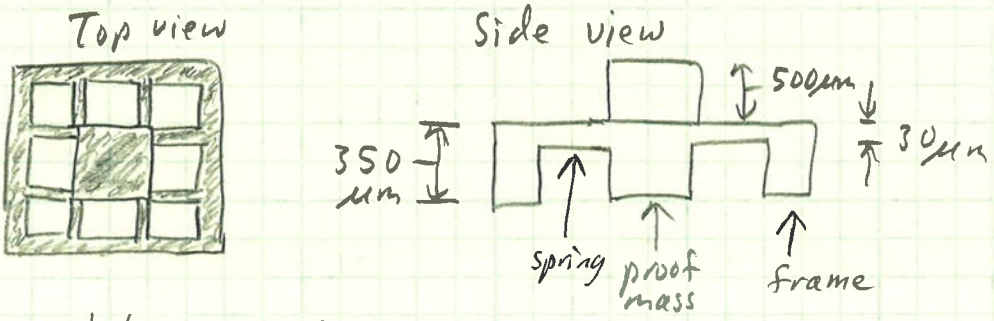
1. Transmissibility Example

Consider this MEMS device

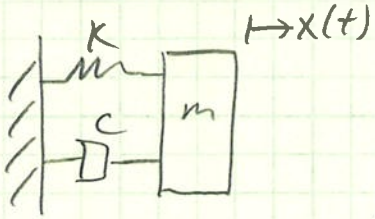


→ show testing plots on next 3 pages

2. Transient Response Analysis

ex: dropping in off Haley Center (LOL)

second order system will have this response:



$$x(t) \sim A\left(\frac{1}{\sqrt{1-\frac{1}{4Q^2}}}\right) e^{\frac{-\omega_n t}{2Q}} \sin\left(\sqrt{1-\frac{1}{4Q^2}}\,\omega_n t + \tan^{-1}\frac{\sqrt{1-\frac{1}{4Q^2}}}{\frac{1}{2Q}}\right)$$

Show plot on next page of time response for $A = 10\mu m$, $f_n = 2\,kHz$ and $Q = 10$

