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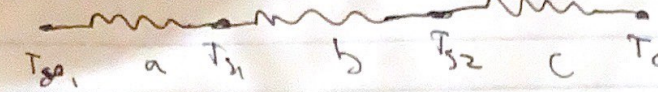
HW 6

1a)



$R_a = \frac{1}{h_1 A}$ $R_b = \frac{L}{kA}$ $R_c = \frac{1}{h_2 A}$

$R_{tot} = \frac{1}{A}\left(\frac{1}{h_1} + \frac{L}{k} + \frac{1}{h_2}\right)$ $q = \frac{T_{\infty,1} - T_{\infty,2}}{R_{tot}}$

$\rightarrow q'' = \frac{T_{\infty,1} - T_{\infty,2}}{\frac{1}{h_1} + \frac{L}{k} + \frac{1}{h_2}}$

$= 7.64 \times 10^3 \frac{W}{m^2}$

b) $7.64 \times 10^3 = \frac{T_{\infty,1} - T_{s,1}}{1/h} \rightarrow T_{s,1} = 585\ K$

$7.64 \times 10^3 = \frac{T_{s,2} - T_{\infty,2}}{1/h} \rightarrow T_{s,2} = 465\ K$

$\frac{d^2T}{dx} = 0 \rightarrow \frac{dT}{dx} = C_1 \rightarrow T = C_1 x + C_2$

$T(0) = 585\ K = 0 + C_2 \therefore C_2 = 585\ K$

$T(0.1) = 0.1\, C_1 + 585 = 465 \rightarrow C_1 = -1194$

$\therefore T(x) = -1194x + 585$

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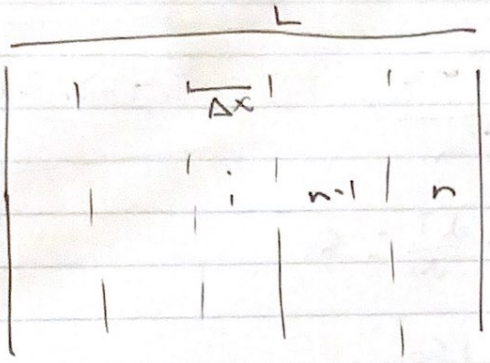
2a) $\underline{\text{Accum}} = \underline{\text{In}} - \underline{\text{Out}} + \underline{\text{Gen}}$

