**TUTORIAL-1**

**Name-Anshul**

**Roll no –M22ME052**

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Took **even number** of points and **with** cosine clustering **naca 2412** profile

**Matlab code :-**

clear all;

close all;

clc;

%%

%naca 2412 nomenclature

ymc\_c=0.02;

xmc\_c=0.4;

tm=0.12;

%%

%cosine clustring

%choose even number of points on circle

n=200;

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

i=1:n/2;

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

%%

%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

%%

%thickness

for j=1:length(x\_c)

tx(j)=tm\*(2.969\*sqrt(x\_c(j))-1.260\*x\_c(j)-3.516\*x\_c(j)\*x\_c(j)+2.843\*x\_c(j)\*x\_c(j)\*x\_c(j)-1.015\*x\_c(j)\*x\_c(j)\*x\_c(j)\*x\_c(j));

end

%%

%upper and lower surface

for j=1:length(x\_c)

xu(j)=x\_c(j)-0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yu(j)=ycx\_c(j)+0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

xl(j)=x\_c(j)+0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yl(j)=ycx\_c(j)-0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

end

x=[fliplr(xl),xu];

y=[fliplr(yl),yu];

plot(x,y);

xlabel('--- x/c ---->');

ylabel('---- y/c ---->');

title('naca 2412');

**Result :-**

****

>> Took **even number** of points and **without** cosine clustering **naca 2412** profile

**Matlab code :-**

clear all;

close all;

clc;

%%

%naca 2412 nomenclature

ymc\_c=0.02;

xmc\_c=0.4;

tm=0.12;

%%

%equal spacing

n=200;

h=1/(n-1);

x\_c=0:h:1;

%%

%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

%%

%thickness

for j=1:length(x\_c)

tx(j)=tm\*(2.969\*sqrt(x\_c(j))-1.260\*x\_c(j)-3.516\*x\_c(j)\*x\_c(j)+2.843\*x\_c(j)\*x\_c(j)\*x\_c(j)-1.015\*x\_c(j)\*x\_c(j)\*x\_c(j)\*x\_c(j));

end

%%

%upper and lower surface

for j=1:length(x\_c)

xu(j)=x\_c(j)-0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yu(j)=ycx\_c(j)+0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

xl(j)=x\_c(j)+0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yl(j)=ycx\_c(j)-0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

end

x=[fliplr(xl),xu];

y=[fliplr(yl),yu];

plot(x,y);

xlabel('--- x/c ---->');

ylabel('---- y/c ---->');

title('naca 2412');

**Result :-**

****

**2(a) For naca 0012**

**Matlab code:-**

clear all;

close all;

clc;

%%

%naca 0012 nomenclature

ymc\_c=0;

xmc\_c=0;

tm=0.12;

alpha=10\*pi/180;%in radian

%%

%cosine clustring

%choose even number of points on circle

n=200;

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

%%

%taking projection on x axis

i=1:n/2;

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

%%

%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

%%

%thickness

for j=1:length(x\_c)

tx(j)=tm\*(2.969\*sqrt(x\_c(j))-1.260\*x\_c(j)-3.516\*x\_c(j)\*x\_c(j)+2.843\*x\_c(j)\*x\_c(j)\*x\_c(j)-1.015\*x\_c(j)\*x\_c(j)\*x\_c(j)\*x\_c(j));

end

%%

%upper and lower surface

for j=1:length(x\_c)

xu(j)=x\_c(j)-0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yu(j)=ycx\_c(j)+0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

xl(j)=x\_c(j)+0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yl(j)=ycx\_c(j)-0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

end

%%

%normal and axial force

x=x\_c(1:end-1);

for j=1:length(x)

dN(j)=-20000\*(x(j)-1)\*(x(j)-1)+119000+(288\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))+731\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j)))\*x(j)^(-0.2);

dA(j)=1019\*x(j)^(-0.2)+(4\*(x(j)-1)\*(x(j)-1)+5.4)\*10000\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))-(2\*(x(j)-1)\*(x(j)-1)+17.3)\*10000\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j));

end

N = trapz(x,dN,2);