→ measure T from plot to get f_n

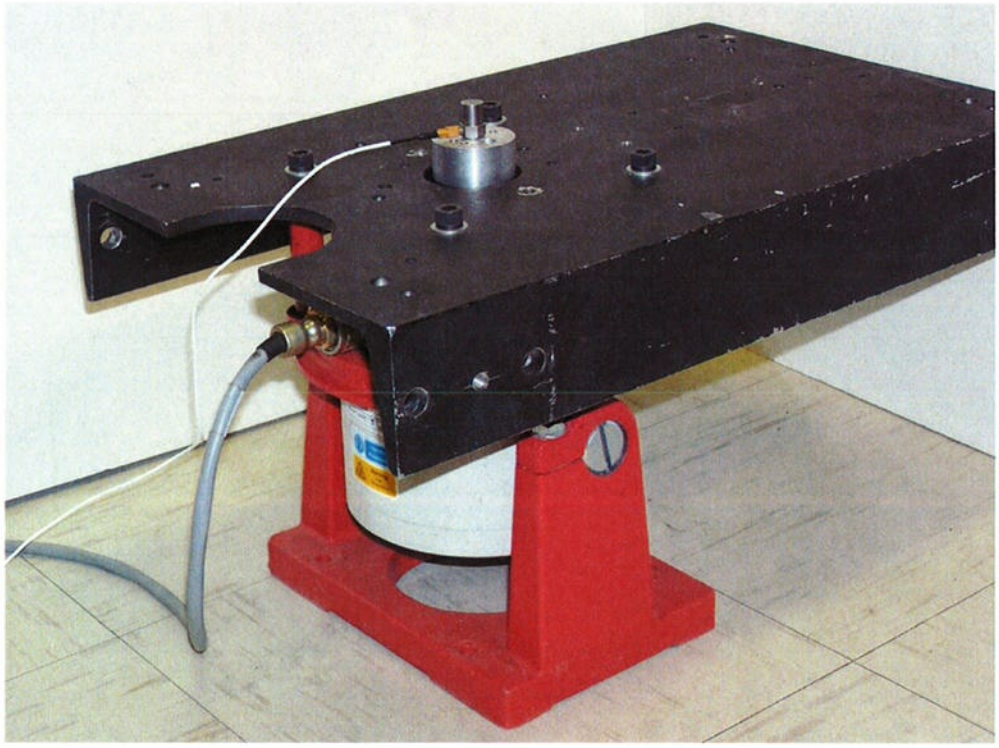
→ measure adjacent peaks to get Q

$$\text{peak1} \sim A e^{-2\pi/2Q}$$

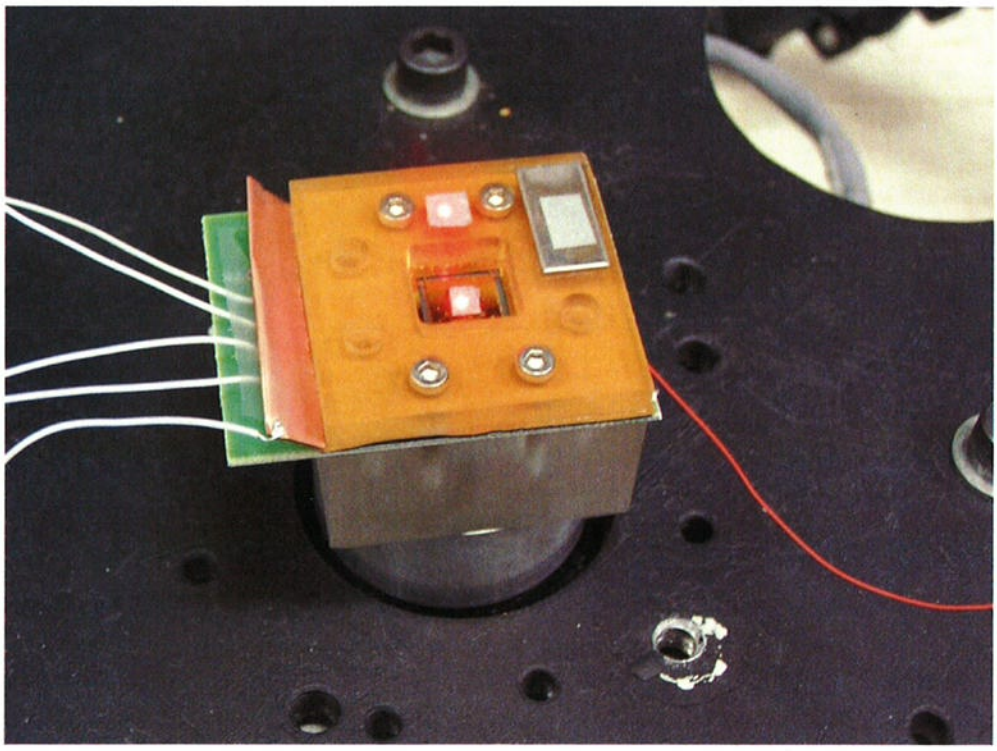
