AAE 334: Aerodynamics

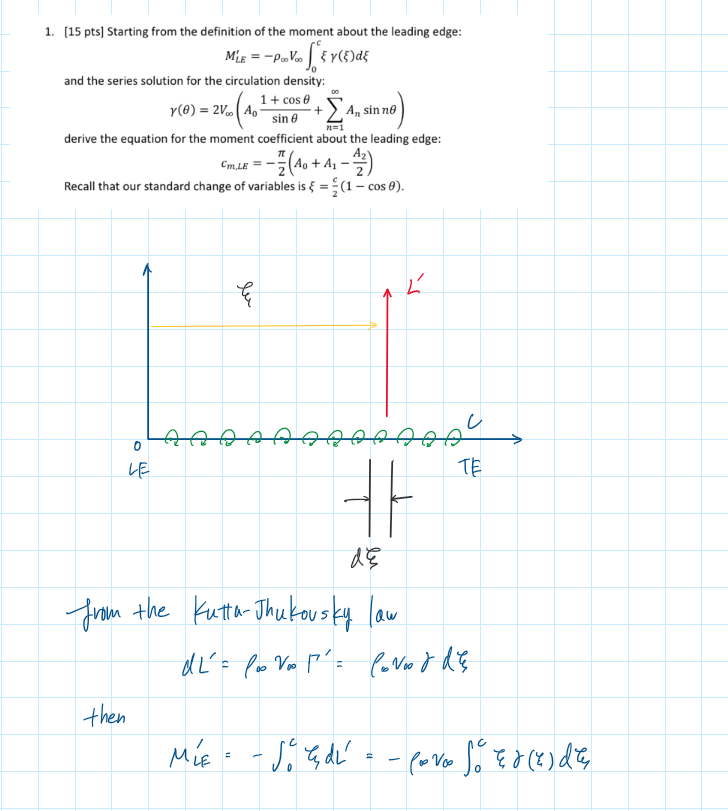
Homework 3: Flat Plate Theory and Effects of Flaps and Slats

