INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

ME 543 (COMPUTATIONAL FLUID DYNAMICS)

HOMEWORK ASSIGNMENT 2

LID DRIVEN SQUARE CAVITY PROBLEM

SUBJECT INSTRUCTOR- Prof A.K. Dass

PROGRAM –M.TECH (FTE)

SUBMITTED BY – SONU PRIYA

ROLL NO - **214103323**

CONTENT

A) C code

```
#include<stdio.h>

#include<math.h>

int main()

{

FILE *fp,*U,*V,u_centre,*v_centre;

fp=fopen("streamplot.plt","w");

U=fopen("u&v_velocityplot.plt","w");

u_centre=fopen("u_cent.txt","w");

v_centre=fopen("v_cent.txt","w");

 Double
SUM,s,error,wold[129][129],siold[129][129],wnew[129][129],sinew[129][129],u[129][129],
v[129][129],sqrdelx,sqrdely,delx=0.0078125,dely=0.0078125,x;

int i,j,k,count=0;

sqrdelx=delx*delx;

sqrdely=sqrdelx;

for(j=0;j<129;j++)

{

for(i=0;i<129;i++)

{

siold[i][j]=0;

wold[i][j]=0;

}

}

for(i=1;i<128;i++)

{

wold[i][128]=0-(2*128);

}
```

```
for(j=0;j<129;j++)
{
for(i=0;i<129;i++)
{
sinew[i][j]=siold[i][j];
wnew[i][j]=wold[i][j];
}
}
do
{
//start :
count++;
for(k=0;k<10;k++)
{
for(j=1;j<128;j++)
{
for(i=1;i<128;i++)
{
 sinew[i][j]=(sinew[i+1][j]+sinew[i-1][j]+sinew[i][j+1]+sinew[i][j-
1]+(sqrdelx*wnew[i][j]))/4.0;
}
}
}
for(j=1;j<128;j++)
{
wnew[0][j]=(0-(2*sinew[1][j]))/sqrdelx;
wnew[128][j]=(0-(2*sinew[127][j]))/sqrdelx;
}
```

```
for(i=1;i<128;i++)
{
wnew[i][0]=(0-(2*sinew[i][1]))/sqrdely;
wnew[i][128]=(0-(2*(sinew[i][127]+dely)))/sqrdely;
}
for(k=0;k<2;k++)
{
for(j=1;j<128;j++)
{
for(i=1;i<128;i++)
{
        wnew[i][j]=(wnew[i+1][j]+wnew[i-1][j]+wnew[i][j+1]+wnew[i][j-1]-
(100.0*(wnew[i+1][j]-wnew[i-1][j])*(sinew[i][j+1]-sinew[i][j-1]))+(100.0*(wnew[i][j+1]-
wnew[i][j-1])*(sinew[i+1][j]-sinew[i-1][j])))/4.0;
}
}
}
SUM=0;
s=0;
for(j=0;j<129;j++)
{
for(i=0;i<129;i++)
{
SUM=SUM+fabs(wnew[i][j]-wold[i][j]);
s=s+fabs(wnew[i][j]);
}
}
error=SUM/s;
```

```
printf("error=%lf\n",error);
for(j=0;j<129;j++)
{
for(i=0;i<129;i++)
{
siold[i][j]=sinew[i][j];
wold[i][j]=wnew[i][j];
}
}
}
while(error>0.000001);
for(j=0;j<129;j++)
{
for(i=0;i<129;i++)
{
 fprintf(fp,"%d\t%d\t%lf\n",i+1,j+1,sinew[i][j]);
}
}
for(j=1;j<128;j++)
{
for(i=1;i<128;i++)
{
 u[i][j]=(sinew[i][j+1]-sinew[i][j-1])/(2*dely);
v[i][j]=(0-1)*(sinew[i+1][j]-sinew[i-1][j])/(2*delx);
}
}
for(j=0;j<129;j++)
```

```
{
for(i=0;i<129;i++)
{
fprintf(U,"%d\t%d\t%lf\t%lf\n",i+1,j+1,u[i][j],v[i][j]);
}
}
  printf("\n%d",count);
  fclose(fp);
for(j=1;j<=129;j++)
  {
     fprintf(u_centre,"%lf\t%d\n",u[65][j],j);
  }
  for(i=1;i<=129;i++)
  {
     fprintf(v_centre,"%d\t%lf\n",i,v[i][65]);
  }
return 0;
}
```

