College of Engineering, Pune-5

End Semester Exam - May 2012

(IE 209) Automatic Control System

S.Y.B.Tech. (Instrumentation and Control)

Duration : 3 Hours

Max. Marks: 50

Instructions to candidates:

1. All questions are compulsory.
2. Assume suitable data, if necessary.

Q. 1 (a) Find $f(0), \dot{f}(0), \ddot{f}(0)$ for the function whose Laplace transform is given below:

$$\frac{4s+1}{s(s^2+2)}$$

(b) Derive mathematical model for the given figure 1. **(5)**

(5)

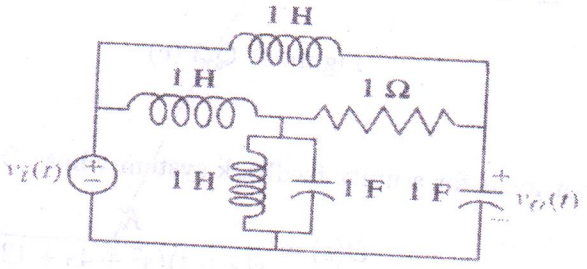

Figure 1: Q.1 (b)

Q. 2 (a) Derive closed loop TF C_2/R_1 for the given figure 2 using block reduction technique. **(5)**

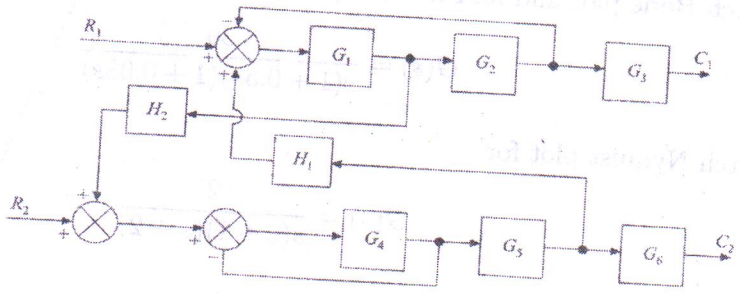

Figure 2: Q.2 (a)

(b) For the figure given in part (a) find TF using Mason's gain formula **(5)**

Q. 3 (a) A second order control system is represented by a TF given below: **(4)**

$$G(s) = \frac{1}{Js^2 + fs + K}$$

where θ_o is the proportional output and T is the input torque.
A step input of $10Nm$ is applied to the system and test results are given below: (a) $M_p = 6\%$ (b) t_p=1 sec and (c) The steady state value of the output is 0.5 radians. Determine the values J, f, K.

(b) Derive mathematical relation between phase margin and damping factor ζ. **(3)**

(c) The system shown in figure 3 is to have the following specifications: **(3)**
$K_v = 10$, $\zeta = 0.5$. Find the value of K_1 and K_f required for the specifications of the system to be met.

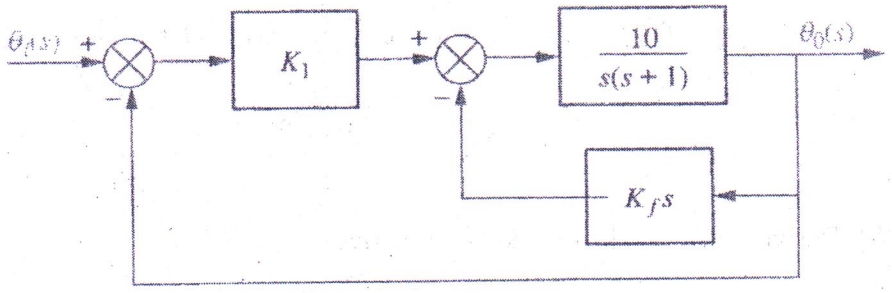

Figure 3: Q.3 (c)

Q. 4 (a) Sketch root locus for a unity feedback system whose OLTF $G(s)$ is given by **(7)**

$$G(s) = \frac{K}{s(s+4)(s^2+4s+13)}$$

(b) Using Routh-Harwitz criterion determine stability of the system whose characteristic equation is given by **(3)**

$$s^6 + 3s^5 + 6s^4 + 12s^3 + 12s^2 + 12s + 8 = 0$$

Q. 5 (a) Sketch Bode plot and find frequency response indices for the system **(5)**

$$G(s) = \frac{30}{s(1+0.5s)(1+0.08s)}$$

(b) Sketch Nyquist plot for **(5)**

$$G(s) = \frac{2}{s(s+1)(s+2)}$$