Design of an Energy Harvester
Project 3C

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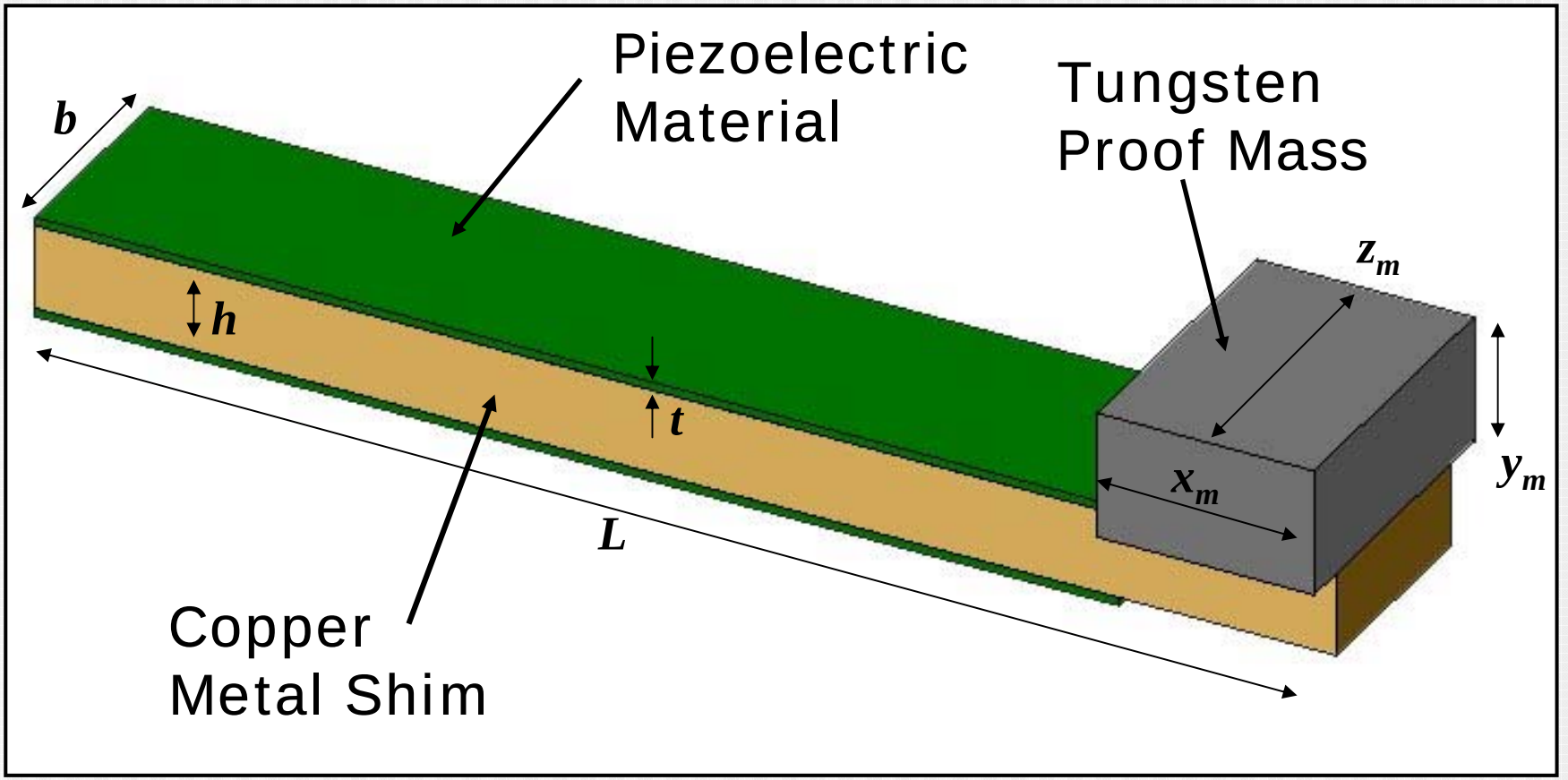
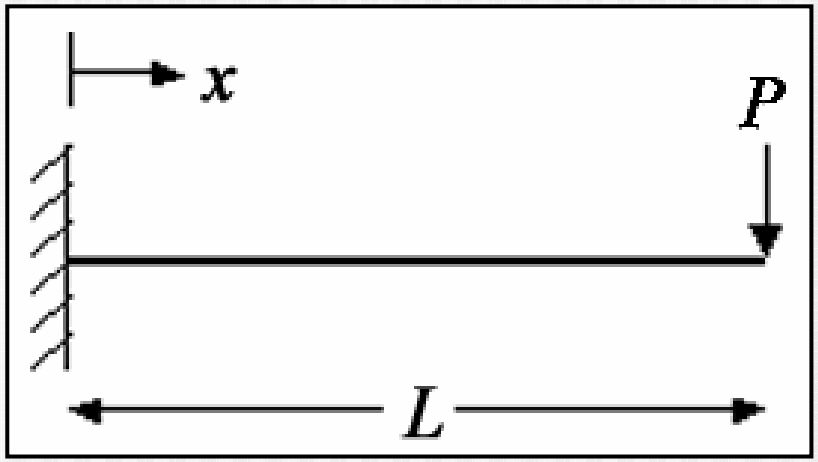
Proposed Design



