Assignment-2

* (1) 1-D Unsteady State Conduction

$$\frac{\partial T}{\partial t} = \frac{\partial}{\partial x}\left(\Gamma \cdot \frac{\partial T}{\partial x}\right)$$

Taking $\Gamma = \frac{K}{\rho C_p}$ as constant,

$$\frac{\partial T}{\partial t} = \Gamma \cdot \frac{\partial^2 T}{\partial x^2} = \frac{K}{\rho C_p} \cdot \frac{\partial^2 T}{\partial x^2}$$

$$\boxed{\frac{\partial T}{\partial t} = \frac{\Delta T}{\Delta t} = \frac{T'(x) - T(x)}{\Delta t}} \quad \text{— (1)}$$

$$\therefore \boxed{\frac{\Delta T}{\Delta t} = \frac{K}{\rho C_p}\left[\frac{T(x+h) - 2T(x) + T(x-h)}{h^2}\right]} \quad \text{— (2)}$$

In (2), we have descritize the $\frac{\partial T}{\partial t}$ and used Taylor's expansion for second order.

$$T(x+h) = T(x) + h\frac{\partial T}{\partial x} + \frac{\partial^2 T}{\partial x^2} \cdot \frac{h^2}{2} + \dots\dots$$

$$T(x-h) = T(x) - h\frac{\partial T}{\partial x} + \frac{\partial^2 T}{\partial x^2} \cdot \frac{h^2}{2} - \dots\dots$$

$$\therefore T(x+h) + T(x-h) = 2T(x) + \frac{\partial^2 T}{\partial x^2} \cdot \frac{h^2}{2}$$

$$\therefore \boxed{\frac{\partial^2 T}{\partial x^2} = \frac{T(x+h) + T(x-h)}{h^2}} \quad \text{— (3)}$$

∴ From eqⁿ ① and ③

$$\frac{T'(x) - T(x)}{\Delta t} = \frac{K}{\rho C_p}\left[\frac{T(x+h) - 2T(x) + T(x+h)}{h^2}\right]$$

∴ $$\boxed{T'(x) = \Delta t \cdot \frac{K}{\rho C_p}\left[\frac{T(x+h) - 2T(x) + T(x+h)}{h^2}\right]}$$

