MCS – lab 1 report: 'Free space propagation'

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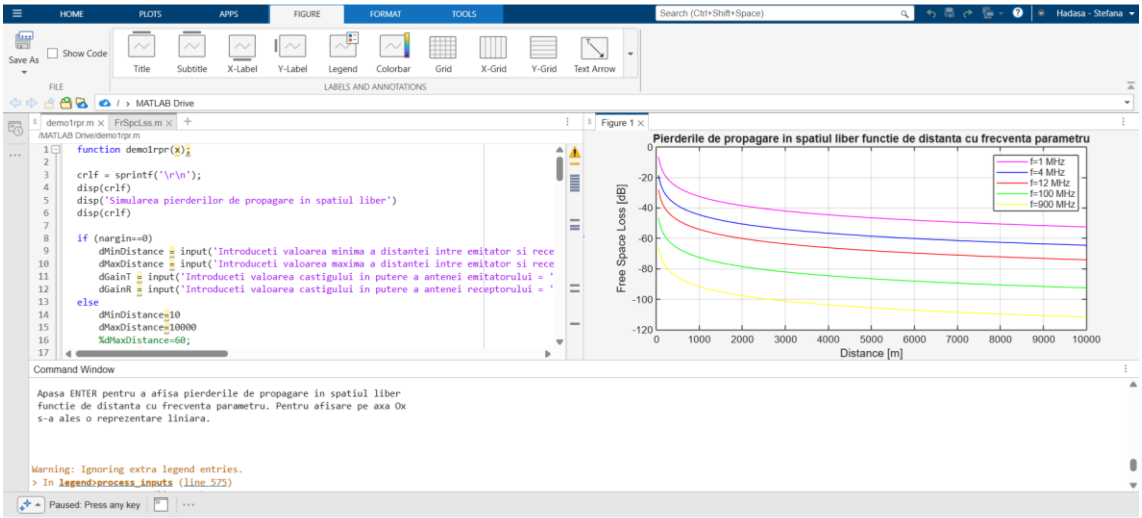
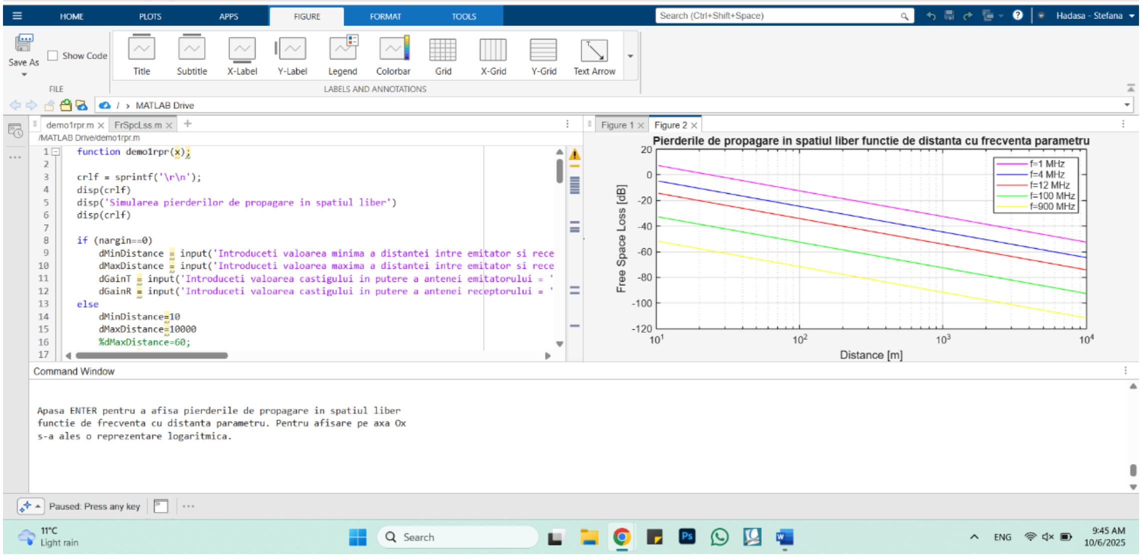
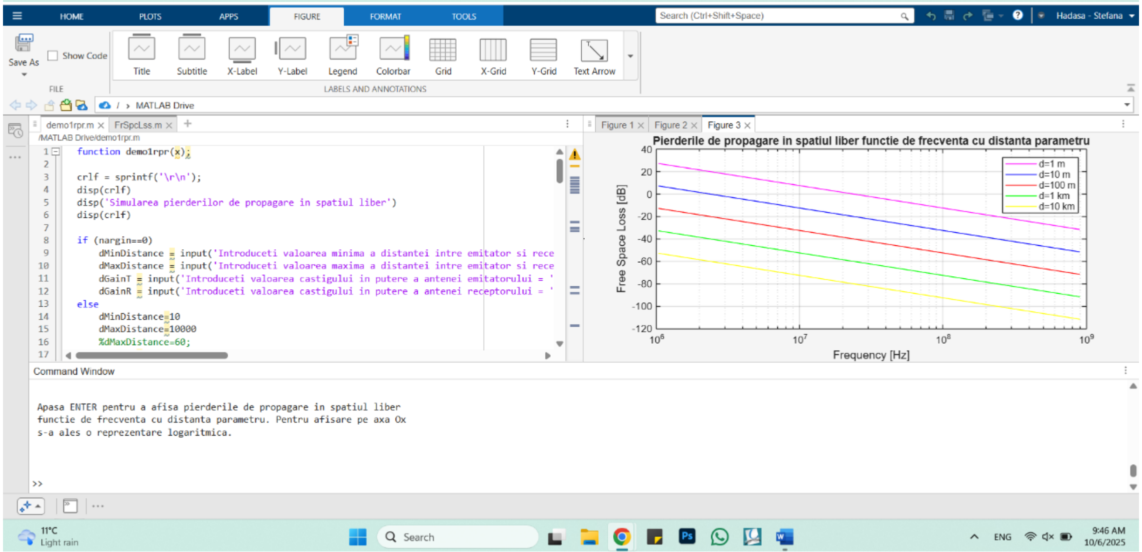






