MA322 – Scientific Computing Lab

Lab – 05

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- Run output_file.m to run the code.

Ques – 1

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Que-1:-
The Forward Difference Table will be:-
1.000e+00       2.214e-01       4.902e-02       1.086e-02       2.380e-03
1.221e+00       2.704e-01       5.988e-02       1.324e-02       0.000e+00
1.492e+00       3.303e-01       7.312e-02       0.000e+00       0.000e+00
1.822e+00       4.034e-01       0.000e+00       0.000e+00       0.000e+00
2.226e+00       0.000e+00       0.000e+00       0.000e+00       0.000e+00

The approximate value of f(0.05) is: 1.05125880

The Backward Difference Table will be:-
1.000e+00       0.000e+00       0.000e+00       0.000e+00       0.000e+00
1.221e+00       2.214e-01       0.000e+00       0.000e+00       0.000e+00
1.492e+00       2.704e-01       4.902e-02       0.000e+00       0.000e+00
1.822e+00       3.303e-01       5.988e-02       1.086e-02       0.000e+00
2.226e+00       4.034e-01       7.312e-02       1.324e-02       2.380e-03

The approximate value of f(0.65) is: 1.91555052
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Ques – 2

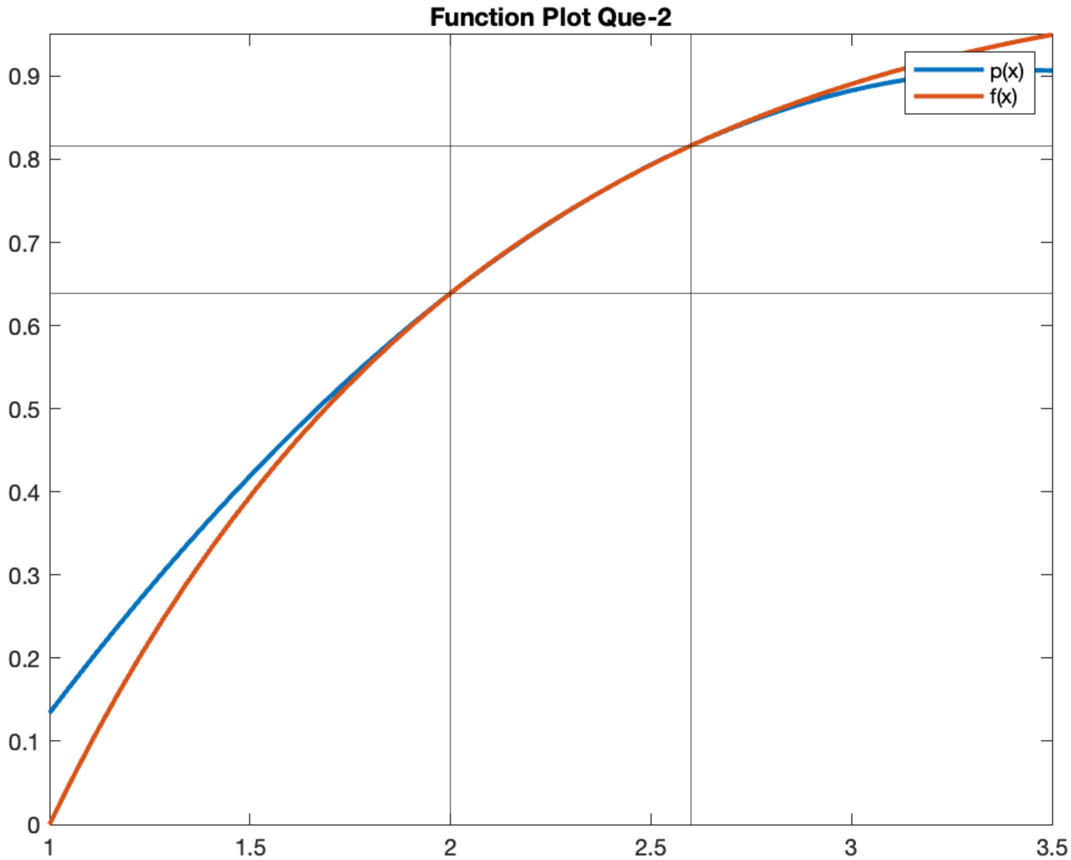
Here, for calculating the theoretical error bound, I found the maximum value of the following expression: -

