

ภาคผนวก

ภาคผนวก ก  
โปรแกรมเรเดีย

## โปรแกรมเรเดียสำหรับขั้วแม่เหล็กแบบที่ 1

```

<<Radia`;
<<Graphics`PlotField3D`;

(*Defining the model*)

Off[General::"spell1"];
geom[circ_]:= (
  ironcolor={0,0,1};
  coilcolor={1,0,0};

  (*The horizontal segment between the corners*)

  lx1=width/2;ly1=(long-
armlong*2)/2;lz1=bhigh;l1={lx1,ly1,lz1};
  p1={width/4,ly1/2,bhigh/2};
  r1=radObjRecMag[p1,l1];
  radObjDivMag[r1,n1];

  (*The right bottom corner*)

  lx2=width/2;ly2=armlong;lz2=bhigh;l2={lx2,ly2,lz2};
  p2={width/4,p1[[2]]+long/2-armlong,p1[[3]]};
  r2=radObjRecMag[p2,l2];
  typ={"cyl",{p2+{0,-
ly2/2,lz2/2},{1,0,0}},p2+{0,ly2/2,lz2/2},lz2/ly2};

If[circ==1,radObjDivMag[r2,{nbr,nbp,n1[[1]]},typ],radObjDivM
ag[r2,n2]];

  (*The vertical segment inside the right-coil*)

  lx3=width/2;ly3=armlong;lz3=high-bhigh;l3={lx3,ly3,lz3};
  p3={width/4,p2[[2]],high/2+bhigh/2};
  r3=radObjRecMag[p3,l3];
  radObjDivMag[r3,n3];

  (*The right top corner*)

  lx4=width/2;ly4=armlong;lz4=phigh;l4={lx4,ly4,lz4};
  p4={width/4,p1[[2]]+long/2-armlong,high+phigh/2};
  r4=radObjRecMag[p4,l4];
  typ={"cyl",{p4+{0,-ly4/2,-lz4/2},{1,0,0}},p4+{0,ly4/2,-
lz4/2},lz4/ly4};

```

```
If[circ==1,radObjDivMag[r4,{nbr,nbp,n1[[1]]},typ],radObjDivMag[r4,n4]];
```

```
(*The right pole face*)
```

```
r5=radObjMltExtPgn[{{{30,15},{30,12},{0,12},{0,15}},200},{{{30,15},{30,12},{16,10},{0,10},{0,15}},205},{{{30,15},{30,12},{16,10},{0,10},{0,15}},225},{{{30,15},{30,12},{0,12},{0,15}},230}}];
radObjDivMag[r5,n5];
```

```
(*Generation of the righth-coil*)
```

```
pc={0,p2[[2]],p3[[3]]+1.5};
```

```
rcoil=radObjRaceTrk[pc,{Rmin,Rmax},{width,armlong},coilhigh,Nseg,-CurDens];
radObjDrwAtr[rcoil,coilcolor];
```

```
(*Generation of the left-coil*)
```

```
pc={0,-p2[[2]],p3[[3]]+1.5};
```

```
lcoil=radObjRaceTrk[pc,{Rmin,Rmax},{width,armlong},coilhigh,Nseg,CurDens];
radObjDrwAtr[lcoil,coilcolor];
```

```
(*make container and set the colors*)
```

```
g=radObjCnt[{r1,r2,r3,r4,r5}];
radObjDrwAtr[g,ironcolor];
radMatApl[g,iron];
t=radObjCnt[{g,rcoil,lcoil}];
```

```
(*Define the symmetries*)
```

```
RadTrfZerPerp[g,{0,0,0},{1,0,0}];
RadTrfZerPara[g,{0,0,0},{0,1,0}];
);
```

```
(*Creating the model and solving*)
```

```
(*Geometry parameters for yoke*)
```

```
armlong=15;
bhigh=20;
long=60;
```

```

width=60;
high=200;
pwidth=1;
phigh=30;
coilhigh=163;
current=1394*0.5; (*in
Ampere-turns @1394 turns 0.5 A*)

(*Geometry parameters for coil*)

Rmin=1;
Rmax=14;
Nseg=4;
CurDens=current/coilhigh/(Rmax-Rmin);

(*Segmentation Parameters*)

nx=8;
nbp=8;nbr=8; (*for the corners*)
n1={nx,3,8}; (*Horizontal segment*)
n2={nx,2,2}; (*Bottom corner*)
n3={nx,8,20}; (*Vertical segment*)
n4={nx,2,2}; (*Top corner*)
n5={nx,3,8}; (*Pole face*)

(*Build the geometry*)

t0=AbsoluteTime[];
radUtiDelAll[];
iron=RadMatSteel37[]; (*define material of yoke-low carbon
steel C<0.19%*)
geom[1];
size=radObjDegFre[t];

(*Solve the geometry*)

t1=AbsoluteTime[];
res=RadSolve[t,0.0001,1500];
t2=AbsoluteTime[];

(*Print The results*)
b0=radFld[t,"By",{0,0,215}];
Print["Mag_Max H_Max N_Iter = ",N[res[[2]],3]," T
",N[res[[3]],3]," T ",res[[4]]];
Print["Built&Solve in ",Round[t1-t0]," & ",Round[t2-t1],"
seconds"]
Print["Interaction Matrix : ",size," X ",size," or
",N[size*size*4/1000000,6]," Mbytes"]
Print["Number of element : ",size*4/3]

