1.(a) What is the "bandwidth" of a control system? (5%)
(b) If poles of a closed-loop system are moved closer to the jω axis, How will the system's the frequency response change? (5%)
(c) Describe briefly the principles of root locus method and Nyquist stability criterion for the stability analysis of the system shown in Fig. 1.(10%)
(d) Repeat part (c) if positive feedback is used instead of negative feedback.(5%)

2. (a)You are asked to design an X-Y table and its PC-based motion control system. Sketch the interconnecting system block diagram and identify all the components, modules or devices required to complete such a system. (Including mechanical, electronic and electrical hardware and software.)(15%)
(b) Both PC and PLC are commonly used in industrial control applications. State the major differences, advantages and disadvantages for the control structures of these two types of controllers. (5%)

3. (a) Find the transfer function $H_V(s)=V(s)/F_a(s)$ for the mechanical system shown in Fig. 2. (15%)
(b) Find the value of ω for which the mass M_2 will remain motionless in the steady state when the input is $f_a(t)=\sin\omega t$. (5%)

4. Find the closed-loop transfer functions $T_1(s)=Y(s)/U(s)$ and $T_2(s)=Z(s)/U(s)$ in the terms of the individual transfer functions A(s),....,E(s) for the block diagram shown in Fig. 3. Give your answer as a ratio of terms that involve only sums, differences, and products of the individual transfer functions. (15%)

5. (a) For the block diagram shown in Fig. 4, find the closed-loop transfer function T(s)=Y(s)/U(s) as a ratio of polynomials. (5%)
(b) Determine the steady-state response to a unit step-function input in terms of K.(10%)
(c) Write the damping ratio ζ and undamped natural frequencu ω_n in terms of the parameter K. Slove for the value of K for which $\zeta = 1/\sqrt{2}$ and find the corresponding numerical value of ω_n. (5%)

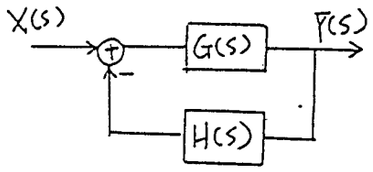

Fig. 1.

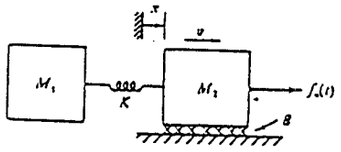

Fig.2

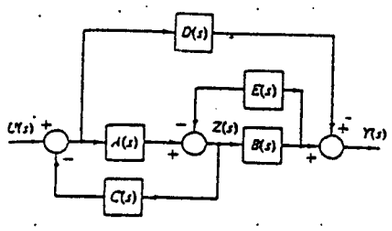

Fig 3.

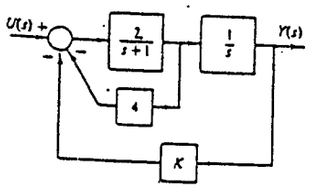

Fig.4