Due: 1/14/18 HW #1 | ENGR 3210 Needham, Jacob

<u>Problem 2.26</u>

Pseudo Code

```
"finding height of rocket as a piecewise function

def timeLess15(time):
    "this function produces a height if time less than 15
    heightBefore15 = 38.1454*t + 0.13743*t*t*t
    return heightBefore15

def timeBetween15and33(time):
    "this function produces a height if time between 15 and 33
    heightBefore33 = 1036 + 130.909*(time-15) + 6.18425*(time-15)*(time-15) - .428*(time-15)*(time-15)*(time-15)
    return heightBefore33

def timeAfter33(time):
    "this function produces a height if time is greater than 33
    heightAfter33 = 2900 - 62.468*(time-33) - 16.9274*(time-33)*(time-33) + .41796*(time-33)*(time-33)*(time-33)
    return heightAfter33

"passing time into correct heigh equation
if time < 0:
    height = 0
    print(height)
else if 0 <= time <15
    height = timeLess15(time)
    print(height)
else if 15 <= time < 33
    height = timeBetween15and33(time)
    print(height)
else
    height = timeAfter33(time)
    if height < 0:
        height = 0
        return height
    print(height)
```

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Problem 3 Taylor series parts 1 and 2

Taylor Series 1

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## 3.A1

$f(x) = e^x$

$f(x)' = e^x$

$f(x'') = e^x$

$\Downarrow$

+ so on.

Taylor series is

$$\sum_{n=0}^{\infty} \frac{f^n(a)}{n!}(x-a)^n$$

if $x_i = 0$ $x = x$

then $\frac{f^0(0)(x-0)^0}{0!} + \frac{f^1(0)(x-0)^1}{1!} + \frac{f^2 0(x-0)^2}{2!}$

becomes $\frac{e^0}{1}x^0 + \frac{e^0(x-0)^1}{1!} + \frac{e^0(x-0)^2}{2!}$

which is $1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} \dots \frac{x^n}{n!} \dots$

## 3.A2

$f(x) = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} \dots$

$f(x) = 1$

$f'(x) = 1+x$

$f''(x) = 1 + x + \frac{x^2}{2!}$

$f'''(x) = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!}$

Actual

$f(1) = e^{-x}$

$= .3678$

$\frac{\text{True value} - \text{Approx}}{\text{True}} \times 100 = \%\ err$

0 order Approx; $(1 - .5) = .5$

$f(1) \approx 1$

$\approx 1$

$\frac{.3678 - 1}{.3678} \times 100 = -172\%$

1st order Approx

$f(1) \approx 1 - (1)$

$\approx 0$

$\frac{.3678 - 0}{3678} \times 100 = 100\%$

2nd order Approx

$f(1) \approx 1 - (1) + \frac{(1)}{2!}$

$\approx .5$

$\frac{.3678 - .5}{.3678} \times 100 = -35.9\%$

3rd order Approx

$f(1) \approx 1 - (1) + \frac{(1)}{2!} - \frac{(1)}{3!}$

$\approx \frac{1}{3}$

$\frac{.3678 - \frac{1}{3}}{.3678} \times 100 = 9.39\%$

Taylor Series

3.B

$f(x) = 20x^3 - 5x^2 + 7x - 80$

$f'(x) = 60x^2 - 10x + 7$

$f''(x) = 120x - 10$

$f'''(x) = 120$

True Value

$f(-1) = -112$

Taylor Series

$f(x) \approx \dots \frac{f^n a}{n!}(x-a)^n + \dots$

Error Approx

$\frac{\text{True Value} - \text{Approx}}{\text{True}} \times 100\%$

0 Order Approximation ; $h = -1 - (1) = -2$

$f(-1) \approx 20(1)^3 - 5(1)^2 + 7(1) - 80$

$\approx -58$

$\frac{-112 - (-58)}{-112} \times 100 = 48.2\%$

1st Order Approx ;

$f(-1) \approx -58 + [60(1)^2 - 10(1) + 7](-2)$

$\approx -172$

$\frac{-112 - (-172)}{-112} \times 100 = 53\%$

2nd Order Approx

$f(-1) \approx -172 + \frac{[120(1) - 10](-2)^2}{2!}$

$\approx 48$

$\frac{-112 - (48)}{-112} \times 100 = 142.8\%$

3rd Order

$f(-1) \approx 48 + \frac{120(-2)^3}{3!}$

$\approx -112$

$\frac{-112 - (-112)}{-112} \times 100 = 0\%$