

## Hints for Chapter 3

#2. Easy. Just make change of units

#4. The time average of any variable  $x$  is

$$\langle x \rangle = \frac{1}{T} \int_0^T \langle x \rangle^2 dt \quad \text{where } T \text{ is the period}$$

$$\text{So } \langle KE \rangle = \frac{1}{T} \int_0^T \langle KE \rangle^2 dt$$

$$\text{and } \langle PE \rangle = \frac{1}{T} \int_0^T \langle PE \rangle^2 dt$$

#10.  $\text{amplitude}(t+\pi) = \frac{\text{amplitude initial}(t=0)}{e^{\beta t}}$  where  $-\beta t$   
Exponential 1. [amplitude =  $Ae$ ]

small  $m \Rightarrow (1+x)^m = 1 + mx + \dots$

#15. write  $x(t)$  and  $\dot{x}(t)$  for critical case

plot the phase diagram  $\dot{x}$  vs  $x$

and  $x$  vs.  $t$   
 $\dot{x}$  vs.  $t$  } on the same graph.

#21. critical damping

write  $x(t) = \dots$  find A and B

$\dot{x}(t) = \dots$

$t$  is large compared to  $\beta \Rightarrow \dot{x} = -\beta x$

Choose these points  $\Rightarrow (-2, 4)$ ,  $(1, 4)$  and  $(4, -1)$  above  
 to plot  $\dot{x}$  vs.  $x$

6 graphs and  $(-1, -4)$ ,  $(1, -4)$  and  $(-4, 0)$  below

# 22. a) overdamping

$$x(t) = e^{-\beta t} (A_1 e^{\omega_2 t} + A_2 e^{-\omega_2 t})$$

$$x(t) = A_1 e^{-\beta_1 t} + A_2 e^{-\beta_2 t}$$

$$\dot{x}(t) = \dots$$

use at  $t=0$   $x(0) = x_0$  and  $\dot{x}(0) = \dot{x}_0$

find  $A_1$  and  $A_2$

b)  $t$  large compared to  $\beta$  ( $A_1 \neq 0$ )

show that  $\dot{x} = -\beta_1 x$  ( $\beta_2 > \beta_1$ )

when  $A_1 = 0$

show that  $\dot{x} = -\beta_2 x$

# 27.

easy! Compare mechanical and electrical systems!