1-D UnSteady State Heat Conduction using Numerical Method

EXPERIMENTAL SOLUTION

T1	T2	T3	T4	T5	T6
46.1	44.1	42.7	40.8	39.5	37.3

NUMERICAL METHOD

T1	T2	T3	T4	T5	T6
46.1	44.34	42.579	40.819	39.06	37.3

h	0.166666667
deltaT	50
K/(Cp*rho)	1.11E-04

TIME	T1	T2	T3	T4	T5	T6
0	46.1	40.000	40.000	40.000	40.000	37.3
50	46.1	41.219	40.000	40.000	39.461	37.3
100	46.1	41.951	40.244	39.892	39.137	37.3
150	46.1	42.439	40.514	39.811	38.921	37.3
200	46.1	42.786	40.758	39.774	38.775	37.3
250	46.1	43.043	40.967	39.771	38.680	37.3
300	46.1	43.239	41.143	39.792	38.622	37.3
350	46.1	43.392	41.292	39.828	38.592	37.3
400	46.1	43.513	41.419	39.873	38.581	37.3
450	46.1	43.612	41.528	39.924	38.583	37.3
500	46.1	43.693	41.624	39.977	38.595	37.3
550	46.1	43.760	41.708	40.030	38.612	37.3
600	46.1	43.818	41.783	40.082	38.633	37.3
650	46.1	43.867	41.850	40.132	38.656	37.3
700	46.1	43.910	41.910	40.180	38.680	37.3
750	46.1	43.948	41.964	40.226	38.704	37.3
800	46.1	43.982	42.013	40.269	38.728	37.3
850	46.1	44.011	42.058	40.310	38.750	37.3
900	46.1	44.038	42.099	40.347	38.772	37.3
950	46.1	44.063	42.136	40.383	38.793	37.3
1000	46.1	44.085	42.171	40.415	38.812	37.3
1050	46.1	44.105	42.203	40.446	38.830	37.3
1100	46.1	44.124	42.232	40.474	38.847	37.3
1150	46.1	44.140	42.259	40.500	38.863	37.3
1200	46.1	44.156	42.283	40.524	38.878	37.3
1250	46.1	44.170	42.306	40.547	38.892	37.3
1300	46.1	44.183	42.327	40.568	38.904	37.3
1350	46.1	44.195	42.346	40.587	38.916	37.3
1400	46.1	44.207	42.364	40.605	38.927	37.3
1450	46.1	44.217	42.381	40.621	38.937	37.3
1500	46.1	44.226	42.396	40.636	38.946	37.3
1550	46.1	44.235	42.410	40.650	38.955	37.3
1600	46.1	44.243	42.423	40.663	38.963	37.3
1650	46.1	44.250	42.435	40.675	38.970	37.3
1700	46.1	44.257	42.446	40.686	38.977	37.3
1750	46.1	44.264	42.456	40.696	38.984	37.3
1800	46.1	44.269	42.466	40.706	38.989	37.3
1850	46.1	44.275	42.474	40.714	38.995	37.3
1900	46.1	44.280	42.483	40.723	39.000	37.3
1950	46.1	44.284	42.490	40.730	39.004	37.3
2000	46.1	44.289	42.497	40.737	39.009	37.3
2050	46.1	44.293	42.503	40.743	39.013	37.3
2100	46.1	44.296	42.509	40.749	39.016	37.3
2150	46.1	44.299	42.514	40.754	39.020	37.3
2200	46.1	44.303	42.519	40.759	39.023	37.3
2250	46.1	44.305	42.524	40.764	39.025	37.3
2300	46.1	44.308	42.528	40.768	39.028	37.3
2350	46.1	44.311	42.532	40.772	39.031	37.3
2400	46.1	44.313	42.536	40.776	39.033	37.3
2450	46.1	44.315	42.539	40.779	39.035	37.3
2500	46.1	44.317	42.542	40.782	39.037	37.3
2550	46.1	44.319	42.545	40.785	39.039	37.3
2600	46.1	44.320	42.548	40.788	39.040	37.3
2650	46.1	44.322	42.550	40.790	39.042	37.3
2700	46.1	44.323	42.553	40.793	39.043	37.3
2750	46.1	44.324	42.555	40.795	39.044	37.3
2800	46.1	44.326	42.557	40.797	39.046	37.3
2850	46.1	44.327	42.558	40.798	39.047	37.3
2900	46.1	44.328	42.560	40.800	39.048	37.3
2950	46.1	44.329	42.562	40.802	39.049	37.3
3000	46.1	44.329	42.563	40.803	39.049	37.3
3050	46.1	44.330	42.564	40.804	39.050	37.3
3100	46.1	44.331	42.566	40.806	39.051	37.3
3150	46.1	44.332	42.567	40.807	39.052	37.3
3200	46.1	44.332	42.568	40.808	39.052	37.3
3250	46.1	44.333	42.569	40.809	39.053	37.3
3300	46.1	44.333	42.569	40.809	39.053	37.3
3350	46.1	44.334	42.570	40.810	39.054	37.3
3400	46.1	44.334	42.571	40.811	39.054	37.3
3450	46.1	44.335	42.572	40.812	39.055	37.3
3500	46.1	44.335	42.572	40.812	39.055	37.3
3550	46.1	44.336	42.573	40.813	39.056	37.3
3600	46.1	44.336	42.573	40.813	39.056	37.3
3650	46.1	44.336	42.574	40.814	39.056	37.3
3700	46.1	44.337	42.574	40.814	39.057	37.3
3750	46.1	44.337	42.575	40.815	39.057	37.3
3800	46.1	44.337	42.575	40.815	39.057	37.3
3850	46.1	44.337	42.576	40.816	39.057	37.3
3900	46.1	44.337	42.576	40.816	39.057	37.3
3950	46.1	44.338	42.576	40.816	39.058	37.3
4000	46.1	44.338	42.577	40.817	39.058	37.3
4050	46.1	44.338	42.577	40.817	39.058	37.3
4100	46.1	44.338	42.577	40.817	39.058	37.3
4150	46.1	44.338	42.577	40.817	39.058	37.3
4200	46.1	44.338	42.577	40.817	39.058	37.3
4250	46.1	44.339	42.578	40.818	39.059	37.3
4300	46.1	44.339	42.578	40.818	39.059	37.3
4350	46.1	44.339	42.578	40.818	39.059	37.3
4400	46.1	44.339	42.578	40.818	39.059	37.3
4450	46.1	44.339	42.578	40.818	39.059	37.3
4500	46.1	44.339	42.578	40.818	39.059	37.3
4550	46.1	44.339	42.579	40.819	39.059	37.3
4600	46.1	44.339	42.579	40.819	39.059	37.3
4650	46.1	44.339	42.579	40.819	39.059	37.3
4700	46.1	44.339	42.579	40.819	39.059	37.3
4750	46.1	44.339	42.579	40.819	39.059	37.3
4800	46.1	44.339	42.579	40.819	39.059	37.3
4850	46.1	44.339	42.579	40.819	39.059	37.3
4900	46.1	44.339	42.579	40.819	39.059	37.3
4950	46.1	44.340	42.579	40.819	39.060	37.3
5000	46.1	44.340	42.579	40.819	39.060	37.3