Cook book and examples for single stub

Type 1 Series stub with same 50 ohm line

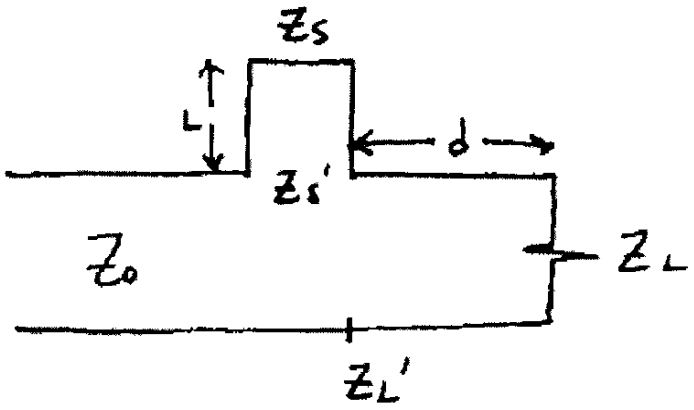


Fig: 1 Series stub

1) Plot z_L ($z_L = Z_L/Z_o$, normalized)

2) Rotate z_L towards the generator until it reaches $r_L = 1.0$ circle (there will be two points, choose the closest one). This is the length (d) between the load and the stub.

3) Read the value of x_L at that point

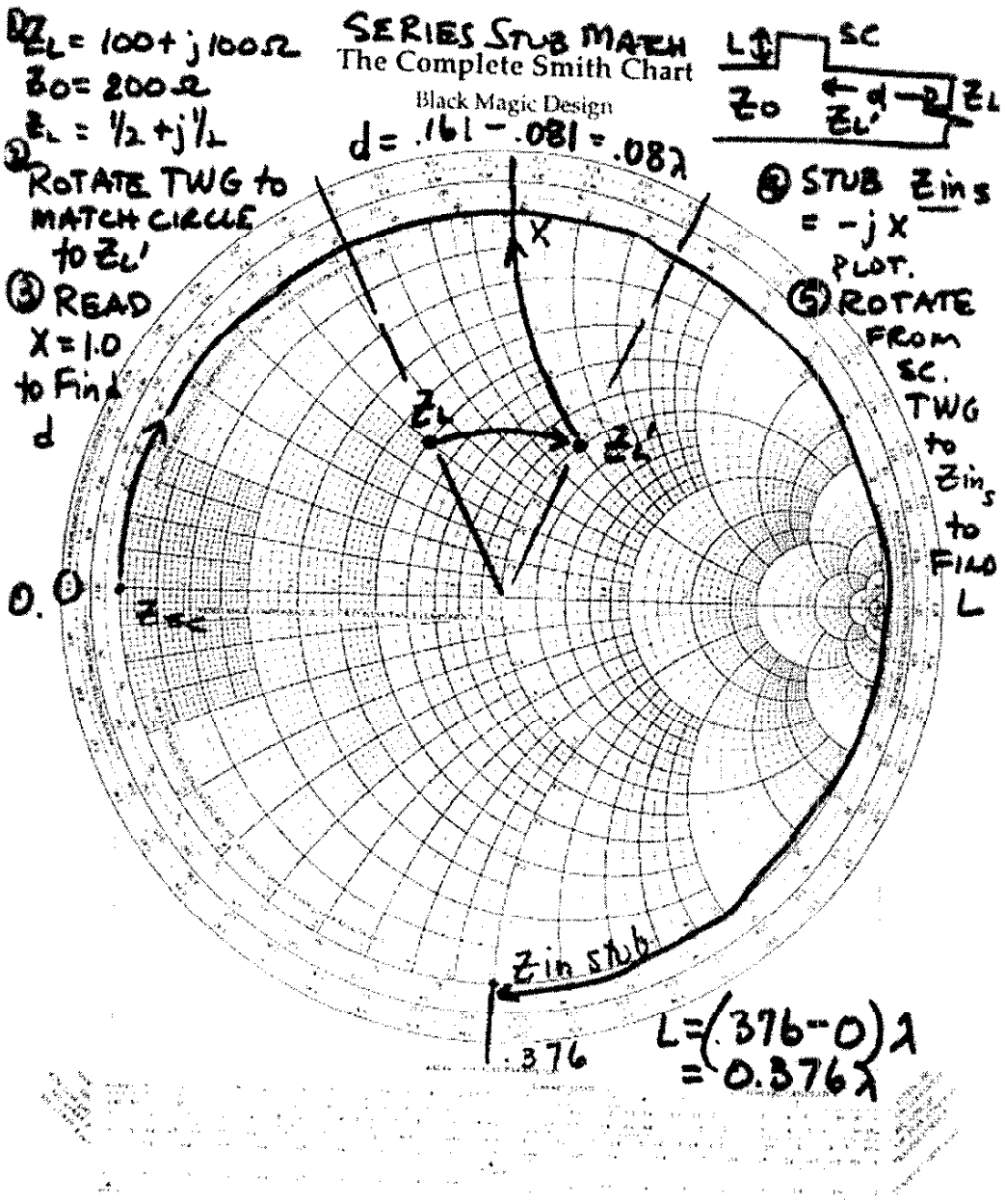
4) Impedance of the stub $x_s = - x_L$

5) Plot x_s on the smith chart and calculate the length of the stub using one of the following two methods.

   a) If you need a short circuited stub, distance (l) is measured from the short circuit point (Zsc) towards generator to x_s.

   b) If you need a open circuited stub, distance (l) is measured from the open circuit point (Zoc) towards generator to x_s.