B) Comparison with Ghia,s data

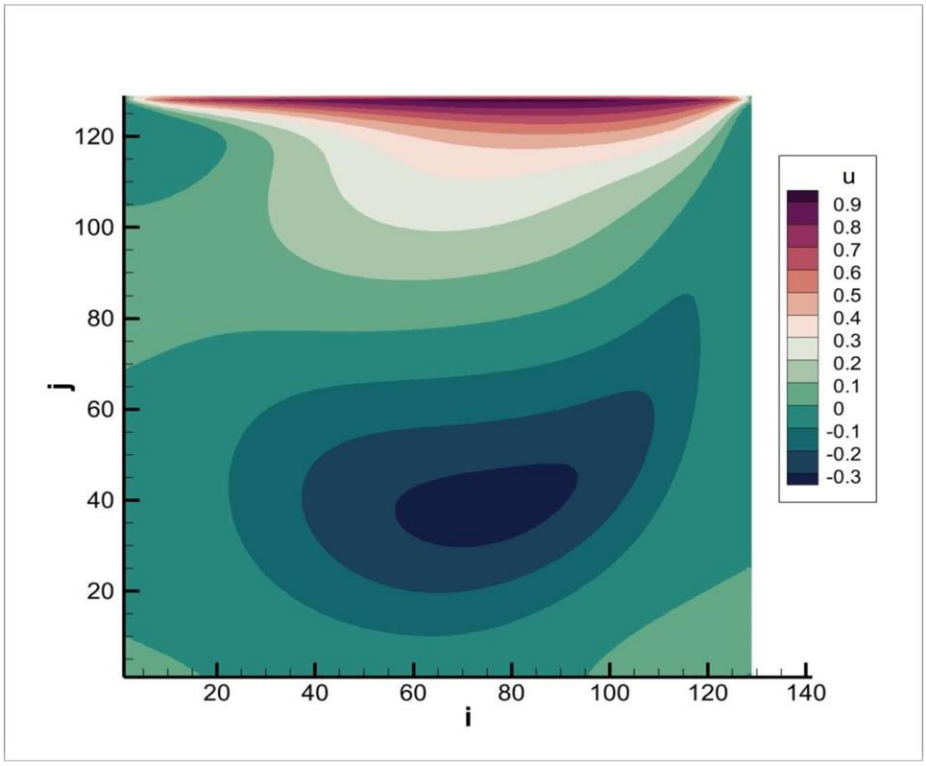
u-velocity along vertical line through geometric centre of the cavity.

i	j	Data found	Ghia's Data
65	129	1.00000	1.00000
65	126	0.756820	0.75837
65	124	0.615529	0.61756
65	123	0.556777	0.55892
65	110	0.288433	0.29093
65	95	0.160382	0.16256
65	80	0.019755	0.02135
65	65	-0.116052	-.11477
65	59	-0.172379	-0.17119
65	37	-0.324515	-0.32726
65	23	-0.237518	-0.24299
65	14	-0.141689	-0.14612
65	10	-0.099967	-0.10338
65	9	-0.089550	-0.09266
65	8	-0.079070	-0.08186
65	4	-0.054300	-0.056200
65	1	0.00000	0.00000

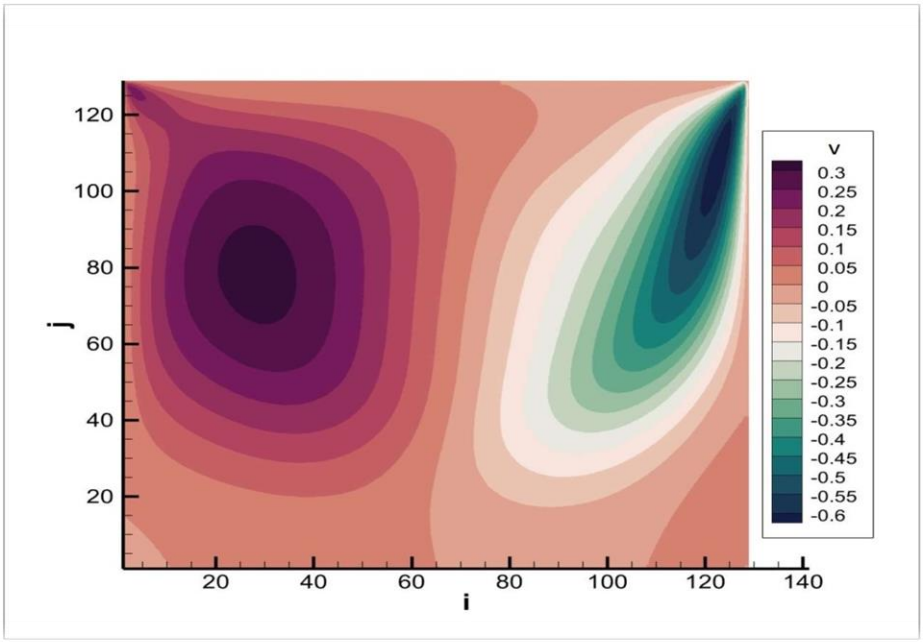
v-velocity along the horizontal line through geometric centre of the cavity.

