Graphical solution using smith chart:

1)a) Shunt S.C. stub:

i) Allocate Z_L.

ii) Rotate the Z_L point to find Y_L point. (through the constant Γ-circle).

iii) Move from Y_L on the constant Γ-circle till hitting the (r=1) circle at two points (Y_1 ,Y_2) towards the generator.

iv) Determine the value of d_1&d_2 where $d_i = d_{Yi} - d_{YL}$ on the WTG scale.

v) Determine the value of 'L' (stub length) by starting on the smith chart at y= ∞ (SC) and moving along the outer edge of the chart to the "-by$_1$" & "-by$_2$" on the WTG scale. ($L_i = L_{byi} - 0.25\lambda$). (+ve)

1)b) Shunt O.C. stub:

- From i to iv same as above

V) Determine the value of 'L' (stub length) by starting on smith chart at y=0 (OC) & moving along the outer edge of the chart to "-by$_1$" & "-by$_2$" on the WTG scale. ($L_i = L_{byi} - 0$).

2)a) Series S.C. stub:

i) Allocate Z_L.

ii) Draw the constant Γ-circle.

iii) Move from the Z_L point on the constant Γ-circle till hitting the (r=1) at two points (Z_1,Z_2) towards the generator.

iv) Determine the value of d_1 & d_2 where $d_i=d_{zi} – d_{ZL}$ on the WTG scale.

v) Determine the value of 'L' (stub length) by starting on smith chart at (z=o) (SC) & moving along the outer edge of the chart to the "$-X_{z1}$" & "$-X_{z2}$" on the WTG scale. ($L_i = L_{xzi} – 0$). (+ve).

2)b) Series O.C. stub:

- From i to iv same as above.

V) Determine the value of 'L' (stub length) by starting on the smith chart at Z= ∞ (OC) and moving along the outer edge & the chart to the "$-X_{z1}$" & "$-X_{z2}$" on the WTG scale. ($L_i = L_{xzi} - 0.25\lambda$).

➢ ***Notes:***

1) In shunt stub case, we consider smith chart as admittance chart so, the const. Γ-circle intersects the "1+jb" circle at two points.

2) In series stub case, we consider smith chart as impedance chart so, the const. Γ -circle intersects the "1+jx" circle at two points.

3) If the stub is made of section of "$\frac{a}{c}$ Z_0" TL (not "Z_0" TL) where a & c are constants (a, c ≠0). Then assume that $Z'_0 = \frac{a}{c} Z_0$ & $Y'_0 = \frac{c}{a} Z_0$ and the values of required normalized stub impedances or admittances will change.

4) Series stubs are very difficult to manufacture using micro-strip lines.

5) As 'd' & 'L' of the stub are shorter this lead to better bandwidth. as the frequency variation of the match decreases.