the chart to this point intersecting the constant $s = 3$ circle at the point B shown in the chart. The constant r and constant x circles passing through the point 'B' provide the load point, which may be read as

$$Z_L = (0.5 - j0.6)$$

The actual value of the load impedance may then be calculated as

$$Z_L = 50 \times (0.5 - j0.6) = (25 - j30)\ \Omega$$

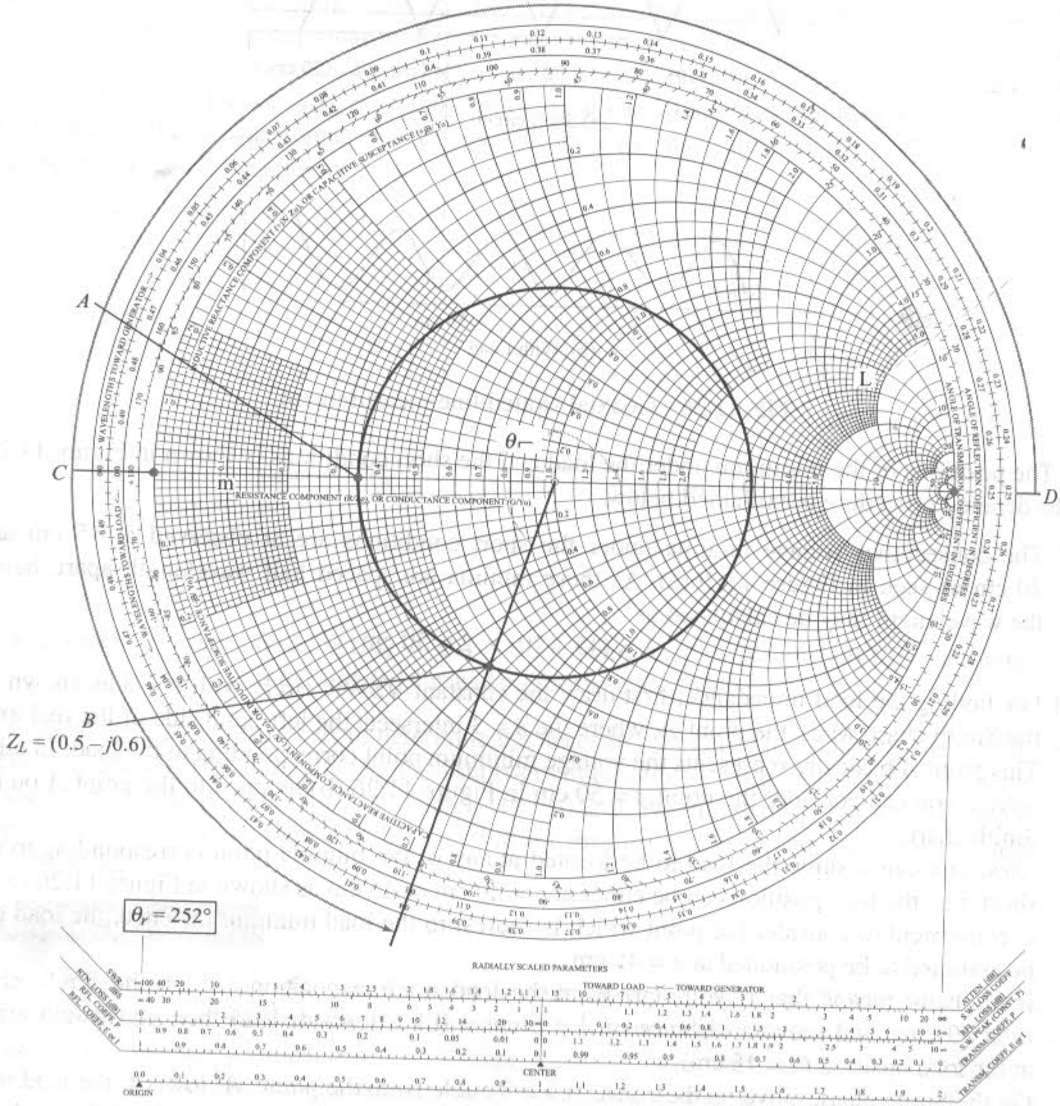

Fig. 11.27 Smith chart.

(c) The reflection coefficient of the load can be found out by measuring $|\Gamma|$and the angle θ_Γ from the Smith chart, which are given as

$$|\Gamma| = 0.5 \text{ and } \theta_\Gamma = 252^\circ$$

$$\text{Hence, } \Gamma = |\Gamma|\, e^{j\theta_r} = 0.5e^{j252^\circ} = 0.5e^{j4.398} = -\,0.1545 - j0.4755$$

$|\Gamma|$ can also be found out analytically using $|\Gamma| = \dfrac{\rho-1}{\rho+1} = \dfrac{3-1}{3+1} = 0.5$

(d) When the actual load is replaced with an *open* circuit, the first voltage minimum would be shifted by 0.25λ away from the load. If the load position is kept fixed at 45.0 cm as shown in Figure 11.26 (a) then the first voltage minima would be located at 45.0 cm + 0.25λ = 57.5 cm on the scale reading. On the Smith chart, the load position would now be on the extreme right-hand side denoted by the point D, and the voltage minimum position would be at the extreme left-hand side denoted by the point C. It can also be interpreted from the Smith chart that if you start from the voltage minimum position (point C) and move a distance of 0.25λ on the outer circle of chart towards load then you would arrive at the point D representing an *open* load.

D11.7 Standing wave measurements on a lossless 75 Ω line show maxima of 18 V and minima of 5 V. One minimum is located at a scale reading of 30 cm. With the load replaced by a short circuit, two adjacent minima are found at scale readings of 17 and 37 cm. Find: (*a*) s; (*b*) λ; (*c*) f; (*d*) Γ_L; (*e*) Z_L.

Ans. 3.60; 0.400 m; 750 MHz; $0.704\angle{-33.0}$; $77.9 + j104.7\,\Omega$

EXAMPLE 11.18

A load impedance given by $Z_L = 100 + j100\,\Omega$ is to be matched to a transmission line having characteristic impedance of 150 Ω. Design a matching network consisting of a short-circuited shunt stub having characteristic impedance of 50 Ω, which is connected at some distance d_{stub} away from the load. The stub should be located at shortest possible distance from the load, and its length should also be minimum. Please use the Smith chart and explain clearly all the steps.

Solution. First, we have to find out the location of the stub d_{stub} with reference to the load which is based on the criterion that the real part of the impedance at this point should be equal to the characteristic impedance of the transmission line. A short-circuited stub is then to be connected in parallel at this point, and the length of this stub L_{stub} should be determined such that it cancels the imaginary part of the load impedance. The overall arrangement of the shunt stub with the load and the transmission line is shown in Figure 11.28. It is also to be noted that for shunt stubs, it becomes more convenient to work with admittances, rather than impedances.

The overall procedure of matching the given load with the transmission line using the Smith chart is given below:

(*a*) Calculate the normalized load impedance and determine the corresponding location marked by the point 'L' on the Smith chart.

$$Z_L = \frac{100 + j100}{150} = (0.667 + j0.667)$$