6) The new $z_{in} = 1 + j0$ (bull's-eye)


SERIES STUB MATCH
The Complete Smith Chart
Black Magic Design
$Z_L = 100 + j100\Omega$
$Z_0 = 200\Omega$
$z_L = \frac{1}{2} + j\frac{1}{2}$
② ROTATE TWG to MATCH CIRCLE to Z_L'
③ READ X = 1.0 to Find d
d = .161 − .081 = .08λ
④ STUB Z_{in_s} = −jX PLOT.
⑤ ROTATE FROM SC. TWG to Z_{in_s} to FIND L
L
SC
Z_0
Z_L'
Z_L
Z_L
Z_L'
X
0.
∞
$Z_{in\ stub}$
.376
$L = (.376 - 0)\lambda$
$= 0.376\lambda$

Type 2 Shunt stub with same 50 ohm line

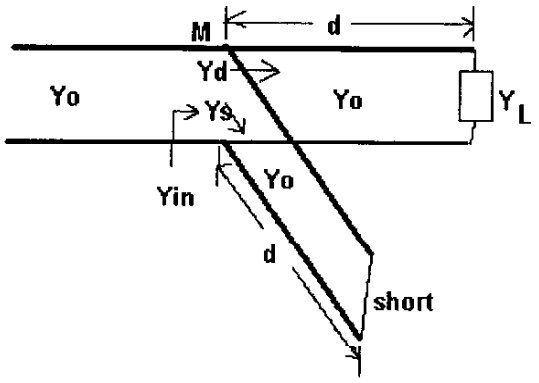


Fig:1 Shunt stub

1. Plot z_L ($z_L = Z_L/Z_o$, normalized)
2. Reflect it through the origin to find y_L
3. Rotate y_L towards the generator until it reaches $r_L = 1.0$ circle (there will be two points, choose the closest one). This is the length (d) between the load and the stub.
4. Read the value of x_L
5. Impedance of the stub $x_s = - x_L$
6. Plot x_s on the smith chart and calculate the length of the stub using one of the following two methods.

   a) If you need a short circuited stub, distance (l) is measured from the short circuit point (Ysc not Zsc) towards generator to x_s.

   b) If you need a open circuited stub, distance (l) is measured from the open circuit point (Yoc not Zoc) towards generator to x_s.

