國立屏東科技大學 九十八 學年度 碩士班暨碩士在職專班 招生考試

自動控制 試題

1. Fig. 1 shows the schematic diagram of a permanent-magnet DC motor. (20 points)

   (1) Please draw the block diagram of this system.

   (2) Determine the transfer function between the input voltage v_i and the output rotational angle θ

   Assume that the torque constant is K_t, the back EMF constant is K_v, and the load inertia, damping coefficient, and stiffness are $J, c,$ and k, respectively.

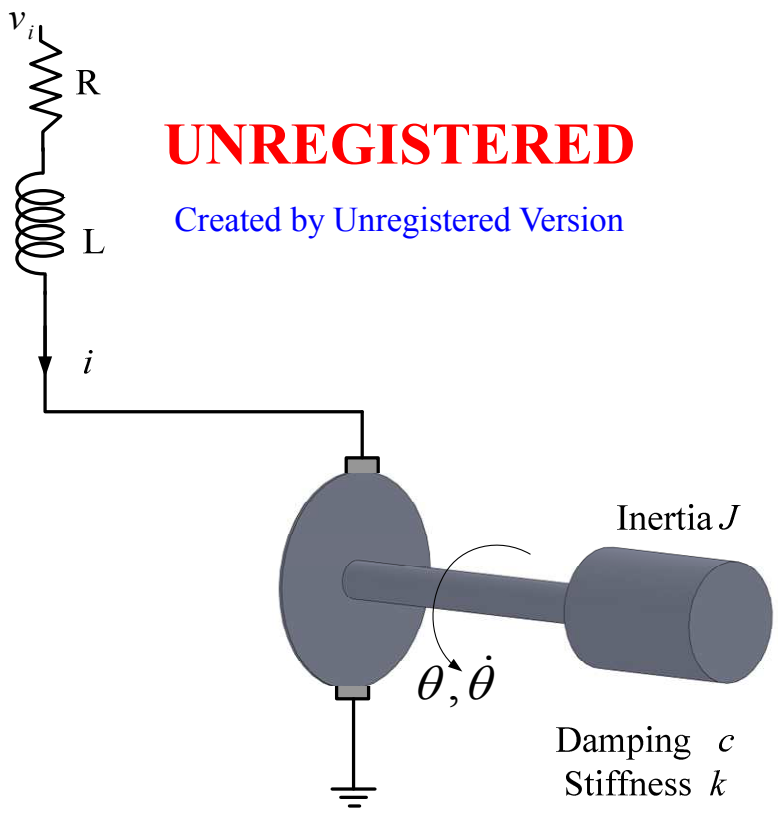

Fig.1 Schematic diagram of a permanent DC-motor

2. Fig.2 shows a speed control system for a vehicle. The command speed v_c is converted to a voltage by means of the cruise control gain K_1, and compared to the actual speed obtained from a tachometer with identical transfer function. The error signal e adjusts the throttle setting such that the resulting force F exerted by the wheels on the vehicle is proportional to e. At this point, a disturbance force due to the wind w acts on the vehicle. (20 points)

   (1) Are the characteristic equations of the transfer functions $\frac{v}{v_c}$ and $\frac{v}{w}$ the same? Prove your answers.

   (2) Find the steady state speed of the vehicle when there is no disturbance and v_c is constant.

   (3) Find the steady state speed of the vehicle when both v_c and the disturbance w are constant

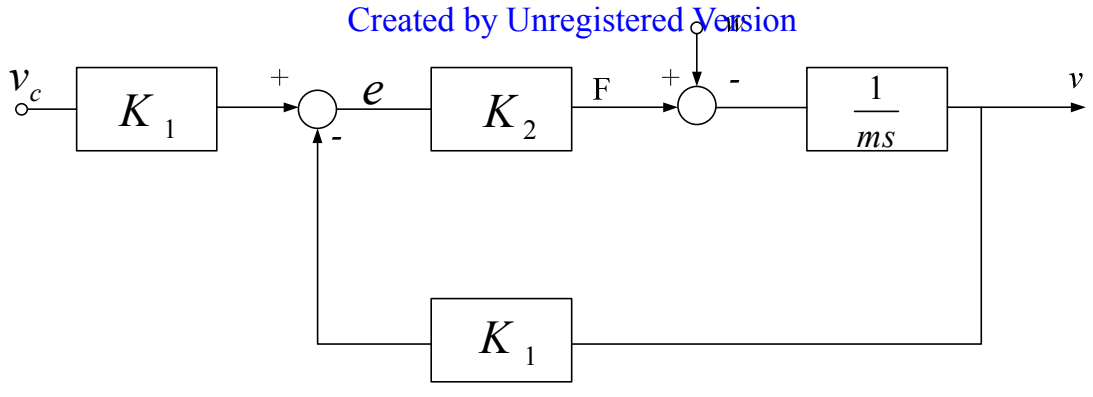

Fig. 2 Vehicle speed control system

3. A unity-feedback control system has the forward path transfer function

$$GH(s) = \frac{K}{s(s^2 + s + 9)}$$

Find the maximum value of K consistent with stability by Nyquist criterion and check the result using Routh-Hurwitz method. (20 points)

4. An open loop SISO control system is represented by the transfer function (20 points)

$$\frac{y}{u} = \frac{8}{s^2 - 9}$$

Comment on the stability and controllability of the open loop system. Find a suitable feedback control of the state variables such that the closed-loop system is critically damped.

5. A spring-mass-friction system is described by the following differential equation (20 points)

$$\frac{d^2 y(t)}{dt^2} + 2\frac{dy(t)}{dt} + y(t) = r(t)$$

(1) Define the state variables as $x_1 = y(t)$ and $x_2 = \frac{dy(t)}{dt}$. Write the state equation in vector-matrix form, and find the state transition matrix $\phi(t)$ of A.

(2) Define the state variables as $x_1 = y(t)$ and $x_2 = y(t) + \frac{dy(t)}{dt}$. Write the state equation in vector-matrix form, and find the state transition matrix $\phi(t)$ of A.

(3) Show that the characteristic equations, $|sI - A| = 0$, for parts (1) and (2) are identical.