

READ INSTRUCTIONS CAREFULLY! Failure to follow them will result in point deductions.

Please complete the following problems, with the following guidelines:

- You are permitted to discuss the questions with each other, but you must independently write your own solutions and abide by the University Honor Code (no sharing of solutions and no plagiarism).
- You may use any resource on the Internet or in the libraries to supplement the text.
- **Show all of your work** for numerical problems, **and explain your reasoning** for all “word” answers.
- Please hand-write your solutions neatly, using only the front side of each page, with your name and assignment number.
- Make sure your problem set is stapled in the upper left-hand corner.
- Late homeworks will receive half credit

1. Concerning Moire patterns:

- a. What are they?
- b. What causes them?
- c. How can they be removed?
- d. When designing an system, how can you avoid introducing them into an image?

2. Complex conjugates can be used to isolate real component of a complex signal. Adding the complex conjugate results in the removal of the imaginary portion, though the result must be divided by two, to maintain magnitude as:

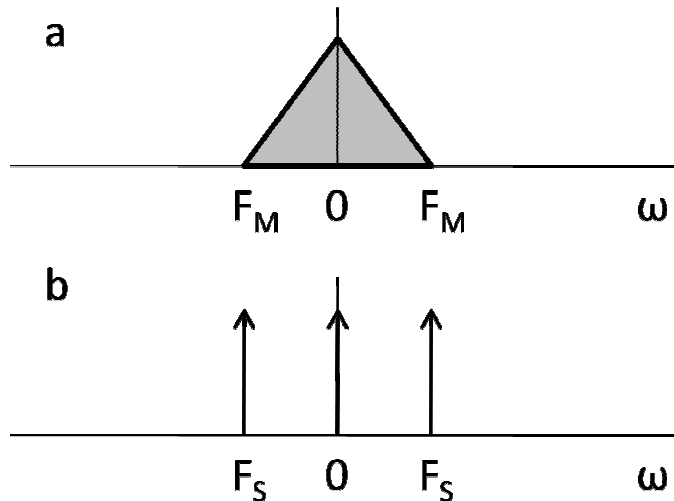
$$\cos \omega = (e^{j\omega t} + e^{-j\omega t})/2$$

Why does *subtracting* the complex conjugate leave only the imaginary portion?

3. What's the difference between image noise, artifact, and distortion? Give an example of each. Which can be corrected, and which can't?

4. The frequency response of a signal is shown in figure a. Draw the frequency response after the signal has been sampled with the sampling train in figure b and explain if the signal can be fully reconstructed from the sampled for:

- I. $F_S = 1.5F_M$
- II. $F_S = 2F_M$
- III. $F_S > 2F_M$



5. Find the Fourier transform of the following continuous signals:

- I. $\delta(x,y)$
- II. $f(x,y) = (1/2)[\sin(2\pi(ax + by)) + \sin(2\pi(ax - by))]$

6. Prove equation 2.92 (The convolution property of the Fourier transform)

7. Consider an LSI system with a PSF given by $h(x,y) = e^{-(x^2 + y^2)/4}$

- I. Calculate the MTF associated with this system
- II. Plot the MTF as a function of frequency

8. For a uniform distribution over the interval $[a,b]$ prove

- I. The pdf $p_N(\eta)$ is :

$1/(b - a)$	for $a \leq \eta \leq b$
0	otherwise
- II. The PDF $P_N(\eta)$ is:

0	for $a \leq \eta$
$(\eta - a)/(b - a)$	for $a \leq \eta \leq b$
1	otherwise
- III. The mean, $\mu_N = (a + b)/2$
- IV. The variance, $\sigma_N^2 = (b - a)^2/12$