```

```

Print["By = ",N[b0,4], " T"]

ob=t;x=0;z=215;ymax=10;Nn=40;
RadPlotOptions[];
by=radFldLst[ob,"By",{x,-ymax,z},{x,ymax,z},Nn,"arg",-ymax];
ListPlot[by,PlotJoined→True,
  FrameLabel→{"Y [mm]","By [T]","X = 0 mm,Z = 215 mm",""}];

ob=t;x=0;y=0;z=200;Nn=40;
bz=radFldLst[ob,"By",{x,y,z},{x,y,z+30},Nn,"arg",z];
ListPlot[bz,PlotJoined→True,
  FrameLabel→{"Z [mm]","By [T]","X = 0 mm,Y = 0 mm",""}];
bx=radFldLst[ob,"By",{-30,0,215},{30,0,215},Nn,"arg",-30];
ListPlot[bx,PlotJoined→True,
  FrameLabel→{"X [mm]","By [T]","Y = 0 mm,Z = 215 mm",""}];

radObjDrwQD3D[t];
radObjDrwQD3D[g];

ob=t;
pl=Plot3D[radFld[ob,"By",{x,0,z}],{x,-
30,30},{z,200,230},AxesLabel→{"X[mm]","Z[mm]","By[T]"}];
data3D=Table[radFld[ob,"By",{i,0,j}],{i,-
30,30},{j,200,230}];
dataX=Table[radFld[ob,"By",{i,0,215}],{i,-30,30}];
dataY=Table[radFld[ob,"By",{0,i,215}],{i,-30,30}];
dataZ=Table[radFld[ob,"By",{0,0,j}],{j,200,230}];

draw=radObjDrw[t];
RadPlot3DOptions[];
Show[Graphics3D[draw],ViewPoint→{8,-
3,3},PlotRange→All,AmbientLight→GrayLevel[0.1]];

```

## โปรแกรมเรเดียสำหรับขั้วแม่เหล็กแบบที่ 2

```

<<Radia`;
<<Graphics`PlotField3D`;

(*Defining the model*)

Off[General::"spell1"];
geom[circ_]:= (
  ironcolor={0,0,1};
  coilcolor={1,0,0};

  (*The horizontal segment between the corners*)

  lx1=width/2;ly1=(long-
  armlong*2)/2;lz1=bhigh;l1={lx1,ly1,lz1};
  p1={width/4,ly1/2,bhigh/2};
  r1=radObjRecMag[p1,l1];
  radObjDivMag[r1,n1];

  (*The right bottom corner*)

  lx2=width/2;ly2=armlong;lz2=bhigh;l2={lx2,ly2,lz2};
  p2={width/4,p1[[2]]+long/2-armlong,p1[[3]]};
  r2=radObjRecMag[p2,l2];
  typ={"cyl",{p2+{0,-
  ly2/2,lz2/2},{1,0,0}},p2+{0,ly2/2,lz2/2},lz2/ly2};

  If[circ==1,radObjDivMag[r2,{nbr,nbp,n1[[1]]},typ],radObjDivM
  ag[r2,n2]];

  (*The vertical segment inside the right-coil*)

  lx3=width/2;ly3=armlong;lz3=high-bhigh;l3={lx3,ly3,lz3};
  p3={width/4,p2[[2]],high/2+bhigh/2};
  r3=radObjRecMag[p3,l3];
  radObjDivMag[r3,n3];

  (*The right pole face*)

  lx4=width;ly4=armlong;lz4=phigh;l4={lx4,ly4,lz4};
  k1={{width/4,p3[[2]]+armlong/2-
  pwidth/2,lz4+high},{width/2,pwidth}};
  k2={{width/4,p3[[2]]-4,high},{width/2,ly4+8}};
  r4=radObjMltExtRtg[{k1,k2}];

