Ben Bemis AME 70634 Homework 2

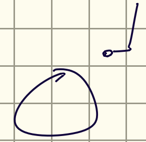
1.) Calibration of Hotwires $St = 0.212\left(1 - \frac{21.2\nu}{UL}\right)$

The relation for the Strahol number is only Valid for $40 \le Re_D \le 150$.
The largest cylinder would be Valid from $Re_D = 40 \rightarrow Re_D = 150$ since $Re_D \propto U$ ∴ This would take us from $5 m/s \rightarrow 18.75 m/s$ (U_∞ at $Re = 40$ is 3.75x Less than at $Re = 150$.)
The next cylinder would be Smaller such that $18 m/s = Re_D = 40$ then as $U_\infty \uparrow$ By a factor of 3.75 $U_\infty = 70.31 m/s$ which is greater than $60 m/s$.

You would only need 2 cylinders, however 3 would provide more Tolerance as the Re_D Approachs 40 and 150 respectively.

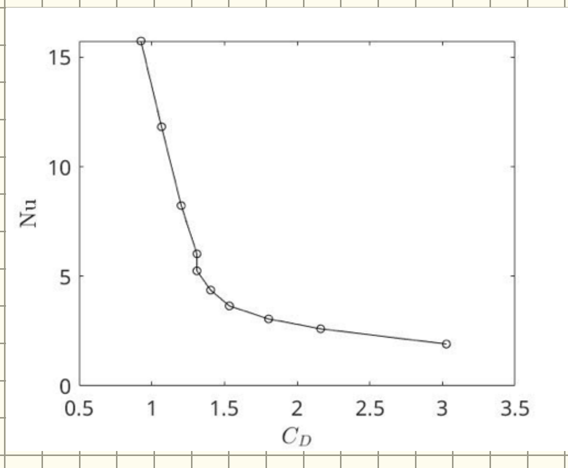
1.2. 1) Start with largest Cylinder at $5 m/s$. With the hotwire in the wake measure the Vootage then preform a FFT
2.) Once you have the peak Shedding frequency, $St = \frac{fD}{U_\infty} = 0.212\left(1 - \frac{21.2\nu}{UL}\right)$. Then use a nonlinear Solver to determine U_∞.
3.) Then Traverse the Hotwire out of the wake, and record the Voltage now that you know U_∞, assuming that $40 \le Re_D \le 150$.
4.) Increase tunnel speed and Repeat Steps 1-4 until $Re_D \ge 150$
5.) Change to a smaller cylinder and Repeat 1-5 until the range of U_∞ is gathered.
6.) Then Use Kings Law to relate Voltage and U_∞.

1.3 AS cylinder diameter decreases make sure hotwire Acts as HW not a Control cylnder. This occurs due to the necessity for a small cylinder to keep the Reynolds number between 40 & 150. This could be further solved by moving the Hotwire downstream in the wake.



2.)

$Nu(Re)$ = Churchill bernstien equation $C_1 + C_2$
$Cd(Re)$ = Digitized $Cd(Re)$ fig 3.6



3.)

Add Control clynders — This will suppress the Von Karman Vortex Street.
Add Tripping wire — This will cause the Boundary layer on the cylinder to transition and remain attached longer.
Add Flexible trailing filaments — This will Mitigate the Von Karman Vortex Street.

3.2 The drag crisis is caused by the transition to turbulence of the boundary layer. Due to the elevated mixing in turbulent boundary layers the Heat transfer will be larger then in laminar flow. This can be useful experimentally to track the location of the onset of transition and can be used in Heat exchangers to boost efficiency.

3.3 - Dimples (golf ball)

- More Stream lined down stream Additions (i.e. splitter plate like) Ex. Torpedo football
- Passive Jet placed at the Stagnation point. (Control of the flow past a sphere near a flat wall using passive jet. Abdulkerim et al.)
- Adaptive Boundary layer Trips (Doi 10.1063/1.5063908 Adaptive - passive control of flow over a sphere for drag reduction. Seobong et al.)