7. The new $y_{in} = 1 + j0$ (bull's-eye)

Q) $Z_L = 75 - j20$

$Z_0 = 50$

SHUNT STUB

The Complete Smith Chart

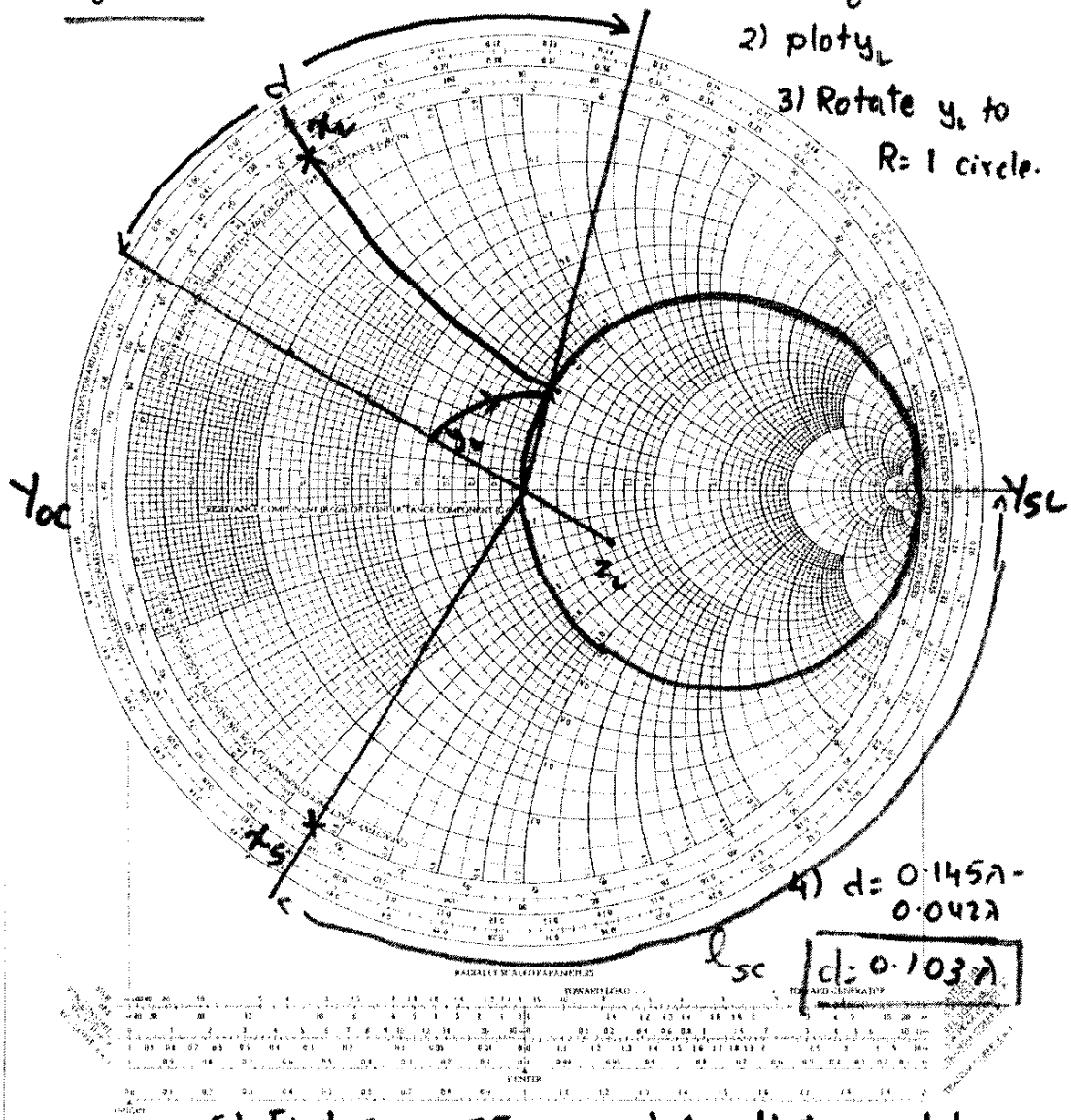
Black Magic Design

Steps

1) $z_L = \frac{Z_L}{Z_0} = 1.5 - j0.4$

2) plot y_L

3) Rotate y_L to R= 1 circle.



4) $d = 0.145\lambda - 0.042\lambda$

$d = 0.103\lambda$

l_{sc}

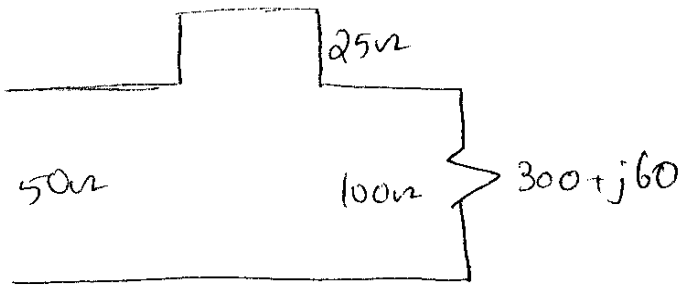
5) Find $x_L = 0.55$

6) $x_S = -0.55$

7) length sc stub

$l_{sc} = 0.42 - 0.25\lambda = 0.17\lambda$

Type 3 Series stub with different line impedances

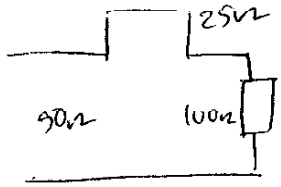


1. Normalise Z_L with respect to Z_{O2} and plot Z_{LN}
2. Get the new matching circle Z_A/Z_{O2}
3. Rotate Z_{LN} towards the generator to the matching circle. This point is Z_{AN}. Calculate the distance (d) of stub from load
4. Renormalize Z_{AN} to get Z_A ($Y_A = Z_{AN}\, Z_{O2}$).
5. Zstub= - Z_A (imaginary part)
6. Normalize Zstub with Z_{os} to get Zsn.
7. Calculate the length of the stub using one of the following two methods.

   a) If you need a short circuited stub, distance (l) is measured from the short circuit point (Zsc) towards generator to Zsn.

   b) If you need a open circuited stub, distance (l) is measured from the open circuit point (Zoc) towards generator to Zsn.

