EMTI CLT - 1 :

To reduce EMI problems in an electric vehicele and improve electromagnetic compatibility (EMC) several practical steps can be taken.

First seperate high-power components like motors and inverters from sensitive control circuits to reduce interference. use shielded and twisted wires for communication lines and route decoupling capacitors to smooth out noise.

Install EMI filters, ferrite, beads and chokes on power and signal lines to block unwanted signals.

Enclose critical electronics in metal shielding to prevent radiation from or into other components.

Make sure all ground connections are tight and corrosion free. During testing check the system for readiated and conducted emmisions under real operating conditions.

Following automotive standards and good design practices helps ensure that all electronic systems work together reliably without interference

It's also important to follow automotive EMC standards such as ISO 11452 and CISPR 25 and test the systems for radiated and conduted emissions

2. · Use radiation - hardened and screened components to tolerate single-event effects and reduce some emissions.
· Physically shield sensitive receiver front ends and electronics with conductive enclosures and properly bonded seams (Faraday cages)
Apply conductive coatings to external surfaces to avoid charging and arcing.
· Isolate and decouple power distribution and add transient protection on feeds to suppress spikes from radiation - included currents
· Design high - quality RF front ends with low noise amplifiers, bandpass filters, and notch filters to reject out - of - band solar / Terrestrial interference before the receiver chain.

Q.3) A lossless 30 m long transmission line with Zo=50Ω is established between two ground stations which operate at 2 MHz. The line is terminated with a load ZL = 60+j40Ω. If u = 0.6c on the line. Write a Scilab code to plot the reflection coefficient (Γ), standing wave ratio (S) and input impedance in smith chart.

Source Code:

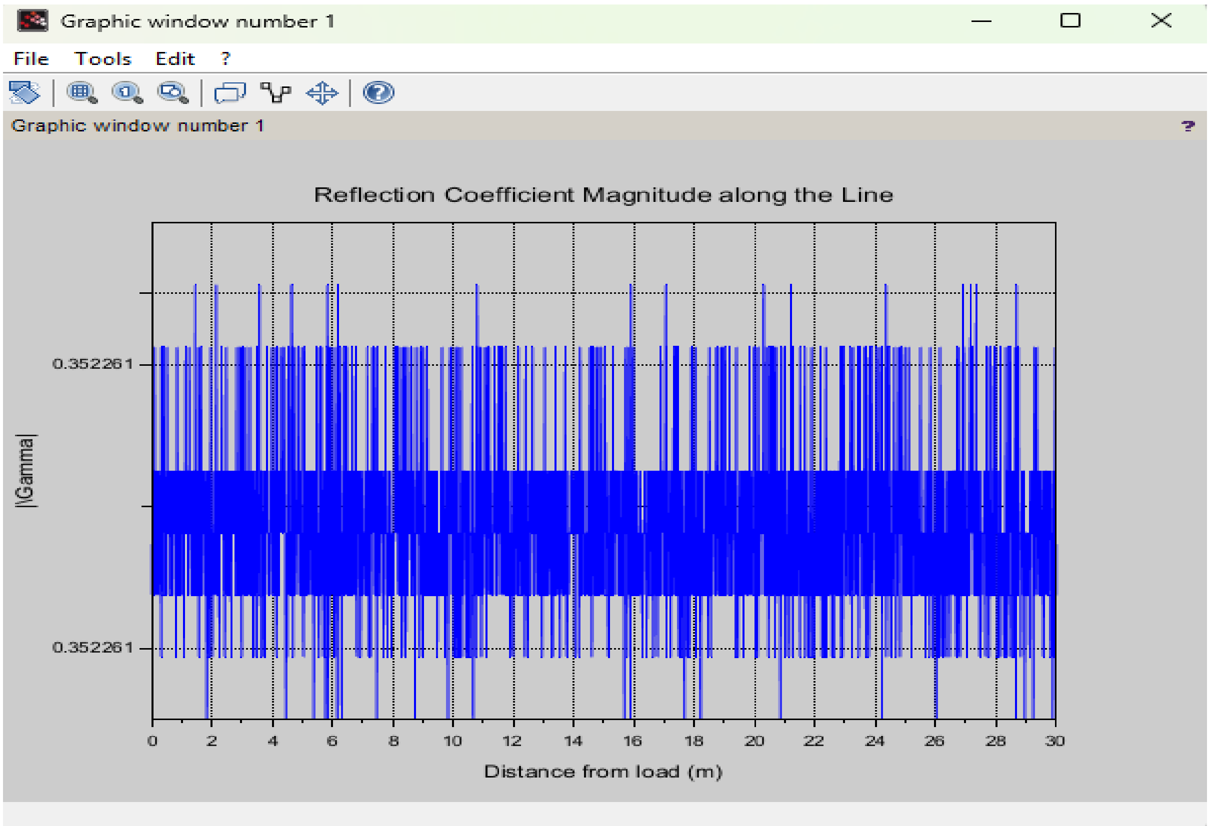
```
// Scilab script for Q3
// Plots: |Gamma| vs distance, SWR vs distance, and Smith-chart (Gamma plane)

clc;
clear;
close;

// Given
Z0 = 50;                 // ohms
ZL = 60 + %i*40;         // load
f = 2e6;                 // Hz
c = 3e8;                 // m/s
u = 0.6 * c;             // propagation velocity
L = 30;                  // line length in meters

// Derived
lambda = u / f;
beta = 2 * %pi / lambda;

// Reflection coefficient at load
Gamma_load = (ZL - Z0) / (ZL + Z0);
Gamma_load_mag = abs(Gamma_load);
```

