Task 4

LAB4: HATA OKUMURA MODEL

NAME: ABDELRAHMAN MATARAWY SAYED
SECTION: 5

Objectives:

- Understand Hata Okumura model.
- effects of diffraction, reflection and scattering of transmitted signals on the received power.
- To simulate the path loss in three different types of environments using MATLAB.

The received power level in dBm is given by:

- ρ_r(dBm) = pt(dBm) + Gt(dBi) − Gr(dB)

The generic form expression for path loss (PL) in dB:

- $\rho_L(dB) = A + B\, log10(d) + C$

The factors A,B depend on the frequency of transmission, antenna heights and the type of environment:

- A = 69.55 + 26.16log10(fc) − 13.82log10(hb) - a(hm)
- B = 44.9 − 6.55log10(hb)

Task Requirements:

- a) plot a graph for the path loss vs. distance using Hata model, for fc = 1500 MHz, hb = 70 m and hm =1.5 m in following environments:
  1. Open
  2. Suburban
  3. Metropolitan

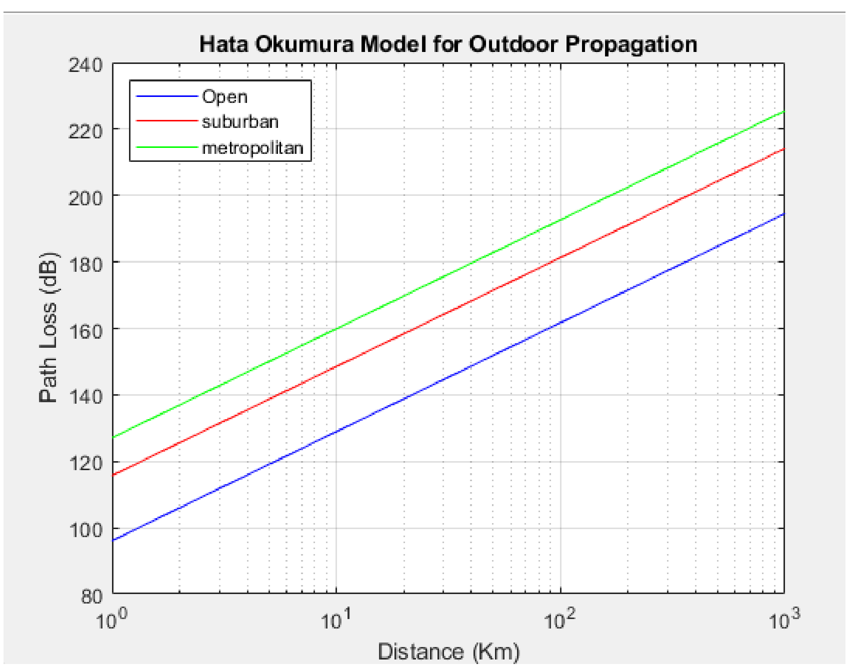
- ## Function Code:

```
function pl=Okumora(fc,d,hb,hm,envtype)
% to make input string as lower letters
% to esnure that this string is identical to our conditon %
envtype = lower(envtype);
% to check what the string is Added %
    switch envtype
        case 'open'
            aHm=(1.1*log10(fc)-0.7)*hm-(1.56*log10(fc)-0.8);
            c=-4.78*(log10(fc)).^2+18.33*log10(fc)-40.98;
        case 'suburban'
            aHm=(1.1*log10(fc)-0.7)*hm-(1.56*log10(fc)-0.8);
            c=-2*(log10(fc/28)).^2-5.4;
        case 'smallcity'
            c=0;
            aHm=(1.1*log10(fc)-0.7)*hm-(1.56*log10(fc)-0.8);
        case 'metropolitan'
            c=0;
            if fc<=200;
                aHm=8.29*(log10(1.54*hm))^2-1.1;
            else
                aHm=3.2*(log10(11.75*hm))^2-4.92;
            end
        otherwise, error('invalid');
    end
% The factors A,B,C depend on
% the frequency of transmission(fc) antenna heights(hb) and the type
% environment(aHm)
A= 69.55 + 26.16*log10(fc) - 13.82*log10(hb) - aHm;
B= 44.9 - 6.55*log10(hb);
% The generic expression for path loss (PL) in dB %
pl= A + B*log10(d) + c;

end
```