1) Design a series stub with different impedances



1) Normalise Z_L w.r.t Z_{O2} and plot Z_{LN}

$$\frac{300+j60}{100} = 3+j\cdot 6$$

2) Get new matching circle

$$\frac{Z_A}{Z_{O2}} = \frac{1}{2}$$

3) Rotate Z_L towards generator to matching circle

$$d = 0.366\lambda$$

4) Renormalise Z_{AN}

$$Z_A = (0.5+j0.65)\times 100$$

$$Z_A = 50+j65$$

5) $Z_{stub} = -j65$

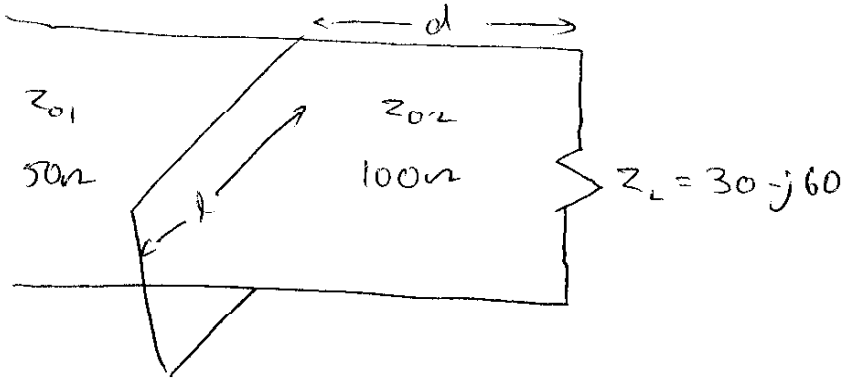
6) Normalise Z_{stub}

$$Z_{stub} = \frac{-j65}{25} = -j2.6$$

7) Calculate length

$$l = 0.058\lambda$$

Type 4 Shunt stub with different line impedances



1. Normalise Z_L with respect to Z_{O2} and plot Z_{LN}
2. Reflect it through the origin to find Y_{LN}
3. Get the new matching circle Y_A/Y_{O2}
4. Rotate Y_{LN} towards the generator to the matching circle. This point is Y_{AN}. Calculate the distance (d) of stub from load
5. Renormalize Y_{AN} to get Y_A ($Y_A = Y_{AN}\, Y_{O2}$).
6. Ystub= - Y_A
7. Normalize Ystub with Y_{os} to get Ysn.
8. Calculate the length of the stub using one of the following two methods.
   a) If you need a short circuited stub, distance (l) is measured from the short circuit point (Ysc not Zsc) towards generator to Ysn.
   b) If you need a open circuited stub, distance (l) is measured from the open circuit point (Yoc not Zoc) towards generator to Ysn.

1) Shunt stub

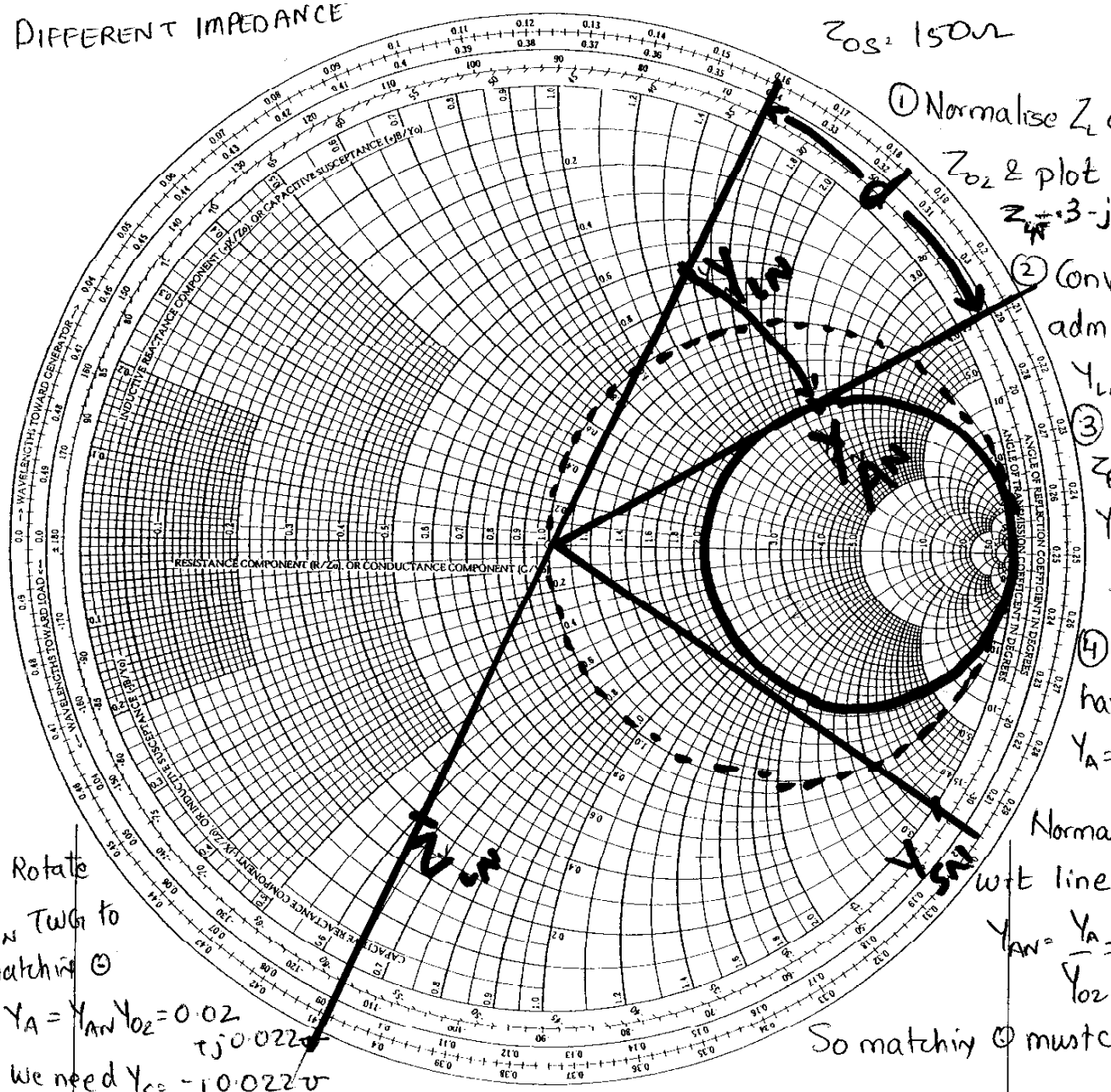
SINGLE STUB MATCHING WHEN ALL LINES ARE OF DIFFERENT IMPEDANCE

$Z_L = 30 - j60$

$Z_{02} = 100\Omega$

$Z_{01} = 50\Omega$

$Z_{0S} = 150\Omega$



① Normalise Z_L w.r.t. Z_{02} & plot

$Z_{LN} = 3 - j0.6$

② Convert to admittance Y_{LN}.