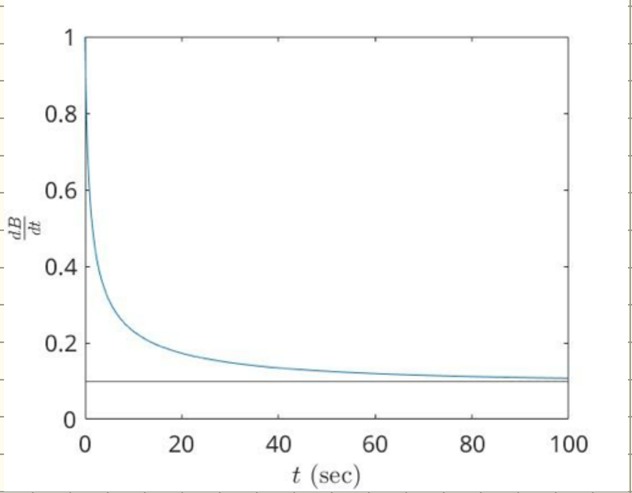
4.)

Eqn 3.1 $\frac{\partial B}{\partial t} = C_1 (Re - Re_{G_c}) B - C_2 |B|^2 B$

$Re \approx Re_{G_c}$

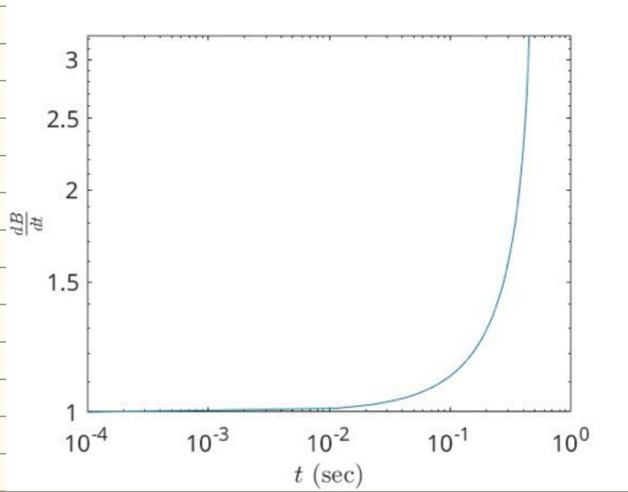
If both C_1 & C_2 are positive.

The Solution Saturates



If C_1 is positive & C_2 is negative.

The Solution grows as B^3 or exponentially in LogLog space



2. Set $\frac{\partial B}{\partial t} = 0$ The Saturation Amplitude can be solved as follows

$0 = C_1 (Re - Re_{G_c}) B - C_2 |B|^2 B \quad$ if $B \neq 0$

$C_1 (Re - Re_{G_c}) = C_2 |B|^2$

$$\boxed{\sqrt{\frac{C_1 (Re - Re_{G_c})}{C_2}} = B}$$

Contents


```
%{

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Advisor: Dr Juliano


Description:
AME 70634: Flow Control
Homework: 2
Due: 10/7/2024


%}
```
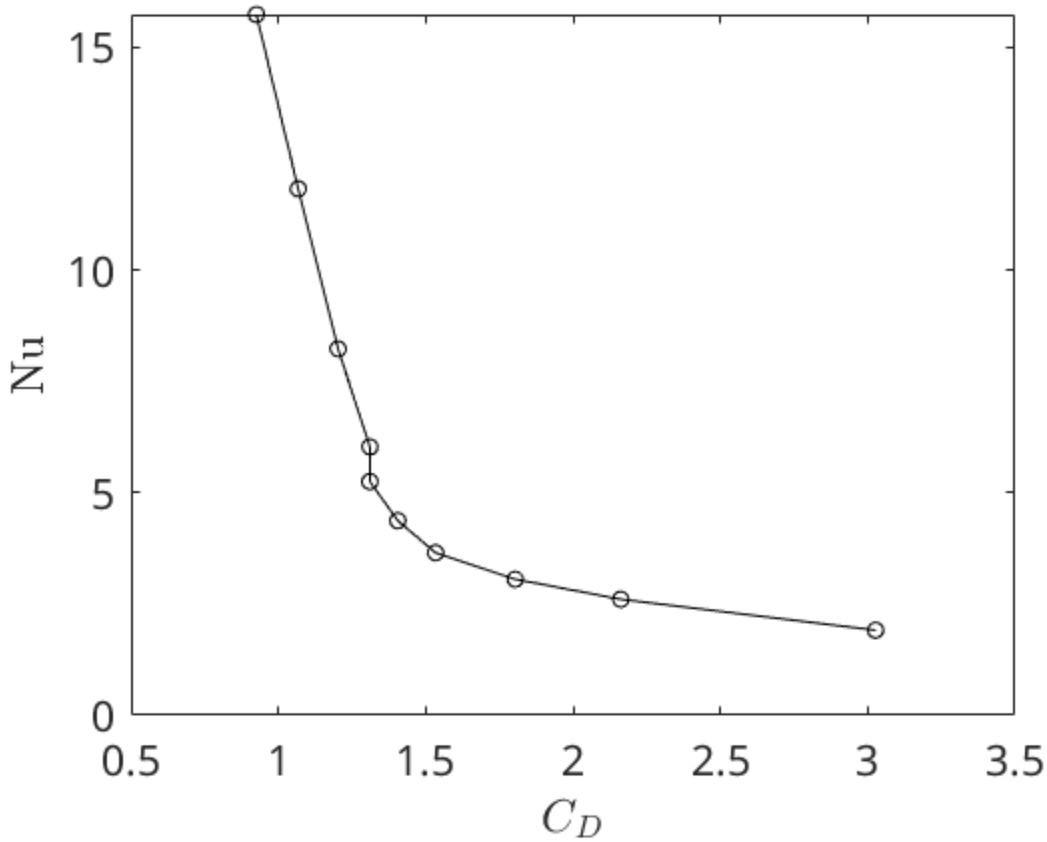