$$\text{peak2} \sim A e^{-4\pi/2Q}$$

R = ratio of peak1 to peak2

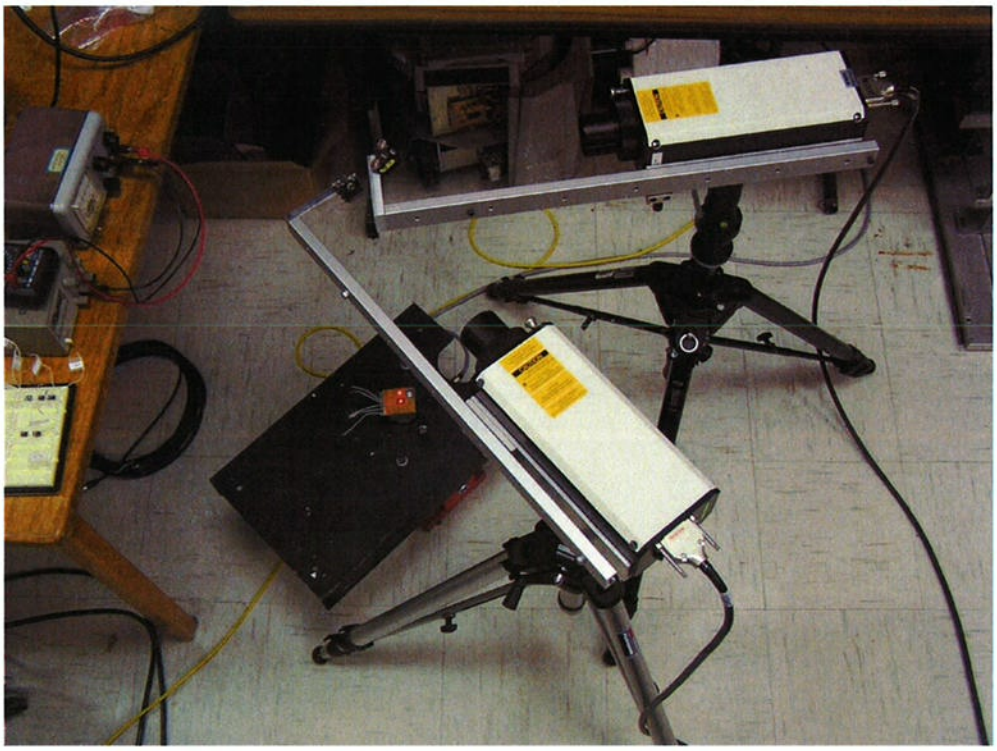
$$R = \frac{e^{-2\pi/2Q}}{e^{-4\pi/2Q}} = e^{\pi/Q} \rightarrow Q = \frac{\pi}{\ln(R)}$$