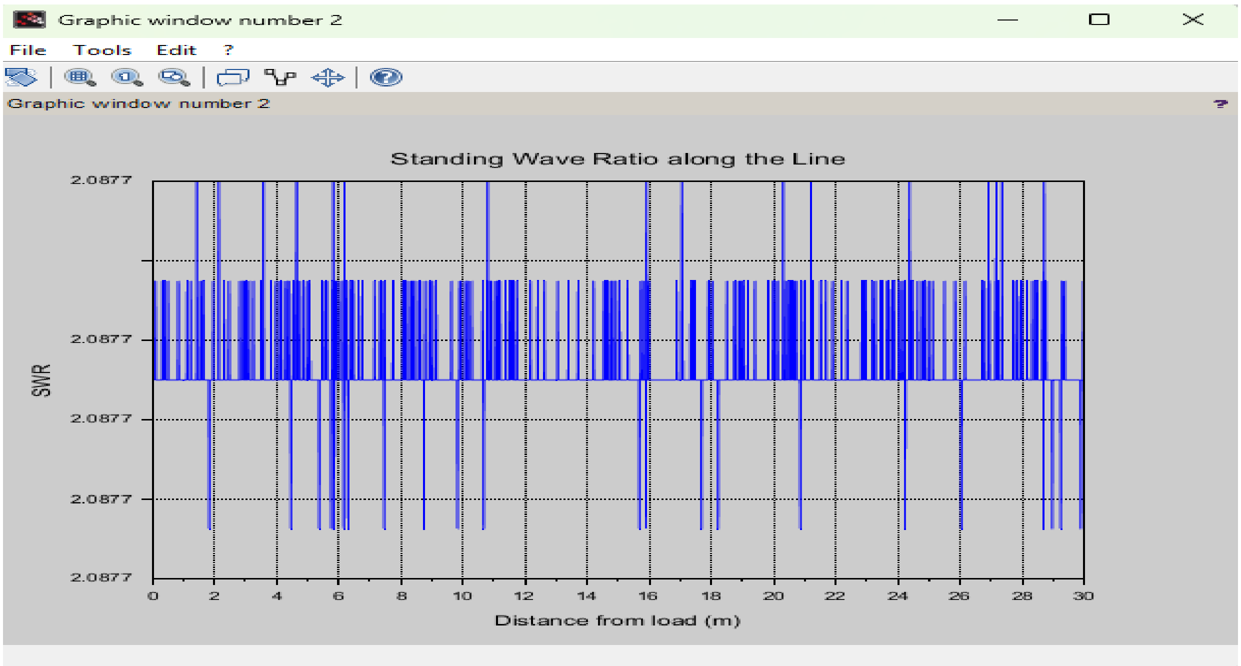
```
Gamma_load_phase_deg = atan(imag(Gamma_load)/real(Gamma_load)) * 180
/ %pi; // approximate angle
SWR_load = (1 + Gamma_load_mag) / (1 - Gamma_load_mag);

// Print numeric checks
disp("Gamma at load: " + string(Gamma_load));
disp(" |Gamma| at load: " + string(Gamma_load_mag));
disp(" Phase (deg) approx: " + string(Gamma_load_phase_deg));
disp(" SWR at load: " + string(SWR_load));

// Sample points along line (0 -> L)
d = 0:0.01:L; // meter resolution (adjust if needed)

// Input impedance along line (lossless)
Zin = Z0 * (ZL + %i*Z0 .* tan(beta .* d)) ./ (Z0 + %i*ZL .* tan(beta .* d));

// Reflection coefficient along line
Gamma_d = (Zin - Z0) ./ (Zin + Z0);

// Plot |Gamma| along the line
figure(1);
plot(d, abs(Gamma_d));
xlabel("Distance from load (m)");
ylabel("|\Gamma|");
xtitle("Reflection Coefficient Magnitude along the Line");
xgrid();

// Plot SWR along the line
```

