**ECE 4960 Spring 2018: Computational and Software Engineering**

**Reading 2: Differentiation in Local Analysis**

Deposit a pdf file of the two tables below to your Git directory before 11:59pm of 2/11

**Document your programming environment: Language; development platform; operating system**

**Prob. 1. (Quadratic function to observe the tradeoffs between the truncation error and round-off error):** For *f(x) = x2*, we know the exact *f’(x=1)* =2.

1.1 Use Eq. (1) below to estimate *f’(x=1)* varying the value of *h* from 0.1 to 10-18 to observe the relative error in calculating *f’(x)*. Tabulate your results with sufficient precision in a table.

1.2 Repeat your calculation with *f(x) = x2* + 108. Add your results to the same table.

1.3 Repeat the above two procedures by using Eq. (2). Add your results to the same table.

 (1)

 (2)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *h* | Error in*f’(x=1)* by Eq. (1) where *f(x) = x2* | Error in*f’(x=1)* by Eq. (1) where *f(x) = x2 + 108* | Error in*f’(x=1)* by Eq. (2) where *f(x) = x2* | Error in*f’(x=1)* by Eq. (2) where *f(x) = x2 + 108* |
| 10–1 | 0.050 | **0.049** |  |  |
| 10–2 | **0.005** | **0.005** |  |  |
| 10–3 |  |  |  |  |
| … |  |  |  |  |
| 10–18 | **1.0** | **1.0** | **1.0** | **1.0** |

**Prob. 2. (Cubic function to observe the Richardson error estimation):** For *f(x) = x3*, we know the exact value of *f’(x=1)* = 3.

2.1 Use Eqs. (3) – (5) below to estimate *f’(x=1)* varying the value of *h* from 2-4 to 2-40 to observe the relative error in calculating *f’(x)*. Tabulate your results with sufficient precision in a table.

2.2 Estimate *η* from Eqs. (6) and (7) for each choice of *h*. Add your results to the same table.

 (3)

 (4)

 (5)

 (6)

 (7)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *h* | Error in*f’(x=1)* by Eq. (3) | Error in*f’(x=1)* by Eq. (4) | Error in*f’(x=1)* by Eq. (5) | *η* by Eq. (6) | *η* by Eq. (7) |
| 2–4 | **3.191** | **3.391** | **2.992** | **2.080** | **2.222** |
| 2–5 | **3.095** | **3.191** | **2.998** | **2.041** | **2.118** |
| 2–6 | **3.047** | **3.094** | **3.000** | **2.021** | **2.061** |
| … |  |  |  |  |  |
| 2–40 | **3.0** | **3.0** | **3.0** | **NaN** | **NaN** |