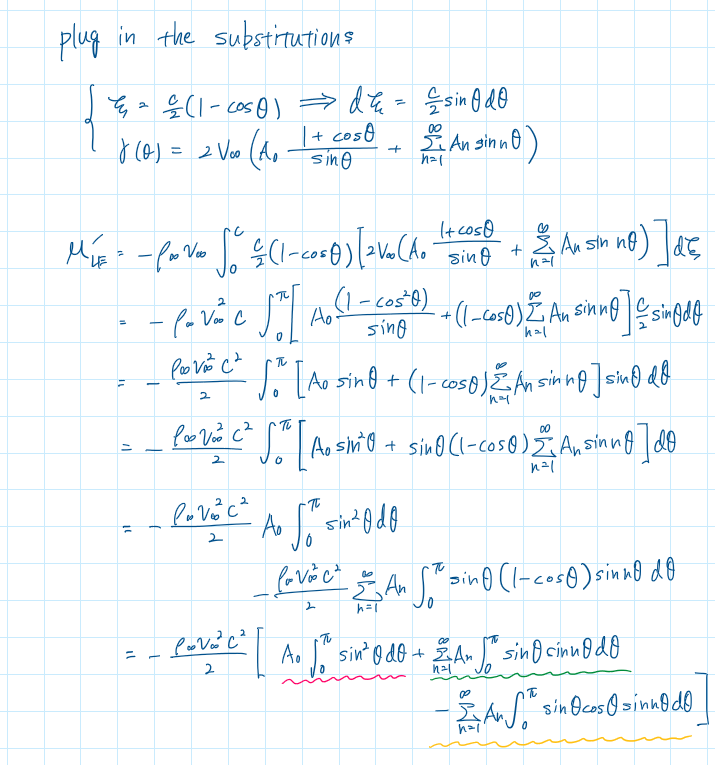
Tomoki Koike

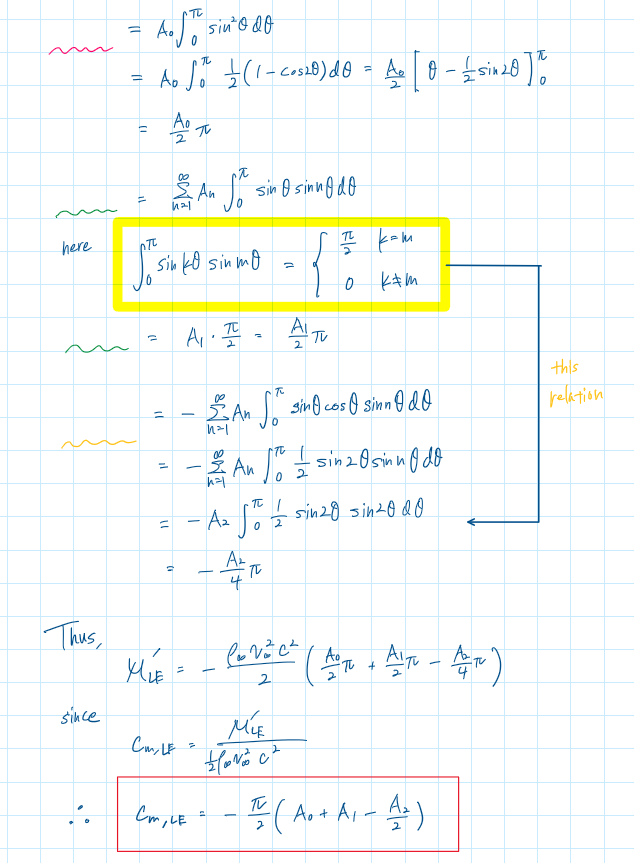
Friday February 7, 2020

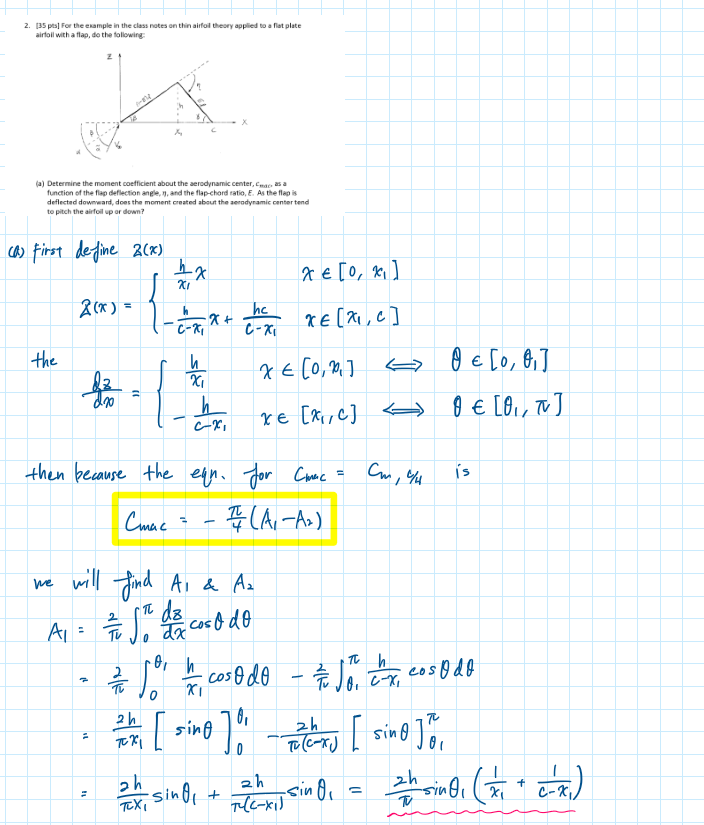
A close up of a tower

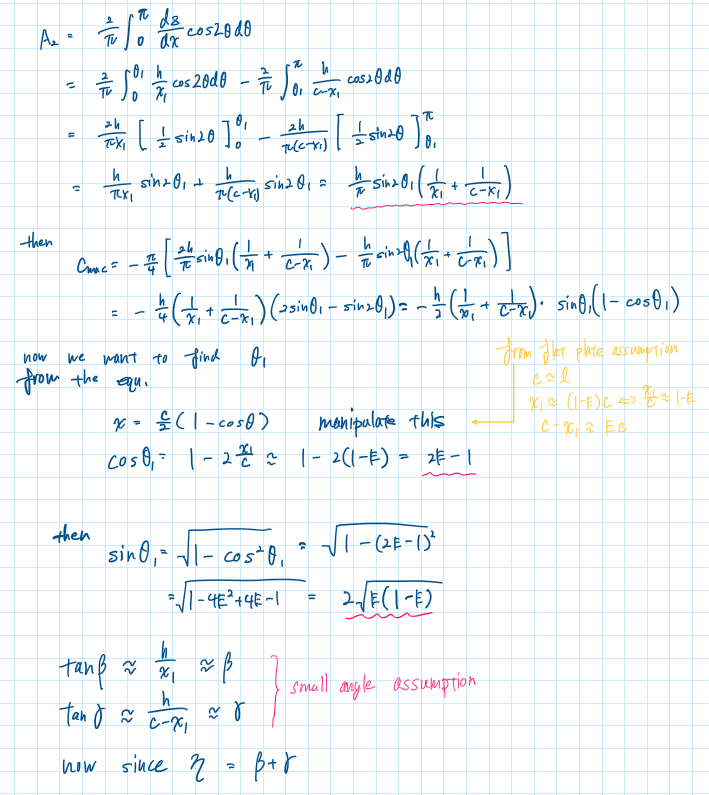
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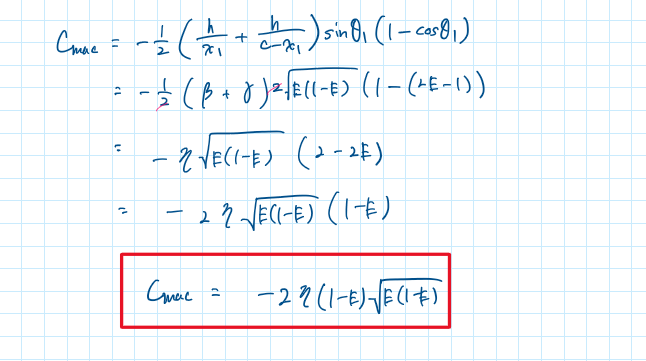