$\rho C_p V \frac{dT}{dt} \quad q''_{in} A \quad - q''_{out} A \quad \dot{E}$



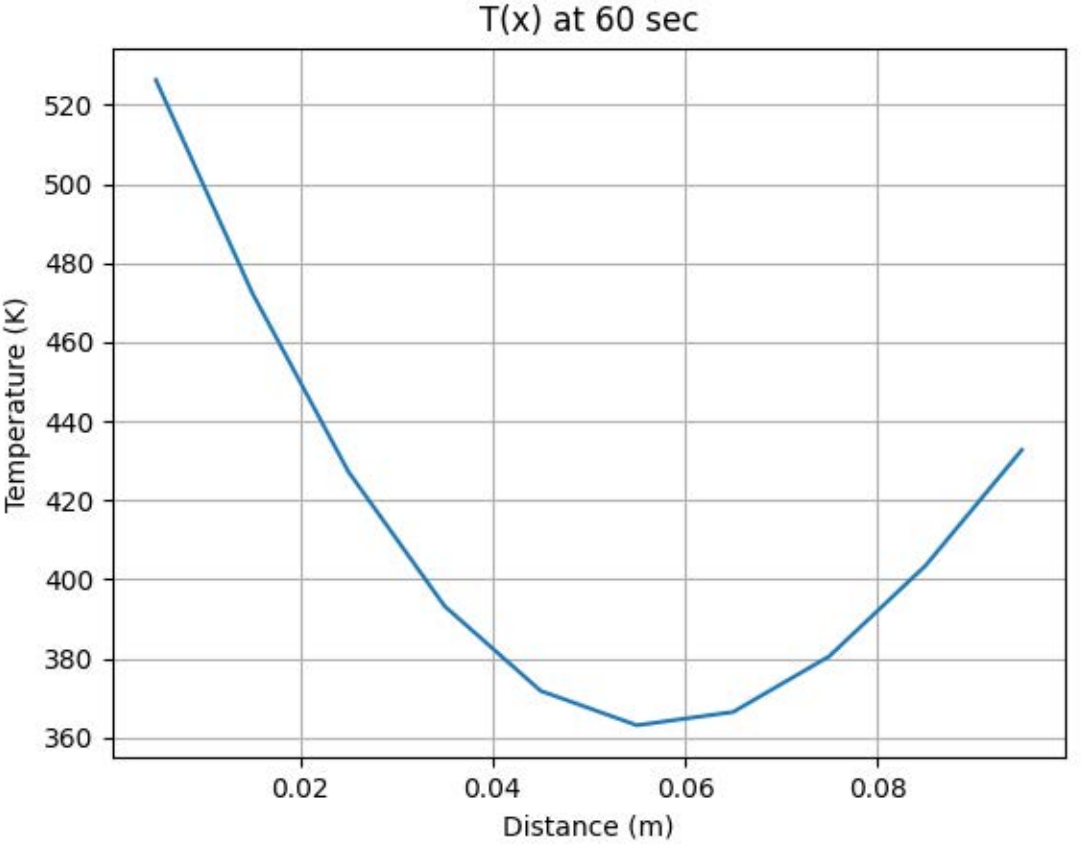
$$\rho C_p \Delta x \cancel{\Delta y} \cancel{\Delta z} \frac{dT}{dt} = -k \frac{dT}{dx}\Big|_x + k \frac{dT}{dx}\Big|_{x+\Delta x}$$

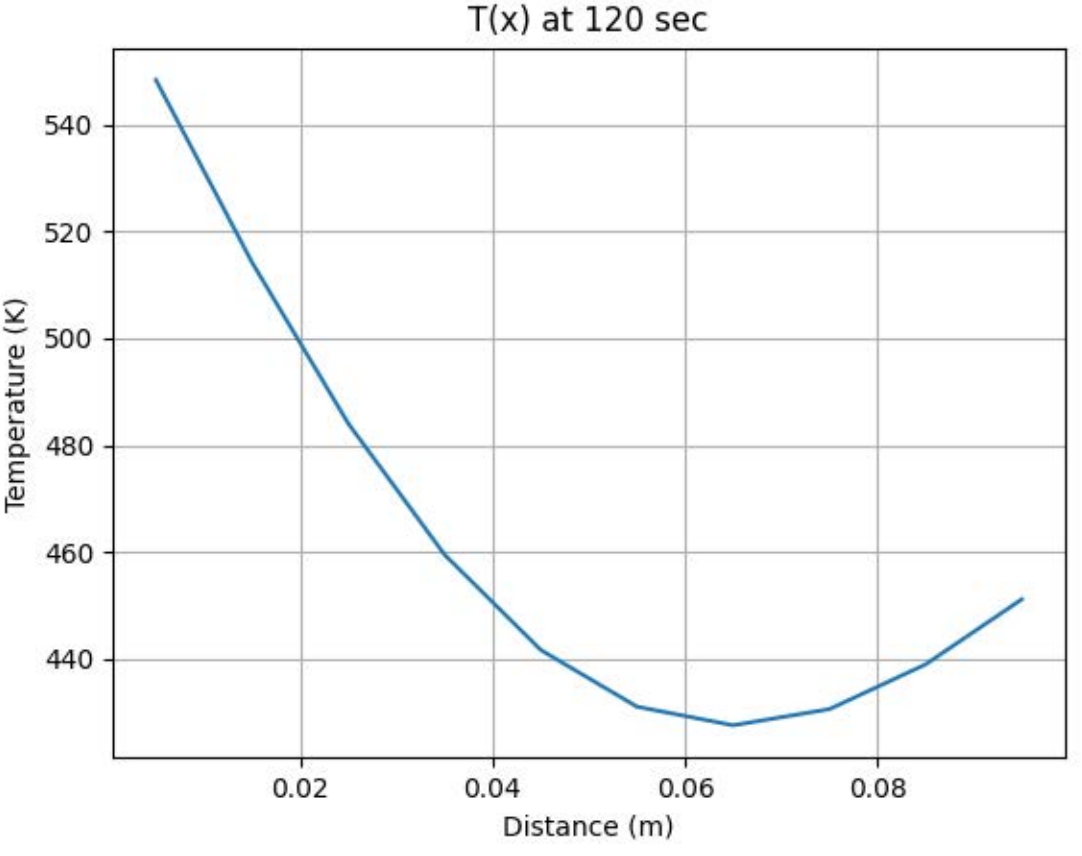
$$\rho C_p \Delta x \frac{dT}{dt} \simeq \frac{-k (T_i - T_{i-1})}{\Delta x} + \frac{k (T_{i+1} - T_i)}{\Delta x}$$

