**TUTORIAL-4**

**Name-Anshul**

**Roll no –M22ME052**

1 matlab code:-

clear all;

close all;

clc;

%%

%naca 4 digit aerofoil (naca uvw) nomenclature

u=input('first digit of naca = ');

v=input('second digit of naca = ');

w=input('last two digit of naca = ');

ymc\_c=u\*0.01;

xmc\_c=v\*0.1;

tm=w\*0.01;

U=100;

c=1;

%%

%cosine clustring

%choose even number of points on circle

n=200;

theta0=2\*pi/(n-1);

i=1:n/2;

x\_c=0.5\*c\*(1-cos((i-0.5)\*theta0));

%%

%camber line formation

for j=1:length(x\_c)

if(x\_c(j)>=0) && (x\_c(j)<=xmc\_c)

ycx\_c(j)=ymc\_c\*(2\*(x\_c(j)/xmc\_c)-(x\_c(j)/xmc\_c)^2);

dyc\_dx(j)=ymc\_c\*(2\*(1/xmc\_c)-(2\*(x\_c(j))/(xmc\_c)^2));

else

ycx\_c(j)=ymc\_c\*(2\*((1-x\_c(j))/(1-xmc\_c))-((1-x\_c(j))/(1-xmc\_c))^2);

dyc\_dx(j)=ymc\_c\*(2\*(-1/(1-xmc\_c))+(2\*(1-x\_c(j))/(1-xmc\_c)^2));

end

end

%%

%

theta0=0:theta0:pi;

syms alpha

a0=alpha-(1/pi)\*trapz(theta0,dyc\_dx,2);

syms N

an=(2/pi)\*trapz(theta0,dyc\_dx.\*cos(N\*theta0));

b=trapz(theta0,sin(theta0).\*sin(N\*theta0));

h=an\*b;

d=matlabFunction(h);

e=trapz(theta0,1+cos(theta0));

syms alpha

if u==0

eqn=a0\*e+d==0;

else

eqn=a0\*e+d(1)==0;

end

f=solve(eqn,alpha);

alpha=180\*double(f)/pi; %in degree

syms alpha x

cl=2\*pi\*(alpha-(1/pi)\*trapz(theta0,dyc\_dx.\*(1-cos(theta0))));

cm\_le=-cl/4+0.5\*trapz(theta0,dyc\_dx.\*(cos(2\*theta0)-cos(theta0)));

cm\_qc=0.5\*trapz(theta0,dyc\_dx.\*(cos(2\*theta0)-cos(theta0)));%pitching moment at quater chord and it is independent of angle of attack

cm\_x=cl\*(x/c)+cm\_le;

cm\_le\_f=matlabFunction(cm\_le);

cl\_f=matlabFunction(cl);

%center of pressure at alpha=0

syms x

eqn=cl\_f(0)\*x/c+cm\_le\_f(0)==0;

g=solve(eqn,x);

x\_p=double(g);

alpha=-pi/18:pi/180:pi/18;

cm\_le\_d=cm\_le\_f(alpha);

cl\_d=cl\_f(alpha);

%plots

figure(1)

yline(cm\_qc);

hold on;

plot(180\*alpha/pi,cl\_d);

xlabel('--alpha (in degree) ---->');

ylabel('--- cm\_qc and cl---->');

legend('cm\_qc','cl');

hold on;

data = readtable('exp.txt');

T = data{:,1};

T2 = data{:,2};

plot (T,T2,'x');

figure(2)

plot(180\*alpha/pi,cm\_le\_d);

xlabel('--alpha (in degree) ---->');

ylabel('--- cm\_le ---->');

**Result:-**

**For naca 2412**

Zero\_lift\_alpha = -2.0770

Cm\_qc = -0.0514

X\_p = 0.4758 (alpha=0)

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Comparision with 0012 (symmetric)



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