Exam1 of Dynamic System Analysis and Simulation in 2013 Spring Semester

Note : You are allowed to use MATLAB except P1.

P1. Consider the system $\ddot{y}(t)+2\dot{y}(t)+2y(t)=\dot{u}(t)-2u(t)$ with initial conditions $\dot{y}(0)$ and $y(0)$.

(4%) (4%) (8%)

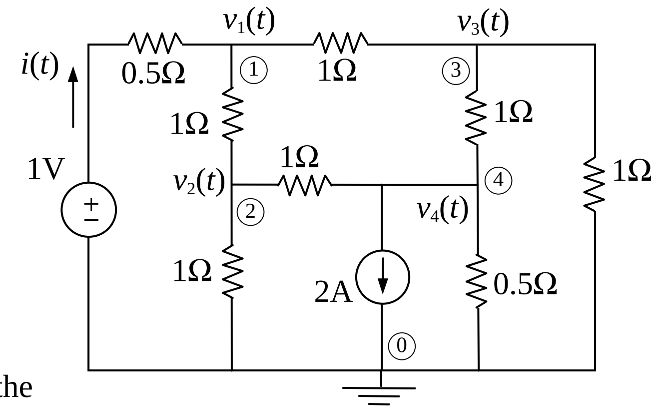
(A) What is the transfer function of the system?

(B) Given $\dot{y}(0)=0$, $y(0)=1$, please find the output $y(t)$ for $t>0$ in free motion?

(C) If $u(t)=cos(t)$, what is the output $y(t)$ as $t\to\infty$?

P2. Determine the current $i(t)$ in the circuit:

(16%)



P3. Consider $\boldsymbol{A}=\begin{bmatrix}-6 & -5 & 5\\ -2 & 0 & 2\\ -12 & -9 & 11\end{bmatrix}$.

(6%) (4%) (10%)

(A) Find the eigenvalues of $\boldsymbol{A}$ and the eigenvectors correspondingly.

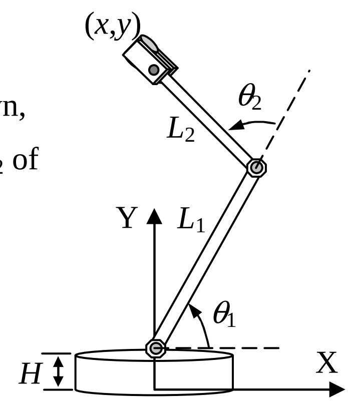
(B) Determine the characteristic equation of $\boldsymbol{A}$.

(C) Let $\boldsymbol{A}^{-2}=a\boldsymbol{A}^2+b\boldsymbol{A}+c\boldsymbol{I}$. Please determine the constants a, b and c.

P4. A two-linked robot stands on a base with height H and grasps an object by its end-effector at position (x,y). Let the lengths of its two links be L_1 and L_2, then the object's position (x,y) can be expressed as

(16)%

$$x=L_1\cos\theta_1+L_2\cos(\theta_1+\theta_2)$$
$$y=H+L_1\sin\theta_1+L_2\sin(\theta_1+\theta_2)$$



Assume that the height H and the lengths L_1 and L_2 are unknown, but the object's position (x,y) and the angular position θ_1 and θ_2 of the two links can be measured. Please determine H, L_1 and L_2 based on the least squares method from the following experimental data:

x	1.01	0.79	0.66	0.43
y	1.37	1.46	1.45	1.49
θ_1	30°	30°	45°	45°
θ_2	30°	45°	30°	45°

P5. Consider the following system described as:

(16%) (16%)

$$\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\end{bmatrix}=\begin{bmatrix}0 & 1\\ -3 & -4\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u(t),\quad x_1(0)=1 \text{ and } x_2(0)=0$$

$$y(t)=x_1(t)-x_2(t)$$

where the input $u(t)=|cos(t)|$. Please plot the output $y(t)$ for $0<t<6$.

(A) Simulate the system by the second order Runge-Kutta method.

(B) Simulate the system by the command "ode45" in MATLAB.