Linear Analysis

Generated by: Analog Insydes GUI

FOR INTERNAL USE ONLY

Initialization (0)

In[1]:=
```
<< AnalogInsydes`
```

In[2]:=
```
Off[General::spell, General::spell1];
```

In[3]:=
```
SetOptions[AnalogInsydes, ModelLibrary -> {"FullModels`"}];
```

In[4]:=
```
SetOptions[BodePlot, PlotPoints -> 200, PlotRange -> All];
```

Get::noopen : Cannot open Graphics`Common`GraphicsCommon`. ≫

Needs::nocont : Context Graphics`Common`GraphicsCommon` was not created when Needs was evaluated. ≫

In[5]:=
```
SetOptions[LinearSolve, Method -> Multifrontal];
```

ReadNetlist (1)

In[6]:=
```
netlist1 = ReadNetlist[
  "D:\\Dokumente\\docs\\ESS\\AG_Schaltungstechnik_2014\\Conrad\\PSpice\\
    Conrad2st_8Ohm.cir",
  "D:\\Dokumente\\docs\\ESS\\AG_Schaltungstechnik_2014\\Conrad\\PSpice\\
    Conrad2st_8Ohm.out",
  Simulator -> "PSpice", KeepPrefix -> False]
```

Out[6]=
```
- Circuit -
```

In[7]:= **DisplayForm[netlist1]**

Out[7]//DisplayForm=

```
Circuit:
  Netlist (Checked, 16 Entries):
   {T1, {4 → C, 3 → B, 5 → E}, Model → Model[BJT, BC547B, T1], Selector → Selecto
   {R2, {4, 3}, Type → Resistor, Value → 390 000., Symbolic → R2}
   {R3, {4, 9}, Type → Resistor, Value → 47 000., Symbolic → R3}
   {R4, {5, 0}, Type → Resistor, Value → 3900., Symbolic → R4}
   {C3, {7, VOUT}, Type → Capacitor, Value → 0.000022, Symbolic → C3}
   {R7, {0, 8}, Type → Resistor, Value → 470., Symbolic → R7}
   {C2, {6, 7}, Type → Capacitor, Value → 0.000047, Symbolic → C2}
   {R6, {9, 7}, Type → Resistor, Value → 2200., Symbolic → R6}
   {C1, {1, 2}, Type → Capacitor, Value → 2.2 × 10^-7, Symbolic → C1}
   {V2, {9, 0}, Type → VoltageSource, Value → {AC → 0, DC | Transient → 20.}, Sym
   {C4, {8, 0}, Type → Capacitor, Value → 0.0001, Symbolic → C4}
   {T2, {7 → C, 4 → B, 8 → E}, Model → Model[BJT, BC547B, T2], Selector → Selecto
   {VIN, {1, 0}, Type → VoltageSource, Value → {AC → 1., DC | Transient → Checke
   {R5, {5, 6}, Type → Resistor, Value → 39 000., Symbolic → R5}
   {R1, {2, 3}, Type → Resistor, Value → 680., Symbolic → R1}
   {RL, {VOUT, 0}, Type → Resistor, Value → 8., Symbolic → RL}
  LocalModelParameters[BC547B, Type → NPN, IS → 7.049 × 10^-15, XTI → 3., EG → 1
  GlobalParameters[Simulator → PSpice]
```

CircuitEquations (2)

In[8]:= **equations1 = CircuitEquations[netlist1, ElementValues -> Symbolic, Formulation -> SparseTableau, AnalysisMode -> AC]**

Out[8]= **-** DAE[AC, <<64 × 64>>] **-**

In[9]:= **DisplayForm[equations1]**

Out[9]//DisplayForm=

$$\begin{pmatrix}
-1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 1 & -1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & -1 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & -1 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & -1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & -1 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & -1 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 1 & -1 & 0 & -1 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & -1 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0 & 0 & 0 & 1 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0
\end{pmatrix}$$

1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	−1	0	0	0	0	0	−1	0	0	1	−1	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
−1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	−1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	Cbc$T1 s	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	Cbe$T1 s	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	gm$T1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	Gmu$T1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	−1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	Cbx$T1 s	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	−1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	−1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	C3 s	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	C2 s
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ReadSimulationData (3)

In[10]:=
```
simulationData1 = ReadSimulationData[
  "D:\\Dokumente\\docs\\ESS\\AG_Schaltungstechnik_2014\\Conrad\\PSpice\\
    Conrad2st_8Ohm.csd", Simulator -> "PSpice"]
```