The simulation results confirm the theoretical expectation that propagation losses grow with distance and frequency. The plotted curves emphasize how signal attenuation becomes more significant for higher frequencies and longer transmission ranges.

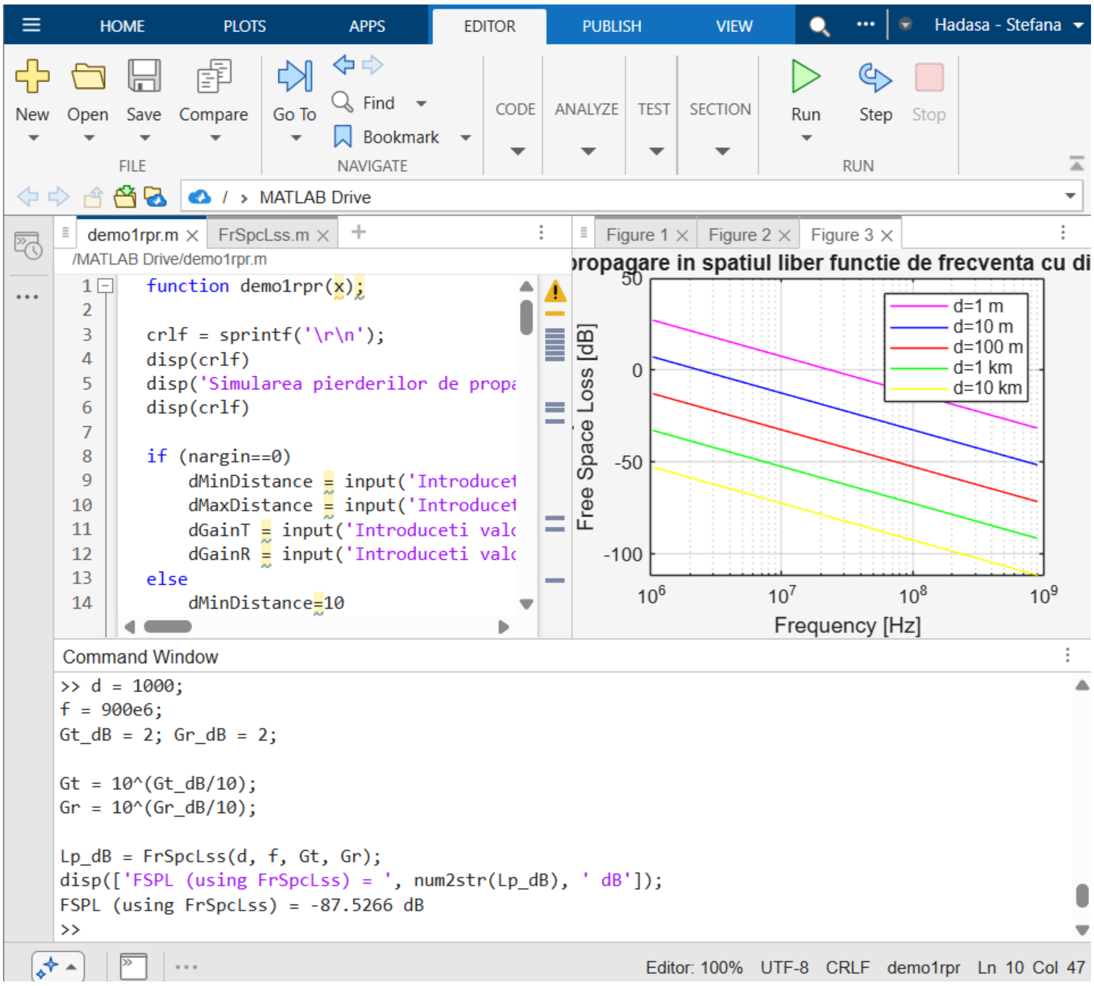
1. **Determine the slope for free space propagation losses variation as a function of frequency.**

20 dB per decade – if frequency increases 10x, free space path loss increases by 20 dB

2. **Determine the slope for free space propagation losses variation as a function of distance.**

20 dB per decade – if distance increases 10x, free space path loss increases by 20 dB