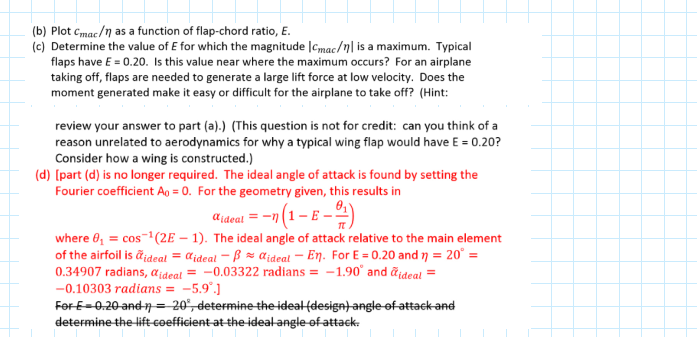








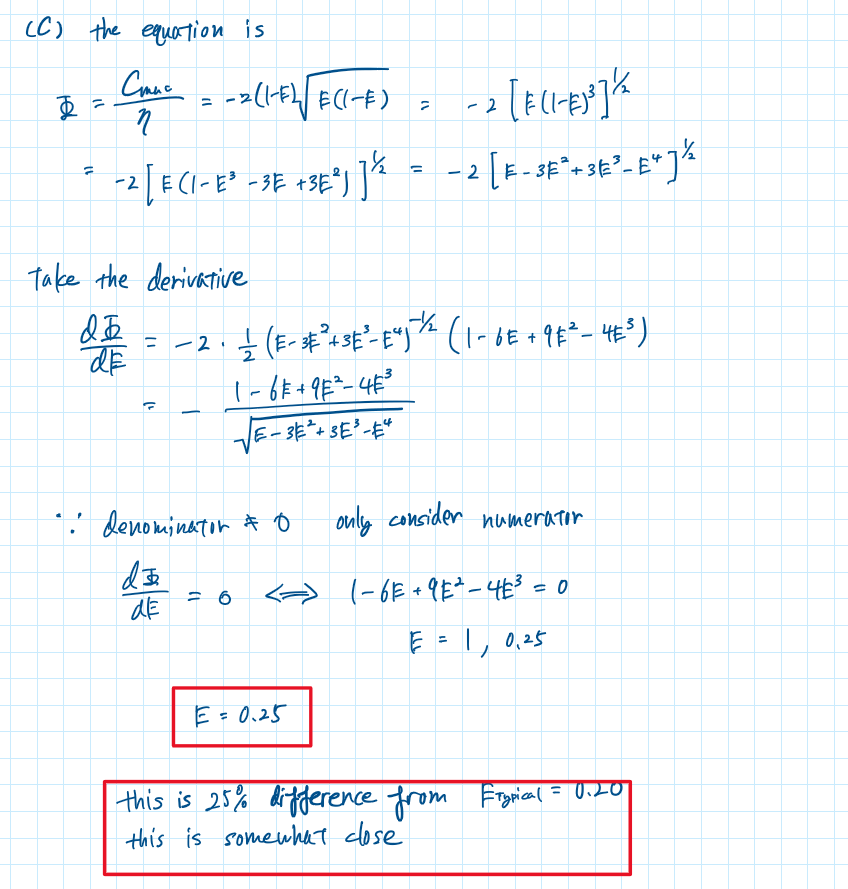


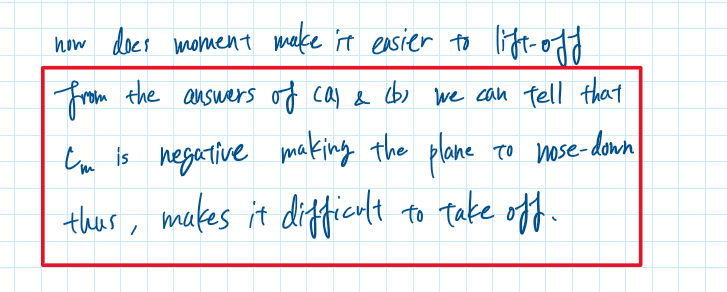


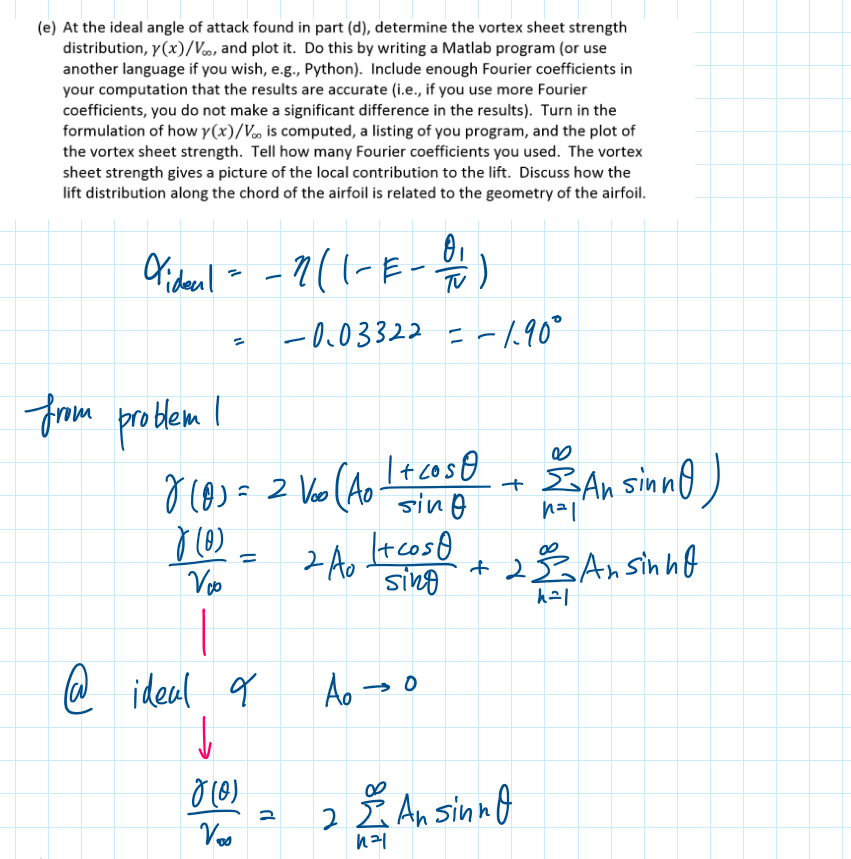


