Accelerometer is a typical MEMS (Micro Electro-Mechanical Systems) product in the market and it normally consists of a proof mass and a flexure structure. The acceleration is measured by the oscillation of the whole structure by a capacitive sensor. For this project, please perform a parametric design of a given accelerometer geometry and requirements.

The accelerometer suspension is a fully, double-folded flexure system as shown in the attached figure. The “bridge beam” (with length denoted $L_b$) is flexible and carries loads via bending stresses. The following parameters are fixed and not adjustable for you:

$$h_1= h_2= h_3= h_b=1.8 \mu m$$
$$b_1= b_2= b_3= b_m=1.8 \mu m$$ (thickness)
$$L_b=150 \mu m$$
$$E=160 GPa$$
$$\rho =2.33 gm/cm^3$$
$$y_a=100 \mu m$$
$$x_a=L_b+2h_1$$
$$x_m=L_b+2L_2+2h_1+2h_3$$

The following constrains are non-negotiable due to geometry and other issues such as the validity of the beam theory

$$L_1 \geq 20 \mu m$$
$$L_2 \geq 20 \mu m$$
$$L_3 \geq 20 \mu m$$
$$L_3 \geq h_2+y_a+L_1$$

The following are the engineering goals you must meet:

- Minimum DC acceleration resolution, $a_r \leq 0.0005g$
- Maximum DC acceleration survival, $a_{\text{max}} \geq 2,000g$
- Maximum die area, $A_d=x_m*(y_m+2L_3+2h_2) \leq 90,000(\mu m)^2$
- Maximum stress in suspension, $\sigma_{\text{max}} \leq 1.6 GPa$

The following are parameters that are dictated by the capacitive sensor

- Motion Resolution, $x_r=(10^{-1} \mu m)^2/(\mu m \text{ width})$

Note that the motion resolution is divided by the width of the proof mass and this motion resolution is an OVERALL resolution presuming the capacitive sensors are operating at the both sides of the proof mass.

Please complete the design by selecting the numerical values for $L_1$, $L_2$, $L_3$ and $y_m$ so that your design meets all the constraints and goals. If you can’t meet all the constraints and
goals, then attempt to meet them as much as possible and explain why you feel your choice of parameters is the best. For the report, please follow the format given on the website and be sure to explicitly state the values of

1. All chosen dimensions for your design.
2. Actual values achieved for all engineering goals
3. Magnitude and location of maximum stress in the suspension.

In the theory section of the report, please be sure to clearly state your decision logic in choosing the values of the dimensions you select. “I just made guesses,” “I gave up after 2 hours of trying” or similar characterizations are not acceptable statements of the decision logic.

Note that all requirements for z-axis shock, cross-axis sensitivity, bandwidth and frequency response have been relaxed for this project.

You can use Matlab or other environment to do the computations and use the FEM analysis to verify your design results.

![Diagram of accelerometer design](image)

**Figure 1,** The accelerometer design. (For simplicity, the suspension on this side of the proof mass is not shown.)