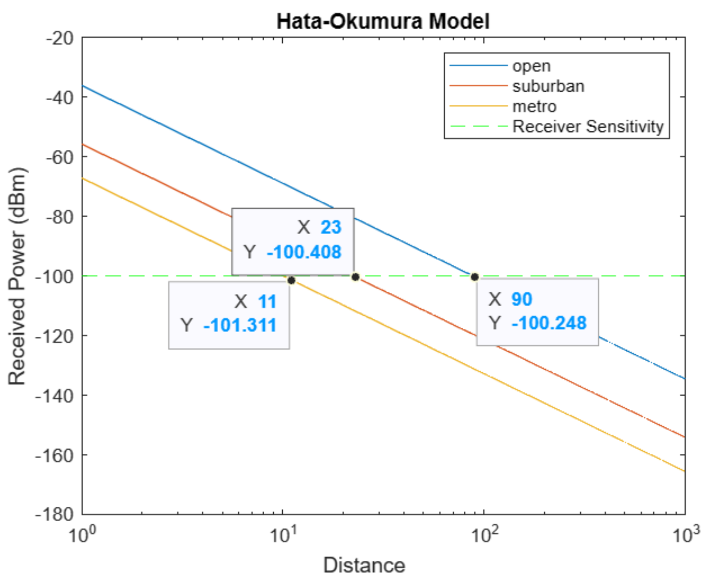
- Main Code:

```
% Abdelrahman Matarawy
% Section 5
clc;
fc=1500;% Frequency in Hz (1500 MHz)
hb=70;% Height of base station in meters
hm=1.5;% Height of mobile station in meters
d=0:1:10e2; % Distance Range
Pt = 1e3; % Transmit power in watts (1 kW)
Pr = 1e-10; % Receiver power in watts (-100 dBm)
c = 3e8; % Speed of light in m/s

% Calculate path loss for each environment
pl_open = Okumora(fc, d, hb, hm, 'open');
pl_suburban = Okumora(fc, d, hb, hm, 'suburban');
pl_metropolitan = Okumora(fc, d, hb, hm, 'metropolitan');

semilogx(d, pl_open, '-b');
hold on;
semilogx(d, pl_suburban, '-r');
semilogx(d, pl_metropolitan, '-g');
xlabel('Distance (Km)');
ylabel('Path Loss (dB)');
title('Hata Okumura Model for Outdoor Propagation');
grid on;
legend('Open', 'suburban', 'metropolitan');
```

- OutPut:



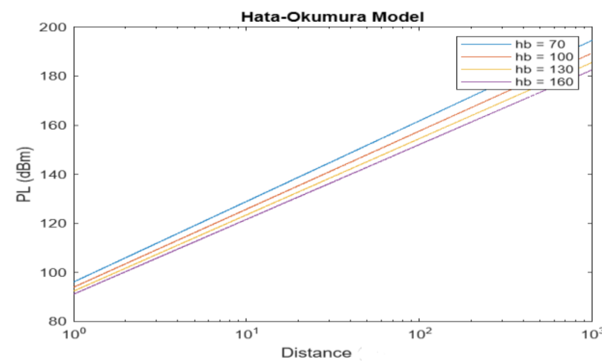
➢ b) For each of the plotted cases find the maximum range that can be covered by a station radiating a power of 1KW given that the receiver sensitivity is -100dBm.



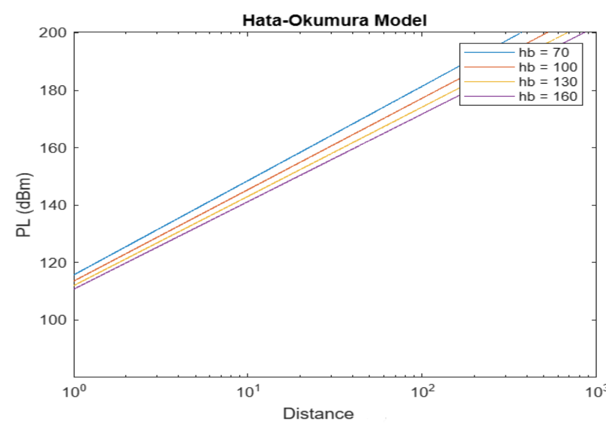
a. open = 11 km
b. suburban = 23 km
c. metropolitan = 90 km

c) Plot the graphs in point (a) at different values of hb (70m-100m-130m-160m) to show the effect of changing the base station height on the path loss.

- Open:



- Suburban:



- metropolitan: