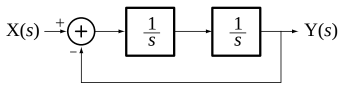
1. Circle the correct answer (marginally-stable is unstable).

(a) Transfer function, $H(s) = \frac{100s}{s^2 + 3s + 2}$. Stable

$$H(s) = \frac{100s}{s^2 + 3s + 2} = \frac{100s}{(s+1)(s+2)}$$ Poles in the open left half-plane.

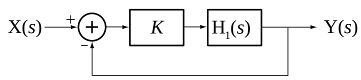
(b)  Unstable



$$s^2 Y(s) = X(s) - Y(s) \Rightarrow Y(s)(s^2 + 1) = X(s) \Rightarrow H(s) = \frac{Y(s)}{X(s)} = \frac{1}{s^2 + 1} = \frac{1}{(s+j)(s-j)}$$

Poles on the $\omega$ axis. Marginally stable, therefore unstable.

2. For each $H_1(s)$ is there a finite positive value of $K$ for which this system is unstable?





(a) $H_1(s) = 1000\frac{s-4}{s+10}$ Yes

In the root locus, the closed-loop pole starts on the loop transfer function pole at $s = -10$ for low $K$ and as $K$ increases the closed-loop pole moves toward the looop transfer function zero at $s = 4$ in the right half-plane. Therefore at some finite positive value of $K$ the system is unstable.

(b) $H_1(s) = \frac{25}{s^2 + 2s + 1}$ No

In the root locus, the closed loop poles start at the loop transfer function double pole at $s = -1$ in the open left-half plane. As $K$ increases the poles migrate straight up and down and therefore never cross into the right half-plane. Therefore for all $K$ the system is stable.

(c) $H_1(s) = -\frac{10}{(s+3)(s+8)(s+22)}$ Yes

There are three real loop transfer function poles in the left half-plane. In the root locus, at some value of $K$ the closed-loop poles will enter the right half-plane. Therefore at some finite positive value of $K$ the system is unstable.