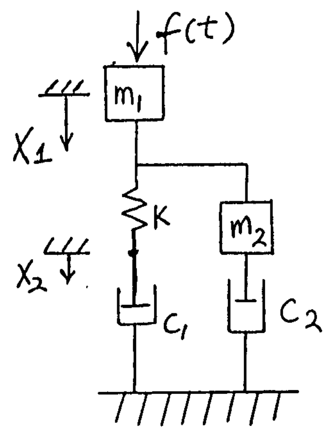
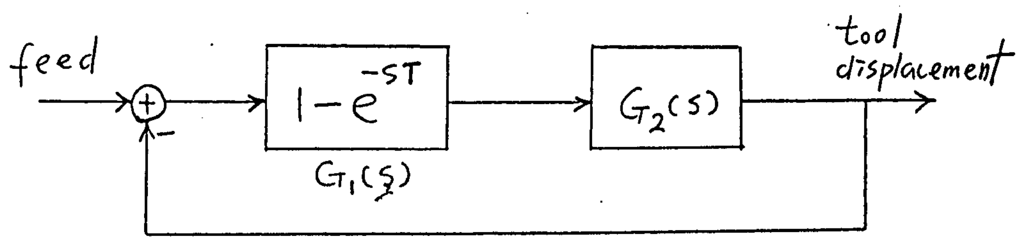
4. The lumped model of a machine is shown below.
   (a): Find the equations of motion for the system. 10%
   (b): Derive the transfer function between the input F(s) and output $X_1(s)$. 15%



5. As shown is the block diagram of a machining system.
   (a): Sketch the frequency response of $G_1(s)$ in polar plot and Bode (gain/phase) plot. 10%
   (b): For the three cases of $G_2(s)$: (1): $G_2(s)=K$, (2): $G_2(s)=K/(\tau s+1)$ and

   (3): $G_2(s)=\dfrac{K}{\frac{s^2}{\omega_n^2}+\frac{2\xi}{\omega_n}\cdot s+1}$

   discuss the stability of this system with each $G_2(s)$. 15% (Suggest using Nyquist criterion)



$T=0.1$ sec

ω_n: natural frequency of $G_2(s)$

ξ : damping ratio of $G_2(s)$

1. (a) Explain the meaning of the absolute stability of a control system ? And, what's the relative stability in the time domain ?

   (b) Which informations can you know from the dominant poles of a control system ?

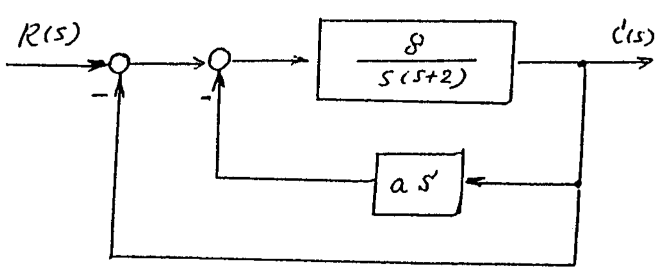
   (c) What are the basic rules to define a point in the s-plane, which is on the root locus of a control system ? explain it, please ?

   (d) Define the meaning of percent of overshoot, peak time, settling time and rise time in the time response of a second order control system ? (20 %)

2. The system illustrated in Fig. is a unity feedback control system with a minor feedback loop (output derivative feedback).

   (a) determine the damping factor and natural frequency, if a=0 ? Also, determine the steady state error resulting from a unit-ramp input ?

   (b) determine the derivative feedback constant "a", which will increase the damping factor of the system to 0.7 ? and, what's the steady state error with a unit ramp input for the setting of the derivative feedback constant ? (20 %)



3. The characteristic equation of a servo control system is given as: $s^3 + 3ks^2 + (k+2)s + 4 = 0$

   Determine the range of value "k" for the system to be stable ?

   (10 %)