Problem\_Set\_3

By

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AE/ME8112 - Comp Fluid Dyn/Heat Transfer

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**Problem\_Set\_3 Questions**

1. Solve 1D convection/diffusion problem governed by:
2. Solve transient heat conduction:

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# Question\_2

Assumptions:

1. We assumed that our plate is x\*y: 5cm\*5cm
2. We assumed that

We are going to solve T(x,y,t) transient heat conduction:

|  |  |
| --- | --- |
|  | (‎2.1) |

Initial condition:

|  |  |
| --- | --- |
|  | (‎2.2) |

Boundary conditions:

|  |  |
| --- | --- |
|  | (‎2.3) |
|  | (‎2.4) |
|  | (‎2.5) |
|  | (‎2.6) |

Implicit discretization of transient heat conduction with source:

|  |  |
| --- | --- |
|  | (‎2.7) |

Integration:

|  |  |
| --- | --- |
|  | (‎2.8) |

Which gives us:

|  |  |
| --- | --- |
|  | (‎2.9) |

Then:

|  |  |
| --- | --- |
|  | (‎2.10) |

Devide both side by (), where and :

|  |  |
| --- | --- |
|  | (‎2.11) |

Doing some simplification ():

|  |  |
| --- | --- |
|  | (‎2.12) |

If , then so for midle points we have:

|  |  |
| --- | --- |
|  | (‎2.13) |

Thus, main fully implicit formulation is Eq. (‎2.12). Now we are going to write our equations for each part of geometry:

1. Midle points:

|  |  |
| --- | --- |
|  | (‎2.14) |

1. West (Conection with 3 points):

|  |  |
| --- | --- |
|  | (‎2.15) |

So we have:

|  |  |
| --- | --- |
|  | (‎2.16) |
|  | (‎2.17) |
|  | (‎2.18) |
|  | (‎2.19) |
|  | (‎2.20) |

So we can write as:

|  |  |
| --- | --- |
|  | (‎2.21) |

where

and

Thus with putting (‎2.21) in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.22) |
|  | (‎2.23) |

1. East (Conection with 3 points):

|  |  |
| --- | --- |
|  | (‎2.24) |

So we have:

|  |  |
| --- | --- |
|  | (‎2.25) |
|  | (‎2.26) |
|  | (‎2.27) |
|  | (‎2.28) |
|  | (‎2.29) |

So we can write as:

|  |  |
| --- | --- |
|  | (‎2.30) |

where

and

Thus with putting (‎2.21) in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.31) |
|  | (‎2.32) |

1. North (connection with three points):

|  |  |
| --- | --- |
|  | (‎2.33) |

So we have:

|  |  |
| --- | --- |
|  | (‎2.34) |
|  | (‎2.35) |
|  | (‎2.36) |
|  | (‎2.37) |
|  | (‎2.38) |

So we can write as:

|  |  |
| --- | --- |
|  | (‎2.39) |

where

and

Thus with putting (‎2.21) in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.40) |
|  | (‎2.41) |

1. South (connection with three points):

|  |  |
| --- | --- |
|  | (‎2.42) |

So we have:

|  |  |
| --- | --- |
|  | (‎2.43) |

|  |  |
| --- | --- |
|  | (‎2.44) |

Thus with putting (‎2.44) in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.45) |
|  | (‎2.46) |

1. South-West point (connection with 2 points)

Thus with putting these equations in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.47) |
|  | (‎2.48) |

1. South-East point (connection with 2 points)

Thus with putting these equations in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.49) |
|  | (‎2.50) |

1. North-West point (connection with 2 points)

Thus with putting these equations in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.51) |
|  | (‎2.52) |

1. North-East point (connection with 2 points)

Thus with putting these equations in (‎2.12) we have:

|  |  |
| --- | --- |
|  | (‎2.53) |
|  | (‎2.54) |

# References

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