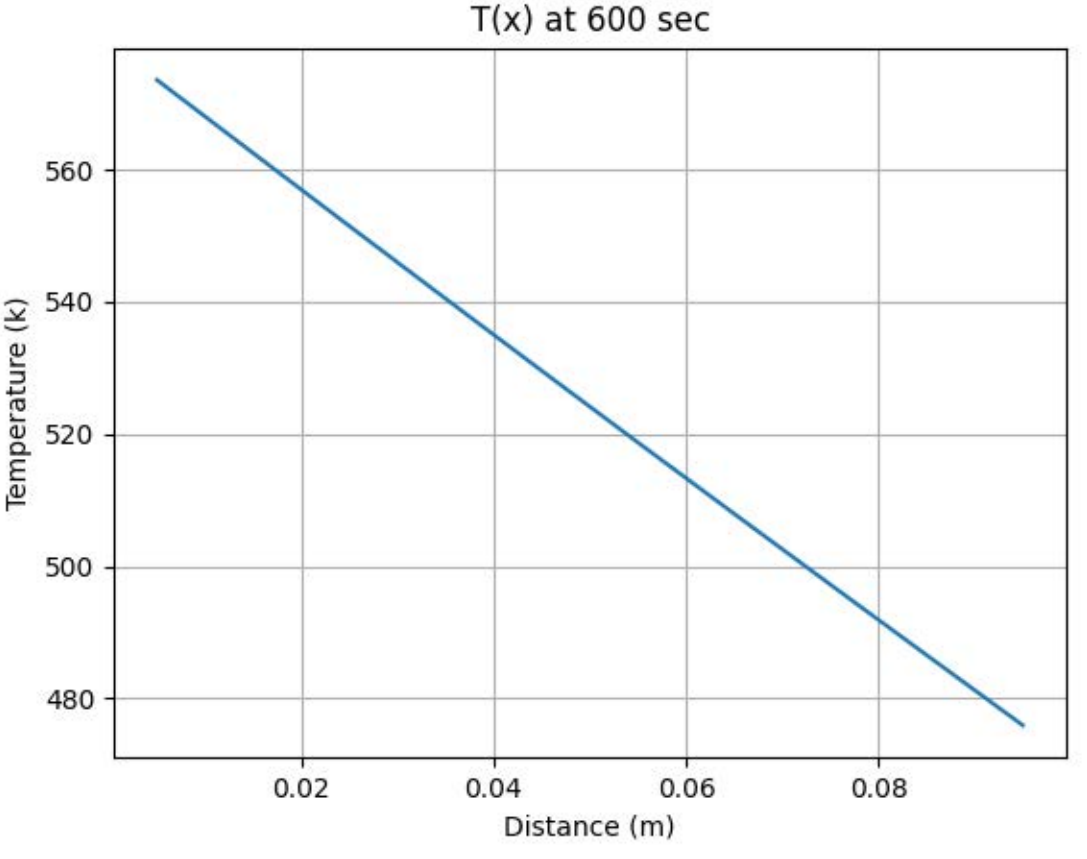
$$\boxed{\frac{dT}{dt} = \frac{k}{\rho C_p \Delta x^2} \left(T_{i+1} - 2T_i + T_{i-1}\right)}$$

