**PROJECT-2**

**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 = ');

% u=2;v=4;w=12;

ymc\_c=u\*0.01;

xmc\_c=v\*0.1;

tm=w\*0.01;

U=100;

%chord

c=1;

%%

%cosine clustring

%choose even number of points on circle

n=160;

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);

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

a1=(2/pi)\*trapz(theta0,dyc\_dx.\*cos(theta0));

b=pi/2;

h=a1\*b;

syms alpha

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

f=solve(eqn,alpha);

a\_l0=double(f);

a=(-10:1:15)\*pi/180;

RA=1:1:8;

N=100;

i=1:1:100;

theta=(i-1)\*pi/(N-1);

%elliptic wing

%cl and cd

for o=1:length(RA)

cl\_e=2\*pi.\*(a-a\_l0)./(1+2./RA(o));

cd\_e=cl\_e.^2/(pi\*RA(o));

% cl\_e\_tilda=cl\_e;

figure(1)

plot(a\*180/pi,cl\_e);

hold on;

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

ylabel('--- lift coefficient elliptic---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

figure(2)

plot(cl\_e,cd\_e);

hold on;

xlabel('-- lift coefficient elliptic ---->');

ylabel('--- induced drag coefficient elliptic---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

end

for o=1:length(RA)

% fix angle of attack 10 degree

cl\_e\_tilda=2\*pi.\*(10\*pi/180-a\_l0)./(1+2./RA(o));

% fix angle of attack 10 degree

a\_i\_e=cl\_e\_tilda/(pi\*RA(o));

figure(3)

plot([theta(1) theta(end)],[cl\_e\_tilda cl\_e\_tilda],'LineWidth',1);

hold on;

ylabel('-- sectional lift coefficient elliptic ---->');

xlabel('--- spanwise location ---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

figure(4)

plot([theta(1) theta(end)],[a\_i\_e a\_i\_e],'LineWidth',1);

hold on;

ylabel('-- downwash elliptic ---->');

xlabel('--- spanwise location ---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

end

%rectangular wing

%cl

C=zeros(N,N);

for o=1:length(RA)

for j=1:N

C(1,j)=j^2;

end

for j=1:N

for i=2:(N-1)

C(i,j)=(2\*RA(o)./pi+j./sin(theta(i))).\*sin(j\*theta(i));

end

end

for j=1:N

C(N,j)=(j^2)\*(-1)^(j+1);

end

B=ones(N,1);

A=C\B;

cl\_r=pi\*RA(o)\*A(1)\*(a-a\_l0);

sigma=3\*(A(3)/A(1))^2+5\*(A(5)/A(1))^2+7\*(A(7)/A(1))^2;

cd\_r=cl\_r.^2.\*(1+sigma)/(pi\*RA(o));

% fix angle of attack 10 degree

cl\_r\_tilda=4\*RA(o)\*(10\*pi/180-a\_l0)\*(A(1)\*sin(theta)+A(3)\*sin(3\*theta)+A(5)\*sin(5\*theta)+A(7)\*sin(7\*theta));

% fix angle of attack 10 degree

a\_i\_r=(10\*pi/180-a\_l0)\*(1\*A(1)\*sin(theta)+3\*A(3)\*sin(3\*theta)+5\*A(5)\*sin(5\*theta)+7\*A(7)\*sin(7\*theta))./sin(theta);

figure(5)

plot(a\*180/pi,cl\_r);

hold on;

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

ylabel('--- lift coefficient rectangular ---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

figure(6)

plot(cl\_r,cd\_r);

hold on;

xlabel('-- lift coefficient rectangular ---->');

ylabel('--- induced drag coefficient rectangular ---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

figure(7)

plot(-0.5\*cos(theta),cl\_r\_tilda);

hold on;

ylabel('-- sectional lift coefficient rectangular ---->');

xlabel('--- spanwise location ---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

figure(8)

plot(-0.5\*cos(theta),a\_i\_r);

hold on;

ylabel('-- downwash rectangular ---->');

xlabel('--- spanwise location ---->');

legend('RA=1','RA=2','RA=3','RA=4','RA=5','RA=6','RA=7','RA=8');

end

**RESULT:-**

**cl\_e** = lift coefficient elliptic

**cd\_e** = induced drag coefficient elliptic

**cl\_e\_tilda** = sectional lift coefficient elliptic

**a\_i\_e** = downwash elliptic

**cl\_r** = lift coefficient rectangular

**cd\_r**  = induced drag coefficient rectangular

**cl\_r\_tilda** = sectional lift coefficient rectangular

**a\_i\_r** = downwash rectangular

a\_l0 = zero lift angle of attack

naca 2412 = -2.07 degree

naca 0012 = 0 degree

**Naca 2412 profile**

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**At fix angle of attack 10 degree**

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**At fix angle of attack 10 degree**

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**At fix angle of attack 10 degree**

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**At fix angle of attack 10 degree**

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**Naca 0012 profile**

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**At fix angle of attack 10 degree**

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**At fix angle of attack 10 degree**

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**At fix angle of attack 10 degree**

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**At fix angle of attack 10 degree**

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