Theoretical Approach

- Simplify the problem



- Cantilever Beam
- Single Material
- Point Force

Governing Equation

$$M(x) = EI\frac{d^2u}{dx^2} = P(x-L)$$

Boundary Conditions

$$y(x=0)=0 \quad \theta(x=0)=0$$

Equation of Elastic Curve

$$u(x) = \frac{P}{6EI}(x-L)^3 - \frac{PL^2}{2EI}x + \frac{PL^3}{6EI}$$

Analytical Model

$$Power = \frac{\omega^2 b^2 h^2 e_{31}{}^2 A^2}{4\left(1 + bL\varepsilon_{33}\omega R / t\right)^2} R$$

$$R_P{}^* = \frac{t}{bL\varepsilon_{33}\omega} \qquad \sigma = \frac{M \cdot b}{2 \cdot I}$$

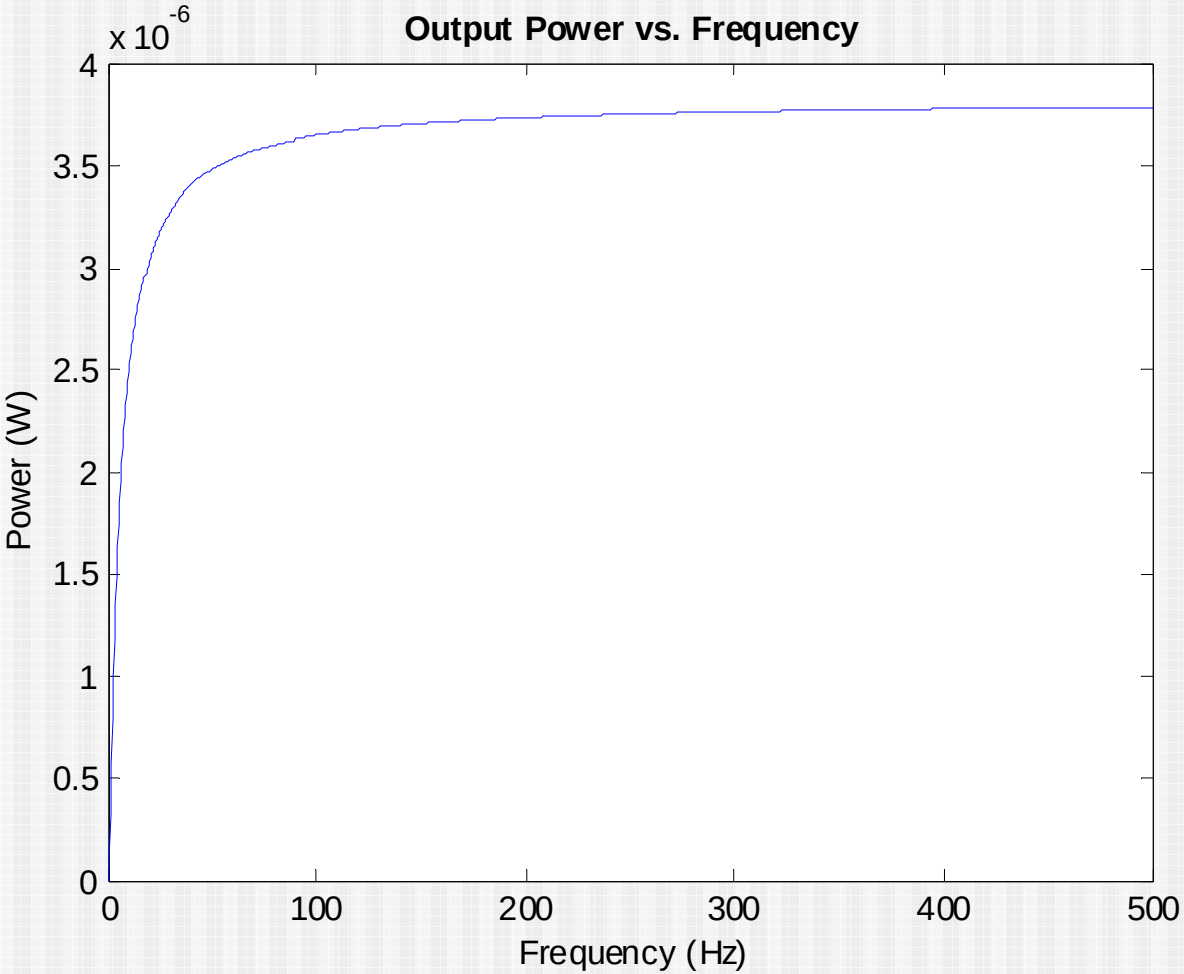
$$u\left(x = L\right) = \frac{PL^3}{3EI} \qquad A = \frac{\sigma}{E}$$