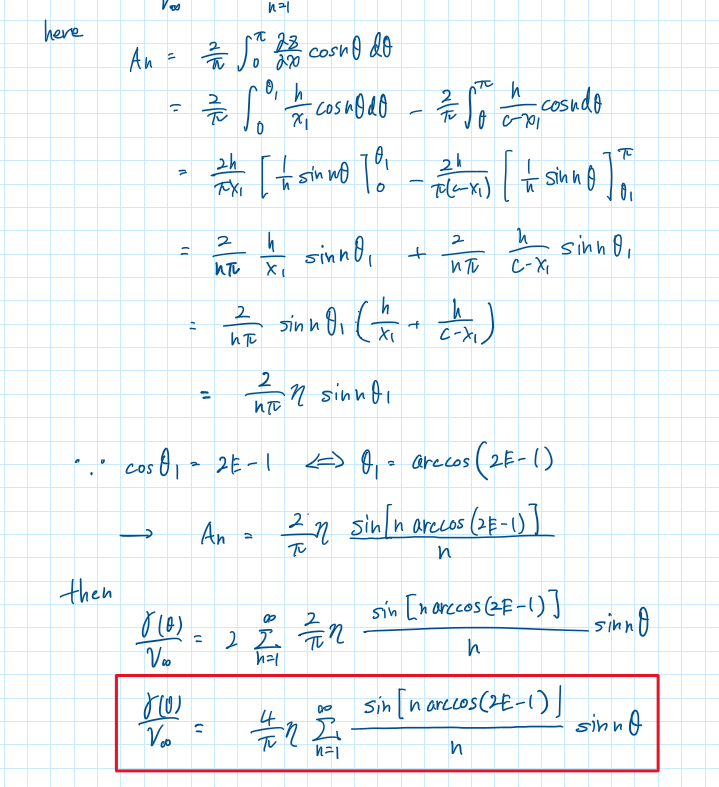
A close up of a map

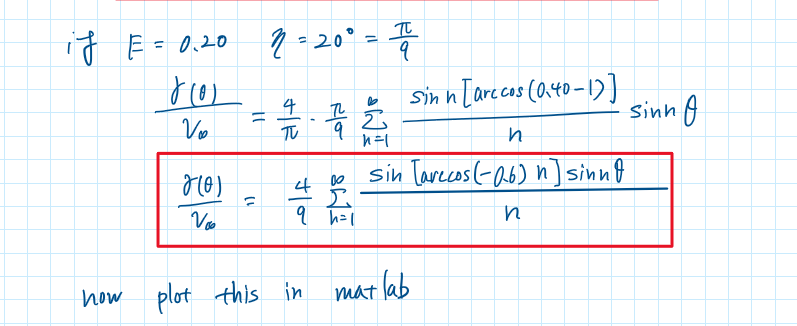
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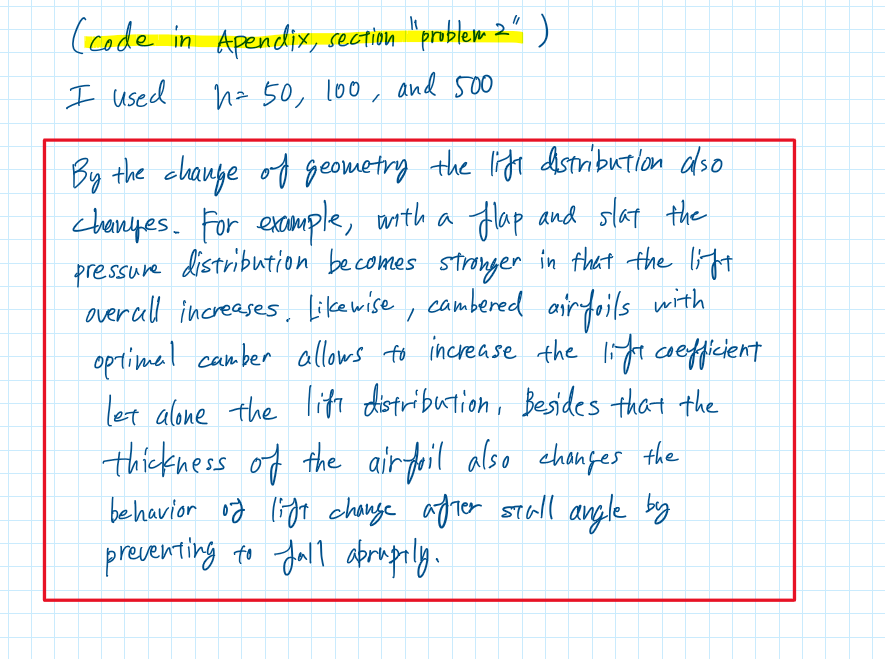


