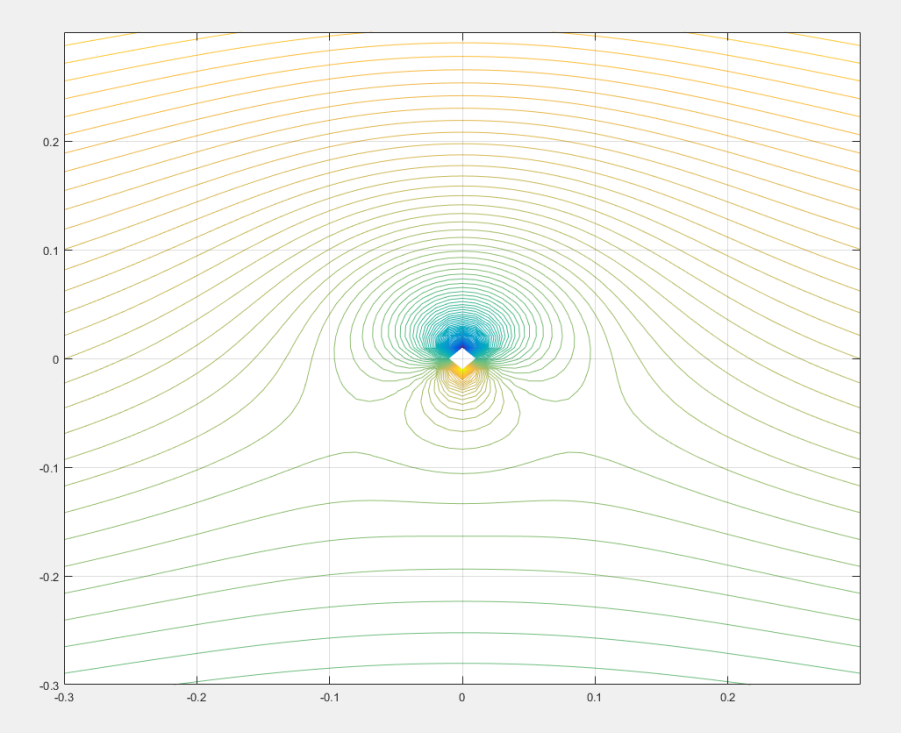
Problem 2

Code:

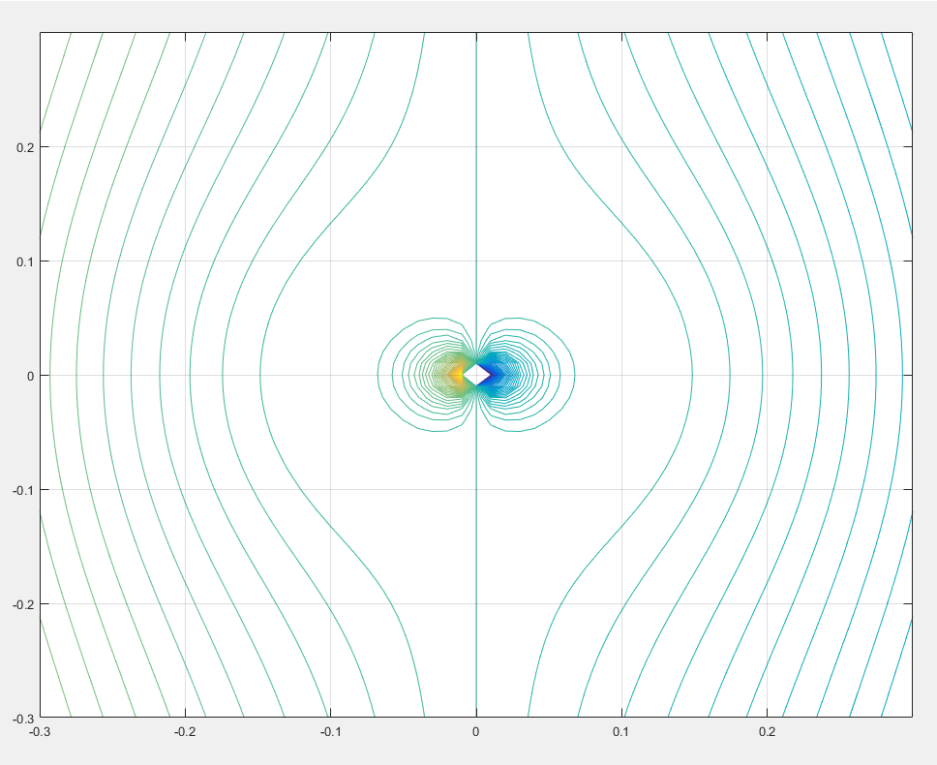
```
clear
clc
close all

U= 10;
a= 0.1;
x=[-.3:.01:.3];
[X,Y] = meshgrid(x);
theta= atan2(Y,X);
r= sqrt(X.^2+Y.^2);
w= -120;
psi= U*sin(theta).*(r-a^2./r)-a^2*w*log(r./a);

contour(X,Y,psi,101)
grid on

phi= U*cos(theta).*(2*a-r-a^2./r);

figure
contour(X,Y,phi,101)
grid on
```