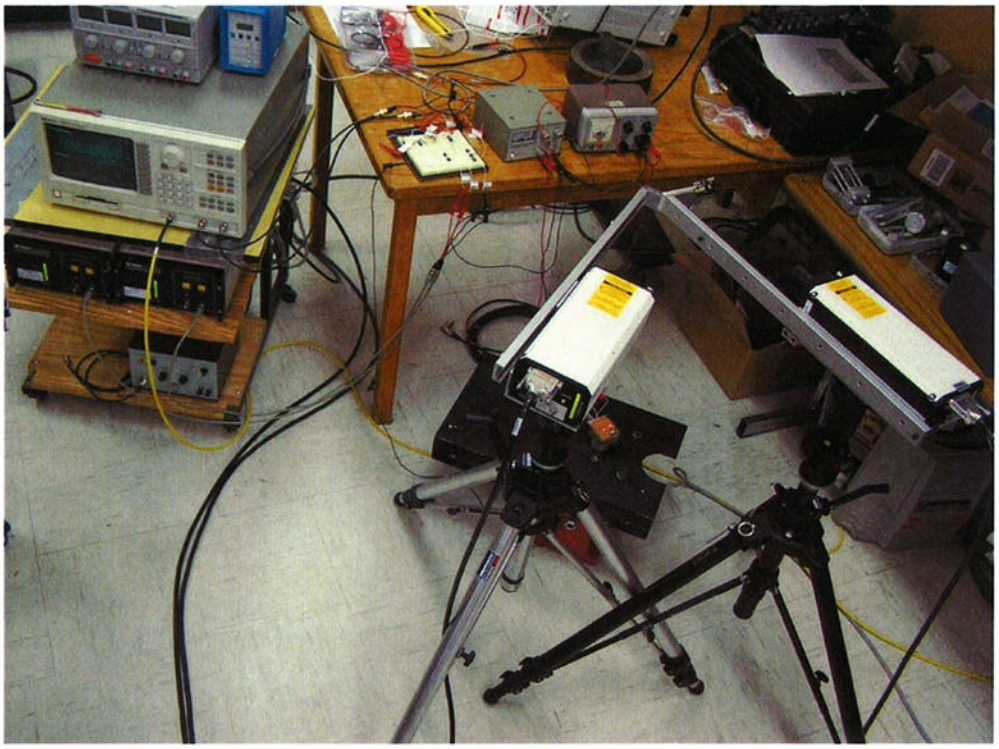
Electromechanical shaker



MEMS device in plastic holder on electromechanical shaker



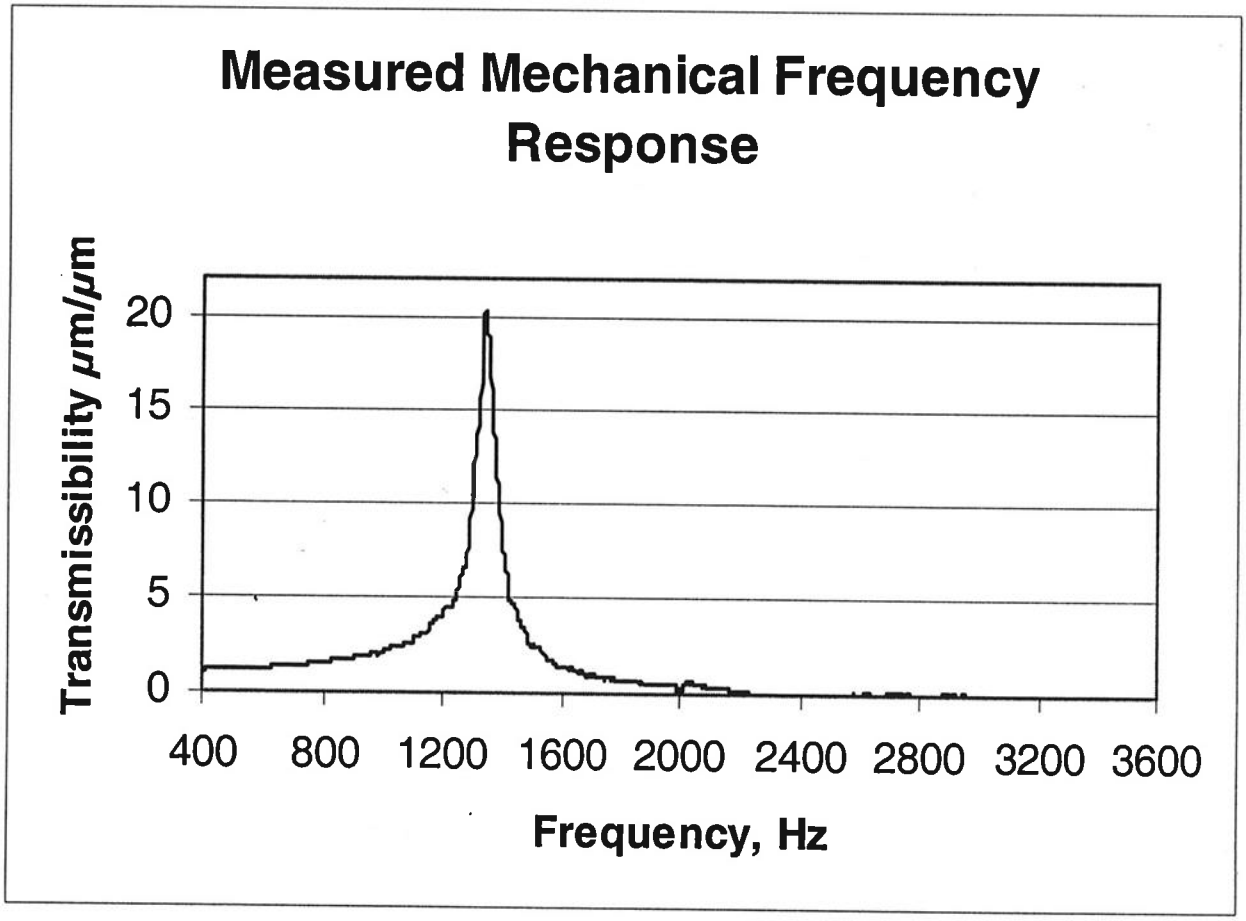
2 laser interferometers used to measure transmissibility of MEMS device on shaker

