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:

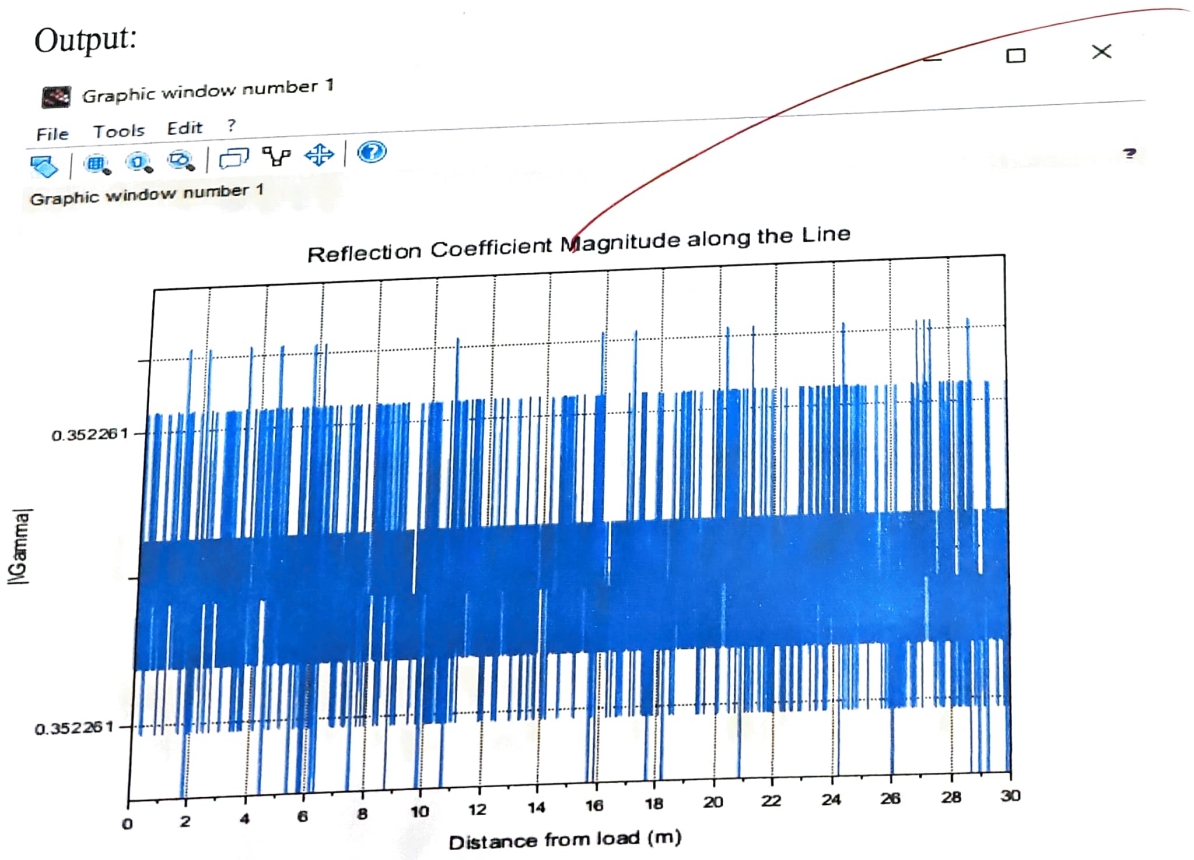
```
// Scilab script for Q3
// Plots: |Gamma| vs distance, SWR vs distance, and Smith-chart (Gamma plane)

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)");
```

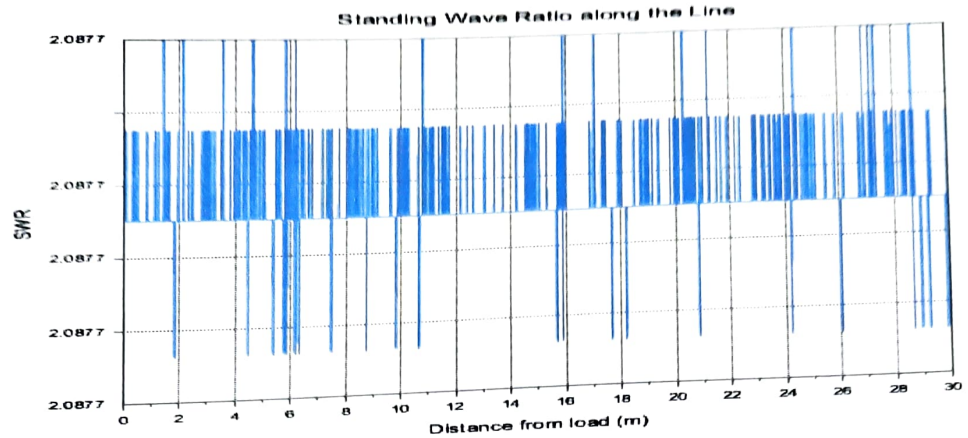
Output:



Graphic window number 2

File Tools Edit ?