$$Power = \frac{9E^{1/2} e_{31}{}^2 \rho^{3/2} a^2}{8\varepsilon_{33} E_{11}{}^{3/2}} \cdot \frac{t x_m{}^{3/2} y_m{}^{3/2} z_m{}^{3/2}}{L^{1/2} b^{1/2} h^{1/2}}$$

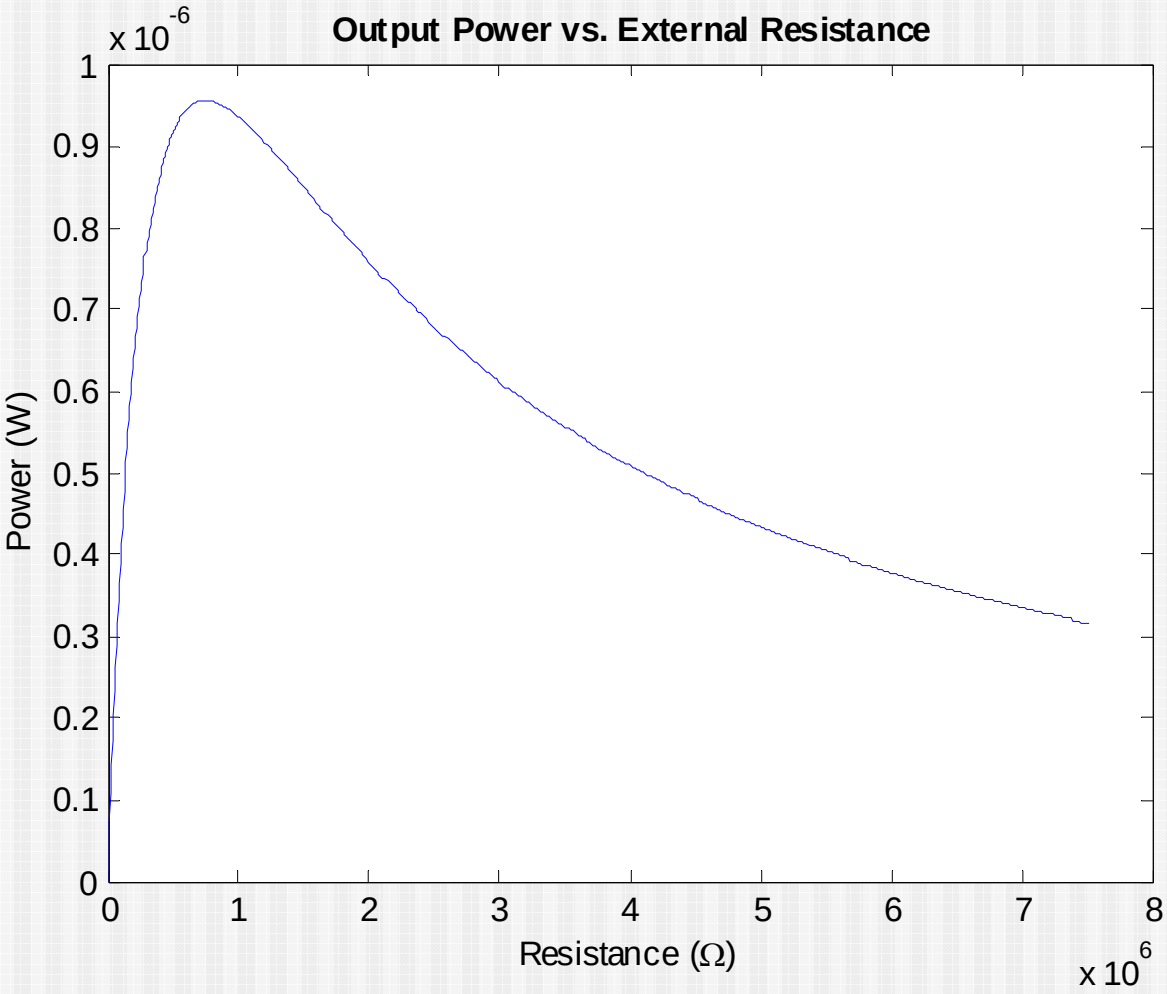
L	↓
b	↓
t	↑
h	↓
x_m	↑
y_m	↑
z_m	↑

* F Lu et. al., “Modeling and Analysis of Micro Piezoelectric Power Generators for Micro-electromechanical-systems Applications”, Smart Mater. Struct. 13(2004) 57-63.

