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## Assignment # 5

### Question # 1 :

**PART 1:** A function is given by  $f(x) = 5e^{-2x}$ . Now Answer the following:

1. [1 Mark] Calculate  $f'(x)$  at  $x = 0.4$  with  $h = 0.32$  using the central difference formula upto 5 significant figures.
2. [1 Mark] Calculate  $f'(x)$  at  $x = 0.4$  with  $h = 0.16$  using the central difference formula upto 5 significant figures.
3. [2 Marks] Now compute  $D_{0.32}^{(1)}$  at  $x = 0.4$  using Richardson extrapolation method upto 5 significant figures.
4. [2 Marks] If the exact value of the derivative,  $f'(0.4)$  is -4.4933, find the percentage error with the extrapolated value found in the previous part.

**PART 2:** In the lecture note and also in the video lecture, we have shown the general expression for  $D_h^{(1)}$ , which is known as the Richardson Extrapolation method to find the numerical derivative of a function. Using the same method, answer the following:

1. [2 Marks] Starting from the expression for  $D_h^{(1)}$ , write the expression for  $D_{h/2}^{(1)}$  up to order of

$O(h^8)$

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2. [2 Marks] Define the 6-th order approximation as the following



$$D_h^{(2)} \equiv \frac{2^4 D_{h/2}^{(1)} - D_h^{(1)}}{2^4 - 1}.$$

Now find an algebraic expression for  $D_h^{(2)}$  up to terms of order  $O(h^8)$ .

### Submission of the Assignment # 5:

- Solve all the problems above.
- Prepare a title page including Your Name, Your ID#, Theory Section #.
- Prepare a single .pdf or .jpg file containing the title page and the solution pages.
- To submit your assignment solution, visit the Submission Link ([Click here](#)). This will take you to a Google Form link.
- Fill up the Google Form link with correct information and upload the file there. You are done.

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