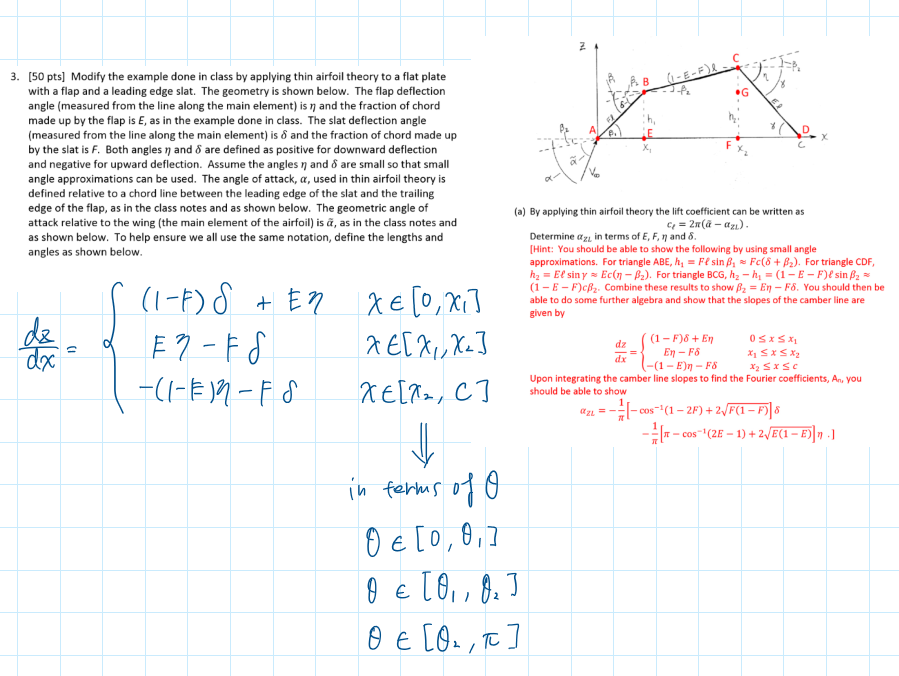


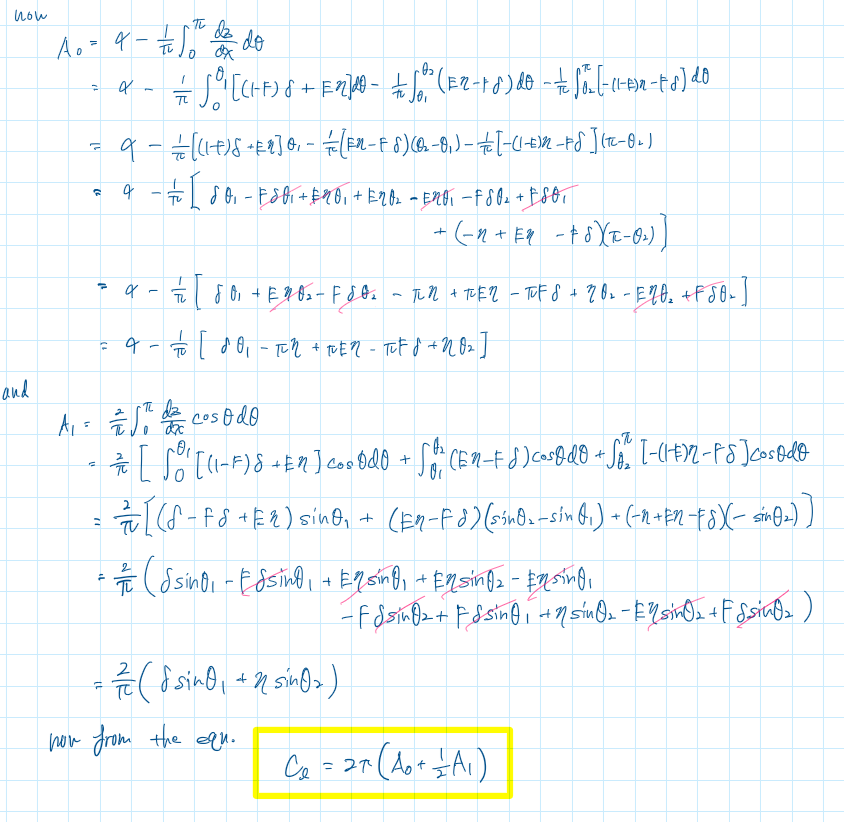


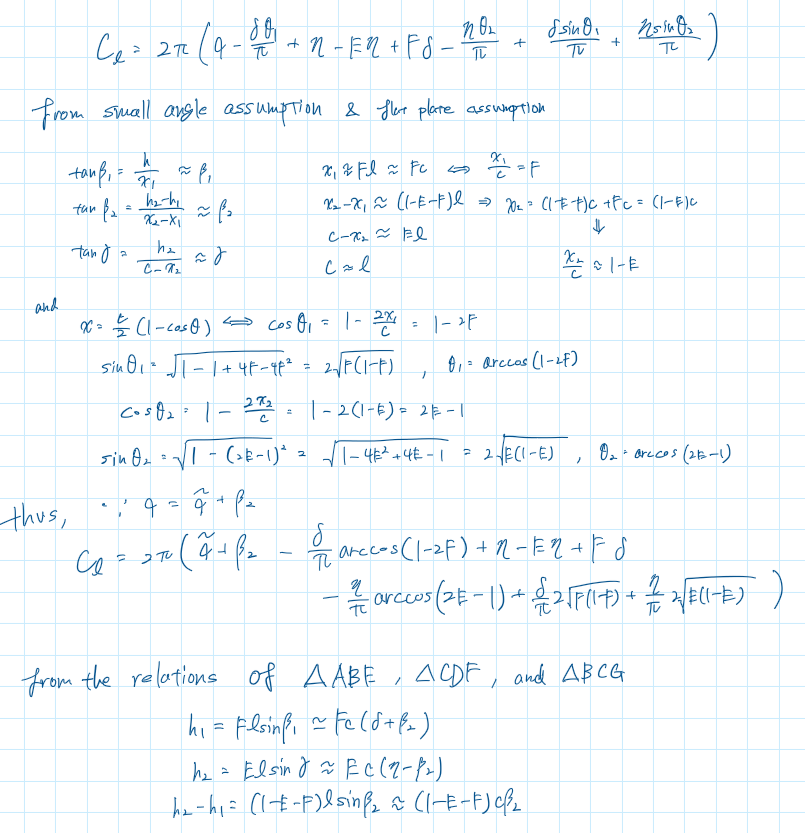
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