Programming Assignment – MM218

(Process Kinetics and Transport)

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Group 22:

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Problem Statement 10

One end of an AISI 316 stainless steel rod of diameter 10 mm and length 0.16 m is inserted into a fixture maintained at 200°C. The rod, covered with an insulating sleeve, reaches a uniform temperature throughout its length. When the sleeve is removed, the rod is subjected to ambient air at 25°C such that the convection heat transfer coefficient is 30 $W/m^2.K$.

(a) Using the explicit finite-difference technique with a space increment of $\Delta x = 0.016$ m, estimate the time required for the midlength of the rod to reach 100°C.

(b) With $\Delta x = 0.016$ m and $\Delta t = 10$ s, compute T(x,t) for $0 \leq t \leq t1$, where t1 is the time required for the midlength for the rod to reach 50°C. Plot the temperature distribution for t = 0, 200s, 400s, and t1.

MATLAB CODE

```
% Problem set 10
% Group 22
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function [Tans]= temperature(x,tg)
    %tg= given time
    %at x=0 T=200 always so we are running this code form x=0.016;


    time=0;
    deltat=10 ;%in seconds
    k= tg/deltat;
    T=zeros(11,k)+200;%T(i) represents temperature at ith position
at t=0
    d=zeros(11);
    for i=1:11
        d(i)=0.016*(i-1);
    end
    count =1;
    while(time<=tg)
        count=count+1;
        time = time+deltat;
        T(2,count)=0.029*T(2,count-1)+0.440*T(3,count-1)+90.3;
        for i = 3:10
            T(i,count)=0.029*T(i,count-1)+0.440*(T(i-1,count-
1)+T(i+1,count-1))+2.3;
        end
        T(11,count)=0.88*T(10,count-1)+3;
       if( time ==400||time ==200|| time==280)
        plot(d,T(:,count));
        hold on;
       end
    end
    l=1;
    while(x>=0)
        x=x-l*0.016;
        l=l+1;
    end
 Tans =T(l+2,count);
xlabel('distance');
ylabel(' temperature');
legend('200','400','tk');
end
```
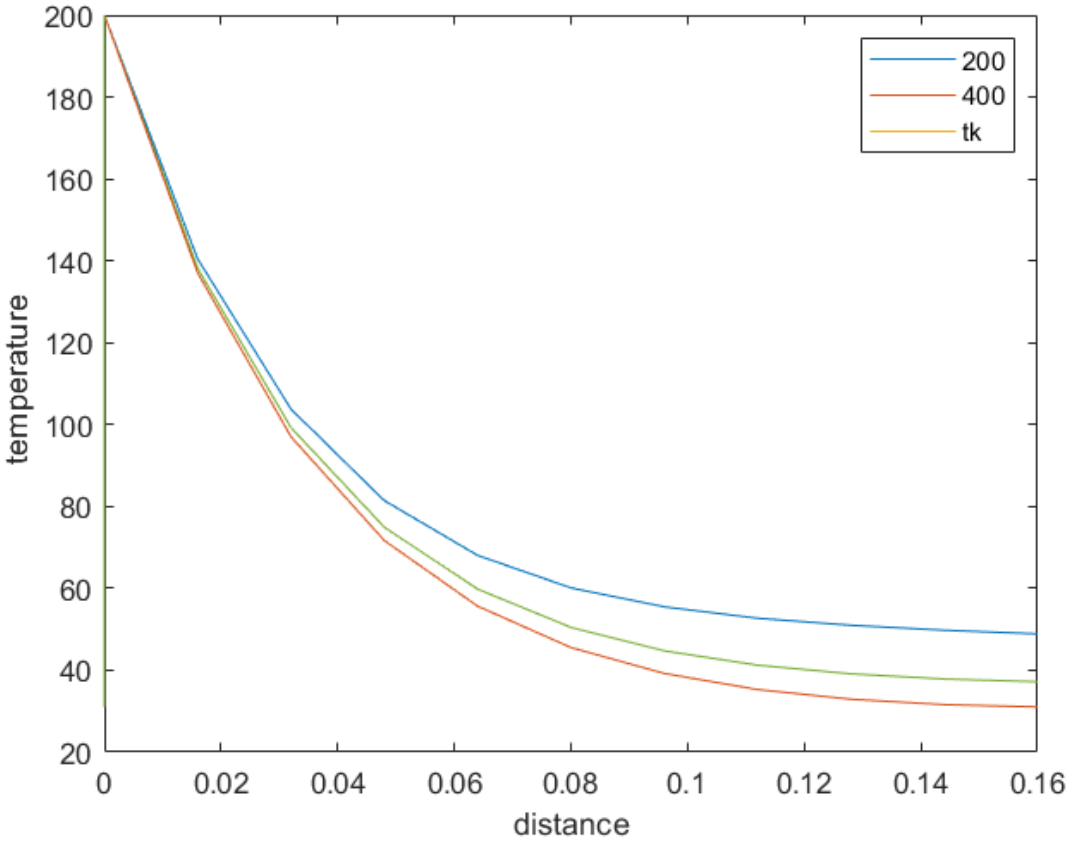