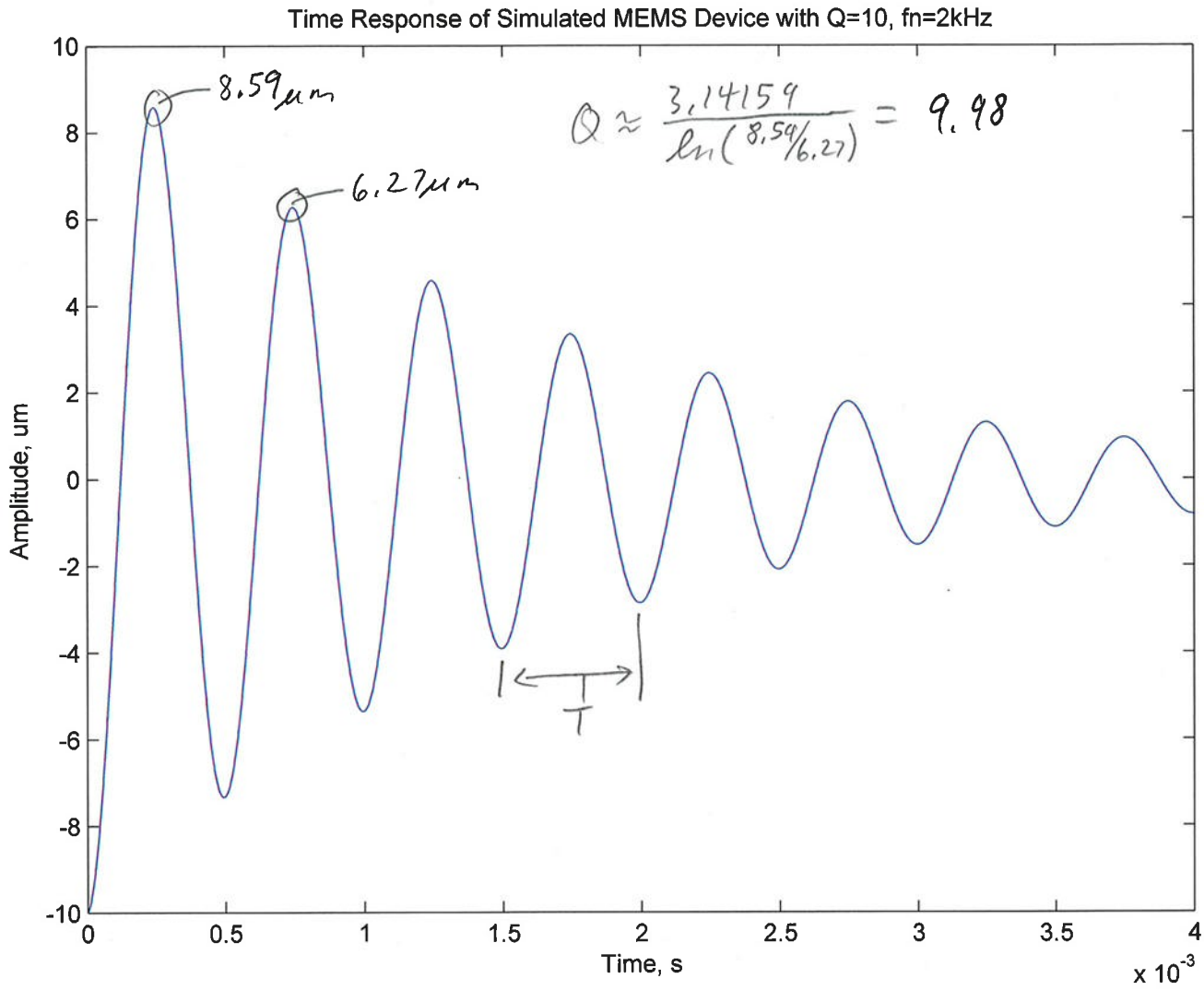


Another view of the test setup

Handout 5

Example Measured Transmissibility of an Actual MEMS Device:




Time Response of Simulated MEMS Device with Q=10, fn=2kHz
8.59μm
6.27μm
$Q \approx \frac{3.14159}{\ln(8.59/6.27)} = 9.98$
T
Amplitude, um
Time, s
x 10^-3
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
0.5
1
1.5
2
2.5
3
3.5
4