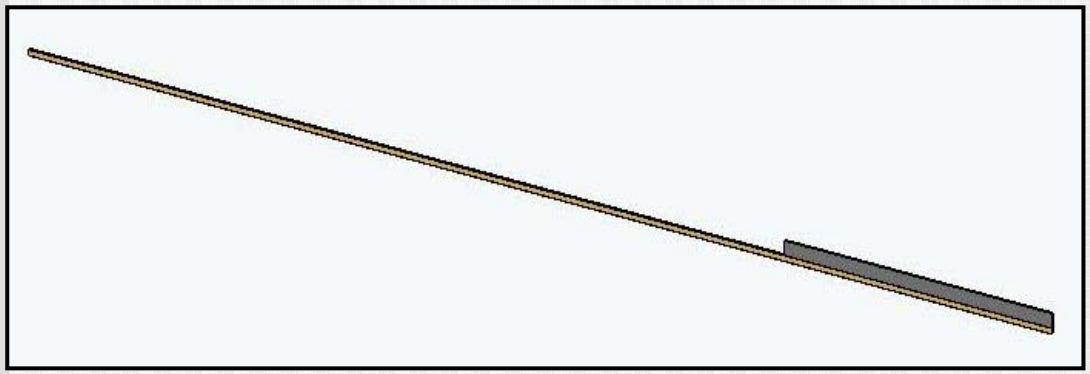
Ext. Resistance vs. Power



Frequency vs. Power



FEM Results



Maximum Displacement: 11.55mm

Maximum Stress: 5.6 Mpa

Power : 0.61 mW

Natural Frequency: 160 Hz

Genetic Algorithm

L = 19mm

b = 1mm

t = 0.5mm

h = 5 mm

x_m = 3584mm

y_m = 101mm

z_m = 1.3mm