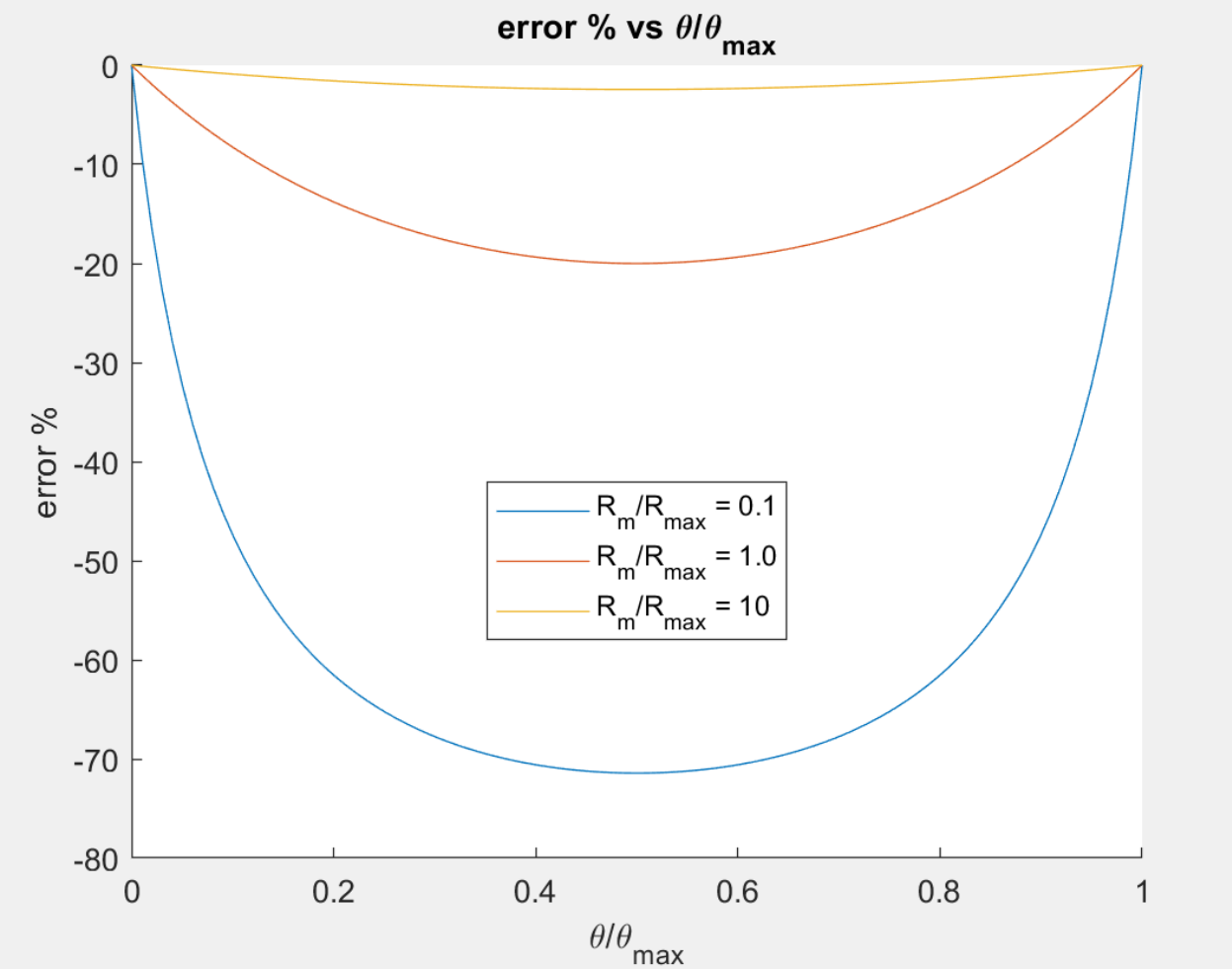
Problem 1

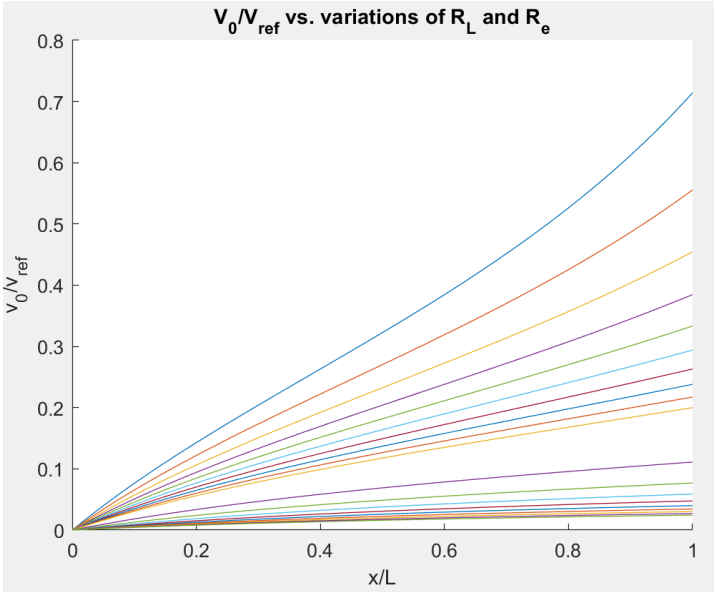


We ideally would like R_m/R_{max} to be as large as possible to avoid high error percentage.

However, we observe in problem 3 that making R_m/R_{max} causes higher nonlinearity.

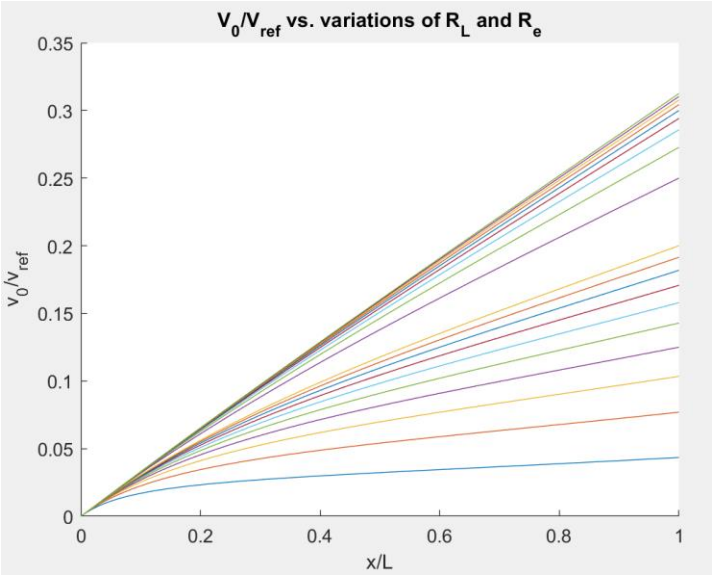
Problem 2

The figure below describes the variation of the normalized output voltage while changing the end resistances. We can see that the larger the end resistance, the more linear the variation of the output voltage will be. However, we are sacrificing sensitivity with increasing end resistance because the slope of the graph decreases with increasing end resistance.