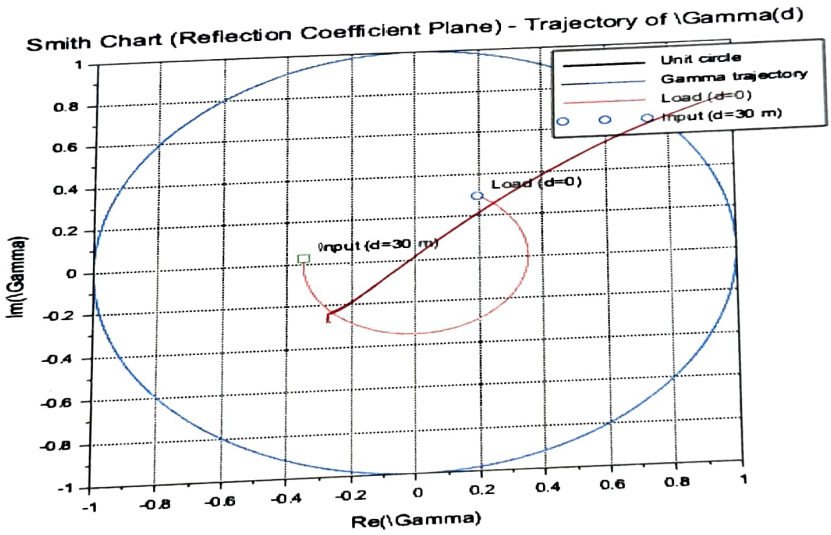
Graphic window number 2



Graphic window number 3

File Tools Edit ?

Graphic window number 3



Scilab 2026.0.0 Console

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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:

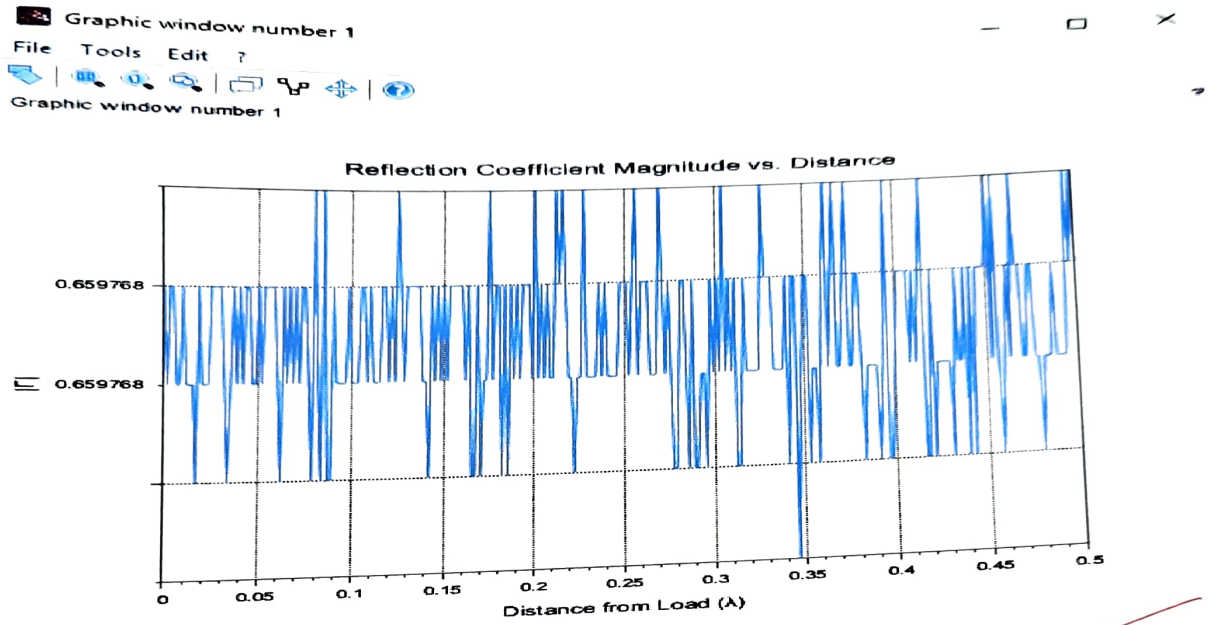
```
// Q4 - Electromagnetic Theory and Interference
// Satellite base station simulation
// Compute and plot Reflection Coefficient, SWR, and Zin at 0.4λ

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
```

