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17/Eng02/035

Computer Engineering

ENGR 381 - Engineering Math I

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

for the  $n$ th derivative,

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

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

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  $n=0$ ,

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

$$(y^1)_0 = (y^0)_0$$

at  $n=1$ ,

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

$$(y^2)_0 = 2(y^1)_0$$

at  $n=2$ ,

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

$$(y^3)_0 = 3(y^2)_0$$

$$(y^3)_0 = 6(y^1)_0$$

at  $n=3$

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

$$(y^4)_0 = 4(y^3)_0 = 4 \times 6(y^1)_0 = 24(y^1)_0$$

at  $n=4$

$$(y^5)_0 = (4+1)(y^4)_0$$

$$= 5(y^4)_0$$

$$= 5 \times 24(y^1)_0$$

$$(y^5)_0 = 120(y^1)_0$$

at  $n=5$

$$(y^6)_0 = (5+1)(y^5)_0$$

$$= 6(y^5)_0$$

$$= 6 \times 120(y')_0$$

$$(y^6)_0 = 720(y')_0$$

at  $n=6$

$$(y^7)_0 = (6+1)(y^6)_0$$

$$= 7(y^6)_0$$

$$= 7 \times 720(y')_0$$

$$(y^7)_0 = 5040(y')_0$$

from maclaurin series,

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

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

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

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

$$\text{but } (y)_0 = 0.0005 \text{ m and } (y')_0 = 0.0005$$

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

(b) when  $x = 5 \text{ m}$

$$y = 0.0005 + 0.0005 [5 + 25 + 125 + 625 + 3125 + 15625 + 78125]$$

$$y = 0.0005 + 0.0005 [97655]$$

$$\therefore y = 48.828 \text{ m}$$

when  $x = 8 \text{ m}$

$$y = 0.0005 + 0.0005 [8 + 64 + 512 + 4096 + 32768 + 262144 + 2097152]$$

$$y = 0.0005 + 0.0005 [2396744]$$

$$\therefore y = 1198.3725 \text{ m}$$

When  $x = 10\text{m}$

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

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

$$y = 5555.5555\text{m}$$

(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').
```