Solution:

Streamfunction:



Velocity Potential:

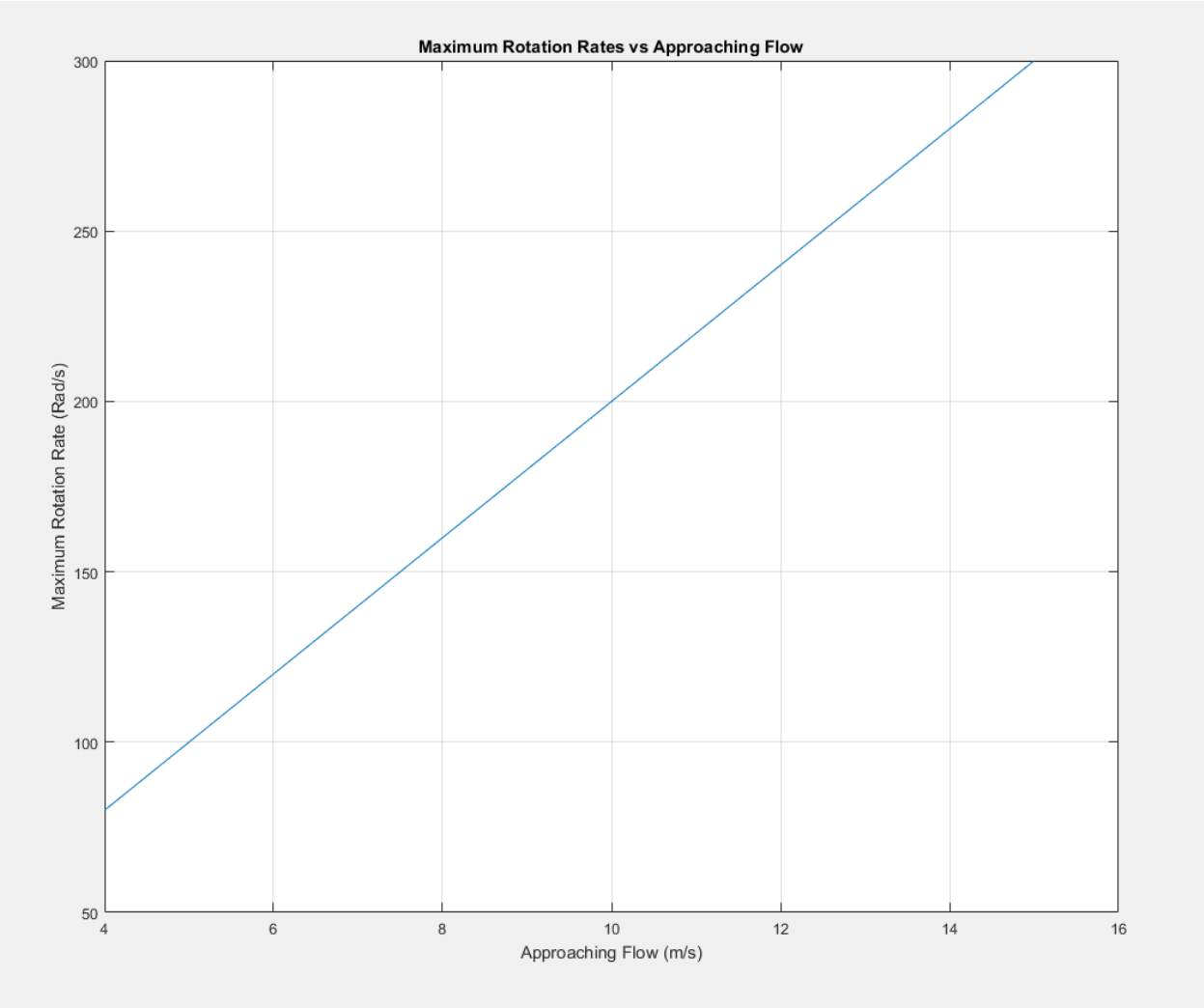


Problem 3

Code:

```
clear
clc
close all

U= [4:.01:15];
a= 0.1;
w= 2*U/a;

plot(U,w)
```

Solution:

