ME 748: Optimum Design of Mechanical Elements and Systems
Spring 2007; Assignment-3

Due: 21st Feb 2007; 5 pm in ECB 3108

Problem 1: Find the expression for the gradient and Hessian for the following functions, and consequently find a local minima, if there exists one (use MATLAB if necessary):

(a) $f = x_1 - \dfrac{10}{x_1 x_2} + 5x_2$; (b) $f = 100(x_2 - x_1^2)^2 + (1 - x_1)^2$; (c) $f = 5x_1 + x_2$

Problem 2: Given a generic quadratic function in two variables:

$$f = 0.5Ax^2 + Bxy + 0.5Cy^2 + Dx + Ey + F$$

classify the various types of contour plots one can expect depending on the various coefficients.

Problem 3: Write a MATLAB function to find the gradient of a spring system:

```
function [GradPE] =
GradPEofSpringSystem_LastName(springSystem,freeNodes,uvOfFreeNodes)
```

where:

- `springSystem is a structure with four entries (see code from web-site): (a) initialNodeLocations, (b) springConnectivity, (c) Forces and (d) stiffness`
- `freeNodes is a (1 x Nf) where Nf is the number of free nodes`
- `uvOfFreeNodes is a (1 x 2*Nf) vector with entries (u1, v1, u2, v2, …) where (ui, vi) is the displacement of the ith node.`
- `GradPE is a (2*Nf x 1) vector with entries (d(PE)/du1, d(PE)/dv1, …)`

Compare the output with finite difference gradient (as a sanity check). As a second verification, use the above code to find the stationary points of various spring systems, via MATLAB's fsolve. No need to submit the latter code, but compare with fminunc method, and provide comments if any.

Problem 4: Consider two circles centered at (x_1, y_1) and (x_2, y_2) with radii r_1 and r_2. Write a Matlab code to find a pair of points (x_1^*, y_1^*) and (x_2^*, y_2^*) on the two circles such that the distance between the two points is a local minima. Assume that the two circles are not concentric. Pose the problem as an *unconstrained* minimization problem, and use appropriate MATLAB optimization routines. Your code format should be:

```
function [x1S,y1S,x2S,y2S] = closestPoints_LastName(x1,y1,r1,x2,y2,r2)
```

Test your code before submitting!