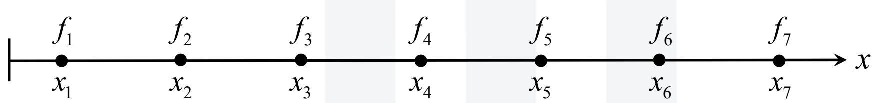
Computational Science:
Computational Methods in Engineering

Numerical Differentiation in MATLAB

MATLAB Code for Numerical Differentiation

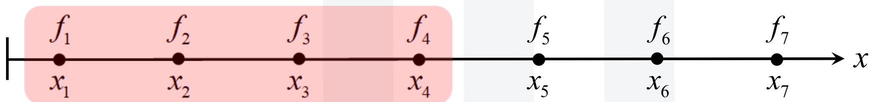
```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
   fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```



Calculation at Point 1

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
   fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
```



$$[\tilde{x}] = [0 \quad h \quad 2h \quad 3h]^T$$

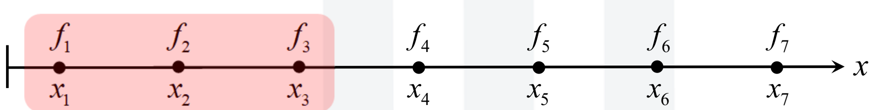
$$\frac{d^2 f_1}{dx^2} \cong \frac{2f_1 - 5f_2 + 4f_3 - f_4}{h^2}$$

EMPossible

Calculation at Point 2

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
   fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;          nx = 2
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```

```
fd(2) = (f(1) - 2*f(2) + f(3))/h^2;
```



$$[\tilde{x}] = [-h \quad 0 \quad h]^T$$

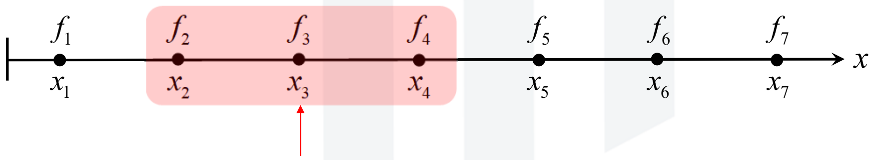
$$\frac{d^2 f_2}{dx^2} \cong \frac{f_1 - 2f_2 + f_3}{h^2}$$

EMPossible

Calculation at Point 3

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
    fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;          nx = 3
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```

```
fd(3) = (f(2) - 2*f(3) + f(4))/h^2;
```



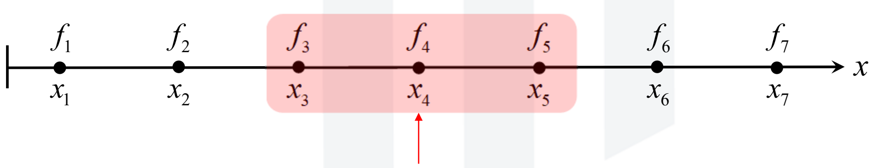
$$[\tilde{x}] = [-h \quad 0 \quad h]^T$$

$$\frac{d^2 f_3}{dx^2} \cong \frac{f_2 - 2f_3 + f_4}{h^2}$$

Calculation at Point 4

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
    fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;          nx = 4
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```

```
fd(4) = (f(3) - 2*f(4) + f(5))/h^2;
```



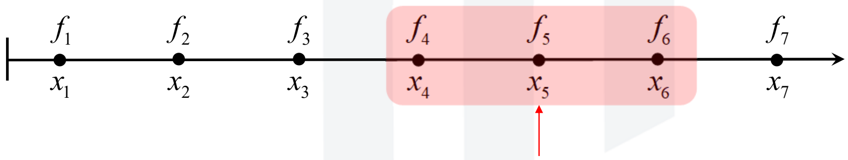
$$[\tilde{x}] = [-h \quad 0 \quad h]^T$$

$$\frac{d^2 f_4}{dx^2} \cong \frac{f_3 - 2f_4 + f_5}{h^2}$$

Calculation at Point 5

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
   fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;          nx = 5
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```

```
fd(5) = (f(4) - 2*f(5) + f(6))/h^2;
```



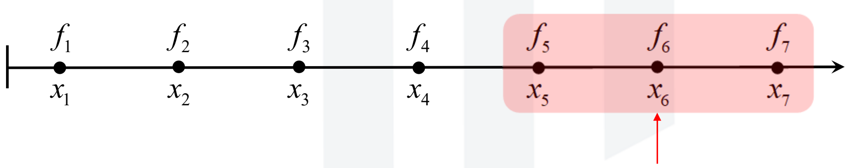
$$[\tilde{x}] = [-h \quad 0 \quad h]^T$$

$$\frac{d^2 f_5}{dx^2} \cong \frac{f_4 - 2f_5 + f_6}{h^2}$$

Calculation at Point 6

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
   fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;          nx = 6
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```

```
fd(6) = (f(5) - 2*f(6) + f(7))/h^2;
```



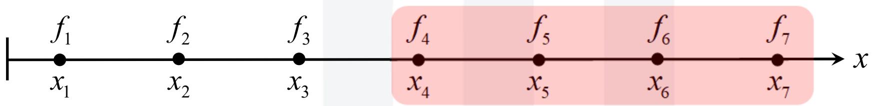
$$[\tilde{x}] = [-h \quad 0 \quad h]^T$$

$$\frac{d^2 f_6}{dx^2} \cong \frac{f_5 - 2f_6 + f_7}{h^2}$$

Calculation at Point 7

```
fd(1) = (2*f(1) - 5*f(2) + 4*f(3) - f(4))/h^2;
for nx = 2 : Nx-1
   fd(nx) = (f(nx-1) - 2*f(nx) + f(nx+1))/h^2;
end
fd(Nx) = (-f(Nx-3) + 4*f(Nx-2) - 5*f(Nx-1) + 2*f(Nx))/h^2;
```

```
fd(7) = (-f(4) + 4*f(5) - 5*f(6) + 2*f(7))/h^2;
```



$$[\tilde{x}] = [-3h \quad -2h \quad -h \quad 0]^T$$

$$\frac{d^2 f_7}{dx^2} \cong \frac{-f_4 + 4f_5 - 5f_6 + 2f_7}{h^2}$$