C PROGRAMMING: SOLVING THE QUADRATIC EQUATION

```
/* This program solves the quadratic equation */
#include <stdio.h>
#include <math.h>
int main(void)
{
double a,b,c,root1,root2;
printf(" Please enter a \n");
scanf("%lf",&a);
printf(" Please enter b \n");
scanf("%lf",&b);
printf(" Please enter c \n");
scanf("%lf",&c);
root1 = (-b + sqrt(b*b-4.*a*c) ) / (2.*a);
root2 = (-b - sqrt(b*b-4.*a*c) ) / (2.*a);
printf("\n First  root is %lf ",root1);
printf("\n Second root is %lf ",root2);
printf("\n ");
return 0;
}
```

Comments:

[1] When you compile with gcc you need to link to the math library

```
gcc -o quadratic.e quadratic.c -lm
```

Otherwise, the compiler does not know about the square root function sqrt . You will also need to use the -lm ‘compiler switch’ if you use other special functions: exp, sin, log, abs

[2] You should always check your codes as much as possible. Often all you can do is special cases because you cannot solve the whole problem. In this case we don’t really need a computer. Try, for example, $a = 2, b = 5, c = -3$ and then solve the problem with pencil and paper (either with the quadratic equation or by factoring).

[3] Can anyone see a flaw in the program? What happens if you run the code with $a = 2, b = 5, c = 4$? What does 'nan' mean? (Answer: not a number).

[4] What is the geometric interpretation of the discriminant being negative? Answer: the parabola $y = ax^2 + bx + c$ doesn't intersect the x-axis.

We can write a better program to deal with the case when the discriminant is negative.

```
/* This program solves the quadratic equation more completely*/
#include <stdio.h>
#include <math.h>
int main(void)
{
double a,b,c,root1,root2;
printf(" Please enter a \n");
scanf("%lf",&a);
printf(" Please enter b \n");
scanf("%lf",&b);
printf(" Please enter c \n");
scanf("%lf",&c);
if (b*b-4.*a*c>0)
{
root1 = (-b + sqrt(b*b-4.*a*c) ) / (2.*a);
root2 = (-b - sqrt(b*b-4.*a*c) ) / (2.*a);
printf("\n First  root is %lf ",root1);
printf("\n Second root is %lf ",root2);
}
else
{
printf("\n Discriminant is negative!  No roots!");
}
printf("\n ");
return 0;
}
```

[5] This upgraded program introduces to a new element of the C language: the if statement. The syntax of the if statement is fairly straightforward: within the parentheses (   ) is an arithmetic expression. If the expression is true, the lines within the first curly brackets { } are executed. If it is false, the lines within the second curly brackets (following the else.) are performed. More complex if statements are also available.

[6] Extra task for those interested: Could you write a program which can deal with negative discriminants and print out a complex number answer like $2+3i$? Hint: you do not need to know how to use complex numbers in C to write the program.

[7] Can you prove the quadratic formula? Hint: Take ax^2+bx and 'complete the square'

$$\begin{aligned} ax^2+bx &= a(x^2+\frac{b}{a}x) = a(x^2+\frac{b}{a}x+\frac{b^2}{4a^2}-\frac{b^2}{4a^2}) \\ &= a(x^2+\frac{b}{a}x+\frac{b^2}{4a^2})-\frac{b^2}{4a} = a(x+\frac{b}{2a})^2-\frac{b^2}{4a} \end{aligned}$$