WORCESTER POLYTECHNIC INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT

COURSE No.: ME-593M, Spring'2002
COURSE NAME: MEMS and Nanotechnology
SUBJECT: Homework assignment

DATE: 08 February 2002
DUE: 15 February 2002

OFFICE HOURS: Everyday from 9:00 to 10:30 AM or by appointment

NAME: _____

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NOTE: In all solutions, state explicitly every assumption and/or approximation made, explain every procedure, and justify its use. Dimensional analyses are absolutely necessary. All results must be expressed in appropriate units. PLEASE, ALWAYS SHOW ALL WORK, while writing your results only on one side of the sheet(s) of paper; start each problem on a new sheet. Attach this sheet to your solution(s).

Please refer to CLASS NOTES & Chapter 6 of TEXTBOOK: *MEMS & microsystems: design and manufacture*, T-R. Hsu, McGraw-Hill, 2002

PROBLEM 5.1. A force $F(t) = 10 \sin(\pi t)$ N/m^3 acts on a displacement of $x(t) = 2 \sin(\pi t - \pi/6)$ m. Determine:

(a) the work done during the first 6 s,
(b) the work done during the first 1/2 s,
(c) the increase in temperature of the system (use properties for SiO_2).

PROBLEM 5.2. Refer to Problem 5.1. If the characteristic length is reduced 1000 times, determine:

(a) the work done during the first 6 s,
(b) the work done during the first 1/2 s,
(c) the increase in temperature of the system (use properties for SiO_2),
(d) discuss your observations.

PROBLEM 5.3. Scaling laws. (Justify all your answers).

(a) Mass scales with a factor of: _____.
(b) Stress scales with a factor of: _____.
(c) Natural frequency scales with a factor of: _____.
(d) Reynolds number (*Re*) scales with a factor of: _____; is the transition *Re* number from laminar to turbulent affected?
(e) Electrical resistance scales with a factor of: _____.

PROBLEM 5.4. What is the primary assumption of continuum mechanics? Give examples where continuum theory breaks down and how MEMS, in some cases, may take advantage of this breakdown.

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