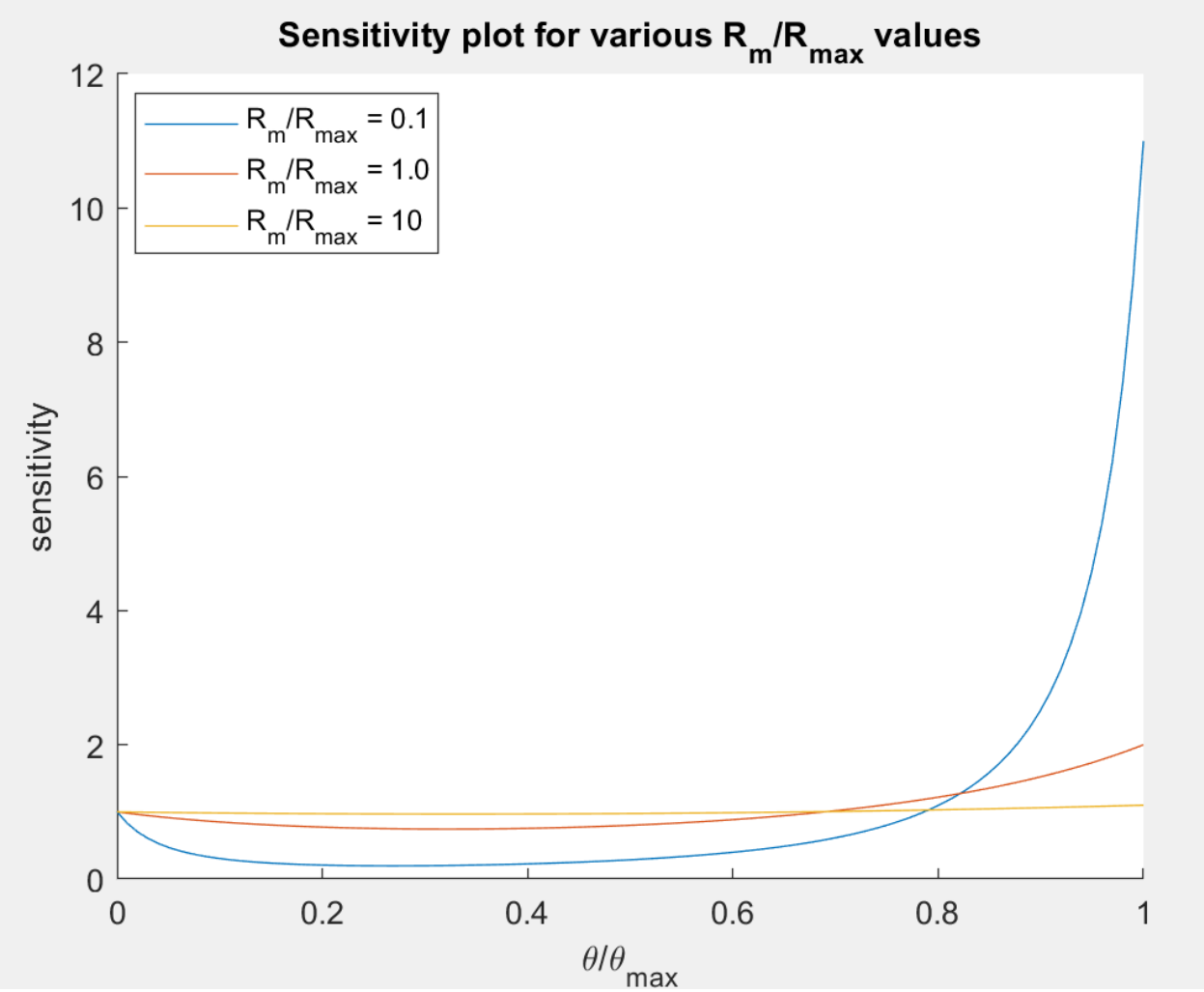
Effect of variation of R_e on V_0/V_{ref}

The figure below describes the normalized output voltage while varying the load resistance. As learned previously in class, increasing the load resistance will cause the normalized output voltage to be more linear since the test point will be closer to an open circuit. When the load resistance go lower, the measurement will both be less sensitive and less linear.



Effect of variation of R_L on V_0/V_{ref}

Problem 3



Upon observing the graph, we learn that the sensitivity of the rotary potentiometer is the highest at

$$\theta / \theta_{max} = 1$$

Solving the derivative of the sensitivity and finding its roots to find out the maximum point will not work since there is no maximum point observed in the graph, only minimum points.

MATLAB Code

```
%ME 473 - HW5
%Khrisna Kamarga

%% Problem 1

clear all; close all; clc;

RmRmax = [0.1, 1, 10];
thetaThetaMax = linspace(0, 1);

hold on
for i = RmRmax
    error = (i./(i + thetaThetaMax - thetaThetaMax.^2) - 1) * 100;
    plot(thetaThetaMax, error);
end
title("error % vs \theta/\theta_{max}");
legend("R_m/R_{max} = 0.1", "R_m/R_{max} = 1.0", "R_m/R_{max} = 10", "Location",
"best");
xlabel("\theta/\theta_{max}");
ylabel("error %");

%% Problem 3
clc;

hold on
for i = RmRmax
    sensitivity = (i*(thetaThetaMax.^2 + i))./(thetaThetaMax.^2 - thetaThetaMax -
i).^2;
    plot(thetaThetaMax, sensitivity);
end
title("Sensitivity plot for various R_m/R_{max} values");
legend("R_m/R_{max} = 0.1", "R_m/R_{max} = 1.0", "R_m/R_{max} = 10", "Location",
"best");
xlabel("\theta/\theta_{max}");
ylabel("sensitivity");

%% Problem 2
clear all; clc; close all;

Rc = 1;
a = linspace(0,1);
ratio = linspace(0.1,0.9,9);
ratio = [ratio linspace(1,10,10)];


hold on
for i = 1
    Rl = i*Rc;
    for j = ratio
        Re = j*Rc;
        for k = a
            y = Rc*Rl*a./((2*Re+Rc*(1-a)).*(Rc*a+Rl)+Rc*Rl*a);
            plot(a,y);
        end
    end
end
title("V_0/V_{ref} vs. variations of R_L and R_e");
xlabel("x/L");
ylabel("v_0/v_{ref}");
```