Yichen Dong Final

Problem 2

```
syms x y z;
f = x^5 + y^4 + z^3 + x*y^2 + y*z +1;
h = hessian(f);
x = 1;
y=1;
z = -1;
subs(h)
%The diagonals are not all positive or negative
```

[20, 2, 0]

[2, 14, 1]

[0, 1, -6]

Problem 5

If X goes first, X will pay inf_x sup_y f(x,y). If Y goes first, Y will receive sup_y inf_x f(x,y). Since sup_y inf_x f(x,y)<= inf_x sup_y f(x,y), Y would rather that X goes first, and X would rather that Y goes first, meaning that they both would prefer to be second.

Problem 6

I assume that f(x*,y*) means that there exists a saddle point in this function. If there is a saddle point within the function, then any other y would have a lower return and any other x would have a higher return for every x and y in f. Of course, this wouldn't work for every function f, but only for those with a saddle point.

Problem 7

Since we know that y^s is a constant, if we fixed y at y^s and allowed x to vary, and the result was a convex function for fixed y^s, then we know that any x that we set that is not at the lowest x^s will be higher, and thus the convexity ensures that f(x^s,y^s)<= f(x,y^s)

Problem 8

Similar logic, but since for fixed x it is a concave function, any y that is not y^s will be lower than f evaluated at y^s.

Problem 9

Using the notes for module 3 and the pset for module 8, we see that if Ax =b, then y is unbounded. Also, since x >= 0, the A.'y >=c. Since in this case we are still maximizing -b.'y, this means that we switched y with -y, and carrying through the negative, we get A.'y<=-c.

Problem 10

They are as stated by "L(x,u) is convex for fixed u", which means that the original c.'x is convex.

Problem 11

Yes, since when we hold u constant we are still adding g(x), and that is still a convex function.

Problem 16-20

```
Q = [2 1;
    1 2];
A = [3 1;
    -3 4];
b = [5;3];
c= [0,0];
[x,fval] = quadprog(Q,c,A,b)
Qd = inv(Q);
cd = -c*inv(Q);
[xd,fvald] = quadprog(Qd,cd,A,b)
Q1 = [1 2;
    2 1];
Qd1 = inv(Q1);
[x1,fval1] = quadprog(Q1,c,A,b)
[xd1,fvald1] = quadprog(Qd1,c,A,b)
fval1 - fvald1
```

Problem 21

F(x) could be not convex if Q did not have all positives on the diagonal.

Problem 22

I believe that this is convex, because the x_i^2 are always a convex function no matter where the intercept is.

Problems 23-25

My logic here is that if we had a semidefinite positive Q, then x.'Qx would always be positive or 0. Thus, if (M-Q) was positive semidefinite, we would have the same effect.