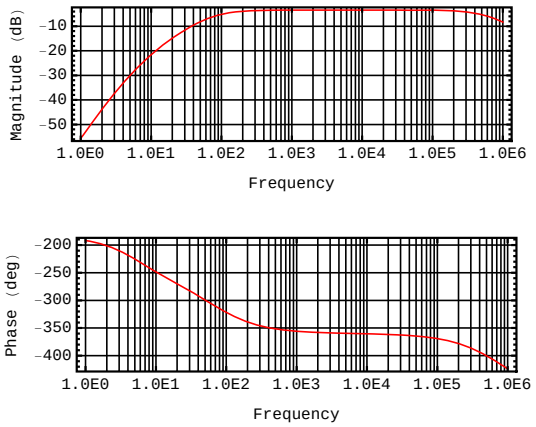
Out[10]=
```
{{V(VOUT) → InterpolatingFunction[{{1., 1.×10^6}}, <>],
  V(4) → InterpolatingFunction[{{1., 1.×10^6}}, <>]}}
```

In[11]:=
```
vout1 = "V(VOUT)" /. First[simulationData1]
```

Out[11]=
```
InterpolatingFunction[{{1., 1.×10^6}}, <>]
```

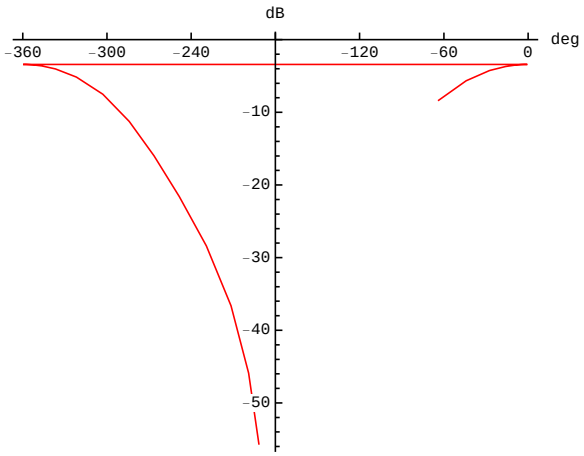
In[12]:=
```
BodePlot[vout1[f], {f, 1*^0, 1*^6}, AspectRatio -> 0.8]
```

Out[12]=



In[13]:=
```
NicholPlot[vout1[f], {f, 1*^0, 1*^6}, AspectRatio -> 0.8]
```

Out[13]=

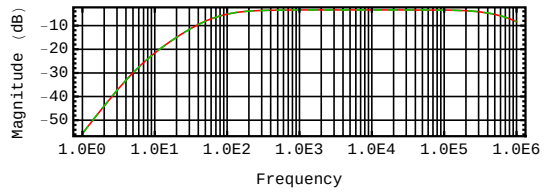


ACAnalysis (4)

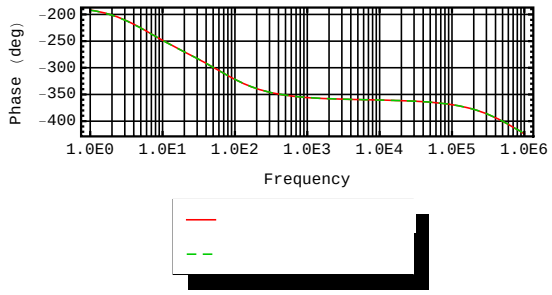
In[14]:=
```
acsweep1 = ACAnalysis[equations1, {V$RL}, {f, 1*^0, 1*^6}]
```

Out[14]=
```
{{V$RL → InterpolatingFunction[{{1., 1.×10^6}}, <>]}}
```

In[15]:= **BodePlot[acsweep1, {vout1[f], V$RL[f]}, {f, 1*^0, 1*^6}]**



Out[15]=



ApproximateMatrixEquation (5)

In[16]:= **sp = {s -> 1.21*^4 I, MaxError -> 1*^-1}**

Out[16]= $\left\{s \to 0. + 12100.\,i,\ \text{MaxError} \to \frac{1}{10}\right\}$

In[17]:= **approximatedMatrixEqs1 = ApproximateMatrixEquation[equations1, V$RL, sp, AnalysisMode -> AC, Protocol -> None, CompressEquations -> True]**

