Test 1- ME 374

Winter 1931

(Open book and notes).

1) (50%)

a) Consider the system in Figure 1 when k_1=100, M=1**,** f(t)=sin(9.9t).

Using the transfer function that relates x to f determine the steady state amplitude of x(t)

b) If a second mass and spring are added to the system as shown in Figure 2 the equation of motions become

$$M\ddot{x} + k_1 x + k_2(x - y) = f(t)$$

$$m\ddot{y} + k_2(y - x) = 0$$

Show the pole(s) and zeros(s) of the transfer function H(s)=X/F in the complex plane. Since there is no damping the poles are all purely imaginary. What should m/k be in order for the steady state solution $x_p(t)$ =0.

Figure 1

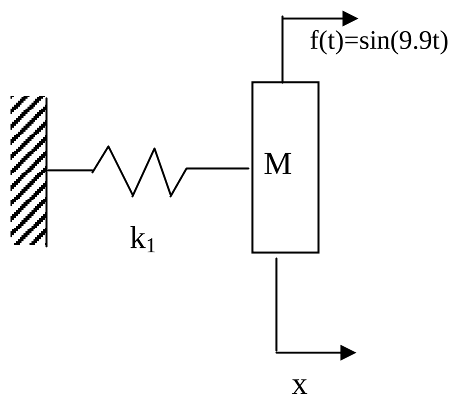
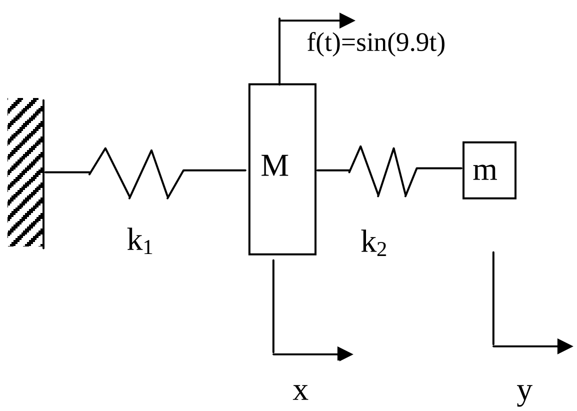


Figure 2



2) (50%) Consider the following state equation

$$\frac{d}{dt}\begin{pmatrix} v \\ f \end{pmatrix} = \begin{bmatrix} 4 & 2 \\ 3 & 5 \end{bmatrix}\begin{pmatrix} v \\ f \end{pmatrix}$$

with

$$\begin{pmatrix} v \\ f \end{pmatrix} = \begin{pmatrix} 2 \\ 1 \end{pmatrix} \quad \text{at} \quad t = 0$$

Using the state transition matrix obtain f as a function of time.