INDIAN INSTITUTE OF TECHNOLOGY GANDHINAGAR

MA 202: MATHEMATICS - IV
Semester–II, Academic Year 2022-23

Tutorial Set -1
Question - 2

By

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➔ In question 2, we are asked to find the square root of a number using the fixed point iteration method. For this, let us say we need to find the square root of a given number X. that is, let $x^2 = X$.

➔ For the fixed-point iteration method, we know that we need to recast the function in terms of x = g(x). Firstly, I let $f(x) = x^2 - X = 0$. Directly recasting f(x) as g(x) = x = X/x might cause some problems when x is small, as it might not converge. For this, I rewrite f(x) as 2x = X/x + x, or in other words, g(x) = x = 0.5*(X/x + x). I have selected the initial root as 1. After iterating through the loops, we can find the approximation to the square root. An important point to note is that the iterations are being stopped if the number of iterations exceeds 1000, OR, the relative approximation error is less than tolerance.

```
function [x_r] = T2_20110131(x0)
% to print the value of x_r up to long decimal digits
format("long")
% Initialize the vales of tolerance and error
tol = 0.00000000001;
err = 1000;

% Checking with the help of Fixed Point Iteration's Method (kindly comment out the code when not
% required)
% Define the initial guess
xi = 1;
% f(x)= x^2 - x0;        Given function
% Run the while loop to run the iterations
while err > tol
    x_r = G(xi);
    err = abs((x_r - xi)/x_r);
    xi = x_r;
end
% Create a function to find the value of G(x(i)) followed by x(i+1)=G(x(i))
function val = G(x)
val = 0.5 * ((x0/x) + x);
end

% % Checking with the help of Newton's Method (kindly comment out the code when not
% % required)
% xi = 1;
```

```
>> [x_r] = T2_20110131(3)

x_r =

   1.732050807568877

>> [x_r] = T2_20110131(10)

x_r =

   3.162277660168379

>>
```

Output of the function

➔ It is also observed that the output remains the same even if the initial root is changed.

➔ As could also be seen after running the block for Newton's method code, Newton's method also gives the same result for the square root of the number. However, it takes a lot of time to run the code for Newton's method. The code for Newton's code can be run by uncommenting the block of code corresponding to Newton's method.

➔ **NOTE**: Kindly uncomment the code of Newton's method and comment out the code for fixed-point iteration, in order to run the code-block for Newton's method.