What is $f_L$? ; What is $f_H$? Show your work.

b) What is $f_c$ and what is $f_d$?

c) Sketch this signal on a frequency domain plot (with appropriate labels) Show where variables above appear on plot with relative amplitudes.
Lesson 20 – Electronic Warfare

28. You are trying to locate an unknown transmitter with two receivers. The first receiver (R1) receives the transmission at t=35 \( \mu \)sec. The second receiver (R2) receives the transmission at t = 12 \( \mu \)sec.

a) Assuming the transmissions left at t=0, which receiver is closer to the target?

b) If R1 is located at (3000, 2000) meters and R2 is located at (2000, 3000) meters, where is the target?

29. You are located 5500 meters from the omnidirectional receiver you are jamming. The transmitted signal you are jamming originates 3000 meters from the receiver. The signal transmitter’s EIRP is 14.5 dBW. Assuming both the transmitter and jammer have line of sight, your jammer EIRP of 44W will allow you to jam the receiver with what J/S ratio?
Lesson 21 – Jamming Mitigation

30. If the frequency range of a Frequency Hopping Spread Spectrum system shown below is 45kHz to 65kHz, and the bit rate is 40kbps, what is the dwell time? (Note: Both graphs are on the same time scale)

31. a) What type of modulation scheme is used for Direct Sequence Spread Spectrum (DSSS)? Show a block diagram of the transmission communication system.

b) What benefit does the higher rate, the chip rate, over the bit rate, in the DSSS scheme, provide?

c) Does the bandwidth of a modulated signal increase or decrease as chip rates and bit rates get higher? Use the Processing Gain equation to discuss. Mention the advantages and disadvantages of wideband modulation.