Computational Fluid Dynamics (AE/ME 339)
MAEEM Dept., UMR

Home Work Problem 3

 (Retain 5 significant digits for your answers)

 Given the function u

$$u = (3x + 2^x)y \qquad\qquad (1)$$

do the following:

a) Calculate, using Taylor series, the backward, forward and central difference approximations of $\dfrac{\partial u}{\partial x}$ at x = 1, y = 1 for Δx = 1.0, 0.5, 0.25, 0.1, 0.05, and 0.01. Plot the error (defined as the difference between the exact value of the derivative obtained by differentiating Eq. (1) and the finite difference approximation, as a function of Δx for each type of differencing. Plot all in one figure.

b) Write expressions for the first term truncated for each of the three differences (BD, FD, CD) obtained in Part (a). Then obtain numerical values for the first term truncated, as a function of Δx. You will need to differentiate u to get $\dfrac{\partial^2 u}{\partial x^2}$ and $\dfrac{\partial^3 u}{\partial x^3}$, etc., to do this.

c) Compare the values of the first term truncated obtained from Part (b) with the truncation error found in Part (a), and discuss the extent to which the first term truncated provides an accurate representation of the truncation error.

Note: Summarize your results in a table.