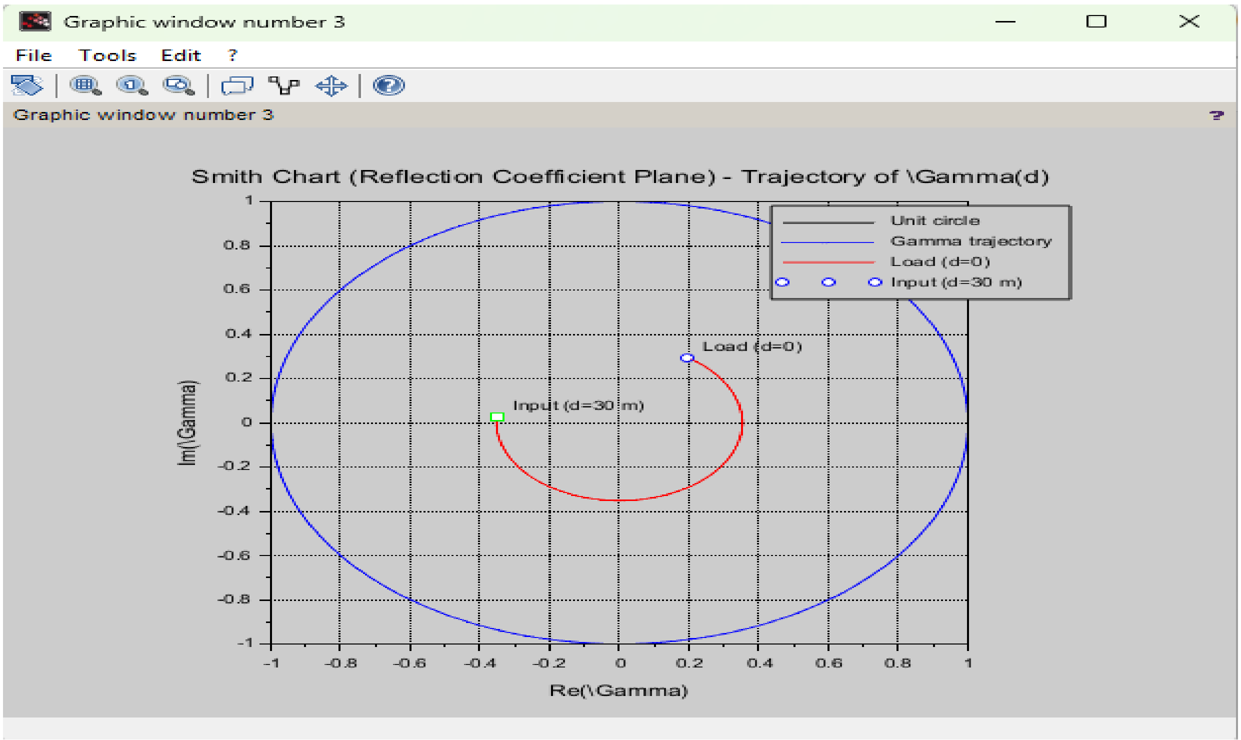
```
SWR_d = (1 + abs(Gamma_d)) ./ (1 - abs(Gamma_d));
figure(2);
plot(d, SWR_d);
xlabel("Distance from load (m)");
ylabel("SWR");
xtitle("Standing Wave Ratio along the Line");
xgrid();

// Smith chart (Gamma plane)
// Unit circle
theta = 0:0.01:2*%pi;
cx = cos(theta);
cy = sin(theta);

// Prepare points for overlay: Gamma trajectory
realG = real(Gamma_d);
imagG = imag(Gamma_d);

// Compute Gamma at input end (d = L) for annotation
Gamma_input = (Zin($) - Z0) / (Zin($) + Z0); // Zin($) = last element
// (Gamma_load already computed for d=0)

// Plot unit circle and Gamma trajectory on same axes
figure(3);
plot(cx, cy, 'k'); // unit circle
// Overlay trajectory and key points in one plot call
plot(cx, cy, realG, imagG, 'r-', real(Gamma_load), imag(Gamma_load), 'bo',
real(Gamma_input), imag(Gamma_input), 'gs');
```

```
xlabel("Re(\Gamma)");
ylabel("Im(\Gamma)");
xtitle("Smith Chart (Reflection Coefficient Plane) - Trajectory of \Gamma(d)");
xgrid();
// keep equal axis scale
a = gca();
a.isoview = "on";
legend(["Unit circle", "Gamma trajectory", "Load (d=0)", "Input (d=30 m)"], 1);

// Optionally annotate numeric values near points
// (Simple text annotations)
xstring(real(Gamma_load)+0.03, imag(Gamma_load), "Load (d=0)");
xstring(real(Gamma_input)+0.03, imag(Gamma_input), "Input (d=30 m)");
```