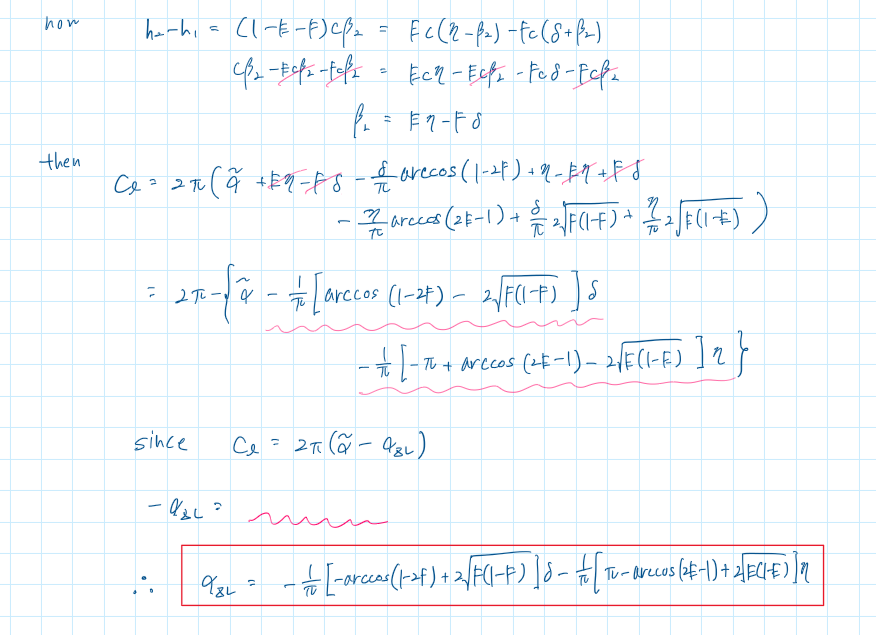
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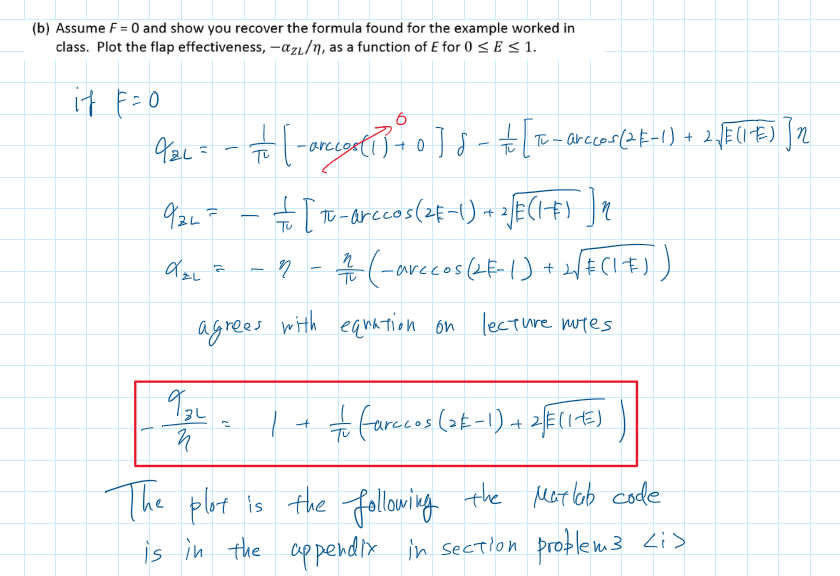