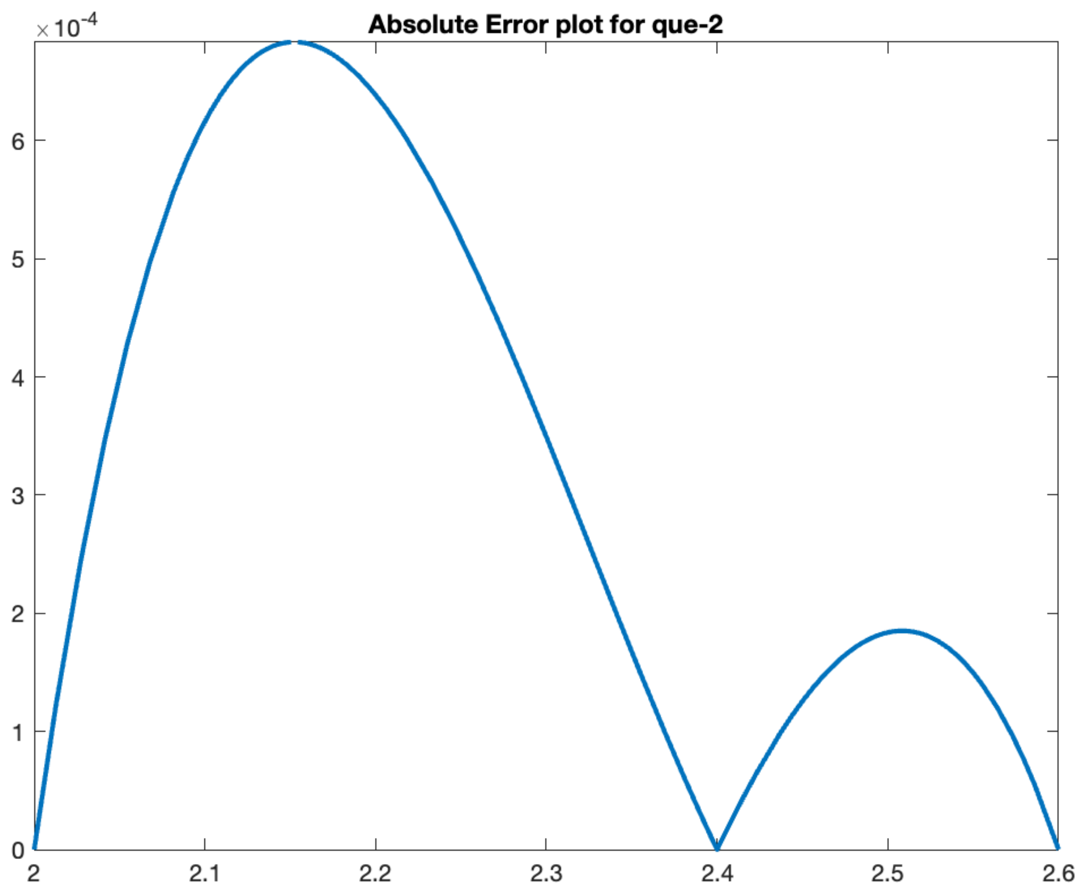
$$\frac{|f'''(\xi(x))|}{3!}|(x-2)(x-2.4)(x-2.6)|$$

in the interval [2, 2.6] The maximum value of $|f'''(\xi(x))|$ is attained at 2 only as f’’’(x) is decreasing, and max value of $|(x-2)(x-2.4)(x-2.6)|$ is attained around x = 2.157 which thus gives the theoretical Error bound as: -9.457890 * 10^{-4}.

Now, to calculate this error bound in MATLAB, I took an array of x values from 2 to 2.6 and $x_{i+1} - x_i$ = 0.001, and calculated the values of both terms at all x, took max m1 and m2 and gave error bound as m1*m2/6. This error bound turned out to be close to the theoretical error bound.

Also, the error plot is given by plotting |p(x) – f(x)| and the function plots are given by simply plotting f(x) and p(x). These show that p(x) successfully interpolates f(x) in interval [2, 2.6].





Ques – 3

Part-(a): - f (0.430000) by Lagrange method is: - 2.3606047341

Part-(b): - f (0.900000) by LaGrange method is: - 0.4419850025

Ques – 4

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Que-4:-
The Divided Difference Table can be given as:-
1.513e+05       2.800e+03       -2.009e+01      5.465e-01       -1.120e-02      9.122e-04
1.793e+05       2.398e+03       -3.695e+00      9.833e-02       3.440e-02       0.000e+00
2.033e+05       2.324e+03       -7.450e-01      1.475e+00       0.000e+00       0.000e+00
2.265e+05       2.309e+03       4.349e+01       0.000e+00       0.000e+00       0.000e+00
2.496e+05       3.179e+03       0.000e+00       0.000e+00       0.000e+00       0.000e+00
2.814e+05       0.000e+00       0.000e+00       0.000e+00       0.000e+00       0.000e+00

Approximate population in the year 1940 = 102397
Approximate population in the year 1975 = 215043
Approximate population in the year 2020 = 513443
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Ques – 5

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Que-5:-
f(0.200000) by lagrange method is :- -5.7785895873
The Divided Difference Table can be given as:-
-6.000e+00      1.052e+00       5.725e-01       2.150e-01       6.302e-02
-5.895e+00      1.223e+00       7.015e-01       2.780e-01       0.000e+00
-5.650e+00      1.574e+00       9.517e-01       0.000e+00       0.000e+00
-5.178e+00      2.240e+00       0.000e+00       0.000e+00       0.000e+00
-4.282e+00      0.000e+00       0.000e+00       0.000e+00       0.000e+00

f(0.200000) by divided differnce is :- -5.7785895873
-------------------------------------------------------------------
After Adding f(1.1) = -3.99583

f(0.200000) by lagrange method is :- -5.7785986494
The Updated Divided Difference Table can be given as:-
-6.000e+00      1.052e+00       5.725e-01       2.150e-01       6.302e-02       1.416e-02
-5.895e+00      1.223e+00       7.015e-01       2.780e-01       7.859e-02       0.000e+00
-5.650e+00      1.574e+00       9.517e-01       3.566e-01       0.000e+00       0.000e+00
-5.178e+00      2.240e+00       1.237e+00       0.000e+00       0.000e+00       0.000e+00
-4.282e+00      2.859e+00       0.000e+00       0.000e+00       0.000e+00       0.000e+00
-3.996e+00      0.000e+00       0.000e+00       0.000e+00       0.000e+00       0.000e+00

f(0.200000) by divided differnce is :- -5.7785986494
```

Here, after adding f (1.1), instead of calculating the whole table again for Newton's Divided Difference method, I resized and updated the existing table and re-calculated the interpolating polynomial p(x) by adding the correction term to it.

We can see both the methods are giving same answer for both the tables, this is because the interpolating polynomial (p(x)) formed by both the methods is completely same, just the method of calculating that is different, both methods are just different representations of each other.

Also, after adding f (1.1) = -3.99583 to the table, the solution is changed but the change is of order 10^{-5} i.e., negligible.