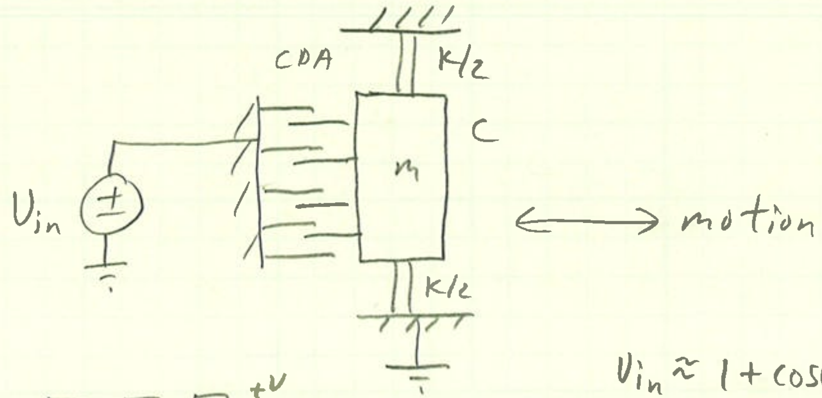
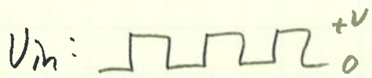
1. MEMS Electrostatic Resonators

consider this device:





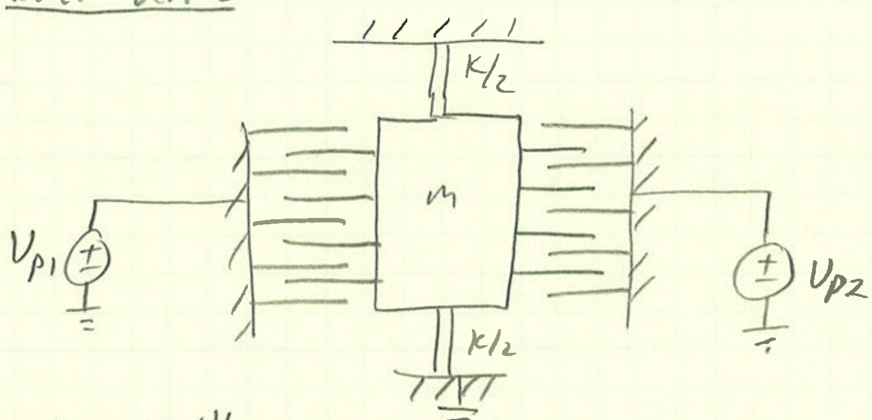
$f = f_n = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$

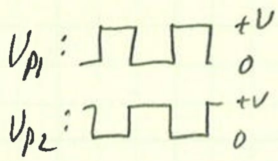
$V_{in} \approx 1 + \cos(\omega t)$

$\therefore V_{in}^2 \approx 1.5 + 2\cos(\omega t) + 0.5\cos(2\omega t)$

although Vin is a square wave, motion is nearly sinusoidal due to high Q of MEMS devices

a. Dual drive





180° out of phase, $f = f_n$

proof mass oscillates at ω_n

Applications: (1) MEMS vibratory gyroscope

(2) low P pressure sensor

(3) RF fiter elements , (4) variable mass-detection sensor

Problems with this approach:

(1) Must tune v_{p1} and v_{p2} to ω_n

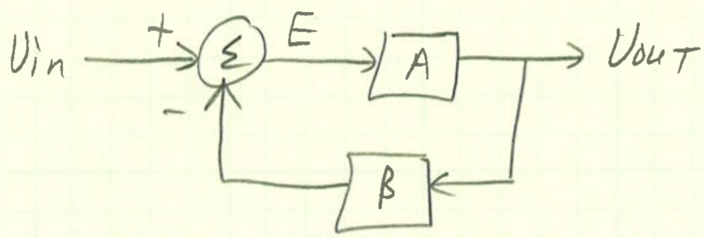
(2) ω_n may change due to temperature, aging, etc.

(3) harmonics of v_{p1} and v_{p2} may excite unwanted vibration modes in the mechanical system

→ ∴ use the MEMS device to realize a feedback sinusoidal oscillator

2. <u>Review of Sinewave Oscillators</u>

Consider this system:



E → "error signal"

A + β are gains

Aβ ≡ loop gain

(1) $E = V_{in} - \beta V_{OUT}$

(2) $V_{OUT} = EA$

(1) → (2): $V_{OUT} = A[V_{in} - \beta V_{OUT}]$

$$V_{OUT}[1 + A\beta] = AV_{in}$$

$$\frac{V_{OUT}}{V_{in}} = \frac{A}{1 + A\beta}$$