1. Consider a dipole antenna with a/λ = 0.006 at 600 MHz.
    a. Find its resonant length and resonant resistance using the plots. Plot R and X over 470-750 MHz using Tai's formula.

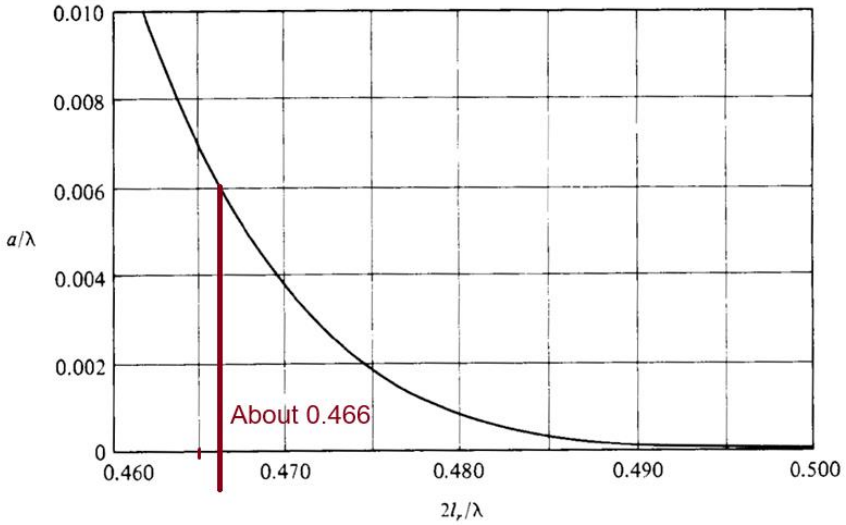


Fig. 7.13 Resonant Length versus Radius for Center-Fed Cylindrical Dipoles

$$\lambda_0 = \frac{c_0}{f_0} = \frac{299792458\ m/s}{600\ MHz} \approx 50\ cm$$

$$\frac{2l_r}{\lambda} \approx 0.466 \rightarrow l_r \approx 11.64\ cm$$

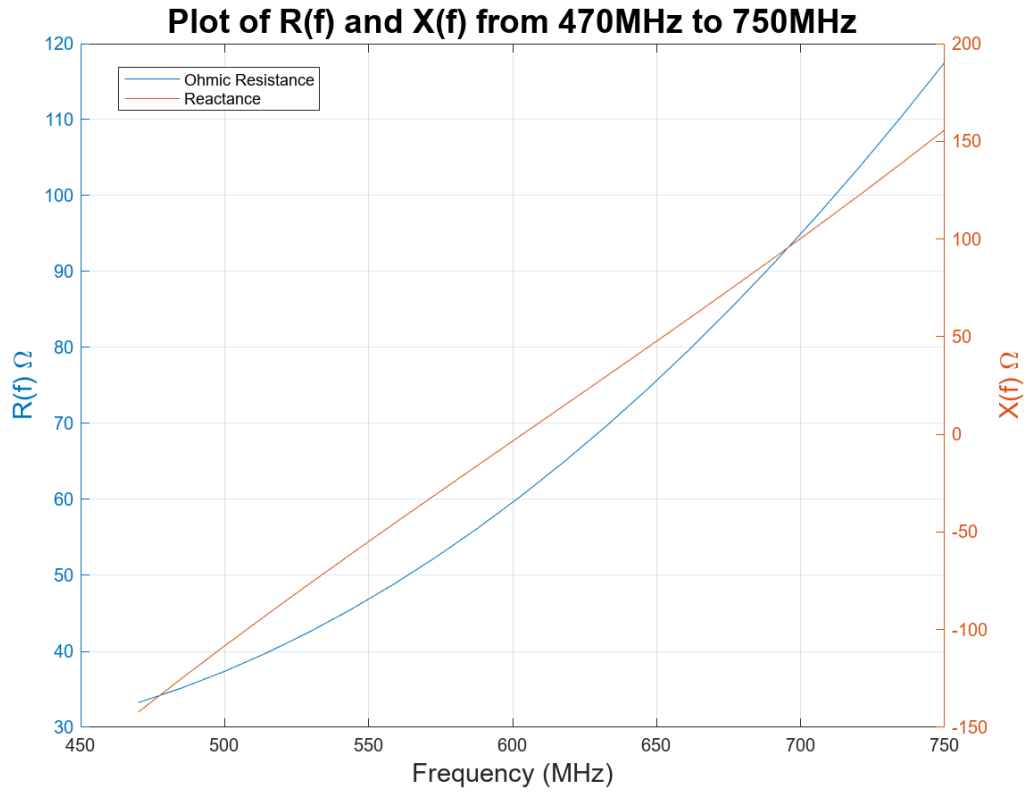
Dipole Length = 23.28 cm

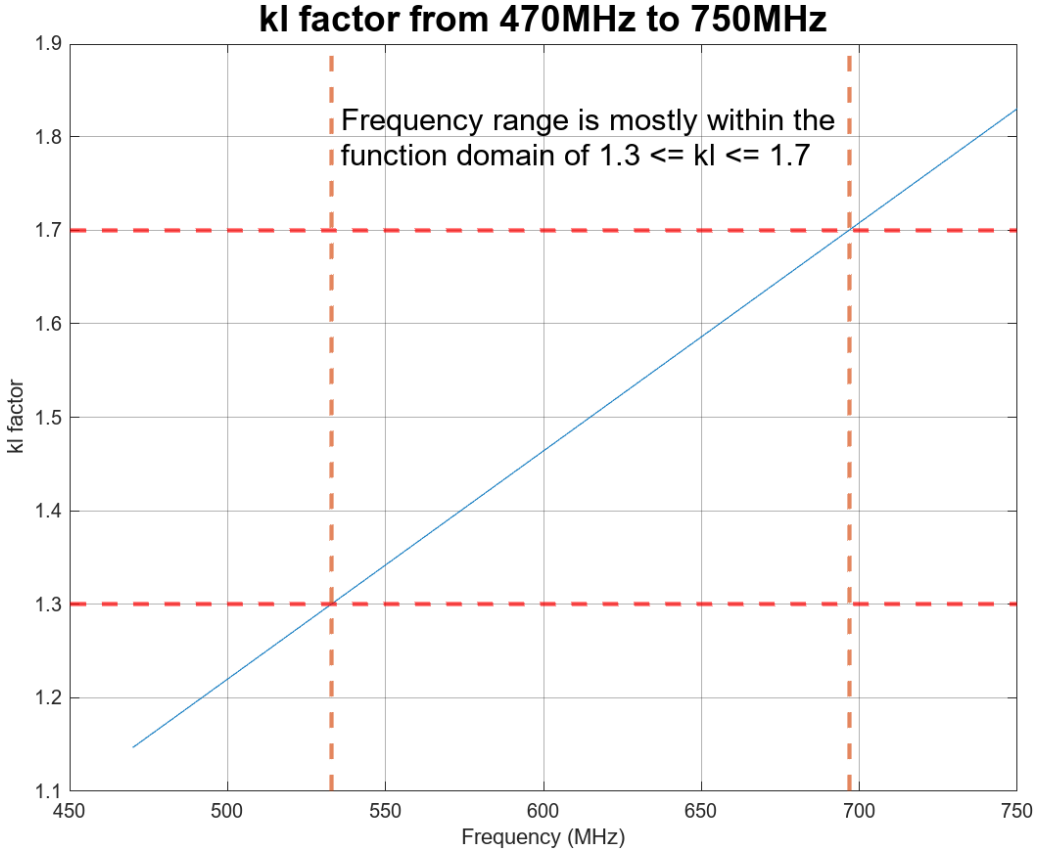
Figure 1 Code

```
syms f
lambda = 3e8/f;
length = 0.233 * 3e8/600e6;
alpha = 0.006;
k(f) = (2*pi)/lambda;
R(f) = 122.65 - 204.1*k(f)*length + 110*(k(f)*length)^2;
X(f) = -1*( 120*(log(2*length/alpha - 1) * cot(k(f)*length)) - 162.5 + 140*k(f)*length - 40*(k(f)*length)^2 );
f1 = linspace(470e6, 750e6, 20);
F = figure;
F.Position = [0,0,800,600];
centerfig(F);
yyaxis left
plot(f1./1e6, R(f1), "DisplayName", "Ohmic Resistance");
ylabel("R(f) \Omega", "FontSize", 14);
hold on;
yyaxis right
ylabel("X(f) \Omega", "FontSize", 14)
plot(f1./1e6, X(f1), "DisplayName", "Reactance");
