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: 2007

Date: August 4, 2007 Time: 13.30-16.30

Subject: 237-502 Adv. Mat. Proc. and Mat. Selection Room: A203

Instructions

1. There are 4 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 30 % of total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score	Student's Score
1.	10	
2.	10	
3.	30	
4.	10	
Total	60	

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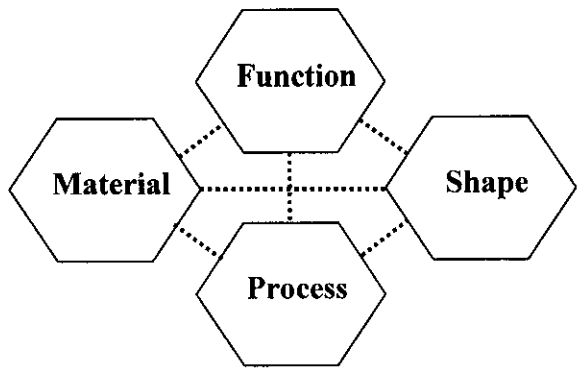
Problem 1

For materials selection in mechanical design, the function, material, shape and process cannot be separated. Explain how they interact with each other. (10 points)



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Problem 2

A cheap material is required for making a heat exchanger to extract heat from geo-thermally heated, saline water at 120°C (and thus under pressure).

Translate the design requirements into function, constraints, objective and free variables (10 points)

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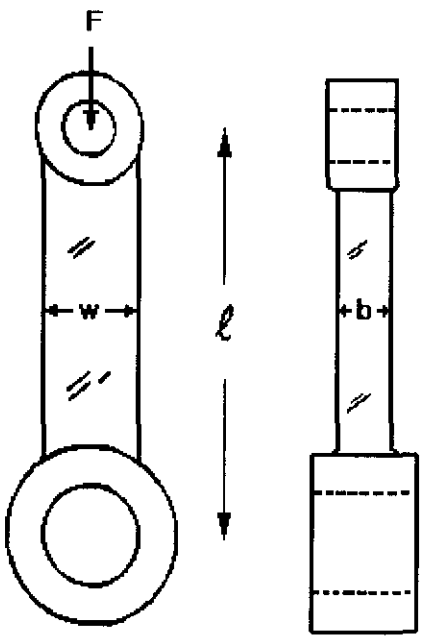
Problem 3

A connecting rod in a high performance internal combustion engine is a critical component, if it fails, catastrophe follows. Yet to minimize inertial forces and bearing loads, it must weigh as little as possible. This implies the use of light, strong materials. The con-rod must have length l to support load without buckling. Assume that the con-rod has a rectangular cross-sectional area of $A = bw$ and $b = \alpha w$, where α is a constant.

Given: Moment of section $I = \frac{bw^3}{12}$



Please show that the material index for the connecting rod $M = \frac{E^{\frac{1}{2}}}{\rho}$, where ρ is density and E is Young's modulus. (30 points)

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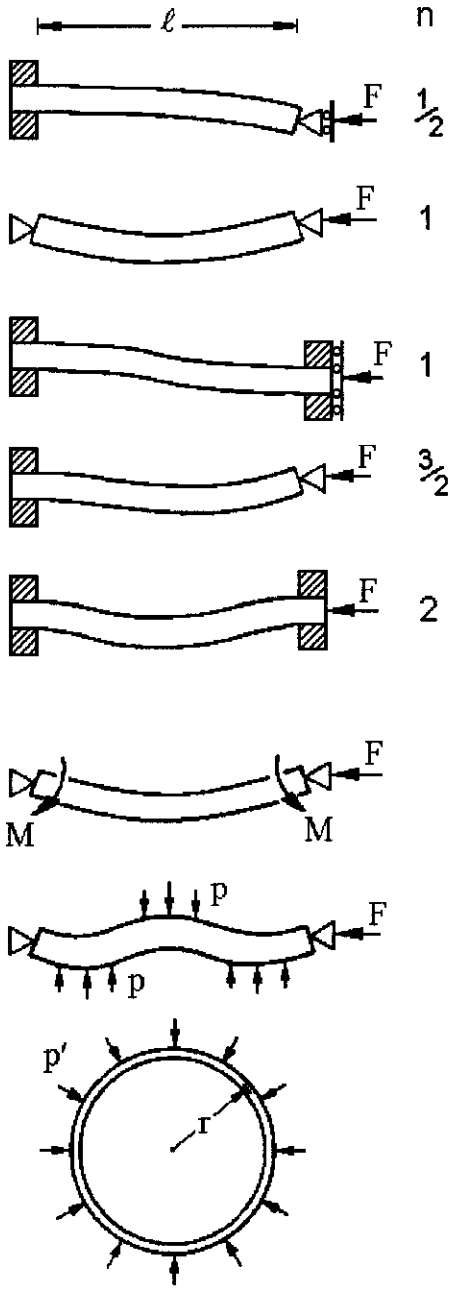
Buckling of Columns and Plates



$$F_{crit} = \frac{n^2 \pi^2 E I}{\ell^2}$$

OR

$$\frac{F_{crit}}{A} = \frac{n^2 \pi^2 E}{(\ell / r)^2}$$

F = FORCE (N)
M = MOMENT (N m)
E = YOUNGS MODULUS (N/m^2)
ℓ = LENGTH (m)
A = SECTION AREA (m^2)
I = SEE FIGURE 6.2 (m^4)
r = GYRATION RAD. $\left(\frac{I}{A}\right)^{1/2}$ (m)
k = FOUNDATION STIFFNESS (N/m^2)
n = HALF-WAVELENGTHS IN BUCKLED SHAPE
p' = PRESSURE (N/m^2)

$$F_{crit} = \frac{\pi^2 E I}{\ell^2} - \frac{M^2}{4 E I}$$

$$F_{crit} = \frac{n^2 \pi^2 E I}{\ell^2} + \frac{k \ell^2}{n^2}$$

$$p'_{crit} = \frac{3 E I}{(r')^3}$$

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Problem 4

Use the strength-density chart below to identify materials with material indices

$$M_1 = \rho < 10 \quad \text{Mg/m}^3 \quad \text{and}$$

$$M_2 = \frac{\sigma_f}{\rho} = 100 \quad \text{MPa/(Mg/m}^3\text{)}.$$

4.1 Draw selection lines M_1 and M_2. Please show how to get the selection lines and what are slope of the lines? (7 points)

4.2 Identify three alloys which have the same performance index. (3 points)