

**CSE330: Spring 2025**  
**Assignment 3**  
**Total Marks: 25**

1. Consider the function  $f(x) = x \ln(x)$ . Now answer the following:

(a) (2 marks) Evaluate the numerical derivative of  $f(x)$  at  $x = 1.0$  with step size  $h = 0.1$  using the **forward and central difference** methods up to 5 significant figures.

(b) (4 marks) Compute the upper bound of the truncation error of  $f(x)$  at  $x = 1.0$  using  $h = 0.1$  for the **backward and central difference** methods up to 5 significant figures.

(c) (4 marks) **Deduce** an expression for  $D_h^1$  from  $D_h$  by replacing  $h$  with  $(4h/3)$  using the Richardson extrapolation method.

(d) (5 marks) For the given  $f(x)$  and  $x_0 = 1$ ,  $h = 0.1$ , find the **upper bound of error** for **Richardson extrapolation of degree 1** equation derived in 1(c).

.

2. (3+2 marks) The following Data set is generated by the function  $f(x) = x \cos(x) - x + \sin(x)$ .

x	1.1	1.2	1.3
f(x)	0.2902	0.1669	0.01131

Based on the above data, compute  $f'(1.2)$  using the **Central Difference** method, and also calculate the **relative error**. Use 4 significant figures.

3. Consider the function  $f(x) = 4x^3 - 9e^{7x}$ . Now answer the following:

a) (3 marks) Compute  $D_{0.2}^{(1)}$  at  $x = 2.7$  using **Richardson extrapolation** method up to 4 significant figures.

b) (2 marks) Compute  $D_{0.2}^{(2)}$  at  $x = 2.7$  using **Richardson extrapolation** method up to 4 significant figures.