Parametric stiffness matrix

Advice *– This is a hard problem, do not unnecessarily complicate this.*

Concept geometry *– See next page for diagram.*

Materials *- If you're missing info you think important, ask Prof. Culpepper and/or research reasonable info to help you. Materials you'll get:*

08 Qty	*93897A263*	*Shoulder Screws; 1/2" Shoulder Length (#10)*
08 Qty	*93897A279*	*Shoulder Screws 3/4" Shoulder Length (#10)*
08 Qty	*94812A500*	*Nylon Hex Nut (#10)*
12 Qty	*90295A420*	*Nylon Washer (#10)*
02 Qty	*8586K171*	*ABS Sheet 12" x 12" x 1/4", Black*

Fabrication *– You may use the waterjet to fabricate the flexures and the board upon which it will mount. You will need a course account to charge for this, you may obtain this from the TA (Dan) once he has checked over your design and he has made sure there is little possibility of running into a problem during water jetting.*

Deliverables *- What you must provide on the due date:*

(a) Hand in the device functioning without problems.

(b) 1 page (front/back, 12pt font, 1" margins) that covers:

(i) functional requirements

(ii) how you modeled performance

(iii) how you experimentally verified performance

(iv) how good your data is

(v) how well your model worked

(vi) what you learned/anything interesting

Charge *- You are charged with building a proof-of-concept prototype of an energy harvester that can harness energy over the broadest range of frequencies possible. The final device (mass-spring sans damper) will be mounted on a structure that vibrates in the y direction. Depending on the situation, the dominant frequency available to excite the device may vary over a range of 2000X.*

Driving need *- Your client is interested in expert advice on the feasibility of creating a device for this purpose – specifically the concept shown on the next page. The device consists of a central mass that is supported by two flexure banks that experience small motions during vibrations. Each flexure bank consists of a constant stiffness flexure (keep this simple!) between the mass and variable stiffness flexure. The y stiffness of the variable stiffness flexure varies with the noted included angles. For the purposes of this prototype, the angle may be manually adjusted by loosening bolts at the ends of beams* b_A, b_B, b_C, *and* b_D*; adjusting the included angle, then tightening the bolts again. Nodes* n_1, n_2, n_{10}, *and* n_{11}, *should be able to move along a slot so that they can be bolted down over a range of angles/positions.*

Modeling *- The axial, in-plane bending and torsional stiffness of the flexure beams need to be simultaneously optimized to optimize performance. You'll need to create a parametric stiffness matrix and use this to determine the best beam geometries, mass and range of included angle. It would be great if you could simplify your efforts by justifying that you should be able to neglect the mass of the flexure beams. You'll use your efforts to prove/disprove the practicability of this concept, and you'll use the model to educate the client on what could be possible if the device is made of different materials and/or different size scales.*

Energy harvesting concept