## Sliding Band Boundary Condition Example

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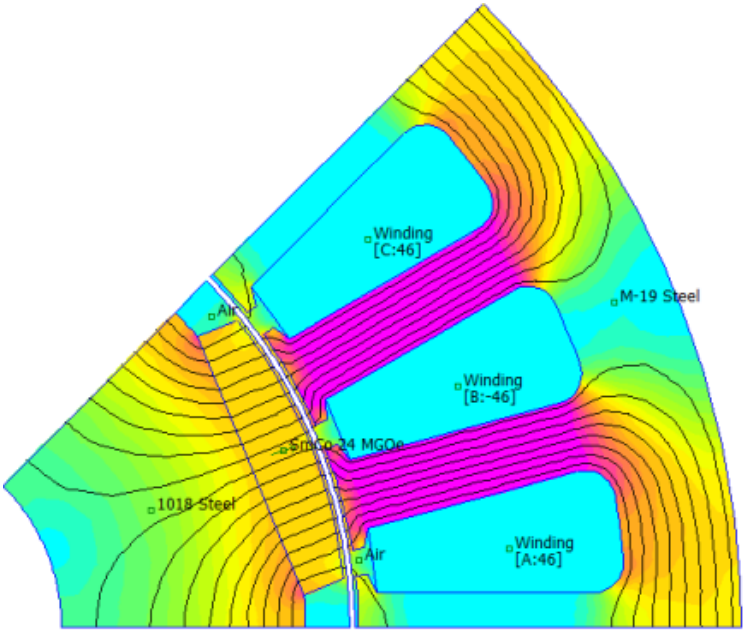
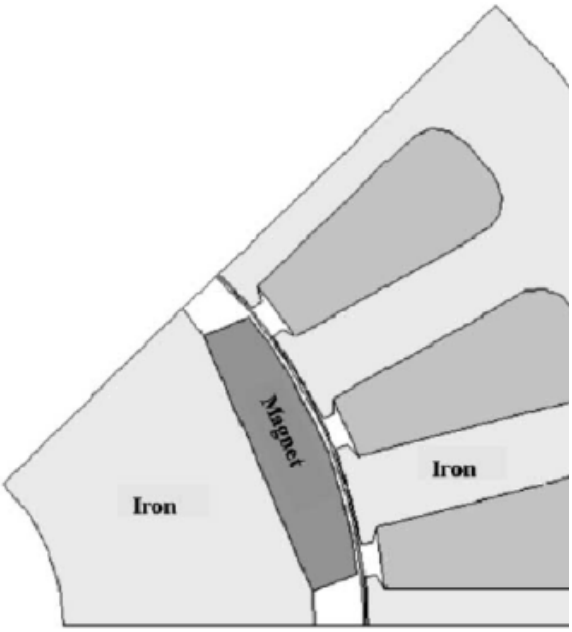
As of 25Feb2018, a new "sliding band" formulation has been included in FEMM to smoothly model rotor motion in rotating electric machines. This notebook uses the sliding band boundary condition to model a brushless DC machine previoulsy presented in:

O.J.Antunes, J.P.A.Bastos, and N.Sadowski, "Using high-order finite elements in problems with movement," IEEE Transactions on Magnetics, 40(2):529-532, March 2004.




In[4]:=
```
<< c:\\femm42\\mathfemm\\mathfemm.m
```

```
MathFEMM loaded at Sun 25 Feb 2018 15:38:51
```

In[5]:=
```
OpenFEMM[1]
```

In[6]:=
```
OpenDocument[NotebookDirectory[] <> "Antunes.FEM"]
```

In[7]:=
```
MISaveAs[NotebookDirectory[] <> "temp.fem"]
```

In[8]:=
```
MIModifyCircProp["A", 1, 0];
MIModifyCircProp["B", 1, 0];
MIModifyCircProp["C", 1, 0];
```

In[11]:=
```
rpm = 360 / 60; (* degrees/sec *)
dt = 5. * 10^(-6);
dtta = 2000. * rpm * dt;
```

In[14]:=
```
CoggingTorque = {};
Aflux = {};
Bflux = {};
Cflux = {};
dtta = 0.06;
n = Round[120 / dtta];
For[k = 0, k ≤ n, k++,
 tta = dtta * k;
 t = dt * k;
 MIModifyBoundProp["mySlidingBand", 10, tta];
 MIAnalyze[1];
 MILoadSolution[];
 tq = MOGapIntegral["mySlidingBand", 0];
 CoggingTorque = Append[CoggingTorque, {t, tq}];
 Aflux = Append[Aflux, {t, MOGetCircuitProperties["A"][[3]]}];
 Bflux = Append[Bflux, {t, MOGetCircuitProperties["B"][[3]]}];
 Cflux = Append[Cflux, {t, MOGetCircuitProperties["C"][[3]]}];
 MOClose[];
 If[Mod[k, 100] == 0, Print[Last[CoggingTorque]]];
]
```

