EE206A Examination: Take Home (due by Monday 6/10/2002 8AM PDT)

Total = 5 questions / 100 points (the questions are not equally weighted)

Notes:

1.Please submit your solution on-line (html or word or pdf or postscript or gif or tiff or framemaker formats are acceptable). In case of multiple files, archive them into a single file using zip or tar. Send an email to mbs@ee.ucla.edu with a URL: do not send the file as an attachment. DON'T FORGET TO WRITE YOUR NAMES INSIDE THE FILES.

2. I also request that you submit a hardcopy within 24 hours, i.e. by Tuesday 6/11/2002. You may slip it under the door of my office or leave in mailbox or give to my assistant.

3. If you write a software program or use a software tool (e.g. Matlab) to solve any of the problems, submit the relevant code, input and output files.

3. No collaboration and plagiarism of any form is allowed: your answers should be your own. Books, papers, and WWW research are okay, but you should not use any document that directly solves a question (e.g. old exam). Moreover, you must refer to any such external source that you use in answering the question (other than papers used in the class).

Collaboration and plagiarism on any part of the exam will lead to straight "F" in the course.

4. Some of the problems may not have an exact or closed-form solution: you may reasonable and justifiable "engineering" simplifications and assumptions, and may use numerical approaches using software tools that you have access to (e.g. MATLAB etc.).

5. Note: I am out of town from Monday June 10 morning. So please submit on time.

Q 1. [25 points]

Select one paper from among those used for student presentations, with the paper being from a presentations NOT not from the presentation that you did. Also, the paper should not be one from your own research group.

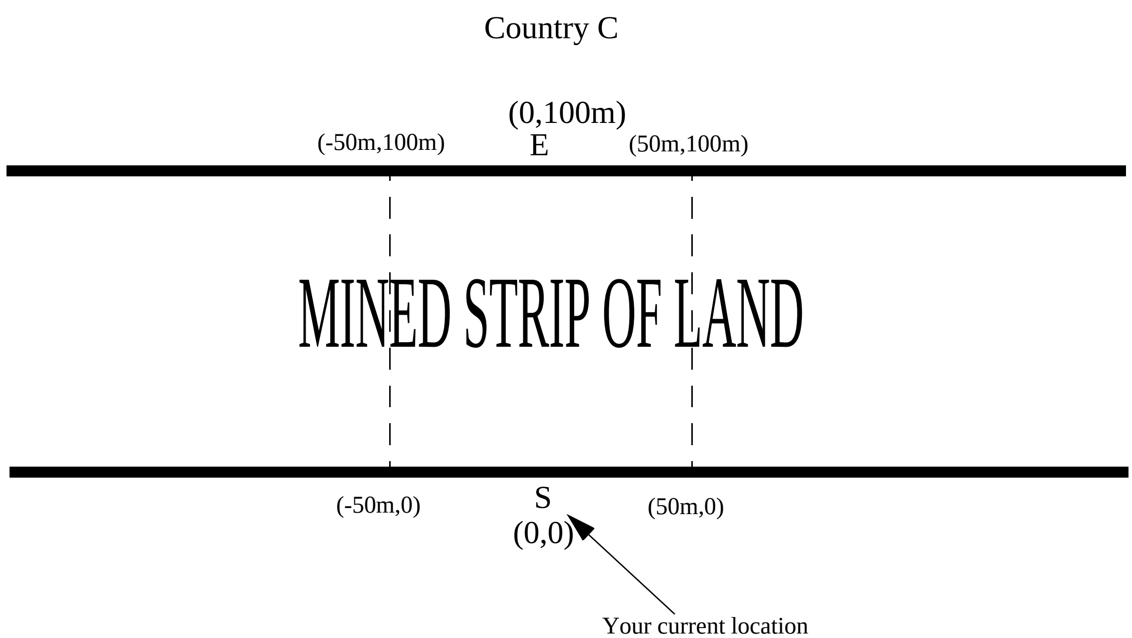
Now, for the paper that you selected, formulate a quantitative problem whose solution requires using the ideas in the paper. Then solve the problem. You will be graded on both how interesting is the problem formulated by you, and the approach and correctness of your solution. You should clearly state the paper and the student presentations for which it was used in the course. As a guideline, the level of complexity of the problem should be similar to those that I gave you in the homework and in this exam. You did read the papers, didn't you?:-).