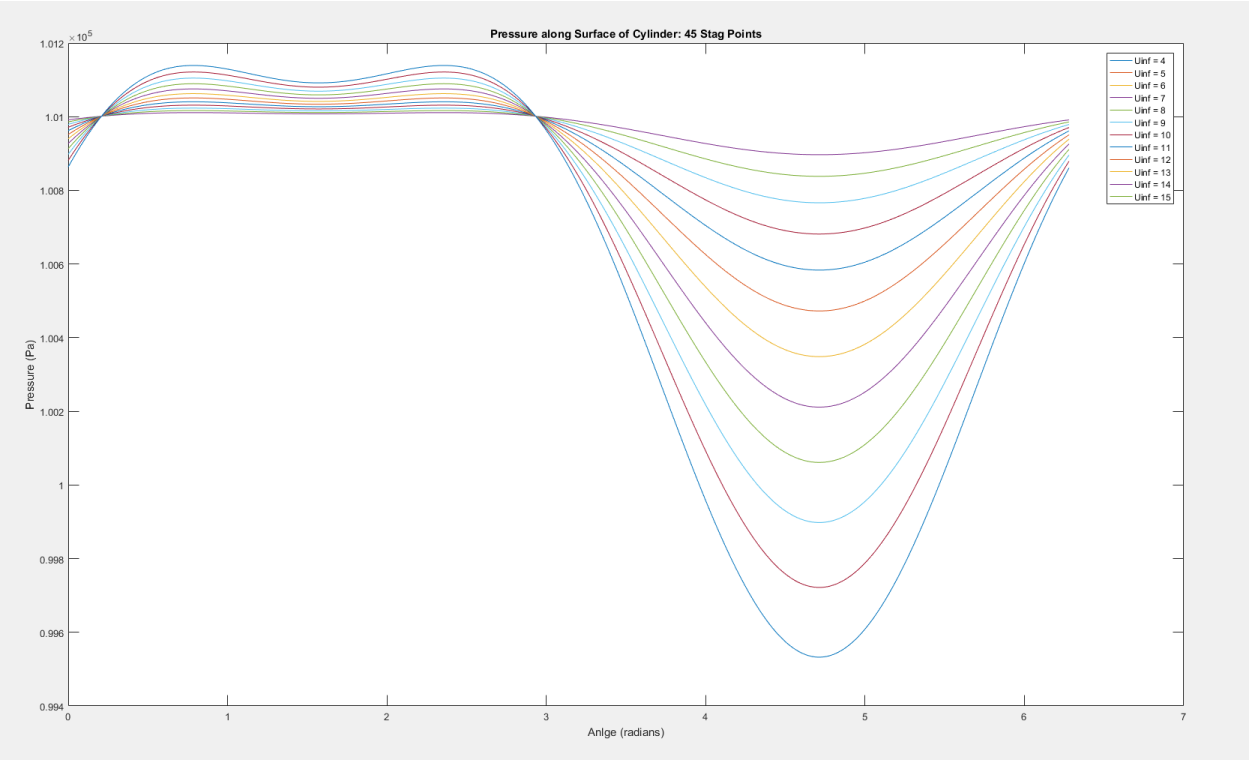


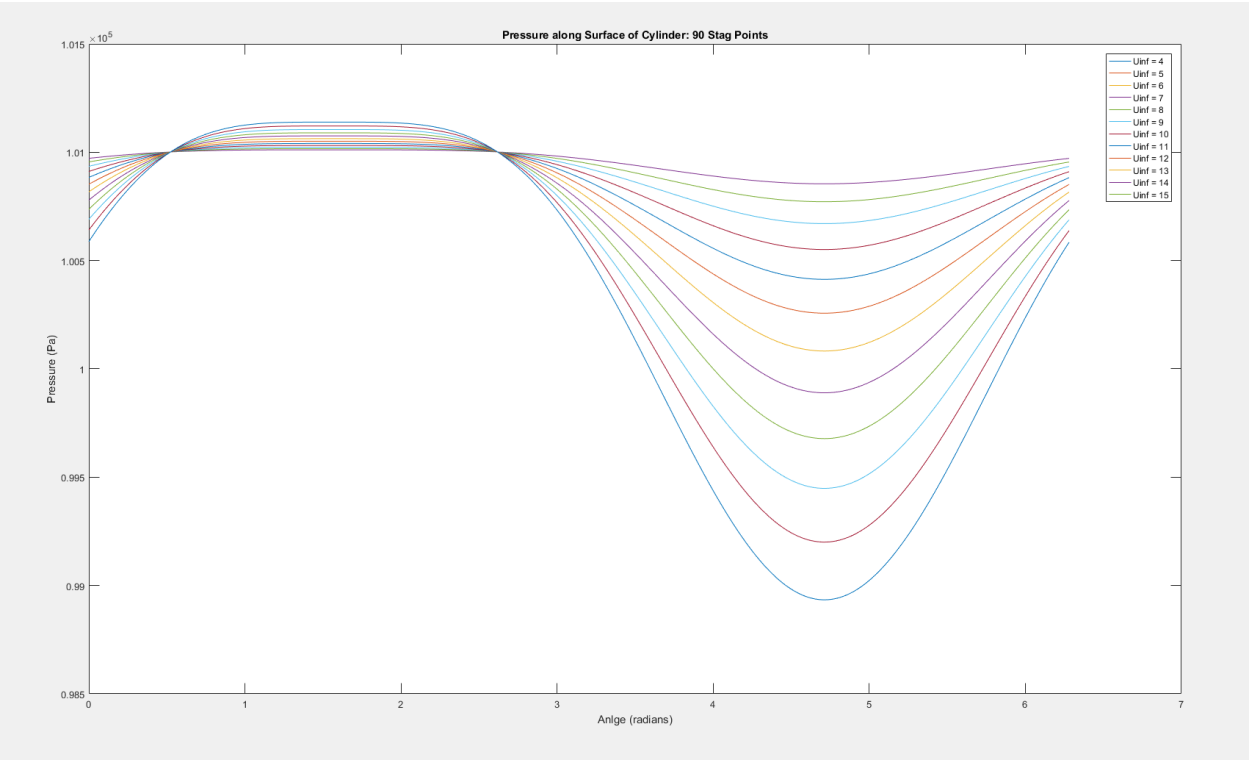
Problem 5

Code:

```
clear
clc
close all

a= 0.1;
U= [4:1:15];
theta= [0:.01:2*pi];
Pinf= 101000; %kPa
rho= 1.225;
g= 9.81;

for i=1:length(U)
   w45= sind(45)*2*U(i)/a;
   w90= sind(90)*2*U(i)/a;
   Ps45(i,:)= Pinf+rho*U(i)^2/2-rho*(-2*U(i)*sin(theta)+a*w45).^2/2+rho*g*a;
   Ps90(i,:)= Pinf+rho*U(i)^2/2-rho*(-2*U(i)*sin(theta)+a*w90).^2/2+rho*g*a;

   figure(1)
   plot(theta,Ps45)
   hold on
   title('Pressure along Surface of Cylinder: 45 Stag Points')
   ylabel('Pressure (kPa)')
   xlabel('Anlge (radians)')

   figure(2)
   plot(theta,Ps90)
   hold on
   title('Pressure along Surface of Cylinder: 90 Stag Points')
   ylabel('Pressure (kPa)')
   xlabel('Anlge (radians)')
end
figure(1)
legend('Uinf = 4','Uinf = 5','Uinf = 6','Uinf = 7','Uinf = 8','Uinf =
9','Uinf = 10','Uinf = 11','Uinf = 12','Uinf = 13','Uinf = 14','Uinf = 15')
figure(2)
legend('Uinf = 4','Uinf = 5','Uinf = 6','Uinf = 7','Uinf = 8','Uinf =
9','Uinf = 10','Uinf = 11','Uinf = 12','Uinf = 13','Uinf = 14','Uinf = 15')
```