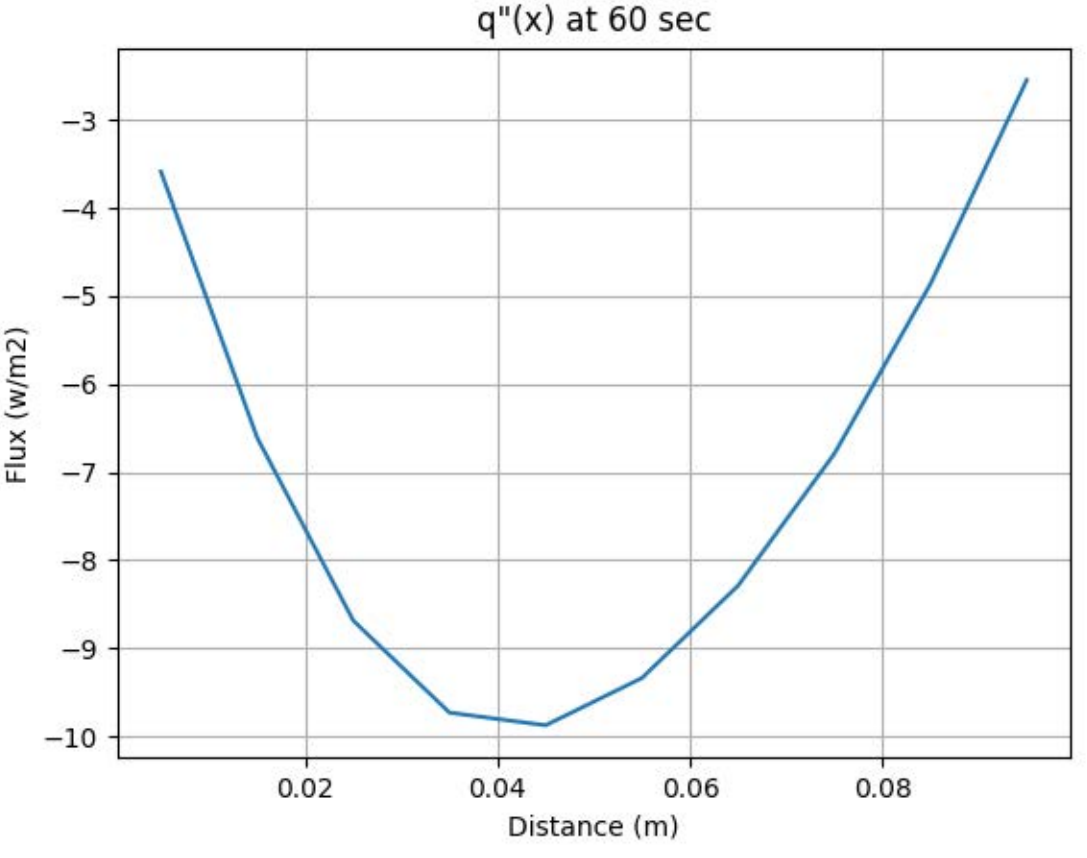
b) $T[0] \simeq 550$ @ **126 sec**

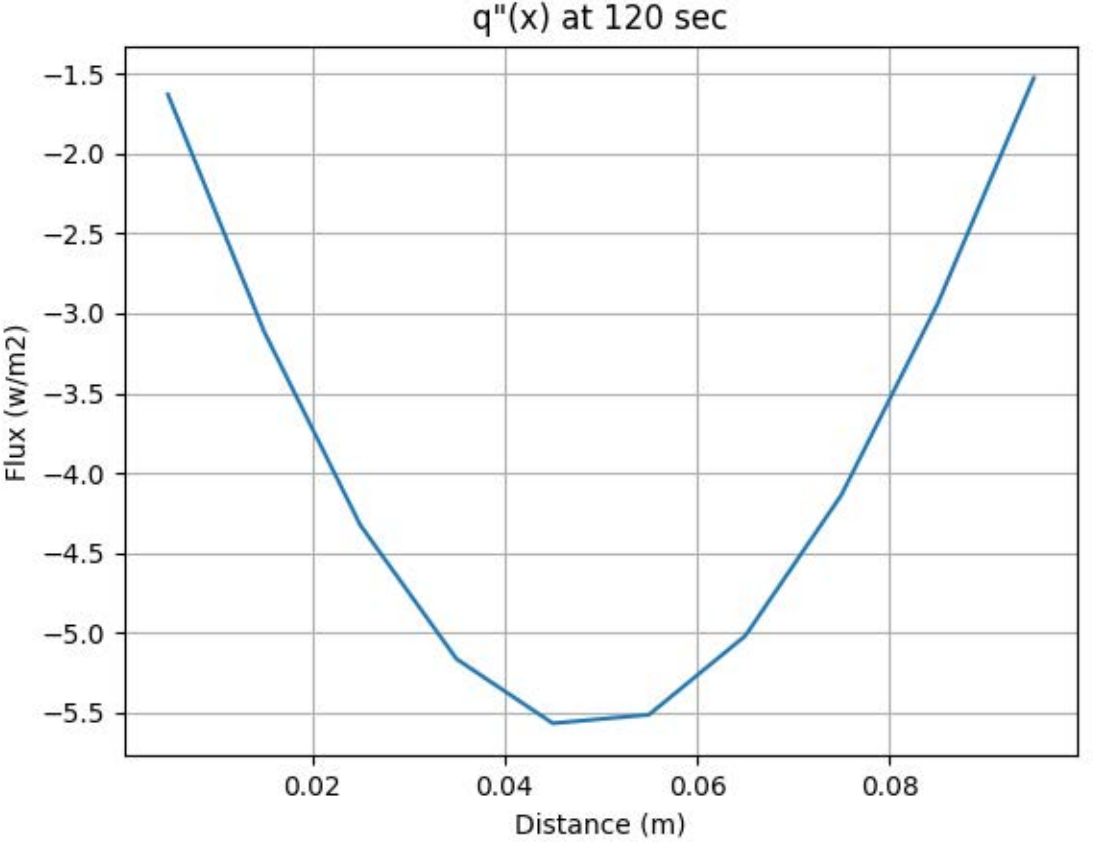
EC) $q'' = -k \frac{dT}{dx}$

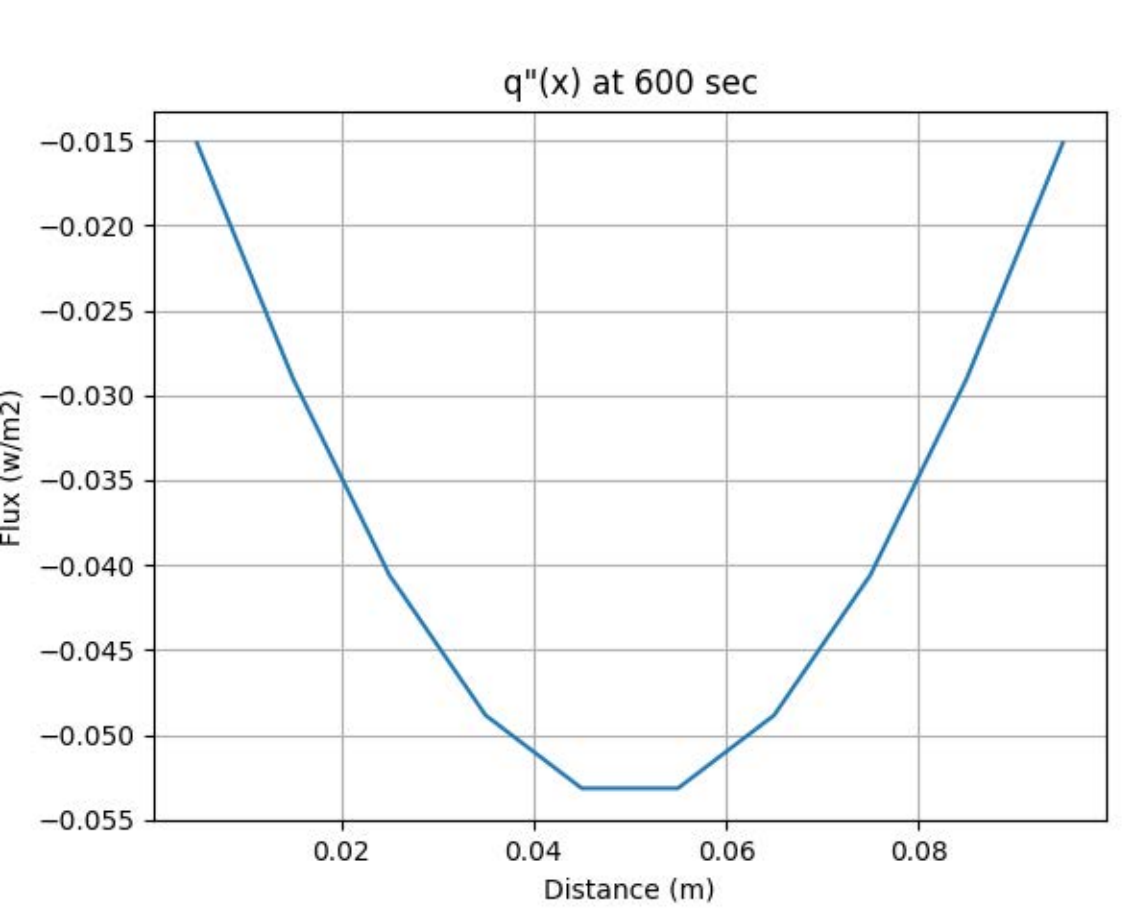

T(x) at 60 sec
Temperature (K)
520
500
480
460
440
420
400
380
360
0.02
0.04
0.06
0.08
Distance (m)


T(x) at 120 sec
Temperature (K)
540
520
500
480
460
440
0.02
0.04
0.06
0.08
Distance (m)


T(x) at 600 sec
560
540
520
500
480
Temperature (k)
0.02
0.04
0.06
0.08
Distance (m)


q"(x) at 60 sec
−3
−4
−5
−6
−7
−8
−9
−10
Flux (w/m2)
0.02
0.04
0.06
0.08
Distance (m)


q"(x) at 120 sec
−1.5
−2.0
−2.5
−3.0
−3.5
−4.0
−4.5
−5.0
−5.5
Flux (w/m2)
0.02
0.04