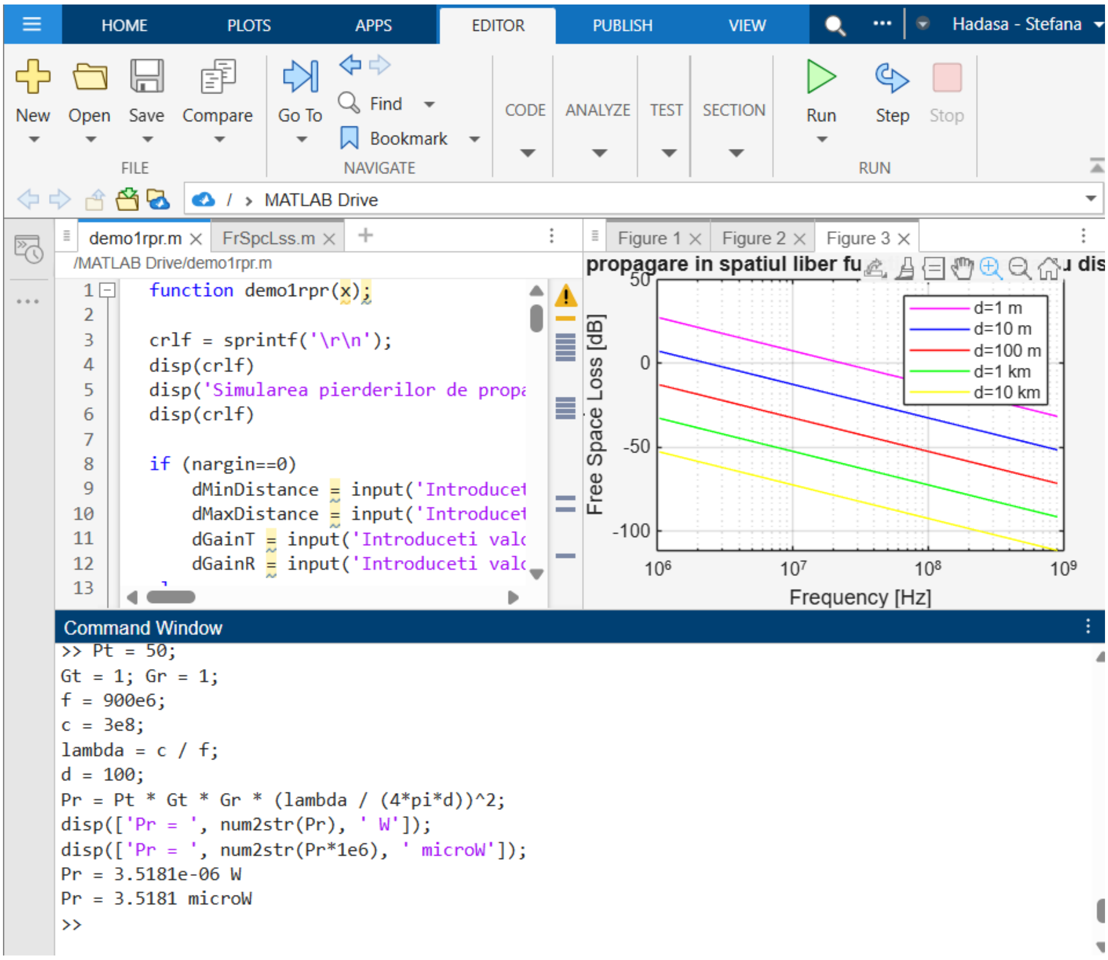
3. **What can be observed in the proximity of the transmitter (distances ≈ wavelength)?**
   In that near-field region, the free-space formula is not valid.
   -The measured power fluctuates rapidly.
   -The inverse-square law doesn't hold.
   -Interference effects may appear.
4. **Determine the propagation losses in the case when the distance between the transmitter and the receiver is d =1 km, the frequency of the signal is f = 900 MHz and the antennae have a gain of 2 dB. Indication: use the Matlab function FrSpcLss.**



Lp= 87.52dB

5. **Consider a radio transmitter with PT= 50 W. If the antenna of the transmitter is isotropic and the frequency of the emitted signal is 900 MHz, compute the free**

space received power at the distance d=100m from the transmitter. It is supposed that the receiver also has an isotropic antenna.



Pr=3.51μW

Another approach:

Info:

PT=50 W

F = 900 MHZ

d=100,

Gt=Gr=0dB

formula from page 2 of Lab 1, formula marked with (2)

L free space = 32.44+20log10(0.1)+20log10(900) = 71.52 dB

To convert PT from W to dBm:

PT(dBm)=10log10(50×1000)=10log10(50000)=47 dBm

Then received power:

PR=PT−Lfs=47−71.52=−24.52 dBm

PR = -24.52 dBm

Same Pr, different unit measurements.

6. **If the power received by an antenna having the gain Gr=2 is Pr=7x10^-10W , and the frequency of the signal is f=900MHz, determine the intensity of the electrical field at the receiver. Indication: relation (3) should be used.**

$$P_R = \frac{E^2 A}{Z_0} = \frac{E^2}{Z_0}\frac{\lambda^2 G_R}{4\pi} = \left(\frac{E\lambda}{2\pi}\right)^2 \frac{\pi G_R}{Z_0} = \left(\frac{E\lambda}{2\pi}\right)^2 \frac{G_R}{120} \qquad (3)$$

```
>> Pr = 7e-10;
Gr = 2;
f = 900e6;
c = 3e8;
lambda = c / f;
eta = 377;
E = sqrt((2 * eta * Pr * 4 * pi) / (Gr * lambda^2));
disp(['E = ', num2str(E), ' V/m']);
disp(['E = ', num2str(E*1e3), ' mV/m']);
E = 0.0054632 V/m
E = 5.4632 mV/m
>> |
```

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