③ We want $Z_B = 50 + j0$

Y_B must be $\frac{1}{50}\mho$

④ We must have $Y_A = \frac{1}{50 + jX}$

Normalise this w.r.t line

$Y_{AN} = \frac{Y_A}{Y_{02}} = 2$

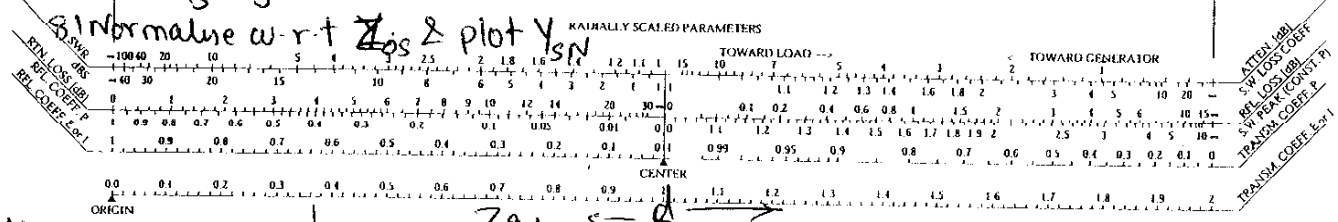
So matching ⊙ must change.

5) Rotate Y_{LN} TWG to matching ⊙

6) $Y_A = Y_{AN} Y_{02} = 0.02 + j0.022\mho$

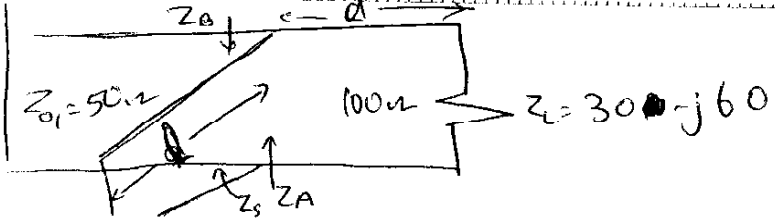
7) We need $Y_S = -j0.022\mho$

8) Normalise w.r.t Z_{0S} & plot Y_{SN}

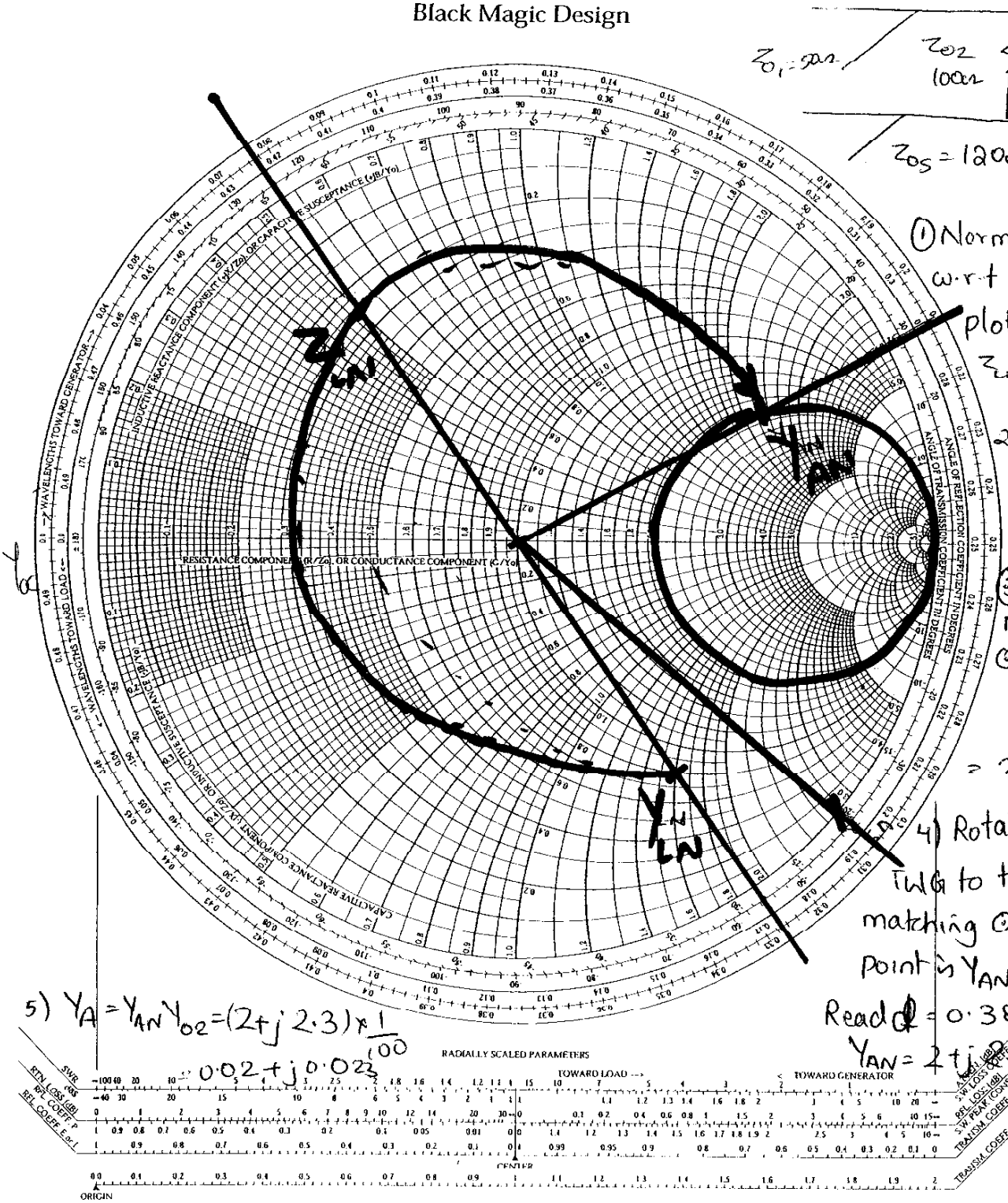


$Y_{SN} = -j3.3$

9) $d = 0.047\lambda$



2) Design a shunt stub for a line with different impedances



$Z_{01} = 50\Omega$ / $Z_{02} = 100\Omega$ } $25+j50$

$Z_{03} = 120\Omega$

① Normalise Z_L w.r.t Z_{02} & plot

$Z_{LN} = 0.25 + j0.5$

② Convert to admittance Y_{LN}

③ Get the new matching

④ $\frac{Y_A}{Y_{02}} = 2$

4) Rotate Y_{LN} TWG to the matching ⊙ This point is Y_{AN}

Read $d = 0.382\lambda$

$Y_{AN} = 2 + j2.3$

5) $Y_A = Y_{AN} Y_{02} = (2 + j2.3) \times \frac{1}{100} = 0.02 + j0.023$

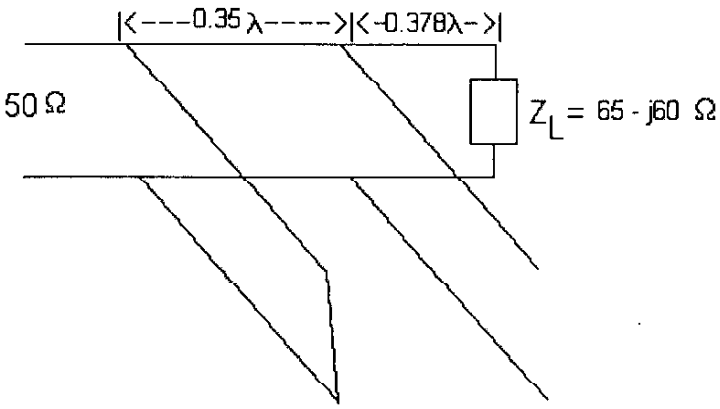
6) $Y_s = -j0.023\,\mho$

