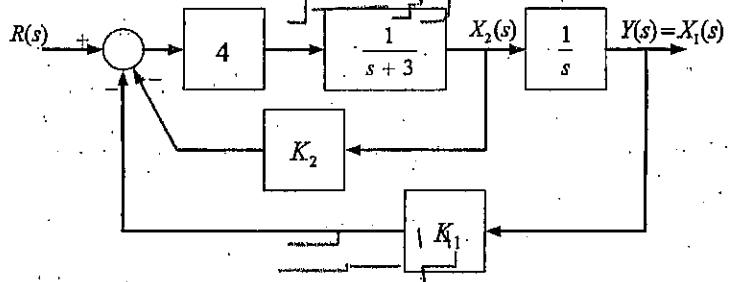
1. (20%) Explain the following terminologies briefly:
   - **(a)** Closed-loop system. (5%)
   - **(b)** Routh-Hurwitz criterion. (5%)
   - **(c)** Bode plot. (5%)
   - **(d)** Separation principle. (5%)

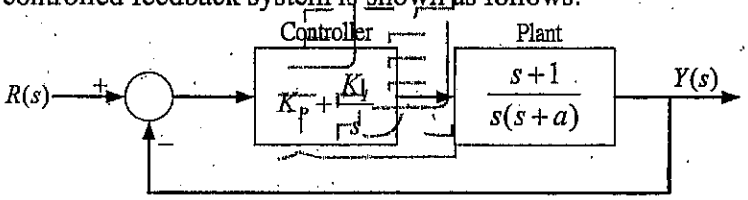
2. (30%) Consider the series RLC circuit (where the resistance R, inductance L and the capacitance C are constants) in series with the voltage input $v(t)$.
   - **(a)** Let the state variables be $x_1(t)=v_C(t)$, which is the voltage across the capacitor, and $x_2(t)=i_L(t)$, which is the current through the inductor. The voltage $v_C(t)$ across the capacitor is the system output. Find both state variable and transfer function models for this system. (10%)
   - **(b)** Determine the conditions for R, L and C to result in a zero-overshoot system response with the rapidest rise time for a unit step input. (10%)
   - **(c)** Determine the conditions for R, L and C to yield an oscillator circuit. Explain why? (10%)

3. (30%) A feedback system has the block diagram shown as follows:



   - **(a)** Determine the transfer function from the input $R(s)$ to the output $Y(s)$. (5%)
   - **(b)** Find the state-space representation with $x_1(t)=y(t)$ and $x_2(t)=\dot{y}(t)$. (5%)
   - **(c)** When $K_1=K_2=K$, select the feedback gain K so that the steady-state error $\lim_{t\to\infty} e(t)$ (where $e(t)=r(t)-y(t)$) for a unit step input is equal to zero. (10%)
   - **(d)** When $K_1=2K_2=1$, find the output $y(t)$ for this system with a unit step input and the initial states $x_1(0)=x_2(0)=1$. (10%)

4. (20%) A PI-controlled feedback system is shown as follows:



   - **(a)** Find the range of K to stabilize this system if $a=0$ and $K_P=K_I=K$. (10%)
   - **(b)** Sketch the root locus for the system in **part (a)** as K increases from zero to infinity. (10%)