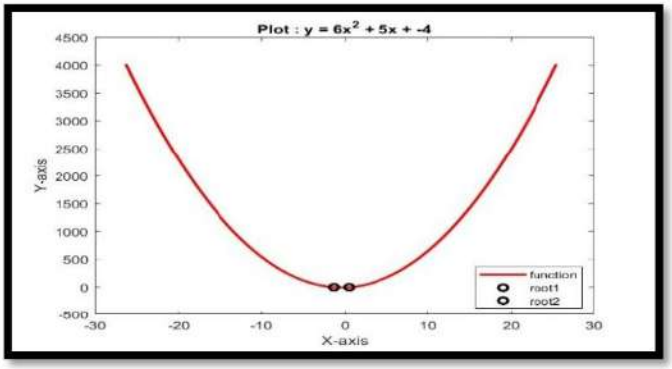
NAVJOT KAUR (301404765)

MACM 316: COMPUTING ASSIGNMENT 1

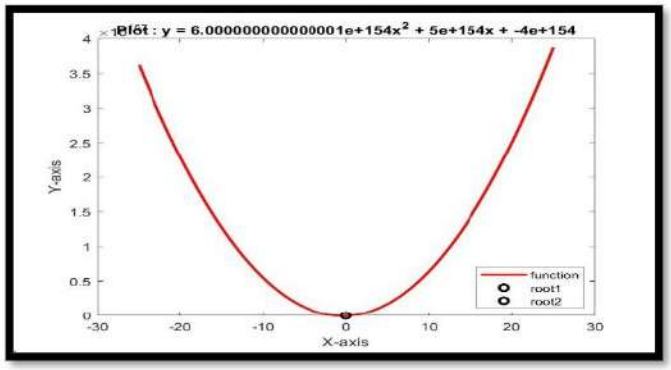
The MATLAB code provided below calculates all the roots of the quadratic equation. It checks all the cases i.e., when discriminant D>0, D=0, and D<0. It also handles special cases when a=0 and b=0. Moreover, when b^2 is much larger than $4ac$, due to subtractive cancellation we experience a poor approximation of root with large relative error. So, to tackle this problem, the provided code uses the alternate quadratic formula obtained by rationalizing the numerator of the original formula which is used based on whether b<0 or not.

Case	a	b	c	root1	root2
1	6	5	-4	-1.3333	0.5000
2	$6 * 10^{154}$	$5 * 10^{154}$	$-4 * 10^{154}$	-Inf	0
3	0	1	1	-1	-------
4	1	-10^5	1	1.0000e-05	1.0000e+05
5	1	-4	3.999999	1.9990	2.0010
6	10^{-155}	-10^{155}	10^{155}	0	Inf

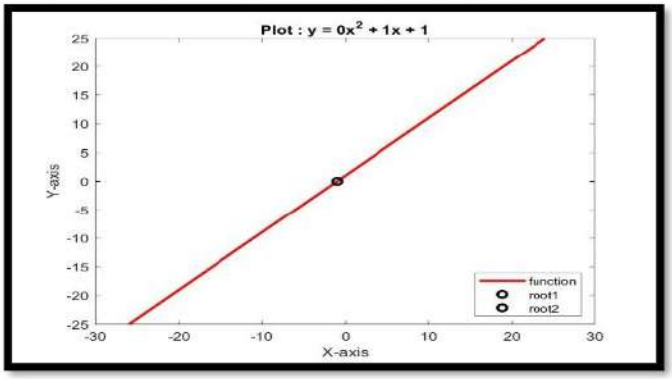
Plot 1: Two real roots



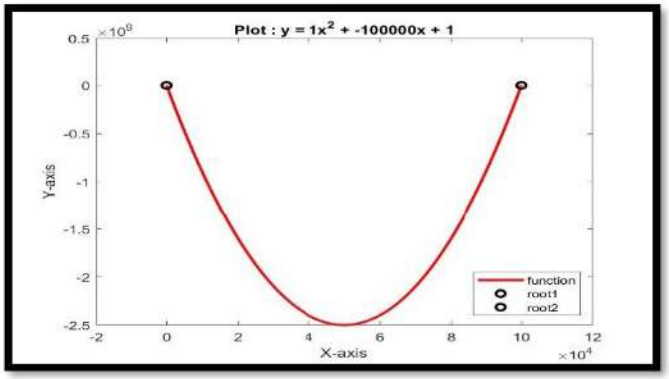
Plot 2: Since b^2 exceeds realmax, root1 is -Inf and root2 is 0 due to division by infinity, it can be seen by zooming in as the points are not on function curve.