$Y_{SN} = \frac{Y_s}{Y_{03}} = \frac{-j.023}{\frac{1}{120}} = -j2.76$

7) $l_{sc} = 0.056\lambda$ (sc)

8) $l_{oc} = 0.306\lambda$ (oc)

Cook Book For Double Stub Matching



1. Plot Z_{LN} = 65-j60/50 =1.3-j1.2 (Z_{LN} =Z_L/Z_o, normalized)
2. Reflect it through the origin to find Y_{LN} (point A)
3. Rotate distance 'd' towards the generator(TWG) on constant |Γ| circle to point B (d=0.378 λ)
4. Draw the matching circle by rotating 0.35 λ towards the load.
5. Move B along constant conductance circle towards the generator until it intersects the rotated matching circle. Name this point C. (Read Y_{CN})
6. Rotate 0.35 λ towards the generator along the constant |Γ| circle . Mark point D
7. Match the stub to 50 ohm line (Y_{NF}= -Y_{ND}). Plot point F
8. Measure length from short circuit point. This is l_2
9. Take imaginary part of point C and point B and calculate

   g_h= gc-gb

10. Plot H
11. Calculate l_1

① $Z_L = (65 - j60)$

$Z_0 = 50\Omega$

$d = 0.378\lambda$

$d_1 = 0.35\lambda$

Stub ① o.c.

Stub ② s.c.