Output:







Scilab 2026.0.0 Console

File Edit Control Applications ?

Scilab 2026.0.0 Console

```
 "Gamma at load: 0.1970803+%i*0.2919708"
 " |Gamma| at load: 0.3522607"
 " Phase (deg) approx: 55.98065"
 " SWR at load: 2.0876619"

-->
```

Q.4) In a satellite base station, a load of 100 + j150 Ω is connected to a 75Ω lossless line. Write a Scilab code to plot the Reflection coefficient (Γ), SWR value and input impedance (Zin) at 0.4λ from the load.

Source Code:

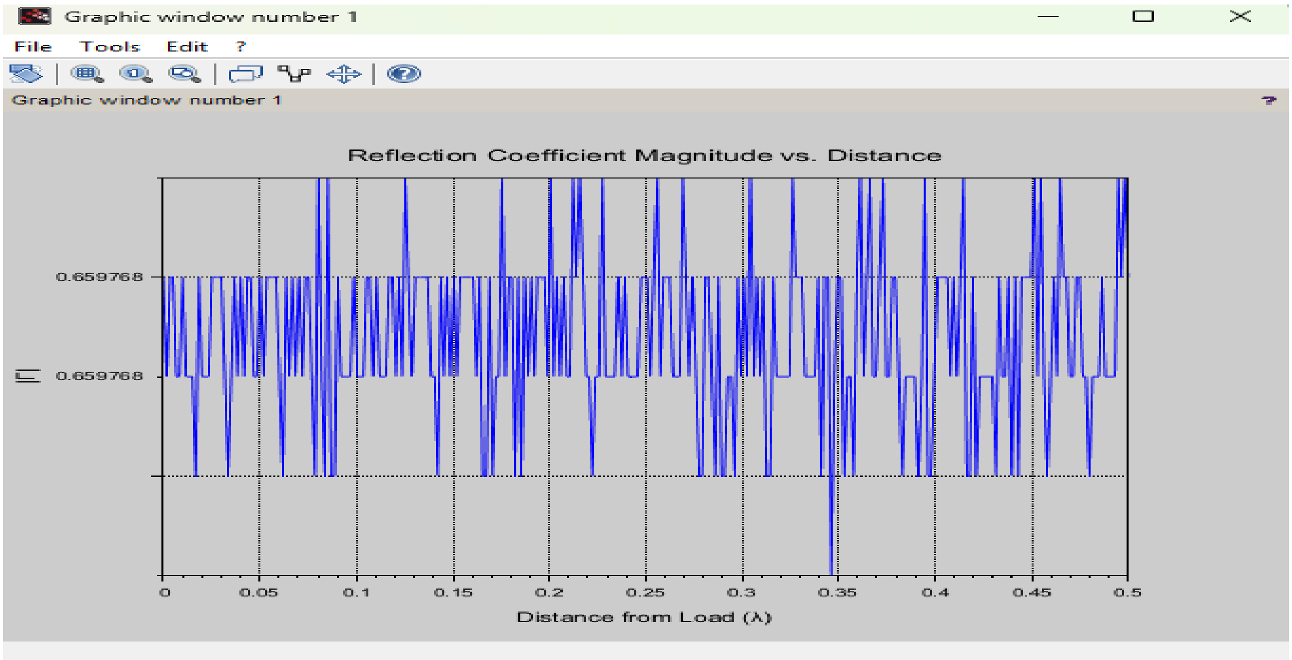
```
// Q4 - Electromagnetic Theory and Interference
// Satellite base station simulation
// Compute and plot Reflection Coefficient, SWR, and Zin at 0.4λ

clc;
clear;
close;

// Given data
Z0 = 75;              // Characteristic impedance (ohms)
ZL = 100 + %i*150;    // Load impedance (ohms)
lambda = 1;           // Normalized wavelength (unit value)
d = 0.4 * lambda;     // Distance from load (in wavelengths)

// Reflection Coefficient at Load
Gamma_L = (ZL - Z0) / (ZL + Z0);
Gamma_mag = abs(Gamma_L);
Gamma_phase_deg = atan(imag(Gamma_L)/real(Gamma_L)) * 180 / %pi;

// Standing Wave Ratio
SWR = (1 + Gamma_mag) / (1 - Gamma_mag);

// Input Impedance at distance d = 0.4λ
```

