1. A coupled spring-mass system is shown in Fig.1 The masses and springs are assumed to be equal.
   (a) What's the transfer function $X_2(s)/F(s)$ ?
   (b) Draw an analogous electrical circuit and write the differential equation of the circuit ? (15%)

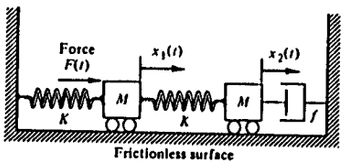



Fig.1

2. If a closed loop control system is unity feedback, which open loop transfer function KG(s), K values can vary from zero to infinity. If the poles of G(s) are 0,-3,-5,-7,-15 and zero is -8 respectively,
   (1) What's the possible root-locus ? Please explain the reason why you make such an approximate plot.
   (2) In your plot, at which cases may the time response of the system have the damping ratio 0.707 and o.5 ? Explain it.
   (3) What's the main purpose to plot the root-locus ? (15%)

3. One important objective of the paper-making process is to maintain uniform consistency of the stock output as it progesses to drying and rolling. A diagram of the thick stock consistency dilution control is system shown in Fig.2. The amount of water added determines the consistency. The signal flow graph of the system is shown in ig.3. Let H(s)=1 and

$$G_c(s)=\frac{K}{10s+1}, \qquad G(s)=\frac{1}{s+10}.$$

   (a) What's the transfer function T(s) of the closed loop control system?
   (b) Determine the sensitivity $S_k$ ?
   (c) Calculate the value of K required for an allowable steady state error of one percent if the input is a step input. (20%)

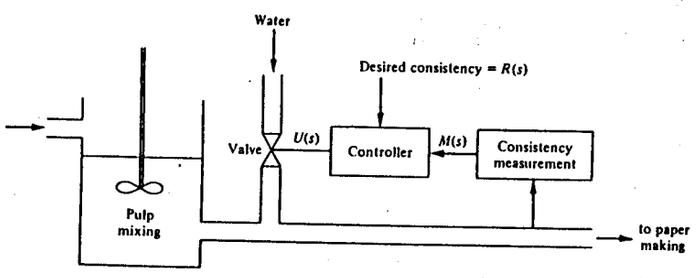



Fig.2

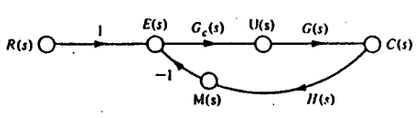
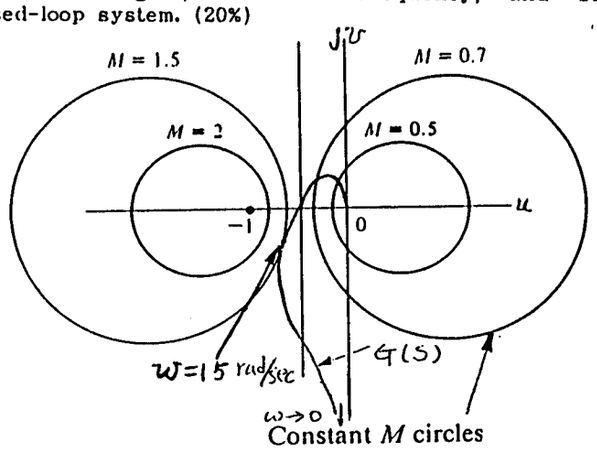



Fig.3

4. You are supposed to buy a plotter system, give and explain your decision reasoning based on frequency-domain justification by plotting a square wave. (15%)

5. Consider a unity feedback system with stable open-loop transfer function G(s) which is shown in the following polar plot, determine and explain the estimated DC-gain, resonance frequency, and stability margin of the closed-loop system. (20%)




6. Use Bode plot to explain the basic principle in cascade compensation using lead and/or lag compensators. (15%)