Assignment - 1

* ① 1-D Steady State Conduction

General Transport Equation is ;

$$\frac{\partial \phi}{\partial t} + (U \cdot \nabla)\phi = \nabla(\Gamma \cdot \nabla)\phi + S$$

Here $\frac{\partial \phi}{\partial t}$ is time related term,

$(U \cdot \nabla)\phi$ is Convection term,

$\nabla(\Gamma \cdot \nabla)\phi$ is Diffusion term,

S is Source term,

For 1-D Steady State Conduction,

$\nabla(\Gamma \cdot \nabla)\phi$ will ~~be~~ not be zero, where there is no Source term so it will be zero and conduction will also be zero.

Also we are assuming Γ as constant.

$$\therefore \Gamma \cdot \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} \right) = 0$$

But as we are taking 1-D only, x term is there and y and z are zero.

$$\therefore T \cdot \left(\frac{\partial^2 T}{\partial x^2}\right) = 0$$

as T depends only on x, we can rewrite as,

$$\frac{d^2T}{dx^2} = 0$$

Using Finite Difference method,

$$\boxed{\frac{d^2T}{dx^2} = 0} \quad \text{— (1)}$$

Using Taylor's Expansion;

$$T(x+h) = T(x) + \frac{dT}{dx} \cdot h + \frac{d^2T}{dx^2} \cdot \frac{h^2}{2} + \cdots$$

$$T(x-h) = T(x) - \frac{dT}{dx} \cdot h + \frac{d^2T}{dx^2} \cdot \frac{h^2}{2} - \cdots$$

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

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

From Eqn (1) and (2)

$$\therefore \frac{d^2T}{dx^2} = \frac{T(x+h) - 2T(x) + T(x-h)}{h^2} = 0$$

$$\therefore \boxed{T(x) = \frac{T(x+h) + T(x-h)}{2}}$$

1-D Steady State Heat Conduction

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	42.58	40.81	39.06	37.3

TIME	T1	T2	T3	T4	T5	T6
0	46.1	40.000	40.000	40.000	40.000	37.3
5	46.1	43.050	40.000	40.000	38.650	37.3
10	46.1	43.050	41.525	39.325	38.650	37.3
15	46.1	43.813	41.188	40.088	38.313	37.3
20	46.1	43.644	41.950	39.750	38.694	37.3
25	46.1	44.025	41.697	40.322	38.525	37.3
30	46.1	43.898	42.173	40.111	38.811	37.3
35	46.1	44.137	42.005	40.492	38.705	37.3
40	46.1	44.052	42.314	40.355	38.896	37.3
45	46.1	44.207	42.204	40.605	38.828	37.3
50	46.1	44.152	42.406	40.516	38.953	37.3
55	46.1	44.253	42.334	40.679	38.908	37.3
60	46.1	44.217	42.466	40.621	38.990	37.3
65	46.1	44.283	42.419	40.728	38.960	37.3
70	46.1	44.259	42.506	40.690	39.014	37.3
75	46.1	44.303	42.475	40.760	38.995	37.3
80	46.1	44.287	42.531	40.735	39.030	37.3
85	46.1	44.316	42.511	40.781	39.017	37.3
90	46.1	44.305	42.548	40.764	39.040	37.3
95	46.1	44.324	42.535	40.794	39.032	37.3
100	46.1	44.317	42.559	40.783	39.047	37.3
105	46.1	44.330	42.550	40.803	39.042	37.3
110	46.1	44.325	42.566	40.796	39.052	37.3
115	46.1	44.333	42.561	40.809	39.048	37.3
120	46.1	44.330	42.571	40.804	39.054	37.3
125	46.1	44.336	42.567	40.813	39.052	37.3
130	46.1	44.334	42.574	40.810	39.056	37.3
135	46.1	44.337	42.572	40.815	39.055	37.3
140	46.1	44.336	42.576	40.813	39.058	37.3
145	46.1	44.338	42.575	40.817	39.057	37.3
150	46.1	44.337	42.577	40.816	39.058	37.3
155	46.1	44.339	42.576	40.818	39.058	37.3
160	46.1	44.338	42.578	40.817	39.059	37.3
165	46.1	44.339	42.578	40.819	39.059	37.3
170	46.1	44.339	42.579	40.818	39.059	37.3
175	46.1	44.339	42.578	40.819	39.059	37.3
180	46.1	44.339	42.579	40.819	39.060	37.3
185	46.1	44.340	42.579	40.819	39.059	37.3
190	46.1	44.340	42.580	40.819	39.060	37.3
195	46.1	44.340	42.579	40.820	39.060	37.3
200	46.1	44.340	42.580	40.819	39.060	37.3