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Course - ENG 281
Assignment III

1. Solution

$x(x-1)y'' + (3x-1)y' + y = 0$

for the nth derivative

$x(x-1)y^{n+2} + (2x-1)ny^{n+1} + n(n-1)y^{n} + (3x-1)y^{n+1} + 3ny^{n} + y^{n} = 0$

$x(x-1)y^{n+2} + y^{n+1}(2xn - n + 3x - 1) + y^{n}(n^2 - n + 3n + 1) = 0$

at $x = 0$

$(y^{n+1})_0(-n-1) + (y^{n})_0(n^2 + 2n + 1) = 0$

$(n+1)(y^{n+1})_0 = -(n^2+2n+1)(y^{n})_0$

$(n+1)(y^{n+1})_0 = (n^2+2n+1)(y^{n})_0$

$(y^{n+1})_0 = (n+1)(y^{n})_0$

at $n = 0$

$(y^{0+1})_0 = (0+1)(y^{0})_0$

$(y')_0 = (y)_0$

at $n = 1$

$(y^{1+1})_0 = (1+1)(y')_0$

$(y'')_0 = 2(y')_0$

at $n = 2$

$(y^{2+1})_0 = (2+1)(y'')_0$

$(y^{3})_0 = 3(y'')$

$(y^{3})_0 = 6(y')_0$

at $n = 3$

$(y^{4})_0 = (3+1)(y^{3})_0$

$(y^{4})_0 = 4(y^{3})_0 = 4 \times 6(y')_0 = 24(y')_0$

at $n = 4$

$(y^{5}) = (4+1)(y^{4})$

$5 \times 24(y')$

$(y^{5})_0 = 120(y')_0$

at $n = 5$

$y = 0.0005 + 0.0005\,[10 + 100 + 1000 + 10000 + 100000 + 1000000 + 10000000]$

$y = 0.0005 + 0.0005\,[11111110]$

$y = 5555.5555\ m$

c) Command window

```
clear
clc
syms x
syms y
x = (0:10)
y = 0.0005 + 0.0005*(x+(x.^2)*(x.^3 +(x.^4)+(x.^5)+
        (x.^6)+(x.^7))
plot (x,y)
grid on
grid minor
xlabel('x')
ylabel('Structural Deformation')
```

$(y^{vi})_0 = (5+1)(y^{v})_0$
$= 6(y^{v})_0$
$= 6\times120(y')_0$
$(y^{vi})_0 = 720(y')_0$
at n = 6
$(y^{vii})_0 = (6+1)(y^{vi})_0$
$= 7(y^{vi})_0$
$= 7\times720(y')_0$
$(y^{vii})_0 = 5040(y')_0$

from maclaurin

$$y = (y)_0 + x(y')_0 + \frac{x^2}{2!}(y'')_0 + \frac{x^3}{3!}(y''')_0 + \frac{x^4}{4!}(y^{iv})_0 + \dots$$

$$\therefore y = (y)_0 + x(y')_0 + \frac{x^2}{2!}(2(y')_0) + \frac{x^3}{3!}(6(y')_0) + \frac{x^4}{4!}(24(y')_0] + \frac{x^5}{5!}(120(y')_0] + \frac{x^6}{6!}(720(y')_0] + \frac{x^7}{7!}(5040(y')_0] + \dots$$

$$y = (y)_0 + (y')_0[x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7 + \dots]$$

but $(y)_0 = 0.0005$ m and $(y')_0 = 0.0005$

$$\therefore y = 0.0005 + 0.0005[x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7]$$

where x = 5 m

$y = 0.0005 + 0.0005[5 + 25 + 125 + 625 + 3125 + 15625 + 78125)$
$y = 0.005 + 0.0005[97655]$
$\therefore y = 48.828$ m

where x = 8 m

$y = 0.0005 + 0.0005[8 + 64 + 512 + 4096 + 32768 + 262144 + 2097$
$y = 1198.3728$ m

when x = 10 m