Name.....Student I.D.....

Department of Mining and Materials Engineering

Faculty of Engineering

Prince of Songkla University

Mid-term Exam for Semester: 1 Academic Year: 2008

Date: July 29, 2008 Time: 9.00-12.00

Subject: 237-502 Adv. Mat. Proc. and Mat. Selection Room: A400

Instructions

1. There are 5 problem sets. Please do all of them and write your answers in the space provided after each problem set.
2. Textbooks and course notes are not allowed.
3. Dictionary and calculator are allowed.
4. This mid-term exam is accounted for 25 % of total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	15	
2.	15	
3.	55	
4.	15	
5.	25	
Total	125	

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Problem 1 (15 points)

1.1 Explain three basic stages of general design process.

1.2 Identify main activities which are performed in each stages of the design process.

1.3 How does the materials selection get involve in each stages of the design process?

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Problem 2 (15 points)

Explain the following terms:

2.1 Material performance index or material index (M).

2.2 Shape factor for an elastic bending beam (ϕ_B^e).

2.3 Material property chart or *Ashby's* chart.

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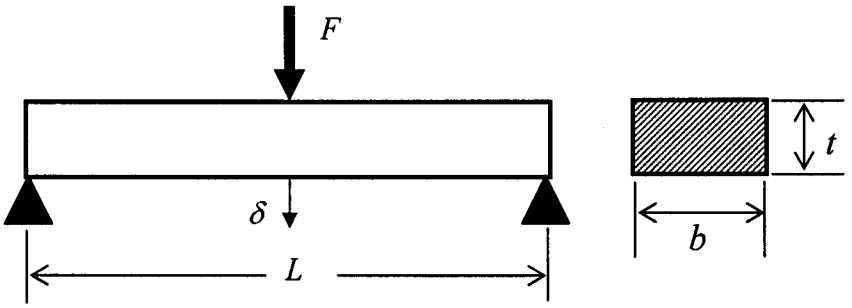
Problem 3 (55 points)

Derive a material index (M) for a light and stiff beam having length L and rectangular section area of width b and thickness t. The length of beam, L is specified but the width and thickness of beam are free. The beam must support a bending load F without deflecting too much, meaning that the bending stiffness S and the maximum displacement δ_{max} are specified. The material for making the beam is free for selection.



The mid-point deflection of an elastic beam of length L loaded in three-point bending by a central load F is given by

$$\delta = \frac{FL^3}{48EI}.$$

The deflection at which failure occurs is

$$\delta_{max} = \frac{\sigma_f L^2}{6tE},$$

where I is the second moment of area; for beam of rectangular section, $I = \frac{bt^3}{12}$ and E and σ_f are the modulus and failure stress of the material of the beam.

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Problem 4 (15 points)

The material index for an efficient furnace wall insulator is given by

$$M = \frac{a^{1/2}}{\lambda}$$

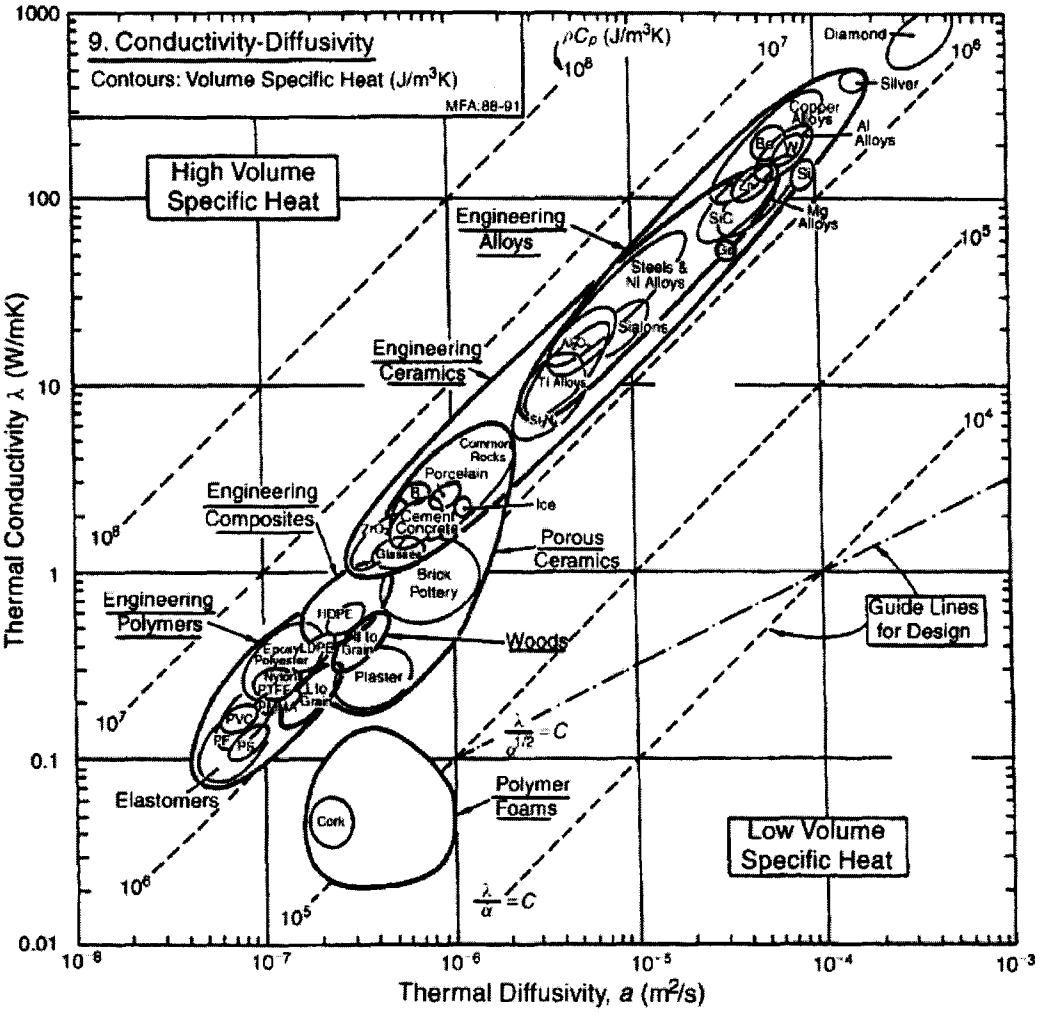
where a is the thermal diffusivity and λ is the thermal conductivity.

4.1 Draw a selection line with $M = \frac{a^{1/2}}{\lambda}$ passing through

$$a = 10^{-6} \quad \text{m}^2/\text{s} \quad \text{and} \quad \lambda = 1 \quad \text{W/mK} \ .$$

Please show your work how to get the selection line.

4.2 Identify three materials which have the same performance.



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Problem 5 (25 points)

Design requirements of a solid circular shaft for transmitting torque *T*.

Function	Shaft
Constraints	Length, L is specified. Do not fail by yielding
Objective	Light weight
Free variables	Diameter, D_0 is free Choices of Materials

Torque at yielding point, T_f is given by

$$T_f = \frac{K\sigma_y}{D_0}$$

where K is the torsional moment of area, for a solid circular shaft, $K = \frac{\pi r^4}{2}$, r is the radius, σ_y is the yield strength of material of the shaft. **Derive a material index *M* for the shaft.**

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