

# Assignment ~~1~~ 2

$f_{\text{approx}}(x)$

$$1. \frac{f(x+h) - f(x)}{h} = f'(x) + \frac{h}{2} f''(x) \dots$$

$$E(h) = \left| \frac{f_{\text{exact}}(x) - f'(x) - \frac{h}{2} f''(x)}{f'(x)} \right|$$

$$= \left| \frac{\frac{h}{2} f''(x)}{f'(x)} \right| = \left| \frac{-\frac{h}{2} \cdot -\alpha^2 \cos(\alpha x)}{-\alpha \sin(\alpha x)} \right| = \text{error as a function of } h$$

(Graphs included for  $\alpha = 1, 10, 100$ )

$$2. \frac{f(x+h) - f(x-h)}{2h} = \frac{f(x) + hf'(x) + \frac{h^2}{2} f''(x) + \frac{h^3}{3!} f'''(x)}{2h} - \frac{(f(x) - hf'(x) + \frac{h^2}{2} f''(x) - \frac{h^3}{3!} f'''(x))}{2h}$$

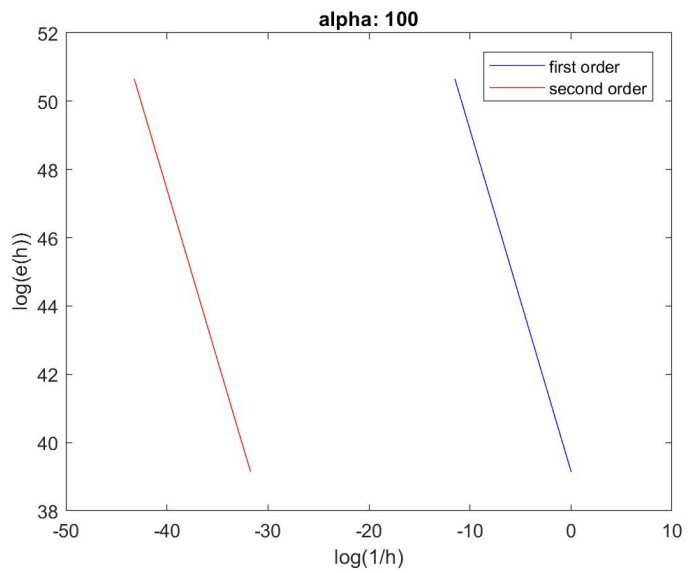
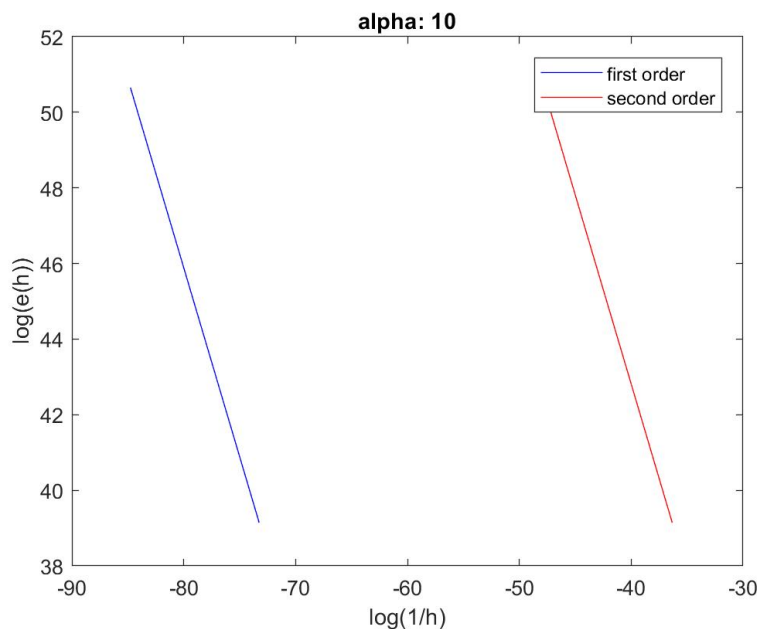
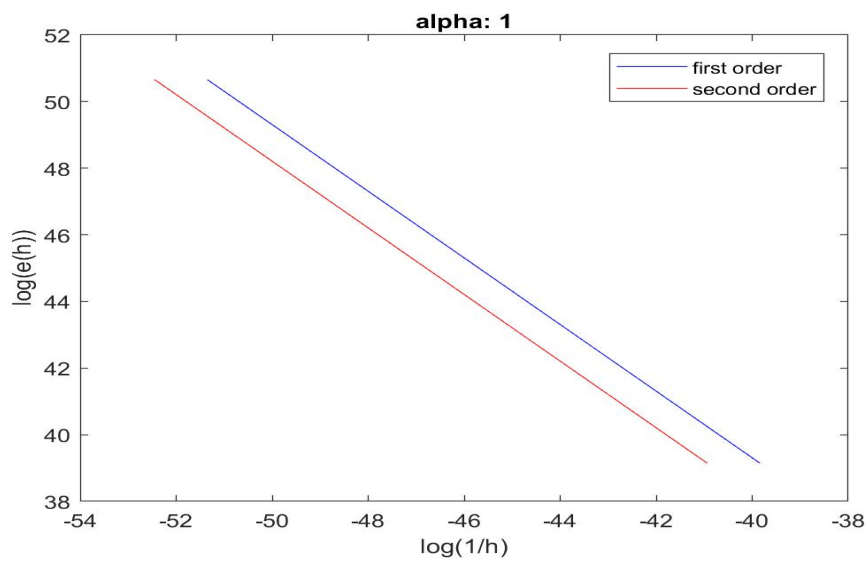
$$= f'(x) + \frac{h^2}{3!} f'''(x)$$

