1. Suppose H(s) in Fig. 8.1 satisfies the following conditions at a frequency ω_1: $|H(j\omega_1)| = 1$ but $\angle H(j\omega_1) = 170°$. Explain what happens. And Repeat the above problem if $|H(j\omega_1)| < 1$ but $\angle H(j\omega_1) = 180°$

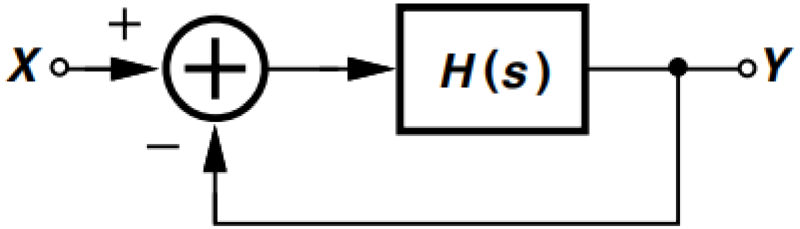

Fig. 8.1 Negative feedback system.

$|H(j\omega_1)| = 1$, $\angle H(j\omega_1) = 170°$, $\frac{Y}{X}(s) = \frac{H(s)}{1+H(s)}$

$$\left|\frac{Y}{X}(j\omega_1)\right| = \frac{1}{\left|1 + e^{+j\frac{170}{180}\pi}\right|} = \frac{1}{0.174} = 5.73$$

$$\angle\frac{Y}{X}(j\omega_1) = \frac{170}{180}\pi - \angle\big(1 + H(j\omega_1)\big) = \frac{17}{18}\pi - 1.4835 = 1.4835 \Rightarrow 85°$$

So if X(t) is a sinusoidal signal at ω_1, the amplitude of output will be multiplied by 5.73, and the phase will change by $85°$

$|H(j\omega_1)| = A < 1$, $\angle H(j\omega_1) = 180°$, $\therefore H(j\omega_1) = Ae^{j\pi} = -A$

$$\left|\frac{Y}{X}(j\omega_1)\right| = \frac{A}{1-A}$$

$$\angle\frac{Y}{X}(j\omega_1) = \pi - 0 = \pi$$

So if the input of the system is a sinusoidal signal at ω_1, the amplitude of output will be multiplied by $\frac{A}{1-A}$ and the phase of output will change by π, compared with input.

2. Is it true that the cross-coupled oscillator of Fig. 8.2 exhibits no supply sensitivity if the tail current source is ideal ?

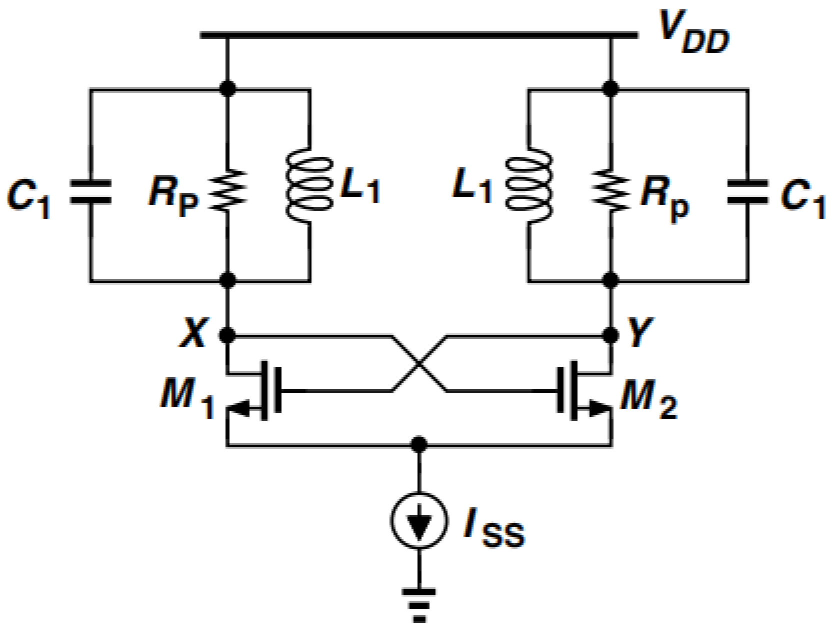

Fig. 8.2

Solution:

No, it is not. The drain-substrate capacitance of each transistor sustains an average voltage equal to V_{DD} (Fig. 8.20). Thus, supply variations modulate this capacitance and hence the oscillation frequency.

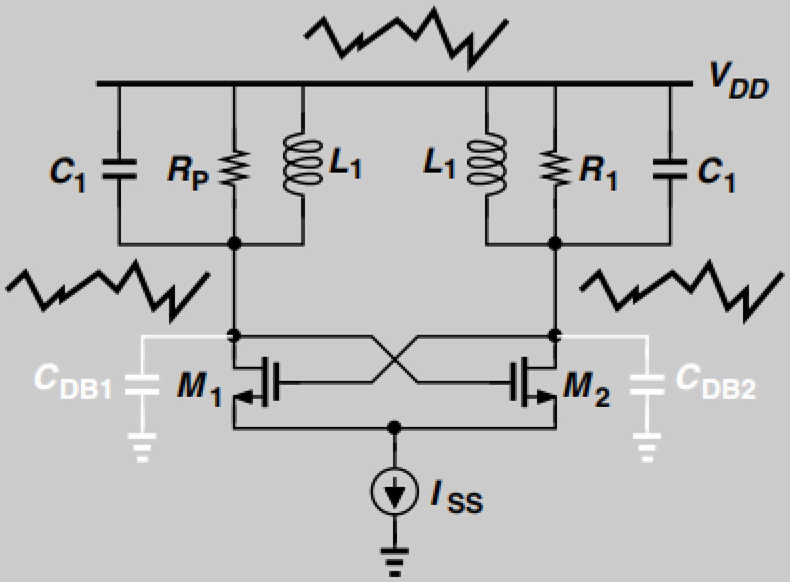

Figure 8.20 *Modulation of drain junction capacitances by V_{DD}.*