

ECE4600/5950: Communication Systems

Homework Assignments

Textbook: *Communication Systems, 5th ed.*, A. Bruce Carlson, P.B. Crilly, McGraw-Hill, 2010. ISBN: 078-0-07-338040-7.

Homework Notes:

- Your submitted text homework solutions must be in the order assigned. Problems that are not in the order assigned (1) may not be graded and (2) you may not get credit for the points.
- Please make your solutions legible ... if I can't find your answers or read what you have written, you will not receive credit for the points.
- Bold problems represent the 5th ed. problem numbers that have changed from the 4th ed.

Homework #1 (due 9/18)

Text: 2.1-2, 2.1-3, 2.1-4, 2.1-5, 2.1-6, **2.1-10, 2.1-11**, 2.2-1, 2.2-2, **2.2-11**,
2.3-1, 2.3-2, 2.3-4, 2.3-5, **2.3-16, 2.3-17, 2.4-2, 2.4-3**

ECE5950 Additional Problems: **2.1-9, 2.2-8, 2.2-9, 2.2-14, 2.3-3, 2.3-18, 2.3-22, 2.3-23, 2.4-4**

Computer Assignment: **2.1-10** and **2.1-11** Plot the reference function, the 3-term Fourier series approximation, the difference between the function and approximation and the squared difference. Select an appropriate time steps for the plots and use summation to verify the percentages solved for in part (a). Repeat the code for a 7-term Fourier series and a 21-term Fourier series.

2.2-1 and 2.2-2 Use MATLAB to plot the resulting frequency response for $0 \leq f \leq 4/\tau$ or $0 \leq f \cdot \tau \leq 4$.

Homework #2 (due 9/25):

Text: 3.1-1, 3.1-2, 3.1-4, **3.2-9**, 3.3-1, 3.3-3, 3.3-6, 3.4-3, 3.4-4, 3.4-6,
3.5-1, 3.5-4, **3.6-3, 3.6-5, 3.6-6, 3.6-7, 3.6-9, 3.6-10**

ECE5950 Additional Problems: 3.1-3, 3.1-9, 3.1-10, **3.2-10**, 3.4-7, 3.5-8

Computer Assignment:

3.1-11 Solve and form a Matlab Plot of the result.

3.2-4, 3.2-5

Homework #3 (due 10/5)

Text: 4.1-3, 4.1-6, 4.1-7, 4.1-9, 4.2-1, 4.2-4, **4.2-9**

ECE5950 Additional Problems: None

Computer Assignment:

(1 [2x Normal Points]) MATLAB: Starting with the AMexample.m file in the Chap 4 Matlab ZIP of the courses web page, generate the AM waveform that corresponds to the following messages:

$$m_1(t) = \frac{1}{4} \cdot \left[\cos(2\pi \cdot 100 \cdot t) + \frac{1}{3} \cos(2\pi \cdot 300 \cdot t) + \frac{1}{5} \cos(2\pi \cdot 500 \cdot t) + \frac{1}{7} \cos(2\pi \cdot 700 \cdot t) \right]$$

$$m_2(t) = \frac{1}{4} \cdot \left[\sin(2\pi \cdot 100 \cdot t) + \frac{1}{3} \sin(2\pi \cdot 300 \cdot t) + \frac{1}{5} \sin(2\pi \cdot 500 \cdot t) + \frac{1}{7} \sin(2\pi \cdot 700 \cdot t) \right]$$

$$m_3(t) = 2 \cdot \left(\frac{2}{\pi} \right)^2 \cdot \left[\cos(2\pi \cdot 100 \cdot t) + \frac{1}{3^2} \cos(2\pi \cdot 300 \cdot t) + \frac{1}{5^2} \cos(2\pi \cdot 500 \cdot t) + \frac{1}{7^2} \cos(2\pi \cdot 700 \cdot t) \right]$$

Provide a time domain output of the resulting AM waveform and describe the signal envelope. Provide a spectral domain output of the AM as well.

(2 [2x Normal Points]) Use the LTSpice IV simulation tool to demonstrate the operation of an envelope detector for AM signals (as shown in Fig. 4.5-6). You will have to generate an AM waveform with a selected message (start with one cosine wave and then possible two cosine waves of slightly different frequencies).

Homework Exam Prep (do not hand in)

Text: 4.3-1, 4.3-4, 4.3-7 (allow for filter transition band), 4.4-1, 4.4-2, 4.4-5, 4.4-6, 4.4-7, **4.4-14**,
4.5-3, **4.5-12**

ECE5950 Additional Problems: None

Computer Assignment:

(1) Use the LTSpice IV simulation tool to demonstrate the operation of a ring modulator (as shown in Fig. 4.3-6). Hint: look in the examples folder of LTSpice IV for the transformer examples.