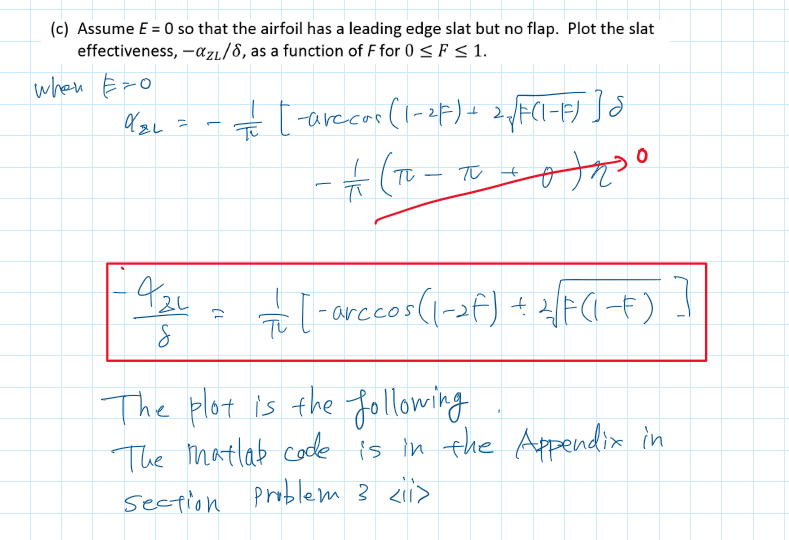






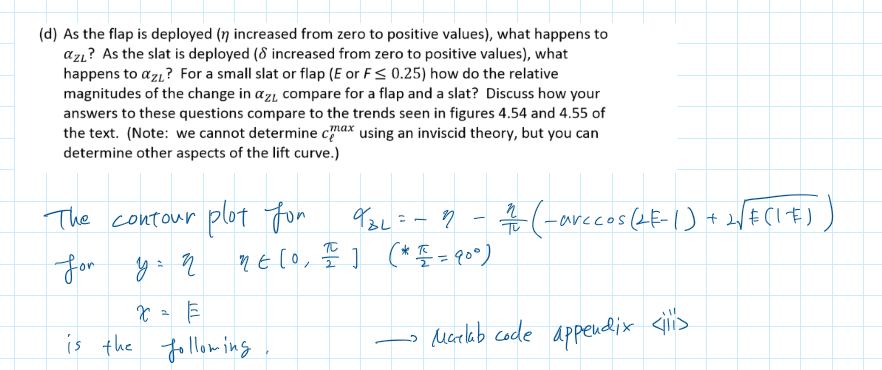
A close up of text on a white background

Description automatically generated



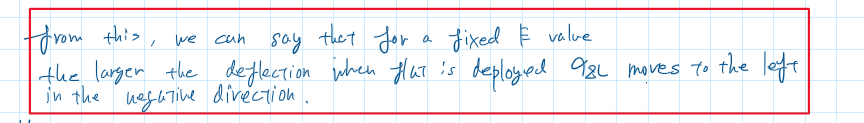
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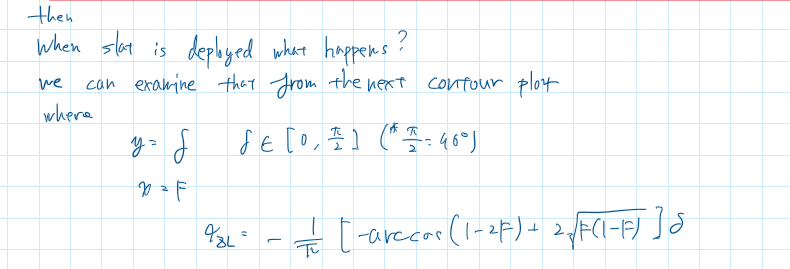
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A close up of a map

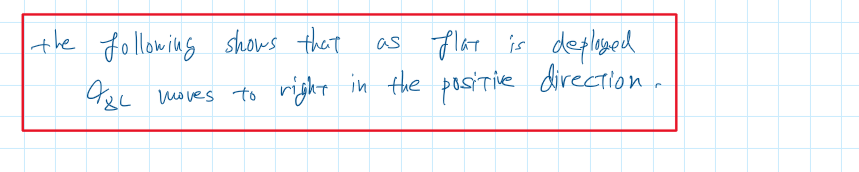
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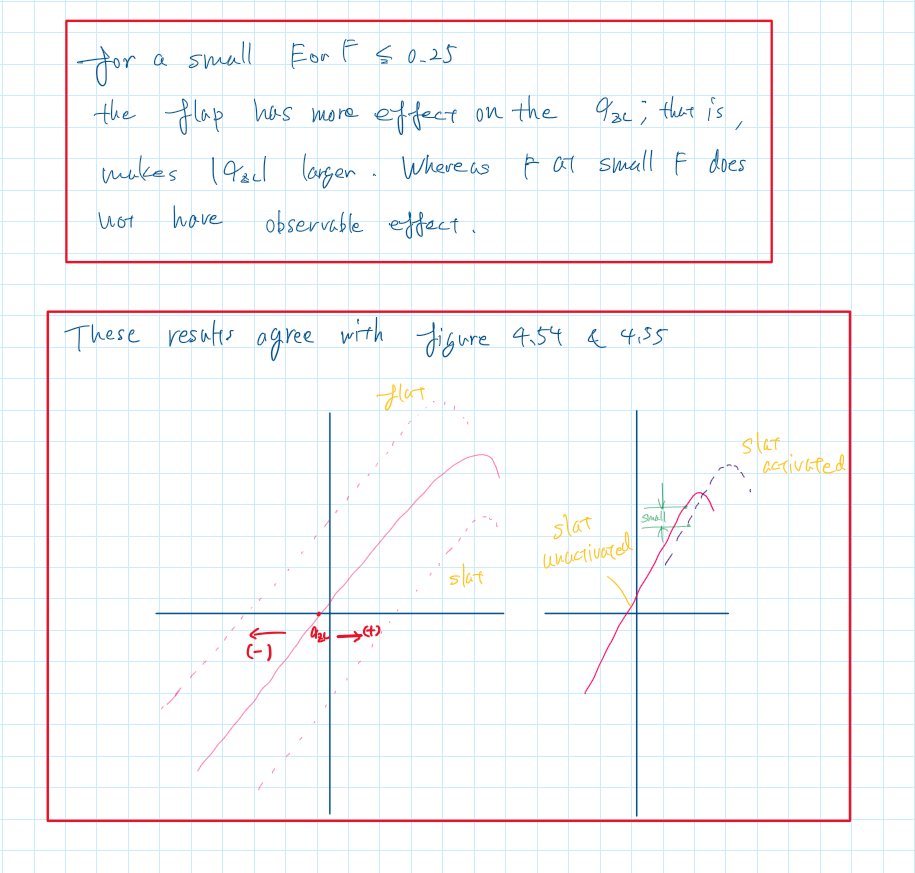




A close up of a map

Description automatically generated





Appendix

HW 3 - matlab code

**problem 1**

clear all; close all; clc

% Plotting the moment coefficient about the aerodynamic center

E = linspace(0,1,100); % flap-chord ratio

C\_mac\_over\_deflect = -2\*(1-E).\*sqrt(E.\*(1-E)); % coefficient per deflection angle

fig1 = figure('Renderer', 'painters', 'Position', [10 10 900 600]);

plot(E, C\_mac\_over\_deflect)

xlabel('flap-chord ratio, E')

ylabel('C\_m\_a\_c per deflection angle')

title({'C\_m\_a\_c per deflection angle VS flap-chord ratio', ...