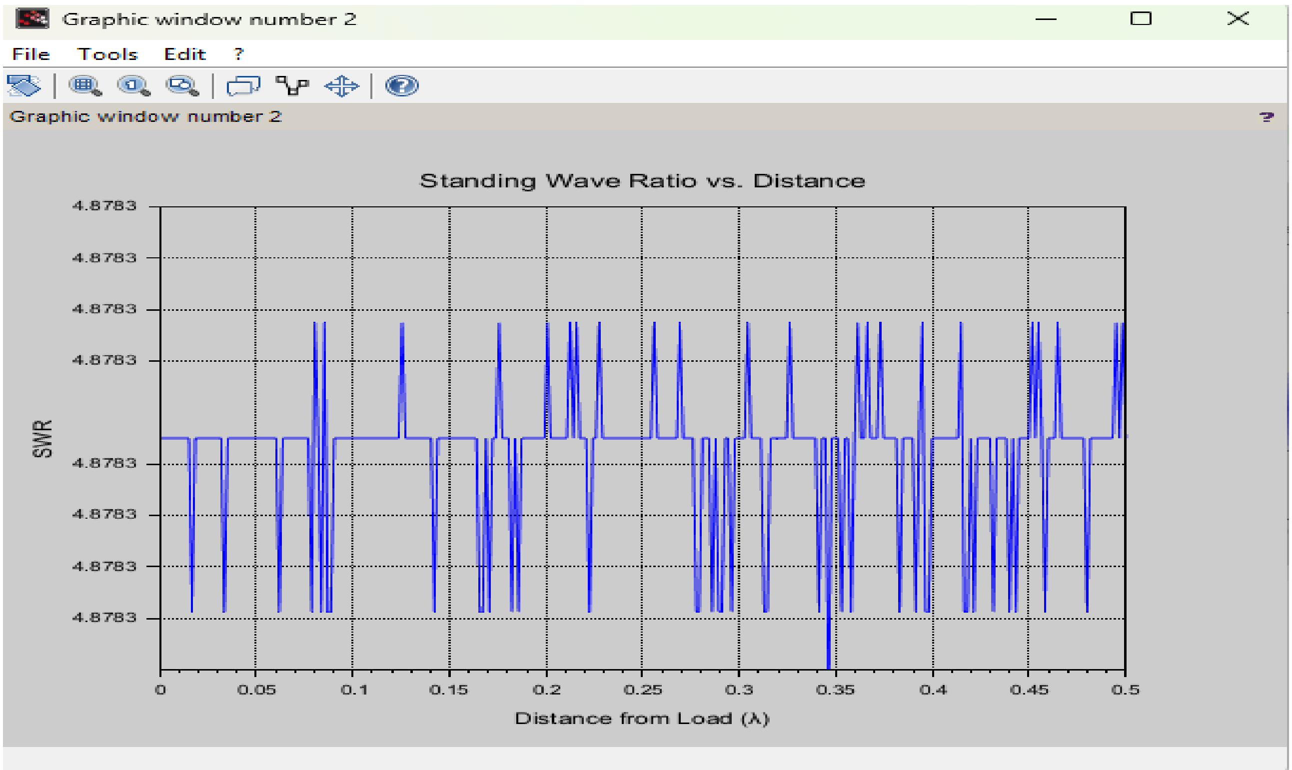
```
beta = 2 * %pi / lambda;            // Phase constant (rad/m)
Zin = Z0 * (ZL + %i*Z0 * tan(beta*d)) / (Z0 + %i*ZL * tan(beta*d));

// Display results
disp("-----------------------------------------------------");
disp("Reflection Coefficient (Γ_L): " + string(Gamma_L));
disp("|Γ_L| : " + string(Gamma_mag));
disp("Phase of Γ_L (degrees): " + string(Gamma_phase_deg));
disp("Standing Wave Ratio (SWR): " + string(SWR));
disp("Input Impedance at 0.4λ (Zin): " + string(Zin));
disp("-----------------------------------------------------");

// For visualization, sweep along 0 to 0.5λ for Γ and SWR variation
d_values = linspace(0, 0.5*lambda, 300);
Zin_values = Z0 * (ZL + %i*Z0 .* tan(beta .* d_values)) ./ (Z0 + %i*ZL .*
tan(beta .* d_values));
Gamma_d = (Zin_values - Z0) ./ (Zin_values + Z0);

// Plot |Γ| vs. distance
figure(1);
plot(d_values, abs(Gamma_d));
xlabel("Distance from Load (λ)");
ylabel("|Γ|");
title("Reflection Coefficient Magnitude vs. Distance");
xgrid();

// Plot SWR vs. distance
SWR_d = (1 + abs(Gamma_d)) ./ (1 - abs(Gamma_d));
```

