```
In[621]:= Δ[S11_, S12_, S21_, S22_] := S11 S22 - S12 S21;
K[S11_, S12_, S21_, S22_] := (1 - Abs[S11]^2 - Abs[S22]^2 + Abs[Δ[S11, S12, S21, S22]]^2) / (2 Abs[S12 S21])
Phase[S_] := Exp[I S Pi / 180];
B1[S11_, S12_, S21_, S22_] := 1 + Abs[S11]^2 - Abs[S22]^2 - Abs[Δ[S11, S12, S21, S22]]^2;
B2[S11_, S12_, S21_, S22_] := 1 - Abs[S11]^2 + Abs[S22]^2 - Abs[Δ[S11, S12, S21, S22]]^2;
C1[S11_, S12_, S21_, S22_] := S11 - Δ[S11, S12, S21, S22] Conjugate[S22];
C2[S11_, S12_, S21_, S22_] := S22 - Δ[S11, S12, S21, S22] Conjugate[S11];
Γpms[S11_, S12_, S21_, S22_] := (B1[S11, S12, S21, S22] + Sqrt[B1[S11, S12, S21, S22]^2 -
        4 Abs[C1[S11, S12, S21, S22]]^2]) / (2 C1[S11, S12, S21, S22]);
Γmms[S11_, S12_, S21_, S22_] := (B1[S11, S12, S21, S22] - Sqrt[B1[S11, S12, S21, S22]^2 -
        4 Abs[C1[S11, S12, S21, S22]]^2]) / (2 C1[S11, S12, S21, S22]);
Γpml[S11_, S12_, S21_, S22_] := (B2[S11, S12, S21, S22] + Sqrt[B2[S11, S12, S21, S22]^2 -
        4 Abs[C2[S11, S12, S21, S22]]^2]) / (2 C2[S11, S12, S21, S22]);
Γmml[S11_, S12_, S21_, S22_] := (B2[S11, S12, S21, S22] - Sqrt[B2[S11, S12, S21, S22]^2 -
        4 Abs[C2[S11, S12, S21, S22]]^2]) / (2 C2[S11, S12, S21, S22]);

GTMax1[S11_, S12_, S21_, S22_, Γl_, Γs_] :=
  ((1 - Abs[Γs]^2) Abs[S21]^2 (1 - Abs[Γl]^2)) / Abs[(1 - S11 Γs) (1 - S22 Γl) - S12 S21 Γs Γl]^2
GTMax2[S12_, S21_, K_] := Abs[S21] / Abs[S12] (K - Sqrt[K^2 - 1]);

(* The below are the scattering parameters for the ideal bias network. *)

In[632]:= S11 = .647 Phase[-178.021];
S12 = .087 Phase[37.927];
S21 = 4.952 Phase[62.701];
S22 = .228 Phase[145.564];

In[636]:= N[Abs[Δ[S11, S12, S21, S22]]]

Out[636]= 0.542397

In[637]:= KVal = Abs[K[S11, S12, S21, S22]]
GTMaxVal = 10 Log10[GTMax2[S12, S21, KVal]]

Out[637]= 0.955845

Out[638]= 17.5526 - 1.29539 i

In[639]:= (* The above was obtained using ideal connections. Note
 that the amplifier is not unconditionally stable. This is the
 reason for the max gain value taking on complex values. *)
```

In[640]:= (* Below are the scattering parameters at 3GHz obtained with the physical bias network. I have added a series resistor to the gate to make the transistor unconditionally stable from 300 MHz to 3 GHz. *)

In[641]:=
```
S11 = .903 Phase[-164.116];
S12 = .115 Phase[67.258];
S21 = .838 Phase[70.703];
S22 = .830 Phase[127.290];
```

In[645]:=
```
Abs[Δ[S11, S12, S21, S22]]
K1 = K[S11, S12, S21, S22]
```

Out[645]= 0.845507

Out[646]= 1.09252

In[647]:= (* Good. The above is stable *)

In[648]:=
```
Gtmax1 = 10 Log10[GTMax1[S11, S12, S21, S22, Γml, Γms]]
Gtmax2 = 10 Log10[GTMax2[S12, S21, K1]]
```

Out[648]= -26.6742

Out[649]= 6.77138

In[650]:= (* Below begins the analytical calculations for the matching network of the device. *)

$\text{Abs}\left[\left(\Gamma^{p}\right)_{ml}[\text{S11, S12, S21, S22}]\right];$

$\Gamma_{ml} = \left(\Gamma^{m}\right)_{ml}[\text{S11, S12, S21, S22}]$

$\text{Abs}\left[\left(\Gamma^{p}\right)_{ms}[\text{S11, S12, S21, S22}]\right];$

$\Gamma_{ms} = \left(\Gamma^{m}\right)_{ms}[\text{S11, S12, S21, S22}]$

Out[651]= -0.382955 - 0.395654 i

Out[653]= -0.771878 + 0.250083 i

In[654]:= $\text{Abs}[\Gamma_{ml}]\ \&\&\ \text{Arg}[\Gamma_{ml}] * 180 / \text{Pi}$

Out[654]= 0.550633 && -134.066

In[655]:= $\text{Abs}[\Gamma_{ms}]\ \&\&\ \text{Arg}[\Gamma_{ms}] * 180 / \text{Pi}$

Out[655]= 0.81138 && 162.048

In[656]:= $Z_{ml} = 50 * \frac{1 + \Gamma_{ml}}{1 - \Gamma_{ml}}$

Out[656]= 16.8382 - 19.122 i

In[657]:= $Z_{ms} = 50 * \frac{1 + \Gamma_{ms}}{1 - \Gamma_{ms}}$

Out[657]= 5.33499 + 7.81 ⅈ

In[658]:= Abs[Z_{ms}] && Arg[Z_{ms}] * 180 / Pi

Out[658]= 9.45823 && 55.6631

In[660]:= Y_{ml} = 1 / Z_{ml}

Out[660]= 0.0259379 + 0.0294557 ⅈ

In[661]:= Lengths[ll_, ls_] := $Y_c \frac{(1 + I\,\text{Tan}[ll] + I\,\text{Tan}[ls])}{1 + I\,\text{Tan}[ll] - \text{Tan}[ls]\,\text{Tan}[ll]}$;

Y_c = 1 / 50;

In[663]:= {x, y} = {ll, ls} /. FindRoot[
{Re[Lengths[ll, ls]] == Re[Y_{ml}], Im[Lengths[ll, ls]] == Im[Y_{ml}]}, {ll, .5}, {ls, .5}]
{x,
y} *
180 /
Pi

Out[663]= {0.0929838, 0.922202}

Out[664]= {5.32758, 52.8383}

In[665]:= (* This tells me that the load matching network should comprise a series stub that is ~5.3 degrees long and an open stub that is ~52.8 degrees long. *)

In[666]:= $Y_{ms} = \frac{1}{Z_{ms}}$;

{x, y} = {ll, ls} /. FindRoot[
{Re[Lengths[ll, ls]] == Re[Y_{ms}], Im[Lengths[ll, ls]] == Im[Y_{ms}]}, {ll, 1}, {ls, .3}]

Out[667]= {0.468804, 1.22506}

In[668]:= {x, y} * 180 / Pi

Out[668]= {26.8605, 70.1909}

In[669]:= (* This tells me that the source matching network should comprise a series stub that is ~26.86 degrees long and an open stub that is ~70.2 degrees long. *)