Solution:


Pressure along Surface of Cylinder: 45 Stag Points
×10^5
1.012
1.01
1.008
1.006
1.004
1.002
1
0.998
0.996
0.994
Pressure (Pa)
0
1
2
3
4
5
6
7
Anlge (radians)
Uinf = 4
Uinf = 5
Uinf = 6
Uinf = 7
Uinf = 8
Uinf = 9
Uinf = 10
Uinf = 11
Uinf = 12
Uinf = 13
Uinf = 14
Uinf = 15


Pressure along Surface of Cylinder: 90 Stag Points
×10^5
1.015
1.01
1.005
1
0.995
0.99
0.985
Pressure (Pa)
0
1
2
3
4
5
6
7
Anlge (radians)
Uinf = 4
Uinf = 5
Uinf = 6
Uinf = 7
Uinf = 8
Uinf = 9
Uinf = 10
Uinf = 11
Uinf = 12
Uinf = 13
Uinf = 14
Uinf = 15

Problem 6 and Problem 7

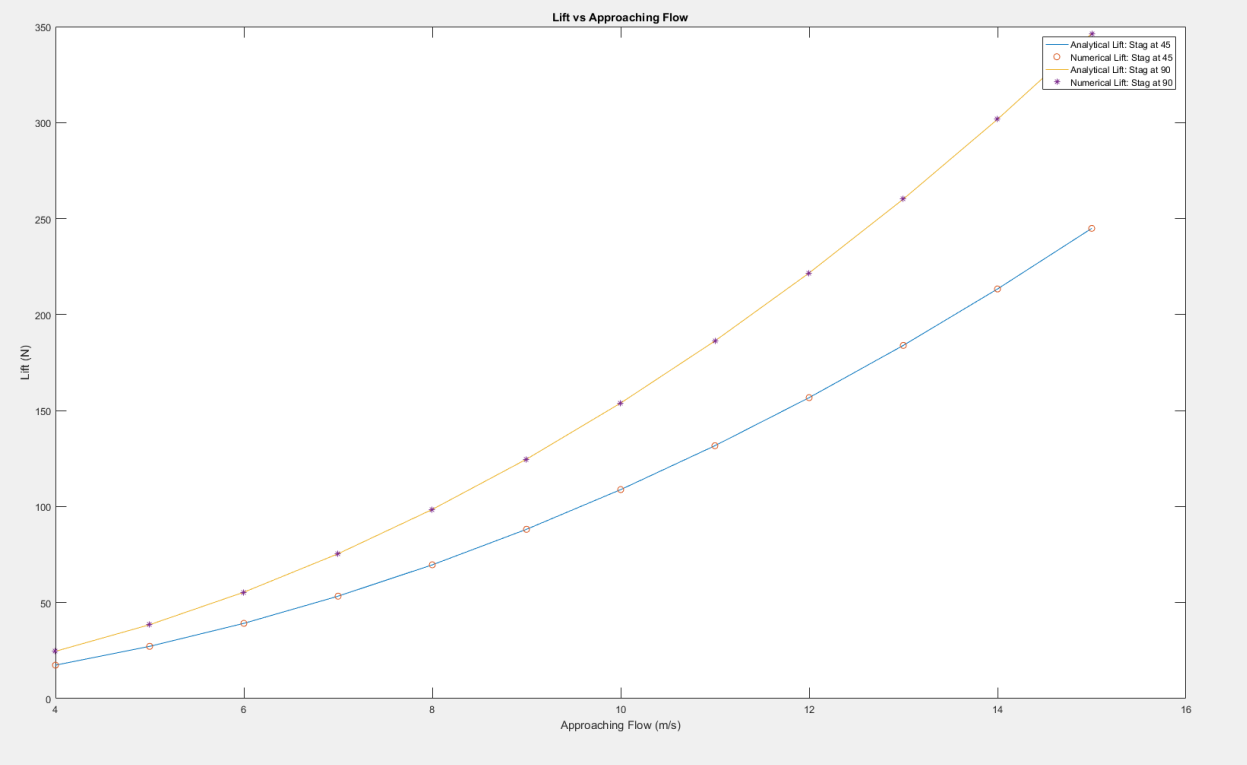
Code:

```
clear
clc
close all

a= 0.1;
U= [4:1:15];
delta= .01;
theta= [0:delta:2*pi];
Pinf= 101; %kPa
rho= 1.225;
g=9.81;

for i=1:length(U)
    w45= sind(45)*2*U(i)/a;
    w90= sind(90)*2*U(i)/a;
    Ps45= (Pinf+rho*U(i)^2/2-rho*(-
2*U(i)*sin(theta)+a*w45).^2/2+rho*g*a).*sin(theta)*delta*a;
    Ps90= (Pinf+rho*U(i)^2/2-rho*(-
2*U(i)*sin(theta)+a*w90).^2/2+rho*g*a).*sin(theta)*delta*a;
    Fy45(i)= sum(Ps45);
    Fy90(i)= sum(Ps90);
end

FortyFive= sind(45)*2*U/a;
Ninety= sind(90)*2*U/a;
LiftActual45= rho*U*2*pi*a^2.*FortyFive;
LiftActual90= rho*U*2*pi*a^2.*Ninety;

plot(U,LiftActual45)
hold on
plot(U,Fy45,'o')
hold on
plot(U,LiftActual90)
hold on
plot(U,Fy90,'*')
legend('Analytical Lift: Stag at 45','Numerical Lift: Stag at 45','Analytical
Lift: Stag at 90','Numerical Lift: Stag at 90')
title('Lift vs Approaching Flow')
ylabel('Lift (N)')
xlabel('Approaching Flow (m/s)')

% % Problem 7

Cl45= 2.1;
Cl90= 3.8;

White45= rho*U.^2*a*Cl45*2;
White90= rho*U.^2*a*Cl90*2;

figure(2)
plot(U,White45,'-o')
```