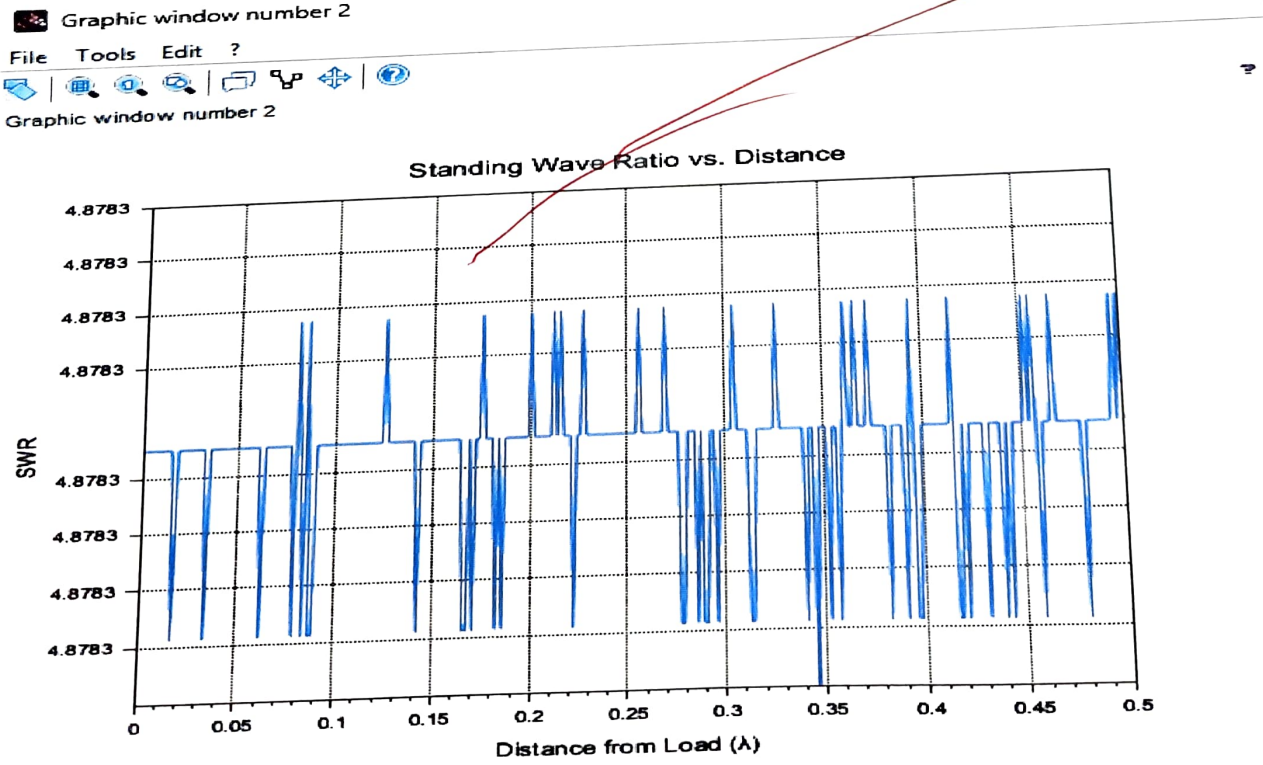
```
beta = 2 * %pi / lambda;          // Phase constant (rad/m)
Zin = Z0 * (ZL + %i*Z0 * tan(beta*d)) / (Z0 + %i*ZL * tan(beta*d));

// 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:

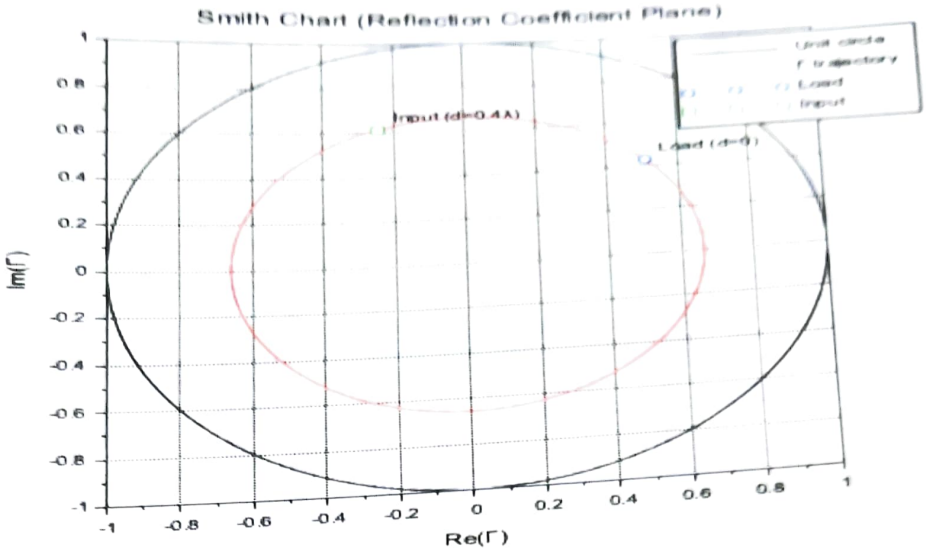




Graphic window number 3

File Tools Edit ?

Graphic window number 3



Scilab 2026.0.0 Console

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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"
"-----------------------------------------------"

-->
```