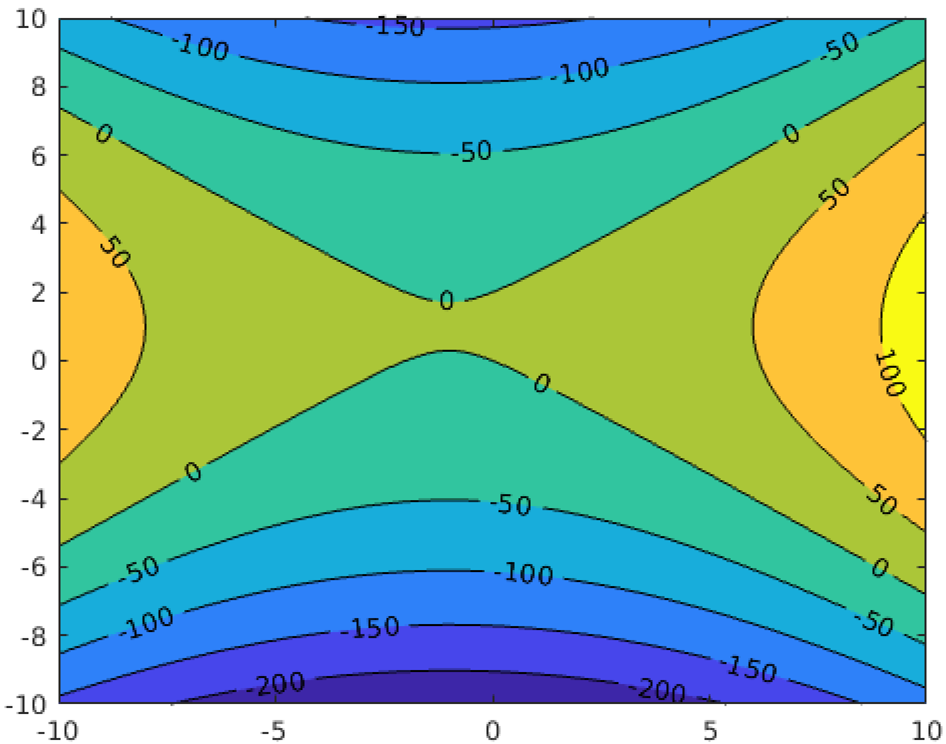
ASSIGNMENT 1: EXERCISE 1

Part A

```
close all; clear all

f = @(x,y) 2.*x + 4.*y + x.^2 - 2.*y.^2;
n = 300;
x = linspace(-10,10,n+1);
y = x;
[X,Y] = meshgrid(x,y);
alpha = 1;
figure
[C,h] = contourf(alpha*X, alpha*Y, f(alpha*X,alpha*Y));
clabel(C,h)
```



Part B

$C = 2x + 4y + x^2 - 2y^2$

$C = (x+1)^2 - \frac{1}{2}(y-1)^2 - \frac{1}{2}$

$(y-1)^2 = 2(x+1)^2 - 1 + 2C$

$y - 1 = \pm\sqrt{2(x+1)^2 - 1 + 2C}$

$y = \pm\sqrt{2(x+1)^2 - 1 + 2C} + 1$

This function describes pretty well the figure shown above. Increasing the constant C (or z-axis) will cause the parabolas created by the square root to increase in distance in seperation in the x direction.

Part C

$f(x, y) = 2x + 4yx^2 - 2y^2$

$\frac{\partial f}{\partial x} = 2 + 2x$

$\frac{\partial f}{\partial y} = 4 - 4y$

$\frac{\partial f}{\partial x} = 0$

$x = -1$

$\frac{\partial f}{\partial y} = 0$

$y = 1$

$\frac{\partial^2 f}{\partial x^2} = 2$

$\frac{\partial^2 f}{\partial y^2} = -4$

$\frac{\partial^2 f}{\partial x \partial y} = 0$

$\frac{\partial^2 f}{\partial y \partial x} = 0$

This point (-1,1) is a stationary point but neither a maxima or minima. This point is an inflection point as shown by the hessian.

ASSIGNMENT 1: EXERCISE 2

Part D

$A = B^T B = x^T B^T B x = (Bx)^T (Bx) \geq 0$

Therefore since this equality holds for all B, A is positive semi-definite

Part E

$f(y + \alpha(x - y)) - \alpha f(x) - (1 - \alpha) f(y) \leq 0$

If this holds true, then the f(x) is convex.

$$(y^T + (\alpha x^T) - (\alpha y)^T)A(y + \alpha x - \alpha y) - \alpha x^T Ax - y^T Ay + \alpha y^T Ay \leq 0$$

$$0 \leq 0$$

All the terms cancel out. Therefore f(x) is convex.

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