Q 2. [15 points]

Formulate a clear "open research problem" on a topic related to this course (i.e. wireless data networking, and networks of wireless embedded devices and sensors).
- what is the question?
- what would it mean to solve it?
- suggest approach and/or means of evaluation.

Answer in no more than 1 page. If you get the idea from some other place, please give appropriate credit by providing a reference.

Q 3. [25 points]



You are a soldier participating in a raid on some terrorist camps inside enemy country C. Unfortunately X has heavily mined a 100 m wide strip of land all along its long border using anti-personnel mines that are triggered by ground vibrations. You are currently at location S with coordinate (0, 0) along this border, and need to get across to a location E = (X_E, 100m) that is right across the mined strip. Since you want to conserve energy, you want to take a path that does not go more than 50m left or right of you current position, i.e. -50m <= X_E <= 50m.

Fortunately the intelligence agency of country has a mole inside C who has given the locations of all the mines, and a mine location map was loaded on to your battlefield wearable computer.

What will be your algorithm to determine the path to take through the minefield to maximize your chances of making it through the minefield alive? You know nothing about the mines except their locations and that the closer you are to a mine, the more likely will it blow up.

Using your algorithm, find the solution path when the locations of all the mines that are within 100m to the left and the right of your current location are as in the table below.

X	Y
-81.6	65.1
-79.9	59.0
92.0	43.2
-61.2	15.0
25.9	75.2
77.6	48.4
-51.3	45.7
-55.3	44.3
68.9	10.5
35.7	41.5
-37.3	71.3
46.4	49.0
9.6	34.9
49.5	82.4
-94.2	56.9
37.2	42.6
72.0	56.3
37.8	33.4
-2.5	31.6
-56.5	30.1
-6.5	12.3
-61.6	22.5
-70.5	14.8
-72.1	1.8
95.5	33.8
-8.9	53.4
-67.9	43.8
-4.2	48.1
30.5	62.5
72.8	87.5
55.9	56.0
-50.2	95.7
-46.1	76.8
24.8	15.6
74.4	12.3
-4.2	2.9
22.5	99.2
54.6	13.1
99.9	36.7
45.2	38.4

Q 4. [10 points]

There are two static wireless nodes A and B with isotropic antennas and same transmit power situated in a static but possibly cluttered environment. A common assertion is that such a situation where A and B have same transmit power leads to a bidirectional link between them: i.e. if A can hear B with enough SNR then so can B when A transmits. As a reference, see Section 3, Para 1 of http://black.csl.uiuc.edu/~prkumar/ps_files/compow_ewc_2002.pdf which is a paper from UIUC (S. Narayanaswamy, V. Kawadia, R. S. Sreenivas, and P. R. Kumar, ``Power Control in Ad-Hoc Networks: Theory, Architecture, Algorithm and Implementation of the COMPOW Protocol.'' Proceedings of the European Wireless Conference -- Next Generation Wireless Networks: Technologies, Protocols, Services and Applications, pp. 156--162, Florence, Italy, Feb. 25--28, 2002.), where the authors invoke symmetry arguments.

Is this true? If so, rigorously prove it. If not, give a counter-example.

Q 5. [25 points]

Consider an ad hoc sensor network where nodes are equipped with QPSK radios that operate at rate r. The power consumption of the radio when transmitting to a node at distance d with specified BER b is Ptx = (α + β*d^4)*r. The path loss model is 1/d^4. The power consumption when in the receive mode is Prx = ρ*r. The radios need a start-up time of Ts when switched to transmit mode. During the start-up time, the power consumption is Ps.

Now, consider a sensor S and gateway G that are distance D apart, and communicate using packets of length L bits. Let the desired BER in the packet flow between S & G be b. What is the optimum number N (>= 0) of multihop relay sensor nodes, and their locations, that you would want to have between S & G so as to minimize the energy consumption by the network (i.e. S, G, and the relay nodes put together?

Find this optimum N for a typical case where r = 1Mbps, α = 45 nJ/bit, β = 0.001 pJ/bit/m^4, ρ = 135 nJ/bit, Ps = 60 mW, Ts = 500 microseconds, L = 30 bytes, b = 1E-4, and D = 10 m, 50 m, 100 m, 500 m, and 1000 m. You need to find optimum N for each different D.

Note that the average probability of bit error for QPSK is Q(sqrt(2Eb/N0)). Also, Q(z) = 0.5*erfc(z/sqrt(2)).