RESULTS


200
180
160
140
120
100
80
60
40
20
temperature
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
distance
200
400
tk

Time taken to reach 100°C is nearly 90.000000 seconds and

Time taken to reach 50°C is nearly 280.000000 seconds.

Below given is Temperature Values in °C from points T_0 to T_{10} in time range 0 to 500 seconds. Column 1 is of t = 0s and Column 51 t = 500s Topmost value in a column is Temperature at point T_0 and Bottommost value is Temperature at point T_{10}.

Columns 1 through 12

200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000
200.0000	184.1000	176.6429	170.0673	165.4504	161.3716	158.1952	155.3843	153.0896	151.0558	149.3474	147.8333
200.0000	184.1000	169.6469	159.5873	150.6216	143.6715	137.4924	132.4625	127.9913	124.2427	120.9141	118.0671
200.0000	184.1000	169.6469	156.5090	145.9211	136.4146	128.5666	121.5472	115.6171	110.3330	105.7903	101.7552
200.0000	184.1000	169.6469	156.5090	144.5667	134.3071	125.0502	117.0652	109.9180	103.6905	98.1480	93.2757
200.0000	184.1000	169.6469	156.5090	144.5667	133.7111	124.0215	115.3236	107.5714	100.6691	94.5038	89.0392
200.0000	184.1000	169.6469	156.5090	144.5667	133.5200	123.6474	114.5871	106.5583	99.2285	92.7580	86.8685
200.0000	184.1000	169.6469	156.5090	144.1323	133.2782	123.0269	114.0747	105.6975	98.3772	91.5838	85.6366
200.0000	184.1000	169.6469	155.5217	143.6114	132.0750	122.2774	112.8888	104.8326	97.2052	90.6071	84.4227
200.0000	184.1000	167.4029	154.4028	141.3456	130.6928	120.2521	111.5136	103.0866	95.9139	89.0869	83.2085
200.0000	179.0000	165.0080	150.3146	138.8745	127.3841	118.0097	108.8219	101.1320	93.7162	87.4043	81.3965

Columns 13 through 24

200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000
146.5367	145.3884	144.3917	143.5097	142.7366	142.0529	141.4494	140.9157	140.4423	140.0235	139.6507	139.3207
115.5429	113.3532	111.4144	109.7156	108.2126	106.8861	105.7129	104.6722	103.7516	102.9319	102.2065	101.5589
98.2417	95.1279	92.3914	89.9695	87.8268	85.9317	84.2471	82.7572	81.4283	80.2526	79.2014	78.2708
88.9546	85.1301	81.7449	78.7338	76.0709	73.6937	71.5917	69.7105	68.0465	66.5547	65.2344	64.0493
84.1456	79.8179	75.9341	72.5024	69.4178	66.6923	64.2400	62.0721	60.1203	58.3935	56.8384	55.4613
81.6765	76.9594	72.8012	69.0281	65.7000	62.6834	60.0200	57.6081	55.4763	53.5475	51.8406	50.2978
80.1516	75.3397	70.9225	67.0391	63.4870	60.3581	57.5045	54.9861	52.6949	50.6696	48.8307	47.2028
79.0401	74.0352	69.6586	65.6149	62.0658	58.8031	55.9311	53.3016	50.9815	48.8644	46.9927	45.2894
77.6735	72.8685	68.3838	64.4676	60.8383	57.6551	54.7220	52.1407	49.7731	47.6842	45.7753	44.0876
76.2235	71.3527	67.1243	63.1778	59.7315	56.5377	53.7365	51.1553	48.8838	46.8004	44.9621	43.2823