title("Plot of R(f) and X(f) from 470MHz to 750MHz", "FontSize", 18);
xlabel("Frequency (MHz)", "FontSize", 14);
grid on;
legend();
```

Figure 2 Code

```
F2 = figure;
F2.Position = [0,0,800,600];
centerfig(F2);
plot(f1/1e6, k(f1).*length);
grid on;
title("kl factor from 470MHz to 750MHz", "FontSize", 18);
ylabel("kl factor");
xlabel("Frequency (MHz)");
text(536, 1.8, {"Frequency range is mostly within the", "function domain of 1.3 <= kl <= 1.7"}, "FontSize", 15);
yline(1.3, '--', 'color', 'red', 'LineWidth', 2);
yline(1.7, '--', 'color', 'red', 'LineWidth', 2);
xline(532.8, '--', 'color', '#D95319', 'LineWidth', 2);
xline(696.73, '--', 'color', '#D95319', 'LineWidth', 2);
pca = gca;
pca.GridAlpha = 0.35;
```


Plot of R(f) and X(f) from 470MHz to 750MHz
Ohmic Resistance
Reactance
R(f) Ω
X(f) Ω
Frequency (MHz)
120
110
100
90
80
70
60
50
40
30
200
150
100
50
0
-50
-100
-150
450
500
550
600
650
700
750


kl factor from 470MHz to 750MHz
Frequency range is mostly within the function domain of 1.3 <= kl <= 1.7
kl factor
Frequency (MHz)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
450
500
550
600
650
700
750