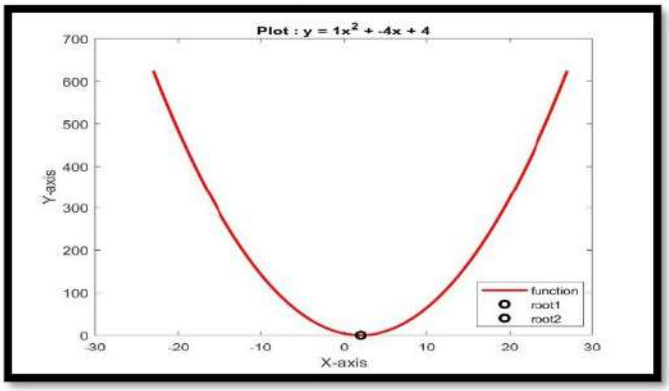
Plot 3: One root because a=0 and the formula is linear.



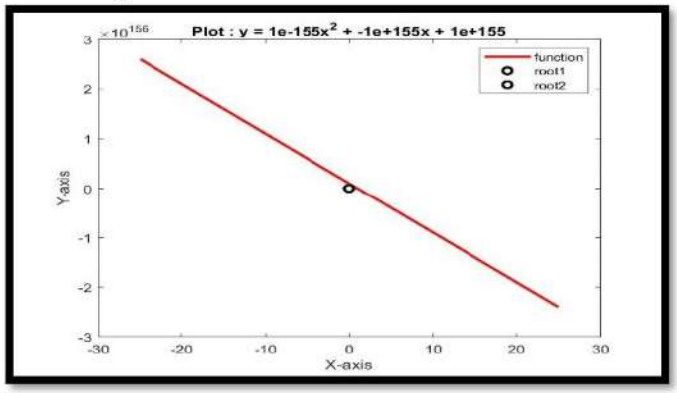
Plot 4: Two real roots.



Plot 5: Two real roots, however the roots are very close to each other, the plot shows them as one point, they can be seen while zooming in.



Plot 6: Since b^2 exceeds realmax, root2 is Inf and root1 is 0 as it is division by infinity, it can be seen by zooming in as the points are not on function curve.



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MATLAB CODE

```
function roots = quadformula(a,b,c)
    D=(b^2) - (4*a*c);
    if a==0
        if b==0
            roots=[];       %no roots because the equation is not quadratic or linear.
            disp("The equation has no roots : "+roots);
        else
            root1 = (-c)/b; root2 = (-c)/b;
            roots = root1;  %one root because the equation is linear.
            disp("The equation has one root : "+roots);
        end
    elseif D>0              %two real roots
        if b<0              %root1 with alternate quadratic formula.
            root1 = (-2*c)/(b-sqrt(D));  root2 = (-b+sqrt(D))/(2*a);
            roots = [root1, root2];
        else                %root2 with alternate quadratic formula.
            root1 = (-b-sqrt(D))/(2*a);  root2 = (-2*c)/(b+sqrt(D));
            roots = [root1, root2];
        end
        disp("The equation has two roots : "); disp(roots);
    elseif D==0             %one real root
        root1 = (-b)/(2*a); root2 = (-b)/(2*a);
        roots = root1;
        disp("The equation has one root : "+roots);
    else
        roots = [];         %two complex roots i.e, no real roots.
        disp("The equation has no roots"); disp(roots);
    end
    if isempty(roots)
        x=linspace(-25,25);
        y=((a*(x.^2))+(b*x)+c);
        plot(x,y,"r-","LineWidth",2);
        xlabel("X-axis");  ylabel("Y-axis");
        title("Plot : y = "+a+"x^2 + "+b+"x + "+c);
        legend("function");
    else                    %cases when one or both roots are infinity.
        if (root1==-Inf) && (root2~=Inf)
            x=linspace(root2-25,root2+25);
        elseif (root1~=-Inf) && (root2==Inf)
            x=linspace(root1-25,root1+25);
        elseif (root1==-Inf) && (root2==Inf)
            x=linspace(-25,25);
        elseif (root1~=-Inf) && (root2~=Inf)
            x=linspace(root1-25,root2+25);
        elseif root1==root2
            if(root1==-Inf)
                x=linspace(-25,25);
            elseif (root1==Inf)
                x=linspace(-25,25);
            end
        end
        y=((a*(x.^2))+(b*x)+c);
        plot(x,y,"r-","LineWidth",2);
        hold on;
        xlabel("X-axis");  ylabel("Y-axis");
        title("Plot : y = "+a+"x^2 + "+b+"x + "+c);
        legend("function");
        plot(root1,0,"ko","LineWidth",2,"DisplayName","root1");
        plot(root2,0,"ko","LineWidth",2,"DisplayName","root2");
        hold off;
    end
end
```