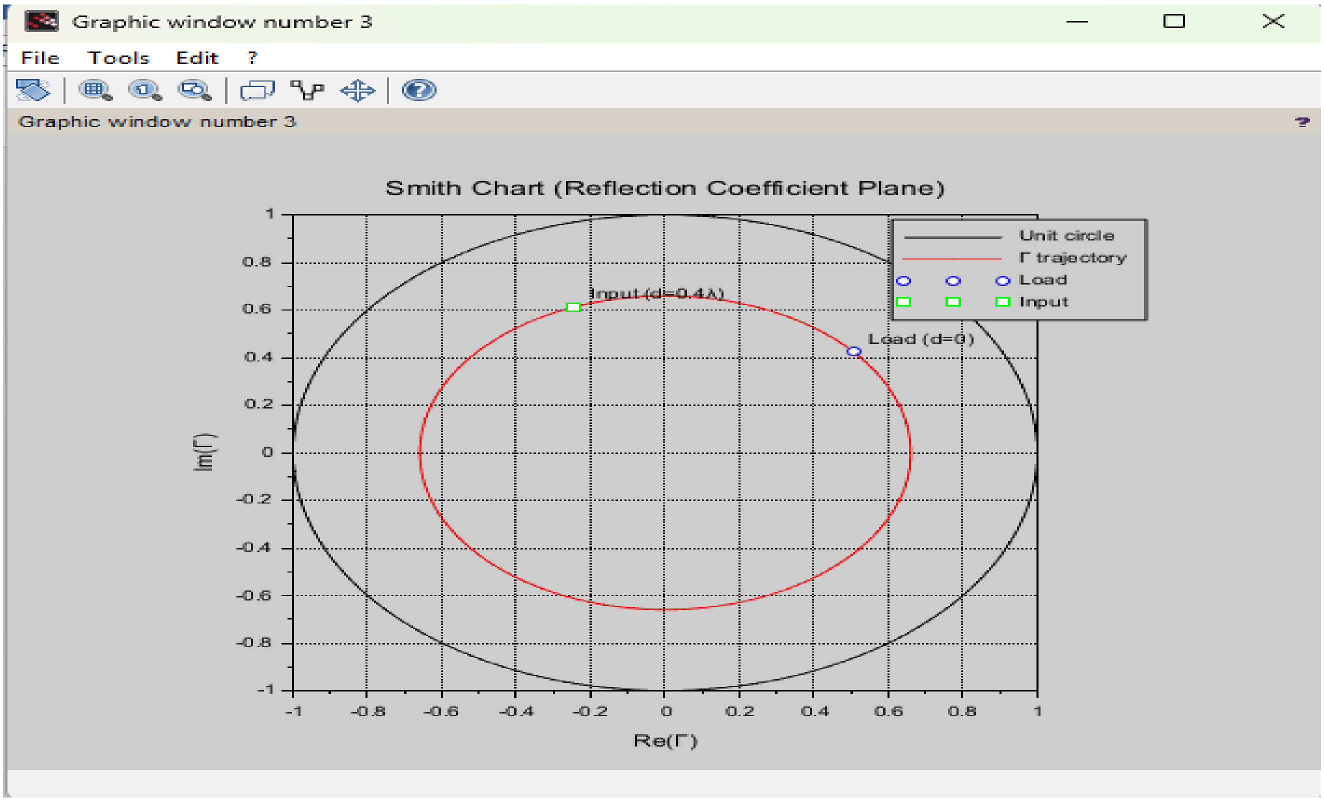
```
figure(2);
plot(d_values, SWR_d);
xlabel("Distance from Load (λ)");
ylabel("SWR");
title("Standing Wave Ratio vs. Distance");
xgrid();

// Smith Chart (Γ plane)
theta = 0:0.01:2*%pi;
cx = cos(theta);
cy = sin(theta);
realG = real(Gamma_d);
imagG = imag(Gamma_d);

figure(3);
plot(cx, cy, 'k'); // unit circle
plot(realG, imagG, 'r-');
xlabel("Re(Γ)");
ylabel("Im(Γ)");
title("Smith Chart (Reflection Coefficient Plane)");
xgrid();
a = gca();
a.isoview = "on";

// Mark important points
plot(real(Gamma_L), imag(Gamma_L), 'bo');
Gamma_input = (Zin - Z0) / (Zin + Z0);
```

```
plot(real(Gamma_input), imag(Gamma_input), 'gs');
xstring(real(Gamma_L)+0.03, imag(Gamma_L), "Load (d=0)");
xstring(real(Gamma_input)+0.03, imag(Gamma_input), "Input (d=0.4λ)");
legend(["Unit circle", "Γ trajectory", "Load", "Input"], 1);
```

Output:







Scilab 2026.0.0 Console

File Edit Control Applications ?

Scilab 2026.0.0 Console

```
 "-----------------------------------------------------"
 "Reflection Coefficient (Γ_L): 0.5058824+%i*0.4235294"
 "|Γ_L| : 0.6597682"
 "Phase of Γ_L (degrees): 39.936383"
 "Standing Wave Ratio (SWR): 4.8783458"
 "Input Impedance at 0.4λ (Zin): 21.964531+%i*47.60816"
 "-----------------------------------------------------"

-->
```