Massachusetts Institute of Technology

Mathematical Methods for Materials Scientists and Engineers

3.016 Fall 2005

W. Craig Carter

Department of Materials Science and Engineering
Massachusetts Institute of Technology
77 Massachusetts Ave.
Cambridge, MA 02139

Problem Set 5: Due Wed. Nov. 30, Before 5PM: email to smallen@.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 some 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. Group names are boldfaced text.

Accio: *Jason Pelligrino (jpell19),Lauren Oldja (oldja), Richard Ramsaran (rickyr21), Jill Rowehl (jillar), JinSuk Kim (jkim123)*

Colloportus: *John Pavlish (jpavlish), Leanne Veldhuis (lveldhui), Jina Kim (jinakim), Samuel Seong (sseong), Annika Larsson (alarsson)*

Densaugeo: *Maricel Delgadillo(maricela), Allison Kunz (akunz), Kyle Yazzie (keyazzie), Saahil Mehra (s_mehra), Vladimir Tarasov (vtarasov)*

Rictusempra: *Eugene Settoon (geneset),EunRae Oh (eunraeoh), Kimberly Kam (kimkam), Charles Cantrell (cantrell), Omar Fabian (ofabian)*

Riddikulus: *John Rogosic (jrogosic),Kelsey Vandermeulen (kvander), Rene Chen (rrchen), Michele Dufalla (mdufalla), Talia Gershon (tgershon)*

Scourgify: *Bryan Gortikov (bryho),Emily Gullotti (emgull), Lisa Witmer (witmer), Katrine Sivertsen (katsiv), Katherine Hartman (khartman)*

Individual Exercise I5-1

Kreyszig Mathematica® *Computer Guide:* problem 9.4, page 107

Individual Exercise I5-2

Kreyszig Mathematica® *Computer Guide:* problem 9.12, page 108

Individual Exercise I5-3

Kreyszig Mathematica® *Computer Guide:* problem 9.18, page 109

Individual Exercise I5-4

Kreyszig Mathematica® *Computer Guide:* problem 9.20, page 109

Individual Exercise I5-5

Kreyszig Mathematica® *Computer Guide:* problem 10.4, page 120

Individual Exercise I5-6

Kreyszig Mathematica® *Computer Guide:* problem 10.14, page 120

Individual Exercise I5-7

Kreyszig Mathematica® *Computer Guide:* problem 11.8, page 131

Individual Exercise I5-8

Kreyszig Mathematica® *Computer Guide:* problem 1.18, page 15

Individual Exercise I5-9

Kreyszig Mathematica® *Computer Guide:* problem 2.2, page 28

Individual Exercise I5-10

Kreyszig Mathematica® *Computer Guide:* problem 2.16, page 30

Group Exercise G5-1

Consider an infinite sheet of thickness a and a thin disk of radius R and thickness b which interact through the London interaction.

1. Upon how many different variables does the interaction energy depend?
2. By rescaling variables, re-express the interaction energy in terms of dimensionless units.
3. Can you calculate the form of the London interaction? between an an infinite sheet of thickness a and a thin disk of radius R and thickness b?
4. Use graphics to visualize the results of your calculations.

Group Exercise G5-2

Download the data from http://www-personal.buseco.monash.edu.au/~hyndman/TSDL/ (SOI.DAT) that describes the monthly difference in in sea-surface air pressure between Darwin, Australia and Tahiti during Jan 1882—May 1993. There is some missing data in this set.

1. Plot the data as a fraction of the standard deviation versus time.
2. Fit the data with a linear model (i.e., $y = y_0 + mx$). Plot and discuss the model's applicability.
3. Create a new data set by subtracting the linear model from the original data. Interpret the meaning of this new data set.
4. To analyze whether there may be any monthly, bi-monthly, or seasonal trends, fit your data with a trigonometric or Fourier series. Comment on the appearance of any trends.
5. Use your models to provide estimates of the missing data.
6. Predict the pressure difference between Darwin and Tahiti in the year 2006.

Group Exercise G5-3

At the MIT Z-Center 3 meter diving board, an average student standing at the end of the diving board causes a deflection of about 0.4 meters.

1. If the diving board is 4 meters long, estimate the product of the elastic modulus and moment of inertia, EI, for the diving board. Estimate the Young's modulus of the diving board material. Track down a an experimental value for wood's elastic moduli and use this data to compare to your estimate.
2. Create an animation of the diving board deflection as an average student walks from one end of this diving board to another.
3. Create an animation of the diving board deflection as average students crawls on his/her stomach to the end of the diving board.
4. Create an animation as a group of random students each holding the hand of the student behind them, walk onto the diving board.