{0, 0.000319675}

{0.0005, −0.0168116}

{0.001, −0.101065}

{0.0015, 0.102224}

{0.002, 0.01559}

$\{0.0025, -4.51556 \times 10^{-6}\}$

{0.003, −0.0168398}

{0.0035, −0.101021}

{0.004, 0.102277}

{0.0045, 0.0156442}

{0.005, 0.000146038}

{0.0055, −0.0168492}

{0.006, −0.101129}

{0.0065, 0.102146}

{0.007, 0.0156285}

{0.0075, 0.000319675}

{0.008, −0.0168116}

{0.0085, −0.101065}

{0.009, 0.102224}

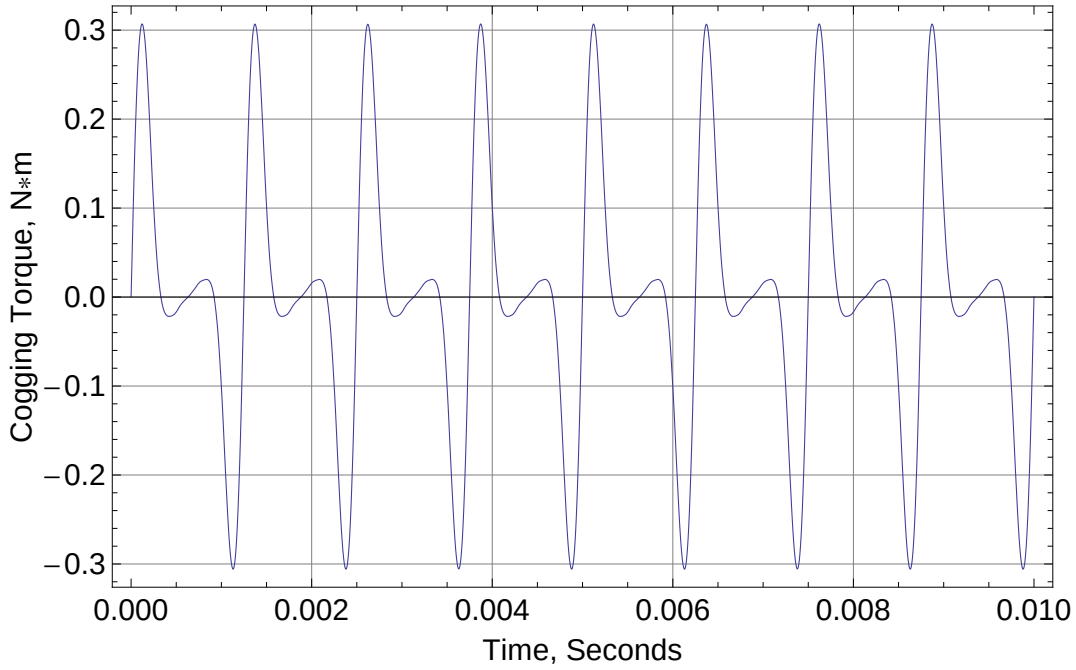
{0.0095, 0.01559}

$\{0.01, -4.51556 \times 10^{-6}\}$

In[21]:=
```
DeleteFile[NotebookDirectory[] <> "temp.fem"];
DeleteFile[NotebookDirectory[] <> "temp.ans"];
CloseFEMM[]
```

```
ListPlot[CoggingTorque, Joined → True, Frame → True,
 GridLines → Automatic, FrameLabel → {"Time, Seconds", "Cogging Torque, N*m"},
 ImageSize → 500, BaseStyle -> {FontFamily → "Arial", FontSize → 14}]
```