① $Z_{LN} = \frac{65 - j60}{50} = 1.3 - j1.2$

② Reflect it through origin to find Y_{LN}

③ Rotate 0.378λ towards the generator on constant |Γ| ⊙ to get to point B

5) Move B along constant ⊙ towards generator until it intersects the rotated matching ⊙

4) Draw matching ⊙ by rotating 0.35λ

6) Rotate 0.35λ towards the generator along |Γ| ⊙s & mark point D

$Y_{NB} = 0.41 - j0.3$

$Y_{NC} = 0.41 - j0.06$

$Y_{ND} = 1 - j0.95$

7) Match stub to 50Ω so we get short ckt $Y_{NF} = -Y_{ND} = +j0.95$

8) Measure length from ~~openckt~~ Point

$l_2 = 0.371\lambda$

9) $g_H = g_c - g_b$

$g_H = -j0.06 + j0.3$

$= j0.24$

Plot H $j0.24$

$l_1 = 0.038\lambda$

3) Design double stub tuner

$Y_{LN} = 0.4 + j1.2$

one stub is at load

& separation between the stubs is ~~3~~ 0.365λ

① ② Since we have been given Y_{LN} first 2 steps can be left off

③ Since $d' = 0$ there is no change in Y_{LN} & B

④ Draw matching ⊙ by rotating 0.365λ

5) Move B along constant conductance ⊙ towards generator until it intersects the rotated matching ⊙

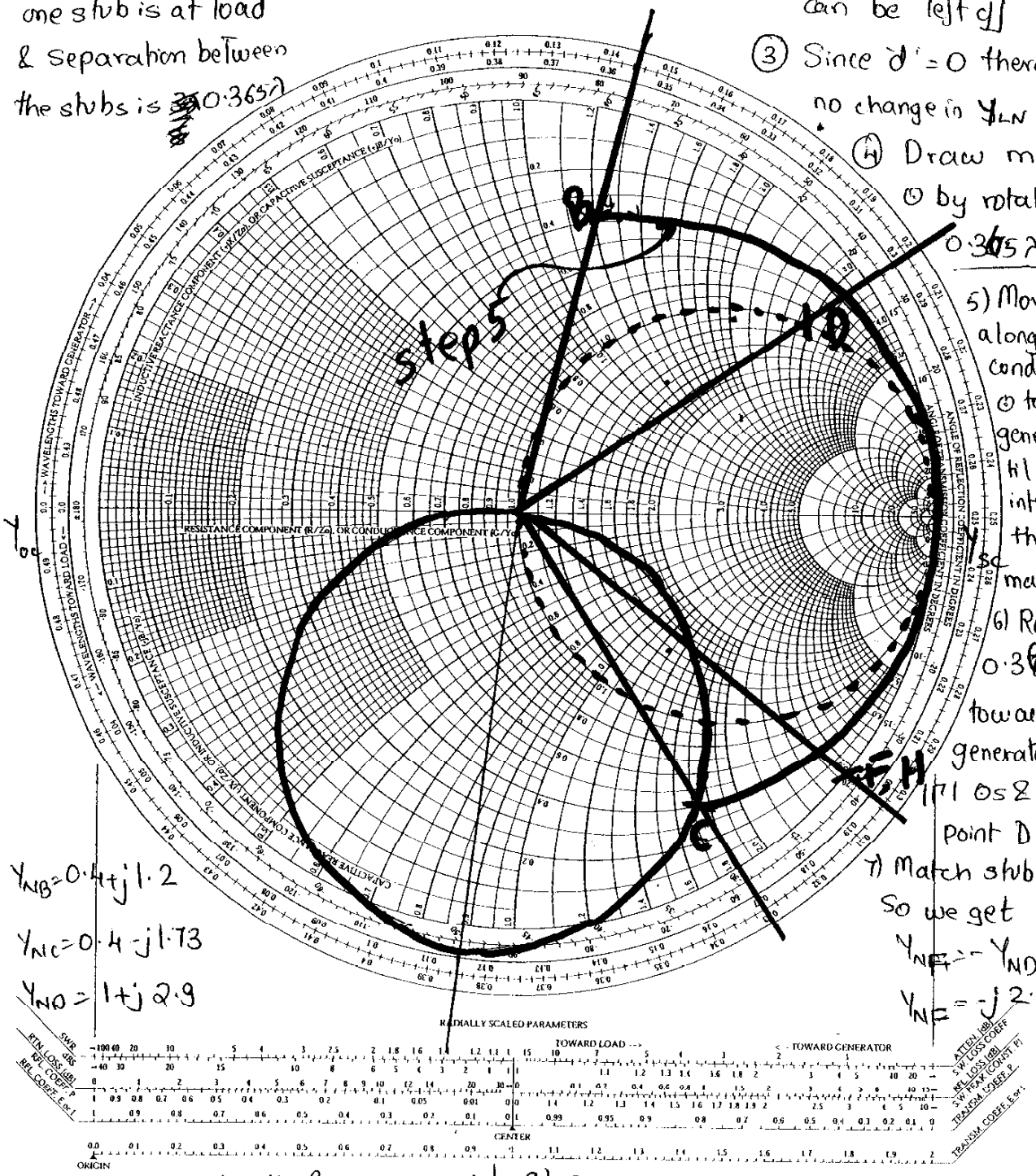
6) Rotate 0.365λ towards the generator along |Γ| 0s & mark point D