'- By: Tomoki Koike'})

grid on

grid minor

box on

saveas(fig1, 'mmt\_coeff.png')

**problem 2**

theta = linspace(0, pi, 2^10); % Define the angle theta

gamma\_over\_Vinf\_50 = 0; % Initiate vortex sheet strength distribution

for n = 1:50

A\_n = sin(n\*acos(-0.6)).\*sin(n.\*theta)/n; % n-th Fourier coefficient

gamma\_over\_Vinf\_50 = gamma\_over\_Vinf\_50 + A\_n; % Summation

end

gamma\_over\_Vinf\_50 = 4/9 \* gamma\_over\_Vinf\_50;

gamma\_over\_Vinf\_100 = 0; % Initiate vortex sheet strength distribution

for n = 1:100

A\_n = sin(n\*acos(-0.6)).\*sin(n.\*theta)/n; % n-th Fourier coefficient

gamma\_over\_Vinf\_100 = gamma\_over\_Vinf\_100 + A\_n; % Summation

end

gamma\_over\_Vinf\_100 = 4/9 \* gamma\_over\_Vinf\_100;

gamma\_over\_Vinf\_500 = 0; % Initiate vortex sheet strength distribution

for n = 1:500

A\_n = sin(n\*acos(-0.6)).\*sin(n.\*theta)/n; % n-th Fourier coefficient

gamma\_over\_Vinf\_500 = gamma\_over\_Vinf\_500 + A\_n; % Summation

end

gamma\_over\_Vinf\_500 = 4/9 \* gamma\_over\_Vinf\_500;

% Plotting

fig2 = figure('Renderer', 'painters', 'Position', [10 10 900 600]);

plot(theta, gamma\_over\_Vinf\_50)

xlabel('angle theta, [radians]')

ylabel('Vortex sheet strength distribution')

title({'Vortex Sheet Strength Dsitribution for Ideal Angle of Attack for a Flat Plate with Flaps', ...

'- By: Tomoki Koike'})

hold on

plot(theta, gamma\_over\_Vinf\_100)

plot(theta, gamma\_over\_Vinf\_500)

hold off

grid on

grid minor

box on

legend('n=50','n=100','n=500')

saveas(fig2, 'vortex\_sheet\_strength.png')

**problem 3 <i>**

E = linspace(0,1,2^11);

alpha\_zl\_E = 1 + (-acos(2.\*E-1) + 2\*sqrt(E.\*(1-E)))/pi;

% Plotting

fig3 = figure('Renderer', 'painters', 'Position', [10 10 900 600]);

plot(E, alpha\_zl\_E)

xlabel('flap-chord ratio, E')

ylabel('flap effectiveness')

title({'Flap Effectiveness vs Flap-chord Ratio', ...

'- By: Tomoki Koike'})

grid on

grid minor

box on

saveas(fig3, 'flap\_effectiveness.png')

**<ii>**

F = linspace(0,1,2^11);

alpha\_zl\_F = (-acos(1-2.\*F) + 2\*sqrt(F.\*(1-F)))/pi;

% Plotting

fig3 = figure('Renderer', 'painters', 'Position', [10 10 900 600]);

plot(F, alpha\_zl\_F)

xlabel('slat-chord ratio, E')

ylabel('slat effectiveness')

title({'Slat Effectiveness vs Slat-chord Ratio', ...

'- By: Tomoki Koike'})

grid on

grid minor

box on

saveas(fig3, 'slat\_effectiveness.png')

**<iii>**

eta = linspace(0,pi/2,2^8);

[X1, Y1] = meshgrid(E, eta);

alpha\_zl\_E = -Y1.\*(1 + (-acos(2.\*X1-1) + 2\*sqrt(X1.\*(1-X1)))/pi);

fig4 = figure('Renderer', 'painters', 'Position', [10 10 900 600]);

contour(X1,Y1, alpha\_zl\_E);

xlabel('flap-chord ratio, E')

ylabel('flap deflection')

title('When Flap is Deployed at some Flap-chord Ratio - By: Tomoki Koike')

colorbar

grid on

grid minor

box on

saveas(fig4, 'flap\_deployed.png')

**<iv>**

delta = linspace(0,pi/2,2^8);

[X2, Y2] = meshgrid(F, delta);

alpha\_zl\_F = -Y2.\*(-acos(1-2.\*X2) + 2\*sqrt(X2.\*(1-X2)))/pi;

fig4 = figure('Renderer', 'painters', 'Position', [10 10 900 600]);

contour(X2,Y2, alpha\_zl\_F);

xlabel('slat-chord ratio, F')

ylabel('slat deflection')

title('When Slat is Deployed at some Slat-chord Ratio - By: Tomoki Koike')

colorbar

grid on

grid minor

box on

saveas(fig4, 'slat\_deployed.png')