$$E(h) = \left| \frac{f'(x) - (f'(x) + \frac{h^2}{3!} f'''(x))}{f'(x)} \right|$$

$$= \left| \frac{-\frac{h^2}{3!} \cdot \alpha^3 \sin(\alpha x)}{-\alpha \sin(\alpha x)} \right| = \text{error as a function of } h$$

(Graphs included for  $\alpha = 1, 10, 100$ )

Graphed as  $\log(E(h))$  vs.  $\log(1/h)$





## Assignment 2 cont.

3.  $f_1(x) = \cos x - x$

\* All with tolerance of  $10^{-10}$ .

$$\text{root} = .739085$$

(Table included for starting Point = 5)

$$f_2(x) = e^{-x} - x$$

(can only run from starting points

$-19 \leq x \leq 19$ , all above that  
MATLAB gives up and can't calculate them

(Table included for starting Point = 19)

$$f_3(x) = x^2 + 1$$

There is no root so the function does not work

(Table included for starting Point = 10,  
25 terms)

"index"	"value"	"index"	"value"	"index"	"value"
"1"	"-109.8206"	"1"	"-18"	"1"	"4.95"
"2"	"15.9608"	"2"	"-17"	"2"	"2.374"
"3"	"-6.6151"	"3"	"-16"	"3"	"0.97638"
"4"	"4.6001"	"4"	"-15"	"4"	"-0.023907"
"5"	"-743.6197"	"5"	"-14"	"5"	"20.9027"
"6"	"3090.7584"	"6"	"-13"	"6"	"10.4274"
"7"	"-3606.1401"	"7"	"-12"	"7"	"5.1658"
"8"	"-1024.2182"	"8"	"-10.9999"	"8"	"2.4861"
"9"	"65.2592"	"9"	"-9.9997"	"9"	"1.0419"
"10"	"25.3715"	"10"	"-8.9993"	"10"	"0.041084"
"11"	"5.63794"	"11"	"-7.99832"	"11"	"-12.1496"
"12"	"-6.50193"	"12"	"-6.99597"	"12"	"-6.03364"
"13"	"3.04871"	"13"	"-5.99049"	"13"	"-2.93395"
"14"	"-0.65241"	"14"	"-4.97803"	"14"	"-1.29656"
"15"	"3.03057"	"15"	"-3.95082"	"15"	"-0.262642"
"16"	"-0.592446"	"16"	"-2.89512"	"16"	"1.77241"
"17"	"2.62766"	"17"	"-1.79583"	"17"	"0.604103"
"18"	"0.282222"	"18"	"-0.682531"	"18"	"-0.525623"
"19"	"0.812704"	"19"	"0.210895"	"19"	"0.688441"
"20"	"0.740192"	"20"	"0.54184"	"20"	"-0.382058"
"21"	"0.739085"	"21"	"0.567027"	"21"	"1.11767"
"22"	"0.739085"	"22"	"0.567143"	"22"	"0.111479"
"23"	"0.739085"	"23"	"0.567143"	"23"	"-4.42941"
		"24"	"0.567143"	"24"	"-2.10182"
				"25"	"-0.813023"

root = .739085  
function: cos(x)-x

root = .567143  
function: (e<sup>-x</sup>)-x

root = None  
function: (x<sup>2</sup>)+1