```

```

radObjDivMag[r4,n4];

(*Generation of the righth-coil*)

pc={0,p2[[2]],p3[[3]]+1.5};

rcoil=radObjRaceTrk[pc,{Rmin,Rmax},{width,armlong},coilhigh,
Nseg,-CurDens];
radObjDrwAtr[rcoil,coilcolor];

(*Generation of the left-coil*)

pc={0,-p2[[2]],p3[[3]]+1.5};

lcoil=radObjRaceTrk[pc,{Rmin,Rmax},{width,armlong},coilhigh,
Nseg,CurDens];
radObjDrwAtr[lcoil,coilcolor];

(*make container and set the colors*)

g=radObjCnt[{r1,r2,r3,r4}];
radObjDrwAtr[g,ironcolor];
radMatApl[g,iron];
t=radObjCnt[{g,rcoil,lcoil}];

(*Define the symmetries*)

RadTrfZerPerp[g,{0,0,0},{1,0,0}];
RadTrfZerPara[g,{0,0,0},{0,1,0}];
);

(*Creating the model and solving*)

(*Geometry parameters for yoke*)

armlong=15;
bhigh=20;
long=60;
width=60;
high=200;
pwidth=1;
phigh=5;
coilhigh=163;
current=1394*1.5;
Ampere-turns @1394 turns 0.5 A*

(*in

(*Geometry parameters for coil*)

Rmin=1;
Rmax=14;

```

```

Nseg=4;
CurDens=current/coilhigh/(Rmax-Rmin);

(*Segmentation Parameters*)

nx=8;
nbp=6;nbr=6; (*for the corners*)
n1={nx,4,6}; (*Horizontal segment*)
n2={nx,2,2}; (*Bottom corner*)
n3={nx,6,30}; (*Vertical segment*)
n4={nx,5,2}; (*Pole face*)

(*Build the geometry*)

t0=AbsoluteTime[];
radUtiDelAll[];
iron=RadMatSteel42[]; (*define material of yoke-low carbon
steel C<0.13%*)
geom[1];
size=radObjDegFre[t];

(*Solve the geometry*)

t1=AbsoluteTime[];
res=RadSolve[t,0.0001,1500];
t2=AbsoluteTime[];

(*Print The results*)
b0=radFld[t,"By",{0,0,206}];
Print["Mag_Max H_Max N_Iter = ",N[res[[2]],3]," T
",N[res[[3]],3]," T ",res[[4]]];
Print["Built&Solve in ",Round[t1-t0]," & ",Round[t2-t1],"
seconds"]
Print["Interaction Matrix : ",size," X ",size," or
",N[size*size*4/1000000,6]," Mbytes"]
Print["Number of element : ",size*4/3]
Print["By = ",N[b0,4]," T"]

ob=t;x=0;z=206;ymax=30;Nn=40;
RadPlotOptions[];
by=radFldLst[ob,"By",{x,-ymax,z},{x,ymax,z},Nn,"arg",-ymax];
ListPlot[by,PlotJoined->True,
FrameLabel->{"Y [mm]","By [T]","X = 0 mm,Z = 206 mm",""}];

ob=t;x=0;y=0;z=200;Nn=40;
bz=radFldLst[ob,"By",{x,y,z},{x,y,z+30},Nn,"arg",z];
ListPlot[bz,PlotJoined->True,
FrameLabel->{"Z [mm]","By [T]","X = 0 mm,Y = 0 mm",""}];

```

```

bx=radFldLst[ob,"By",{-30,0,206},{30,0,206},Nn,"arg",-30];
ListPlot[bx,PlotJoined→True,
  FrameLabel→{"X [mm]","By [T]","Y = 0 mm,Z = 206 mm",""}];

radObjDrwQD3D[t];
radObjDrwQD3D[g];

ob=t;
pl=Plot3D[radFld[ob,"By",{x,y,206}],{x,-30,30},{y,-
30,30},AxesLabel→{"X[mm]","Z[mm]","By[T]"}];
data3D=Table[radFld[ob,"By",{i,j,206}],{i,-30,30},{j,-
30,30}];
dataX=Table[radFld[ob,"By",{i,0,206}],{i,-30,30}];
dataY=Table[radFld[ob,"By",{0,i,206}],{i,-30,30}];
dataZ=Table[radFld[ob,"By",{0,0,j}],{j,200,230}];

draw=radObjDrw[t];
RadPlot3DOptions[];
Show[Graphics3D[draw],ViewPoint→{8,-
3,3},PlotRange→All,AmbientLight→GrayLevel[0.1]];

```

ภาคผนวก ข  
โปรแกรมแลปวิ