A = trapz(x,dA,2);

b=[N;A];

a=[cos(alpha),sin(alpha);-sin(alpha),cos(alpha)];

F = a\b;

L=F(1);

D=F(2);

%%

%moments

for j=1:length(x)

dM\_le(j)=(20000\*(x(j)-1)\*(x(j)-1)-119000-(288\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))+731\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j)))\*x(j)^(-0.2))\*x(j)+((40000\*(x(j)-1)^2 + 54000)\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))+288\*x(j)^(-0.2))\*yu(j)+(-20000\*(x(j)-1)\*(x(j)-1)\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j))+731\*x(j)^(-0.2))\*yl(j);

end

M\_le=trapz(x,dM\_le,2);

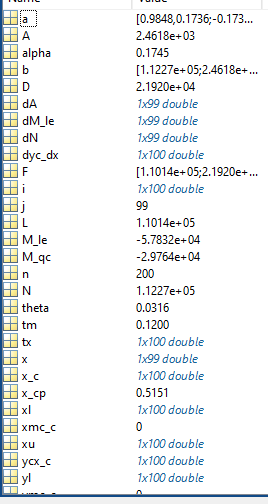
M\_qc=M\_le+N\*0.25;

%%

%center of pressure

x\_cp=-M\_le/N;

**Result:-**



**2(b) for naca2412**

**Matlab code :-**

clear all;

close all;

clc;

%%

%naca 2412 nomenclature

ymc\_c=0.02;

xmc\_c=0.4;

tm=0.12;

alpha=10\*pi/180;%in radian

%%

%cosine clustring

%choose even number of points on circle

n=200;

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

%%

%taking projection on x axis

i=1:n/2;

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

%%

%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

%%

%thickness

for j=1:length(x\_c)

tx(j)=tm\*(2.969\*sqrt(x\_c(j))-1.260\*x\_c(j)-3.516\*x\_c(j)\*x\_c(j)+2.843\*x\_c(j)\*x\_c(j)\*x\_c(j)-1.015\*x\_c(j)\*x\_c(j)\*x\_c(j)\*x\_c(j));

end

%%

%upper and lower surface

for j=1:length(x\_c)

xu(j)=x\_c(j)-0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yu(j)=ycx\_c(j)+0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

xl(j)=x\_c(j)+0.5\*tx(j)\*dyc\_dx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

yl(j)=ycx\_c(j)-0.5\*tx(j)/sqrt(1+dyc\_dx(j)\*dyc\_dx(j));

end

%%

%normal and axial force

x=x\_c(1:end-1);

for j=1:length(x)

dN(j)=-20000\*(x(j)-1)\*(x(j)-1)+119000+(288\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))+731\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j)))\*x(j)^(-0.2);

dA(j)=1019\*x(j)^(-0.2)+(4\*(x(j)-1)\*(x(j)-1)+5.4)\*10000\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))-(2\*(x(j)-1)\*(x(j)-1)+17.3)\*10000\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j));

end

N = trapz(x,dN,2);

A = trapz(x,dA,2);

b=[N;A];

a=[cos(alpha),sin(alpha);-sin(alpha),cos(alpha)];

F = a\b;

L=F(1);

D=F(2);

%%

%moments

for j=1:length(x)

dM\_le(j)=(20000\*(x(j)-1)\*(x(j)-1)-119000-(288\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))+731\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j)))\*x(j)^(-0.2))\*x(j)+((40000\*(x(j)-1)^2 + 54000)\*(yu(j+1)-yu(j))/(x\_c(j+1)-x\_c(j))+288\*x(j)^(-0.2))\*yu(j)+(-20000\*(x(j)-1)\*(x(j)-1)\*(yl(j+1)-yl(j))/(x\_c(j+1)-x\_c(j))+731\*x(j)^(-0.2))\*yl(j);

end

M\_le=trapz(x,dM\_le,2);

M\_qc=M\_le+N\*0.25;

%%

%center of pressure

x\_cp=-M\_le/N;

**Result:-**