Preperation of the workspace

```
fontsize = 16;


% set(0,'DefaultFigureWindowStyle','docked')
set(0,'DefaultTextInterpreter','latex')
set(0,'DefaultAxesFontSize',fontsize)
set(0,'DefaultLegendFontSize',fontsize)
colors  = ["#000000","#1b9e77","#d95f02","#7570b3","#0099FF"];
```

Problem 2

```
Pr = 0.71;
C1 = 0.3;
C2 = (0.62 * Pr^(1/3)) / (1+(0.4/Pr)^(2/3))^(1/4);

Cd = [11.024348691549282, 3.027027027027027;
22.539339047347912, 2.1621621621621623;
32.22814389988288, 1.8040540540540542;
47.60439595420854, 1.5337837837837838;
70.3167554794647, 1.4054054054054055;
103.86532592315581, 1.310810810810811;
139.16480383601055, 1.310810810810811;
266.6136330715482, 1.2027027027027029;
563.1035111041316, 1.0675675675675675;
1010.894613309757, 0.9256756756756758];

Nu = C1+C2.*(Cd(:,1).^(0.5));

figure
plot(Cd(:,2),Nu,"ko-")
```

```
xlabel("$C_D$")
ylabel("Nu")
```

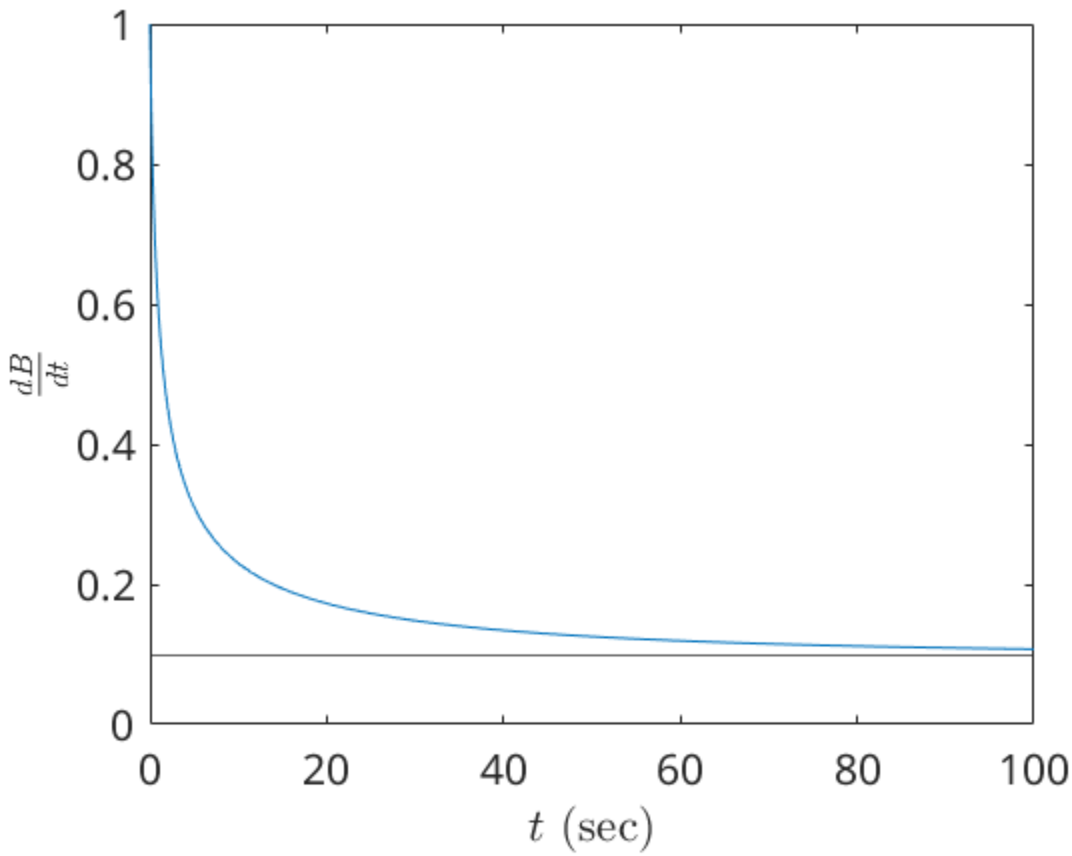


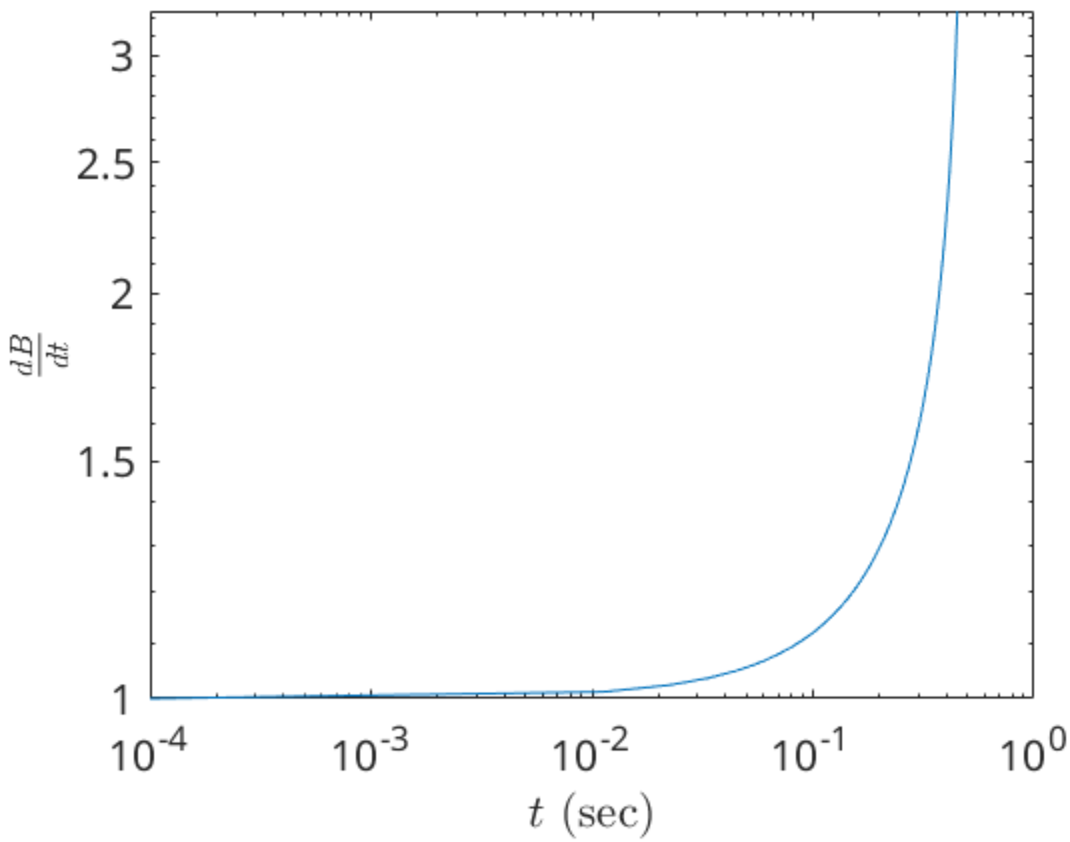
Problem 4

c1 & c2 positive

```
Re_crit = 0.01;
c1 = 1;
c2 = 1;
[t,dB] = ode45(@(t,B) c1*(Re_crit)*B - c2*abs(B)^2*B, [0.0001,100], 1);


figure
plot(t,dB)
yline(0.1)
ylim([0,1])
xlabel("$t$ (sec)")
ylabel("$\frac{dB}{dt}$")

% positive c1 -c2

c1 = 1;
c2 = -1;
[t,dB] = ode45(@(t,B) c1*(Re_crit)*B - c2*abs(B)^2*B, [0.0001,0.45], 1);
```

```
figure
loglog(t,dB)
xlabel("$t$ (sec)")
ylabel("$\frac{dB}{dt}$")
```





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