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

Department of Mining and Materials Engineering

Faculty of Engineering

Prince of Songkla University

Mid-Term Examination for Semester: 1 Academic Year: 2015

Date: October 6, 2015 Time: 13.30-16.30

Subject: 237-405 Materials and Process Selection Room: A401

Instructions

1. There are 4 problems (8 pages including cover page). Please do all of them. Write your answers in the space provided.
2. Text books and course notes are not allowed.
3. Dictionary and calculator are allowed.
4. This mid-term exam is accounted for 25 % of total grade of this course.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	15	
2.	20	
3.	45	
4.	20	
Total	100	

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

Problem 1 (15 points)

1.1 What are the three stages for 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 involve in each stages of the design process?

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

Problem 2 (20 points)

According to Ashby's material selection strategy, there are four basic steps which are translation, screening, ranking, and documentation. Explain each step of material selection.

2.1 Translation (5 points)

.....

.....

.....

.....

.....

.....

.....

2.2 Screening (5 points)

.....

.....

.....

.....

.....

.....

.....

2.3 Ranking (5 points)

.....

.....

.....

.....

.....

.....

2.4 Documentation (5 points)

.....

.....

.....

.....

.....

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

Problem 3 (35 points)

Springs for trucks

For the design of vehicle suspension it is desirable to minimize the mass of all components. You have been asked to select a material and dimensions for a light spring to replace the steel leaf spring of an existing truck suspension. The existing leaf-spring is a beam, shown schematically in the Figure 3. The new spring must have the same length L and stiffness S as the existing one, and must deflect through a maximum safe displacement δ_{max} without failure. The width b and thickness t are free variables.

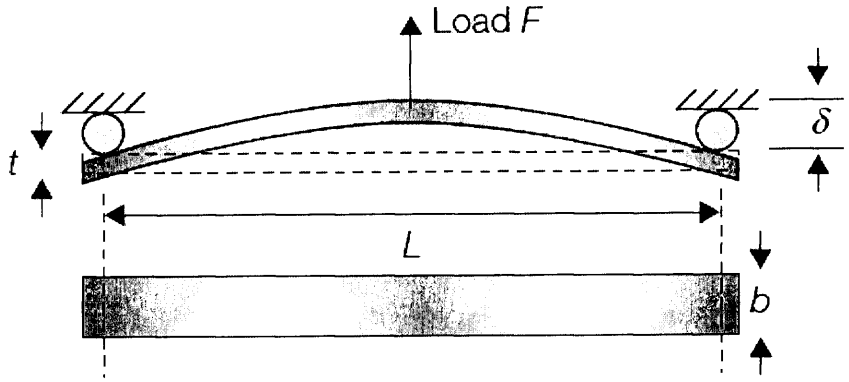

Figure 3

Derive a material index for the selection of a material for this application. Note that this is a problem with two free variables: b and t ; and there are two constraints, one on safe deflection δ_{max} and the other on stiffness S. Use the two constraints to fix free variables. The following table catalogs the requirements.

Function	Leaf spring for truck
Constraints	Length L specified Stiffness S specified Maximum displacement δ_{max} specified
Objective	Minimize mass
Free variables	Spring thickness t Spring width b Choice of material

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

You will need the equation for the mid-point deflection of an elastic beam of length L loaded in three-point bending by a central load F:

$$\delta = \frac{1}{48}\frac{FL^3}{EI}.$$

The stiffness of an elastic beam is defined by

$$S = \frac{F}{\delta}.$$

And for the deflection of the beam at which failure occurs:

$$\delta_{\max} = \frac{1}{6}\frac{\sigma_f L^2}{tE}$$

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

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

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

Problem 4 (20 points)

Use the Young's modulus-Density (E-ρ) chart to identify materials with both

$M_1 = E > 100$ GPa and

$M_2 = \dfrac{E^{1/3}}{\rho} \geq 0.003$ $(\text{GPa})^{1/3}/(\text{kg/m}^3)$.

4.1 Draw the selection lines M_1 and M_2 on the chart, please show your work how to obtain the lines (10 points)
4.2 Label the selection region on the chart (5 points)
4.3 Identify the material(s) (5 points)

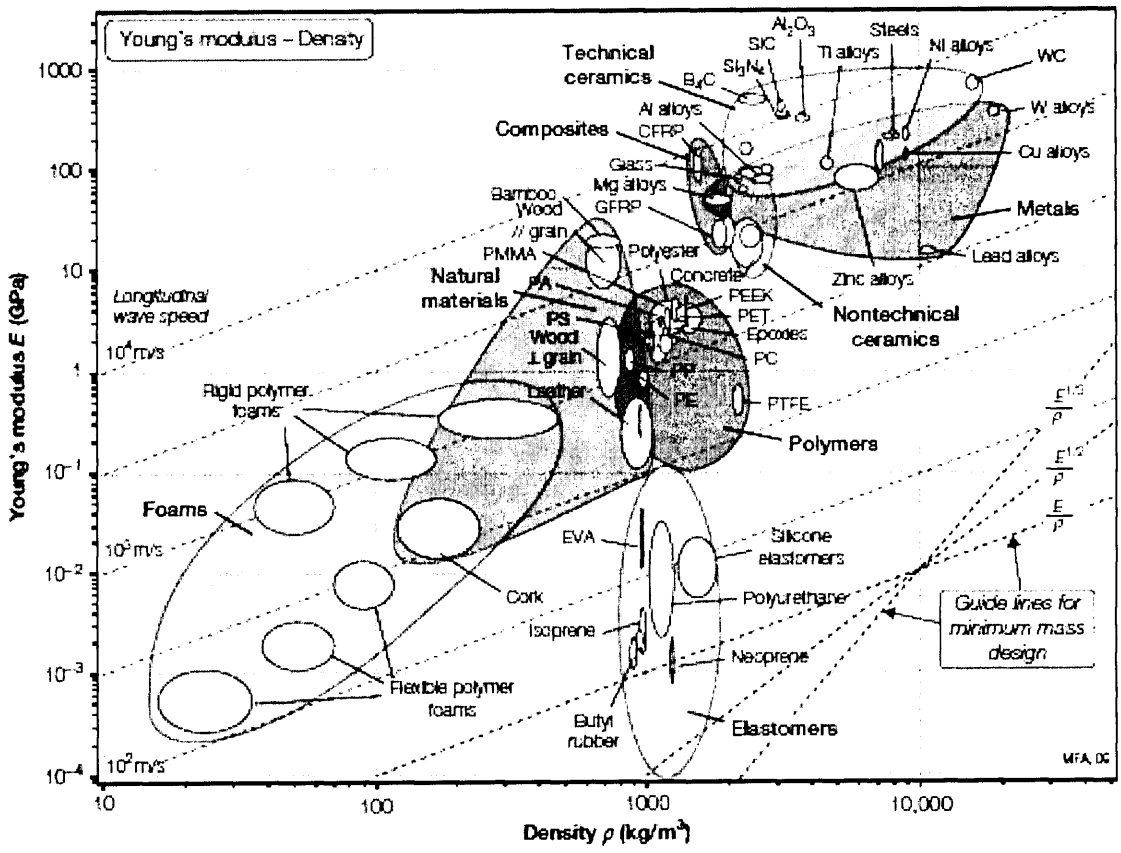

Figure 4 Young's modulus – Density chart