Exam #1 (10/9)

Homework #4 (due 10/23)

Text: 4.3-1, 4.3-4, 4.3-7 (allow for filter transition band), 4.4-1, 4.4-6, **4.4-14**, 4.5-3, **4.5-12**

Text: 5.1-1, 5.1-2, 5.1-9, **5.1-18**, 5.2-1, **5.2-8**, **5.2-9**, 5.3-9, 5.4-3

ECE5950 Additional Problems: 5.1-10, **5.2-11**, **5.2-14**

Computer Assignment:

Generate in Matlab 5.1-4.

Familiarize yourselves with the PM and FM example Matlab code. What bandwidths should the low pass filters used after complex mixing to baseband (or zero frequency) be? Derive the new cutoff frequencies, make the modifications and compare the results. Use the chirp waveform for this problem.

Homework #5 (due 10/30)

Text: 6.1-1, 6.1-3, 6.1-5, 6.1-7, 6.1-17, 6.1-18, 6.2-4, 6.3-3, 6.3-6

ECE5950 Additional Problems: 6.1-4, 6.1-13, 6.2-5

Computer Assignment: (1) Generate the MATLAB code to plot 6.1-10. (2) Use SwCAD III and any additional circuitry necessary to show the chopper operation of the schematic shown in Figure 6.1-1(c) of the text.

Homework #6 (due 11/4)

Text: 7.1-3, 7.1-8, 7.1-11, 7.1-17, 7.1-18, 7.2-1, 7.2-2, 7.2-5, 7.2-7, 7.2-8, 7.2-14, 7.3-3, 7.3-7, 7.3-9, 7.4-1,

ECE5950 Additional Problems: 7.1-9, 7.3-5, 7.3-6

Computer Assignment: Generate a Matlab simulation that demonstrates Figure 7.2-6 using the interpolated signals generated in the AM/PM/FMExample Matlab scripts. Use the Gong for one input and the Chirp for another. (a) Insure that the transmitter and receiver oscillators are perfectly synchronized, (b) that the transmitter and receiver oscillators are offset by $\pi/8$ (22.5 degrees), (c) the transmitter and receiver oscillators are offset by $\pi/4$ (45 degrees), and (d) the transmitter and receiver oscillators are offset by $\pi/2$ (90 degrees). (Problem 7.2-7)

Exam #2 (11/9)

Homework #7 (11/20)

Text: 8.1-4, 8.1-13, 8.2-12, 8.2-14, 8.3-1, 8.3-2, 8.4-4, 8.4-7, 8.4-8, 8.4-11, 8.4-12, 8.4-15, 8.4-19, 8.4-20, 9.1-6, 9.1-7, 9.1-8, 9.1-9, 9.2-1, 9.2-2, 9.2-3, 9.2-10, 9.2-13

ECE5950 Additional Problems: 8.1-10, 8.4-21, 8.4-25, 9.1-10, 9.1-11, 9.2-8, 9.2-9

Computer Assignment: None

Homework #8 (11/30)

Text: 9.3-3, 9.3-5, 9.3-14, 9.5-3, 9.5-4

Text: 10.1-1, 10.1-3, 10.1-7, 10.1-8, 10.2-1, 10.2-2, 10.2-10, 10.3-1, 10.3-2

ECE5950 Additional Problems: 9.3-3, 9.3-15, 9.4-11, 10.2-3, 10.2-5

Computer Assignment: None

Homework #9 (12/2)

Text: 10.3-3, 10.3-6, 10.4-1, 10.4-3, 11.1-1, 11.1-2, 11.1-5, 11.1-7, 11.1-9, 11.1-14

ECE5950 Additional Problems: 10.3-10, 10.4-2, 11.1-3, 11.1-4, 11.1-10, 11.1-18

Computer Assignment: Using the FMExample.m file previously provided, add AWGN using the randn.m Matlab function to the modulated FM waveform.

For (S/N) = 0 dB, +10 dB, +20 dB, and +30 dB, listen to the simulation and compute the post-demodulated output (S/N).

To perform this operation, demodulate the signal without noise to determine the post-demodulation output signal power. Then perform the operation with the defined modulated FM signal (S/N) value and determine the post-demodulation output signal power. Since the signal and noise should be independent, you can deduce the value of the noise power. If you don't like this approach, simulate with signal, noise, and signal plus noise and measure the power for each one to form the output (S/N) and check yourself.

Homework #10 (12/11)

Text: 11.2-1, 11.2-2, 11.2-6, 11.2-10,

14.1-2, 14.1-3, 14.1-4, 14.1-7, 14.2-1, 14.2-2, 14.2-6, 14.2-7, 14.2-14, 14.2-15

ECE 5950 Projects Due (12/11)

Takehome (12/14) → 5:00 pm

Final (12/17) → 10:15-12:15