ASSIGNMENT 3

Simulation of the temperature profile in a continuously heated pipe, with a steady flow

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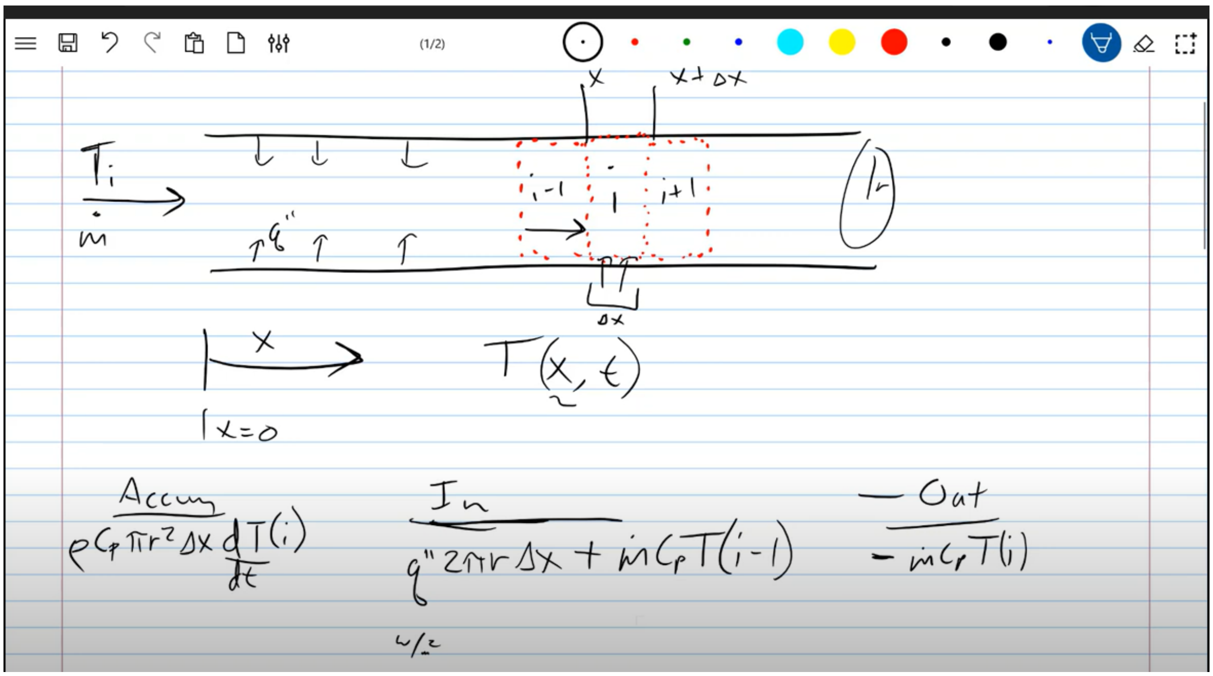

$$\boxed{\cancel{\rho c_p \pi r^2 \Delta x \frac{dT(i)}{dt}} = q'' 2\pi r \Delta x + \dot{m} c_p \left(T(i-1) - T(i)\right)}$$

$$\boxed{\frac{dT(i)}{dt} = \frac{q'' 2\pi r \Delta x + \dot{m} c_p \left(T(i-1) - T(i)\right)}{\rho c_p \pi r^2 \Delta x}}$$

$$T(i)_k \approx T(i)_{k-1} + \left.\frac{dT(i)}{dt}\right|_{k-1} \Delta t$$

$$0 = q'' 2\pi r \Delta x + \dot{m} c_p \left(T(i-1) - T(i)\right)$$

divide by Δx

$$0 = q'' 2\pi r + \dot{m} c_p \left(\frac{-\Delta T}{\Delta x}\right)$$

$\lim \Delta x \to 0$

$$\dot{m} c_p \frac{dT}{dx} = q'' 2\pi r \qquad T(x)$$

$$\int dT = \frac{q'' 2\pi r}{\dot{m} c_p} \int dx \quad \rightarrow \text{integrate}$$

$$T = \frac{q'' 2\pi r}{\dot{m} c_p} x + C_1 \qquad @\ x = 0,\ T = T_i$$

$$T = \frac{q'' 2\pi r}{\dot{m} c_p} x + C_1$$

$@ \; x = 0$

$T = T_i$

$$T_i = C_1$$

$$T(x) = T_i + \frac{q'' 2\pi r}{\dot{m} c_p} x$$

```python
import numpy as np
import matplotlib.pyplot as plt
pi = 3.14159
L = int(input("Enter the length: "))
r = float(input("Enter the radius: "))
n = int(input("Enter n: "))
m = int(input("Enter the mass flow rate: "))
Cp = int(input("Enter Cp: "))
rho = int(input("Enter the densitry: "))
Ti = int(input("Enter the initial temperature: "))
T0 = int(input("Enter T0: "))
q_flux = int(input("Enter flux "))
t_final = int(input("Enter final T: "))
dt = int(input("Enter dt: "))
```

```
Enter the length: 50
Enter the radius: 0.01
Enter n: 100
Enter the mass flow rate: 3
Enter Cp: 4180
Enter the densitry: 1000
Enter the initial temperature: 400
Enter T0: 300
Enter flux 100000
Enter final T: 700
Enter dt: 1
```

```python
dx = L/n
x = np.linspace(dx/2, L-dx/2, n)
T = np.ones(n)*T0
dTdt = np.zeros(n)
t = np.arange(0, t_final, dt)
for j in range(1,len(t)):
  plt.figure(1)
  plt.clf()
  dTdt[1:n] = (m*Cp*(T[0:n-1]-T[1:n])+q_flux*2*pi*r*dx)/(rho*Cp*dx*pi*r**2)
  dTdt[0] = (m*Cp*(Ti-T[0])+q_flux*2*pi*r*dx)/(rho*Cp*dx*pi*r**2)
  T = T + dTdt*dt
  plt.figure(1)
  plt.plot(x,T, color = 'blue', label = 'Transient')
  plt.xlabel('Distance (m)')
  plt.ylabel('Temperature (K)')
  plt.legend(loc = 'upper left')
  plt.show()
  plt.pause(0.05)
```