Out[17]= **-** DAE[AC, <<14 × 14>>] **-**

In[18]:=
```
DisplayForm[approximatedMatrixEqs1]
```

Out[18]//DisplayForm=

$$\begin{pmatrix} -1 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & R4 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & Rpi\$T2 & 0 & 0 \\ 0 & 0 & 0 & gm\$T2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & RL \end{pmatrix} . \begin{pmatrix} V\$RO\$T1 \\ V\$R4 \\ V\$RPI\$T2 \\ VC\$VC\$T2 \\ V\$VIN \\ V\$RL \\ I\$VC\$T1 \\ I\$RC\$T1 \\ I\$R4 \\ I\$C3 \\ I\$RPI\$T2 \\ I\$VC\$T2 \\ I\$RC\$T2 \\ I\$RL \end{pmatrix} == \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ VIN \\ 0 \end{pmatrix}$$

ComplexityEstimation (6)

In[19]:=
```
ComplexityEstimate[approximatedMatrixEqs1] // N
```

Out[19]= 1.

Solve (7)

In[20]:=
```
solve1 = Solve[approximatedMatrixEqs1, V$RL]
```

Out[20]= $$\left\{\left\{V\$RL \to \frac{gm\$T2\ RL\ Rpi\$T2\ VIN}{R4}\right\}\right\}$$

In[21]:=
```
solvedFunction1 = V$RL /. First[solve1] // Simplify
```

Out[21]= $$\frac{gm\$T2\ RL\ Rpi\$T2\ VIN}{R4}$$

In[22]:=
```
solvedFunction1n =
 solvedFunction1 /. GetDesignPoint[approximatedMatrixEqs1]
```

Out[22]= 0.722544

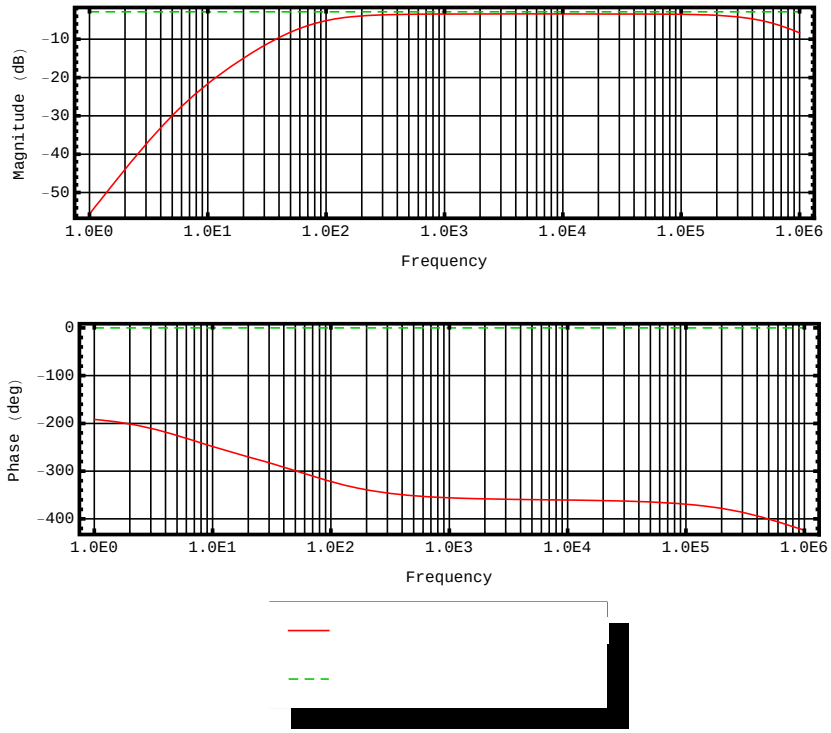
ACAnalysis (9)

In[23]:=
```
acsweep2 = ACAnalysis[approximatedMatrixEqs1, {V$RL}, {f, 1*^0, 1*^6}]
```

Out[23]= $\{\{V\$RL \to InterpolatingFunction[\{\{1., 1. \times 10^6\}\}, <>]\}\}$

In[24]:=
```
BodePlot[acsweep2, {vout1[f], V$RL[f]}, {f, 1*^0, 1*^6}]
```

Out[24]=



ComplexityEstimation (8)

In[25]:=
```
ComplexityEstimate[equations1] // N
```

Out[25]= 168 548.