Columns 25 through 36

200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000
139.0262	138.7654	138.5321	138.3254	138.1403	137.9761	137.8289	137.6982	137.5811	137.4769	137.3836	137.3005
100.9855	100.4726	100.0181	99.6110	99.2500	98.9264	98.6391	98.3814	98.1525	97.9471	97.7645	97.6006
77.4375	76.6991	76.0372	75.4502	74.9236	74.4562	74.0367	73.6641	73.3296	73.0321	72.7651	72.5275
62.9996	62.0568	61.2208	60.4698	59.8033	59.2043	58.6723	58.1943	57.7693	57.3874	57.0476	56.7424
54.2211	53.1218	52.1319	51.2536	50.4628	49.7606	49.1286	48.5669	48.0615	47.6120	47.2076	46.8477
48.9308	47.6963	46.6013	45.6131	44.7359	43.9447	43.2417	42.6082	42.0448	41.5373	41.0857	40.6792
45.7272	44.4194	43.2357	42.1852	41.2358	40.3924	39.6309	38.9538	38.3431	37.7997	37.3100	36.8739
43.7811	42.4117	41.1973	40.0969	39.1199	38.2359	37.4504	36.7486	36.1092	35.5395	35.0323	34.5750
42.5501	41.1884	39.9510	38.8535	37.8584	36.9747	36.1748	35.4638	34.8212	34.2495	33.7334	33.2739
41.7971	40.4441	39.2458	38.1569	37.1911	36.3154	35.5378	34.8339	34.2082	33.6427	33.1395	32.6854

Columns 37 through 48

200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000	200.0000
137.2260	137.1596	137.1001	137.0471	136.9996	136.9572	136.9192	136.8852	136.8548	136.8277	136.8033	136.7816
97.4547	97.3239	97.2073	97.1027	97.0095	96.9259	96.8513	96.7844	96.7247	96.6712	96.6234	96.5806
72.3142	72.1243	71.9538	71.8018	71.6655	71.5439	71.4348	71.3375	71.2501	71.1722	71.1023	71.0399
56.4706	56.2265	56.0090	55.8137	55.6396	55.4833	55.3438	55.2187	55.1070	55.0068	54.9173	54.8370
46.5241	46.2358	45.9768	45.7459	45.5384	45.3534	45.1872	45.0390	44.9059	44.7871	44.6804	44.5852
40.3172	39.9915	39.7013	39.4403	39.2077	38.9985	38.8120	38.6444	38.4948	38.3605	38.2405	38.1329
36.4812	36.1313	35.8164	35.5357	35.2832	35.0580	34.8556	34.6749	34.5126	34.3677	34.2375	34.1213
34.1677	33.8008	33.4738	33.1794	32.9169	32.6807	32.4701	32.2807	32.1116	31.9597	31.8240	31.7022
32.8595	32.4904	32.1578	31.8613	31.5944	31.3564	31.1422	30.9511	30.7793	30.6260	30.4882	30.3651
32.2810	31.9164	31.5915	31.2988	31.0379	30.8031	30.5936	30.4051	30.2370	30.0858	29.9509	29.8296

Columns 49 through 51

200.0000	200.0000	200.0000
136.7621	136.7447	136.7291
96.5423	96.5080	96.4773
70.9839	70.9339	70.8890
54.7653	54.7010	54.6435
44.4997	44.4234	44.3549
38.0367	37.9504	37.8733
34.0169	33.9237	33.8401
31.5934	31.4957	31.4084
30.2546	30.1558	30.0672
29.7213	29.6240	29.5371