7) Match stub to 50Ω

So we get

$Y_{NE} = -Y_{ND}$

$Y_{NE} = -j2.93$



$Y_{NB} = 0.4 + j1.2$

$Y_{NC} = 0.4 - j1.73$

$Y_{ND} = 1 + j2.9$

8) Measure length from sc point

$l_2 = 0.08\lambda$

9) $g_h = g_c - g_b$

$= -j2.93$

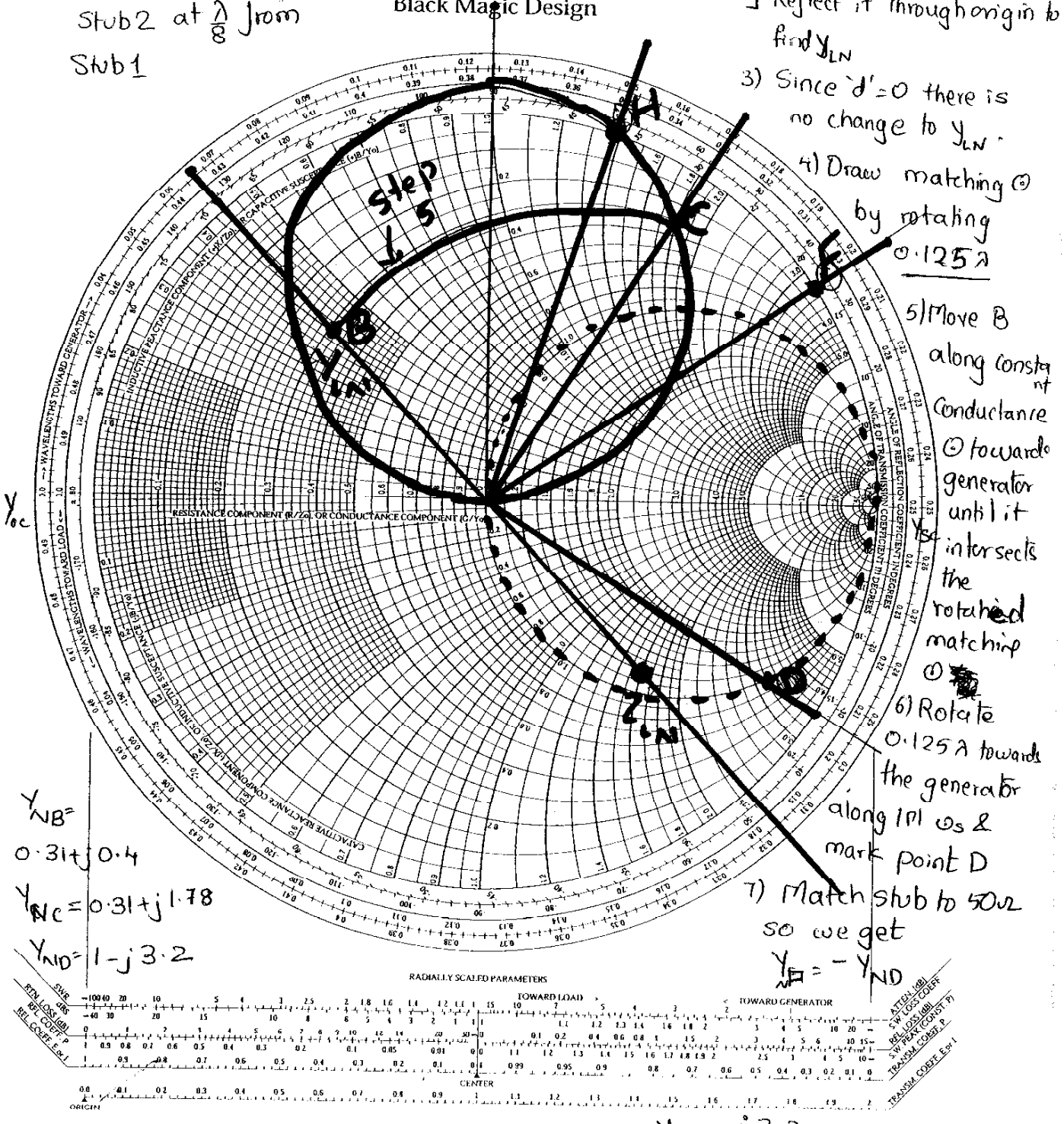
$l_1 = 0.08\lambda$

Plot ⓗ $-j2.93$

2) $Z_L = 60 - j80\ \Omega$ to $50\ \Omega$ line

Stub1 at load

Stub2 at $\frac{\lambda}{8}$ from Stub1



1] $Z_{LN} = \frac{60 - j80}{50} = 1.2 - j1.6$

2] Reflect it through origin to find Y_{LN}

3) Since 'd' = 0 there is no change to Y_{LN}.

4) Draw matching ⊙ by rotating 0.125λ

5) Move B along constant Conductance ⊙ towards generator until it intersects the rotated matching ⊙

6) Rotate 0.125λ towards the generator along IRI ω_s & mark point D

7) Match stub to $50\ \Omega$ so we get $Y_{LD} = -Y_{ND}$

$Y_{NB} = 0.31 + j0.4$

$Y_{NC} = 0.31 + j1.78$

$Y_{ND} = 1 - j3.2$

$Y_{NE} = j3.2$

8) Measure length from open ckt point

$l_2 = 0.202\lambda$

9) $g_H = g_c - g_b$

$g_H = 1.78 - 0.4$

$= 1.38$

Plot H $j1.38$

10) Calculate l_1

$l_1 = 0.15\lambda$