

# Homework #1

due Tuesday February 5

( Note: I have explicitly typed the questions assigned from Hirose & Lonngren for the benefit of those who do not yet have a book. Please purchase a book ASAP. H & L #5 refers to a drawing in the book and I have tried to describe it in words. It is the same figure that I have drawn many times in lecture of the mass attached to a spring on a horizontal surface.)

1. Hirose and Lonngren Chapter 1 #1 Calculate

$$\frac{d}{dx} \sin 5x, \frac{d^2}{dx^2} \sin 5x, \frac{d}{dx} \cos 3x, \frac{d^2}{dx^2} \cos 3x. \quad (1)$$

(Note that the equations on page 1 of your book are wrong.)

2. Hirose and Lonngren Chapter 1 #4 Show that functions

- (a)  $x = A \sin \omega t$ ,
- (b)  $x = A \sin \omega t + B \cos \omega t$
- (c)  $x = A \cos(\omega t + \phi)$

all satisfy

$$M \frac{d^2 x}{dt^2} = -kx \quad (2)$$

provided  $\omega = \sqrt{k/M}$ . A, B, and  $\phi$  are constants.

3. Hirose and Lonngren Chapter 1 #5 (If a 1.5 kg mass attached to spring in the horizontal plane is displaced so that the spring is compressed 10 cm then released, twenty observations are observed in 1 minute. Find

- (a) The spring constant.
- (b) The equation describing the oscillation.
- (c) The energy associated with the oscillation.

( Answer: 6.6 N/m, (-10 cm)cos(2.1t),  $3.3 \times 10^{-2}$  J )

4. Hirose and Lonngren Chapter 3 #3. (Show that

$$\cos x = \frac{e^{ix} + e^{-ix}}{2}, \quad \sin x = \frac{e^{ix} - e^{-ix}}{2i}. \quad (3)$$

Also display these relationships geometrically as vector diagrams in the  $x - y$  plane.

5. To take successive derivatives of  $e^{i\theta}$  with respect to  $\theta$ , one merely multiplies by  $i$ :

$$\frac{d}{d\theta} (Ae^{i\theta}) = iAe^{i\theta} \quad (4)$$

Show that this prescription works if the sinusoidal representation  $e^{i\theta} = \cos \theta + i \sin \theta$  is used.

6. Write the following in exponential form i.e.  $z = \rho e^{i\theta}$  and draw it:

(a)  $z = 1 + 2i$

(b)  $z = -3 + 2i$

(c)  $z = 5 - 3i$