Massachusetts Institute of Technology

Mathematical Methods for Materials Scientists and Engineers

3.016 Fall 2011

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Problem Set 2: **Out: 14 Sept.** and **Due: 23 Sept.**

This problem set has only an estimation problem and a group problem. Email group assignments to 3016-psets(the symbol at)pruffle.mit.edu

The following are this week's randomly assigned homework groups. The first member of the group is the "Homework Jefe" who will be in charge of setting up work meetings and have responsibility for turning in the group's homework notebook. If for some reason, the first member in the list is incapacitated, recalcitrant, or otherwise unavailable, then the second member should take that position. *Attention slackers:* The Jefe should include a line at the top of your notebook listing the group members that participated in the notebook's production; only those listed will receive credit. Group names are boldfaced text.

Baiocasses: *nmin, shames, kcapshaw, csample, venjamio*
Carnutes: *mramundo, dicksonw, deeni, ajuan90*
Curiosolitae: *mgager, krossick, dondina, elai*
Parisii: *babajide, ekrueger, kirbyd, cscorpio*
Petrocorii: *maxp, vchia, celiney, pdhyun*
Tectosages: *claudiar, afevans, mplaut, sterrito*
Vangiones: *emcd2692, mbrefo9, owenrees, leecb*
Vocvontii: *jbalchun, reblin, schafer, mountjoy*

Estimation Exercise E2-1

(Attach your solution and your assumptions to your solution, and enter your result at the URL given below)

Suppose that all of the gravitational potential energy of the Eiffel tower were to be used to heat up the material that makes up the Eiffel tower. How many degrees Celsius would the material change?

Use the gravitational potential relative to the base of the Eiffel tower.

Enter your answer in units of degree Celsius at:
`http://bit.ly/oTlakL`

Group Exercise G2-1

Every effort should be made to make the graphics for this problem beautiful. Make graphic design problems part of your group exercise. Also, produce copious comments for how your code works; this should also be checked and edited by all members of the group.

1. Plot the two functions:
$$f(\beta, x, y) = x^2 - \beta xy + y^2$$
$$g(x, y) = yx^2 + xy^2$$
for several values of β.

2. Find an expression for the intersection of these two surfaces. Your expression should be in terms of β

3. Plot the intersection curves and the two surfaces together for different values of β.

4. Plot the two surfaces, but only display the regions where $f(\beta, x, y) > g(x, y)$.

5. Write a function that finds the area, $A_p(\beta)$ of the projection where $f(\beta, x, y) > g(x, y)$ for values of x and y such that $-1 \leq x \leq 1$ and $-1 \leq y \leq 1$. Use the projection onto the $z =$ constant plane (e.g., the $z = 0$ plane). You many need to use a numerical integration.

6. Compute the curvatures of the two surfaces, and plot these curvatures as a function of x and y.

7. Find the value of β which minimizes the difference of the squares of the two surfaces in the region $-1 \leq x \leq 1$ and $-1 \leq y \leq 1$, i.e.,
$$L(\beta) = \int_{-1}^{1} \int_{-1}^{1} (f(\beta, x, y) - g(x, y))^2 \, dxdy$$

8. Plot the curve $L(\beta)$ versus $A_p(\beta)$