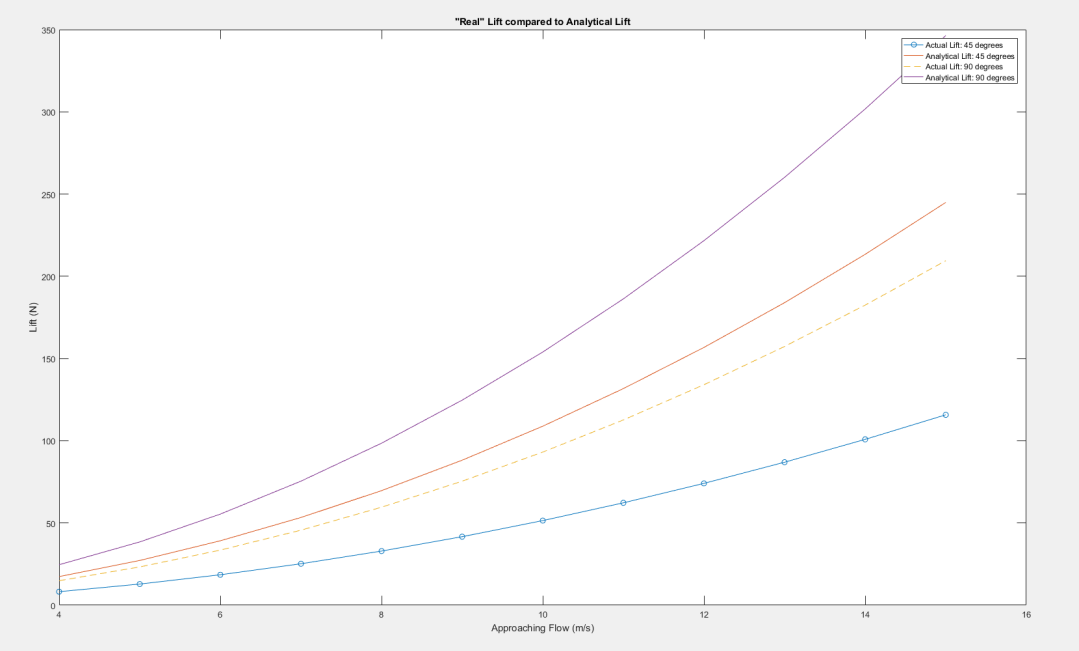
```
hold on
plot(U,LiftActual45)
hold on
plot(U,White90,'--')
hold on
plot(U,LiftActual90)
legend('Actual Lift: 45 degrees','Analytical Lift: 45 degrees','Actual Lift:
90 degrees','Analytical Lift: 90 degrees')
title('"Real" Lift compared to Analytical Lift')
ylabel('Lift (N)')
xlabel('Approaching Flow (m/s)')

Cd45= .62;
Cd90= .5;
WhiteDrag45= rho*U.^2*a*Cd45*2;
WhiteDrag90= rho*U.^2*a*Cd90*2;
ratio45= White45./WhiteDrag45;
ratio90= White90./WhiteDrag90;

figure(3)
plot(U,ratio45,'-o')
hold on
plot(U,ratio90)
legend('Ratio: 45','Ratio: 90')
title('Ratio of "Real" Lift and Drag')
ylabel('Fl/Fd')
xlabel('Approaching Flow (m/s)')
plot(U,ratio90)
```

