**International IT University**

Faculty of Computer technologies and cyber security

Department: MCM



**Report**

In the discipline «Numerical Analysis»

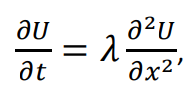
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Task 3: 1D Heat Equation

1. , where 𝑡 > 0, 𝑥 ∈ [0, 𝐿] and 𝜆 – heat transfer coefficient
2. Approximate, and we have:

 for each part

1. Multiply to delta t to get rid of the denominator:



1. Let’s take the  as r:



1. And in the end we have:



Code and graph:

*import* numpy *as* np  
*import* matplotlib.pyplot *as* plt  
  
  
*def* thomas(a, b, c, d):  
 n = len(d)  
 cp = c.copy()  
 dp = d.copy()  
  
 *for* i *in* range(1, n):  
 m = a[i] / b[i - 1]  
 b[i] -= m \* cp[i - 1]  
 dp[i] -= m \* dp[i - 1]  
  
 x = np.zeros(n)  
 x[-1] = dp[-1] / b[-1]  
 *for* i *in* range(n - 2, -1, -1):  
 x[i] = (dp[i] - cp[i] \* x[i + 1]) / b[i]  
 *return* x  
  
  
N = 50  
dx = 1.0 / N  
x = np.linspace(0, 1, N + 1)  
  
k = 1.0  
dt = 0.001  
t\_max = 0.1  
n\_steps = int(t\_max / dt)  
r = k \* dt / dx \*\* 2  
  
u\_left = 0.0  
u\_right = 0.0  
  
u = np.sin(np.pi \* x)  
  
*for* n *in* range(n\_steps):  
 n\_int = N - 1  
 a\_arr = -r \* np.ones(n\_int)  
 b\_arr = (1 + 2 \* r) \* np.ones(n\_int)  
 c\_arr = -r \* np.ones(n\_int)  
 d\_arr = u[1:-1].copy()  
 d\_arr[0] += r \* u\_left  
 d\_arr[-1] += r \* u\_right  
 u\_new\_inner = thomas(a\_arr.copy(), b\_arr.copy(), c\_arr.copy(), d\_arr)  
 u[0] = u\_left  
 u[-1] = u\_right  
 u[1:-1] = u\_new\_inner  
  
plt.figure(figsize=(8, 5))  
plt.plot(x, u, 'o-', label='Распределение температуры при t\_max')  
  
plt.xlabel('x')  
plt.ylabel('u(x, t\_max)')  
plt.title('1D уравнение теплопроводности (неявная схема, метод Томаса)')  
plt.legend()  
plt.grid()  
  
plt.annotate("u(0)=0", xy=(0, u\_left), xytext=(0.05, u\_left + 0.2),  
 arrowprops=dict(facecolor='black', arrowstyle="->"), fontsize=9)  
plt.annotate("u(1)=0", xy=(1, u\_right), xytext=(0.8, u\_right + 0.2),  
 arrowprops=dict(facecolor='black', arrowstyle="->"), fontsize=9)  
  
plt.show()