0.06
0.08
Distance (m)


q"(x) at 600 sec
−0.015
−0.020
−0.025
−0.030
−0.035
−0.040
−0.045
−0.050
−0.055
Flux (w/m2)
0.02
0.04
0.06
0.08
Distance (m)

```python
import numpy as np
import matplotlib.pyplot as plt

L = 0.1                     #m
Ts1 = 584.7                             #k
Ts2 = 465.3                 #k
T0 = 300                    #k
ro = 1150                   #kg/m3
cp = 468                    #J/kg/k
k = 6.4                     #w/m/k
tfin = 600                   #sec

n = 10                      #number of nodes
dx = L/n                    #
alpha = k/ro/cp             #
dt = 1

x = np.linspace(dx/2,L-dx/2,n)

T = np.ones(n)*T0
dTdt = np.empty(n)
t = np.arange(0,tfin,dt)
# q2 = np.empty(n)

for i in range(1,len(t)):

    for j in range(1,n-1):
        dTdt[j] = alpha*(T[j+1]-2*T[j]+T[j-1])/dx**2
        # q2[j] = -k*dTdt[j]
    dTdt[0] = alpha*(T[1]-2*T[0]+Ts1)/dx**2
    # q2[0] = -k*dTdt[0]
    dTdt[n-1] = alpha*(Ts2-2*T[n-1]+T[n-2])/dx**2
    # q2[n-1] = -k*dTdt[n-1]
    T = T+dTdt*dt
    if T[0] >= 550:
        if T[0] < 550.2:
            print(T[0],i)
    # plt.cla()
plt.plot(x,T)
plt.xlabel('Distance (m)')
plt.ylabel('Temperature (k)')

plt.pause(0.0001)
plt.title('T(x) at 600 sec')
plt.grid()
```

```
plt.savefig('600sec.png')
plt.show()
```