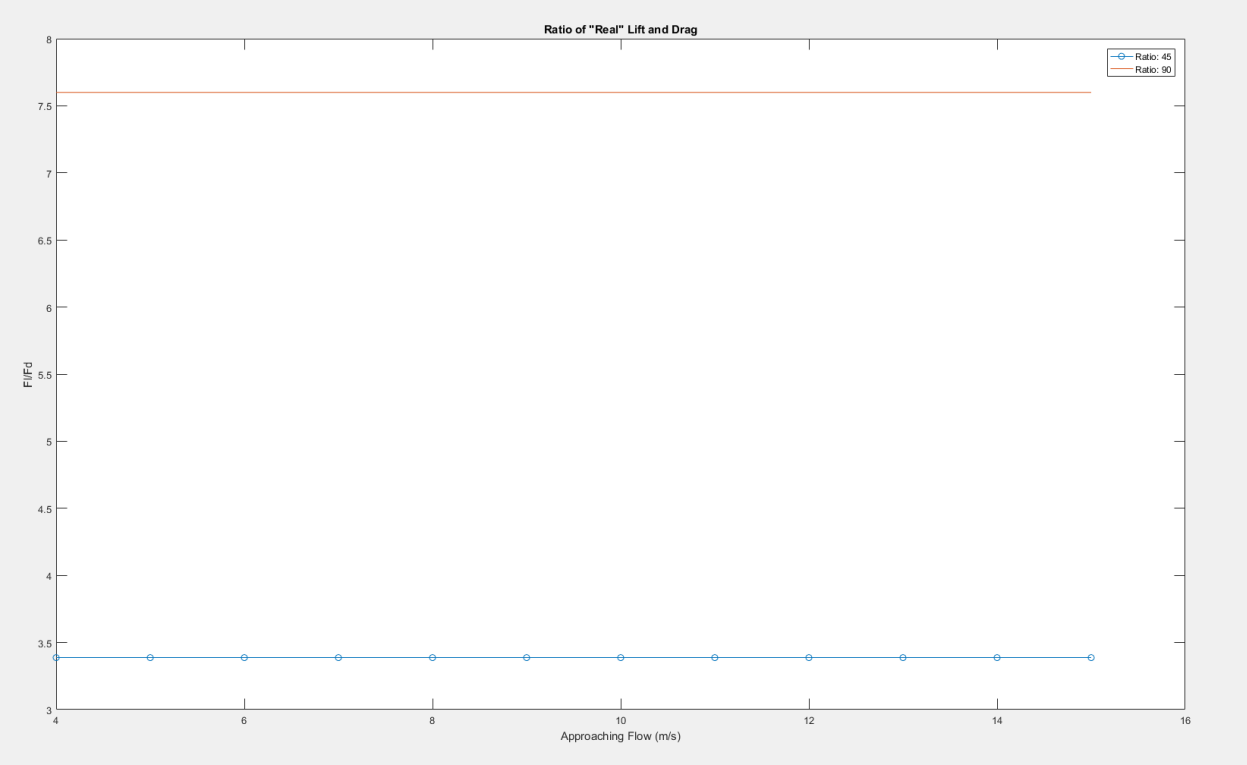
Solution:

Problem 6:



Problem 7:




Ratio of "Real" Lift and Drag
Ratio: 45
Ratio: 90
Fl/Fd
Approaching Flow (m/s)
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
4
6
8
10
12
14
16