Out[24]=



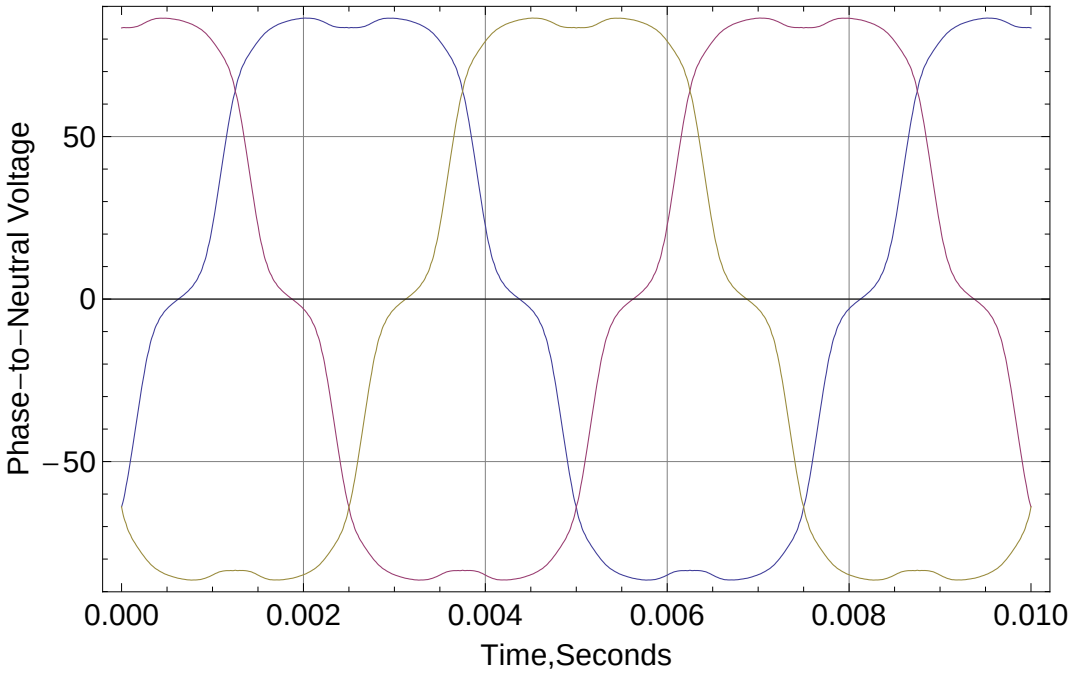

In[25]:=
```
Va = 8 * D[Interpolation[Aflux][T], T];
```

In[26]:=
```
Vb = 8 * D[Interpolation[Bflux][T], T];
```

In[27]:=
```
Vc = 8 * D[Interpolation[Cflux][T], T];
```

In[28]:=
```
Plot[{Va, Vb, Vc}, {T, 0, 0.01}, ImageSize → 500, Frame → True,
 GridLines → Automatic, FrameLabel → {"Time,Seconds", "Phase-to-Neutral Voltage"},
 BaseStyle -> {FontFamily → "Arial", FontSize → 14}]
```

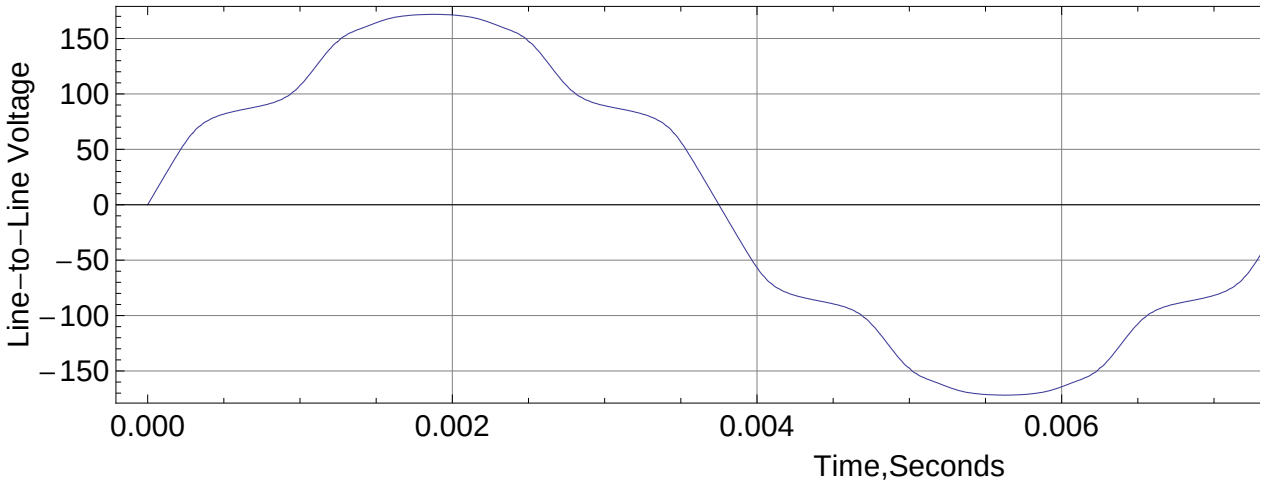
Out[28]=




In[29]:=
```
Vll = Va - Vc;
```

In[30]:=
```
Plot[Vll, {T, 0, 0.01}, AspectRatio → 0.25, Frame → True, GridLines → Automatic,
 PlotPoints → 1000, FrameLabel → {"Time,Seconds", "Line-to-Line Voltage"},
 BaseStyle → {FontFamily → "Arial", FontSize → 14}, ImageSize → 800]
```

Out[30]=



In[31]:=
```
Plot[Vll, {T, 2.85 * 10^(-3), 3.15 * 10^(-3)}, PlotPoints → 1000, Frame → True,
 GridLines → Automatic, PlotRange → {60, 97}, PlotStyle → {Thick, Orange},
 ImageSize → 500, BaseStyle → {FontFamily → "Arial", FontSize → 14},
 FrameLabel → {"Time, Seconds", "Line-to-Line Voltage"}]
```

Out[31]=