i	j	Data found	Ghia's data
129	65	0.00000	0.00000
125	65	-0.122390	-0.12146
124	65	-0.157657	-0.15663
123	65	-0.193594	-0.19254
122	65	-0.229472	-0.22847
117	65	-0.382543	-0.23827
111	65	-0.447675	-0.44993
104	65	-0.382538	-0.38598
65	65	0.052614	0.05186
31	65	0.298871	0.30174
30	65	0.299111	0.30203
21	65	0.278312	0.28124
13	65	0.227009	0.22965
11	65	0.206652	0.20920
10	65	0.194654	0.19713
9	65	0.181208	0.18360
1	65	0.00000	0.00000

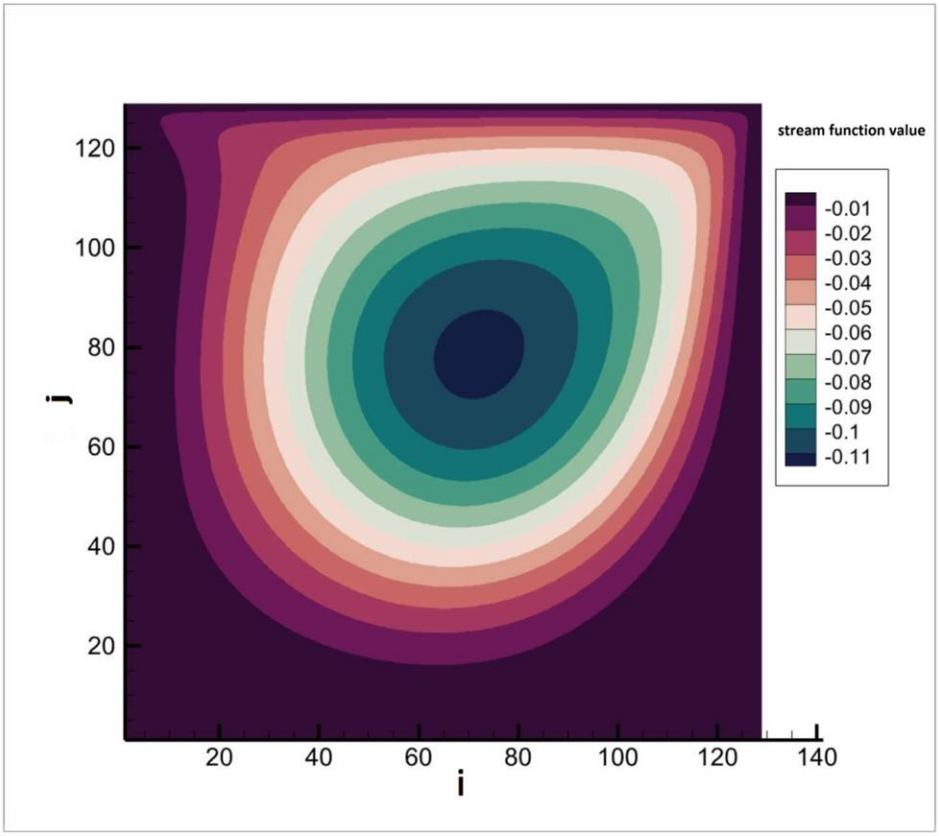
C) U-velocity plot



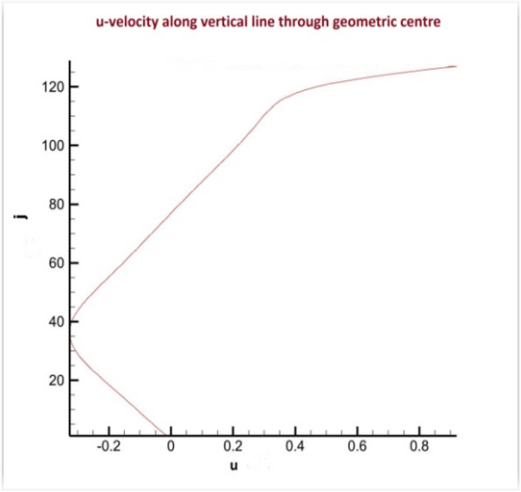
D) V-velocity plot

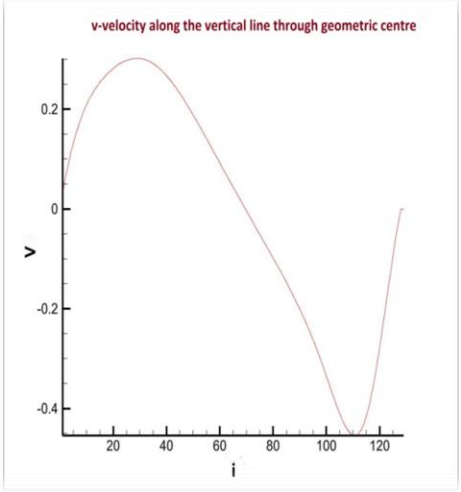


E) Countours of streamline plot



F) Conclusion:





The above plot drawn is according to data found while executing and when we compare these plots with Ghia's data , we can find that the plot is approximately similar to the data which we get. So we can say that the plot which we get after simulation is correct and and we will get the the same result according to the ghia's result for a lid driven square cavity with Re=400.