```
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];
Γ^p_ms[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]);
Γ^m_ms[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]);
Γ^p_ml[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]);
Γ^m_ml[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. *)

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

N[Abs[Δ[S11, S12, S21, S22]]]
0.542397

KVal = Abs[K[S11, S12, S21, S22]]
GTMaxVal = 10 Log10[GTMax2[S12, S21, KVal]]
0.955845

17.5526 - 1.29539 i

(* 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. *)
```

```
(* 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. *)

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

Abs[Δ[S11, S12, S21, S22]]
K1 = K[S11, S12, S21, S22]

0.845507

1.09252

(* Good. The above is stable *)

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

-26.6742

6.77138

(* Below begins the analytical calculations
 for the matching network of the device. *)
```

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

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

$-0.382955 - 0.395654\, i$

$-0.771878 + 0.250083\, i$

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

$0.550633\ \&\&\ -134.066$

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

$0.81138\ \&\&\ 162.048$

$$Z_{ml} = 50 * \frac{1 + \Gamma_{ml}}{1 - \Gamma_{ml}}$$

$16.8382 - 19.122\, i$

$$Z_{ms} = 50 * \frac{1 + \Gamma_{ms}}{1 - \Gamma_{ms}}$$

5.33499 + 7.81 i

Abs[Z_{ms}] && Arg[Z_{ms}] * 180 / Pi

9.45823 && 55.6631

$Y_{ml} = 1 / Z_{ml}$

0.0259379 + 0.0294557 i

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

$Y_c = 1 / 50;$

```
{x, y} = {ll, ls} /. FindRoot[
   {Re[Lengths[ll, ls]] == Re[Yml], Im[Lengths[ll, ls]] == Im[Yml]}, {ll, .5}, {ls, .5}]
{x,
  y} *
 180 /
  Pi
```

{0.0929838, 0.922202}

{5.32758, 52.8383}

```
(* 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. *)
```

$$Y_{ms} = \frac{1}{Z_{ms}};$$

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

{0.468804, 1.22506}

{x, y} * 180 / Pi

{26.8605, 70.1909}

```
(* 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. *)
```