Case Study Modelling an Electronic Component

Azure Hutchings Jean-Luc Danoy
Faris Saad S Alsubaie

28 October 2019

Executive Summary

Write Abstract Here

Contents

1 Introduction

1.1 Purpose of the Report

The following report investigates the steady-state heat distribution in a newly designed component.

The report will discuss the mathematical model of the heat distribution in the component and the numerical methods used to solve it in MATLAB.

1.2 The Maths of the Problem

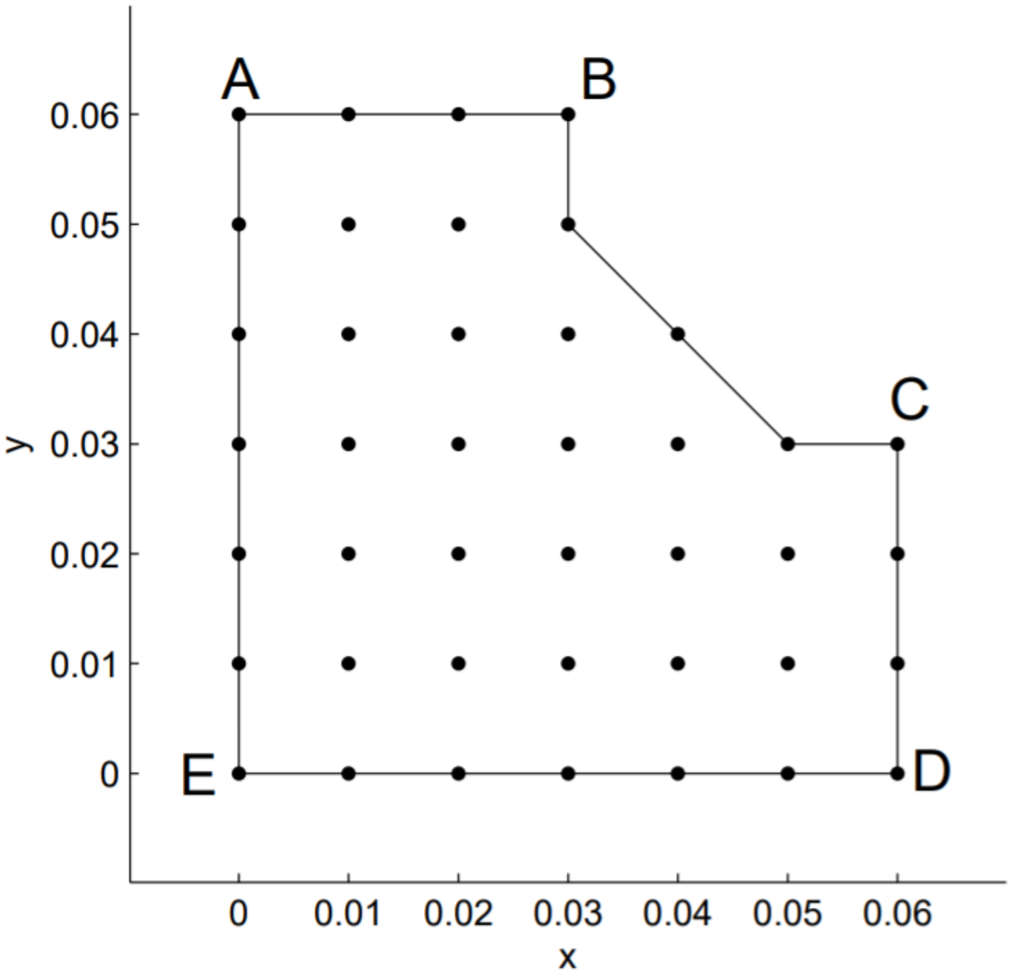


Figure 1: Schematic of electronic component.

The component schematic is shown in Figure 1. The location of the component within the device means it's subject to different temperature condition along it's boundaries. The boundary A-B is in perfect thermal contact with another component which the temperature is known to 70°C. The boundary C-D is also in perfect thermal contact with another component which the temperature is known to be 40°C. The boundary A-E-D is thermally insulated and the boundary B-C is exposed to the air at ambient temperature.

This type of model can be described with Laplace's equation. Letting $T(x, y)$ represent the temperature of the component at point (x, y), the model is as follows

$$\begin{array}{cc} \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0 & \text{in the interior} \\ T = 70 & \text{on boundary A-B} \\ T = 40 & \text{on boundary C-D} \\ \boldsymbol{\nabla} T \cdot \hat{\mathbf{n}} = 0 & \text{on boundary A-E-D} \\ k\boldsymbol{\nabla} T \cdot \hat{\mathbf{n}} = h(T_\infty - T) & \text{on boundary B-C} \end{array}$$

Where the thermal conductivity is $k = 3Wm^{-1}C^{-1}$, and the heat transfer coefficient is $h = 20Wm^{-2}C^{-1}$. To begin with, we will assume the ambient termperature is $T_\infty = 20$.

2 Discretising the Problem

To numerically solve this problem, we must construct a finite difference mesh and create a matrix to represent this information.

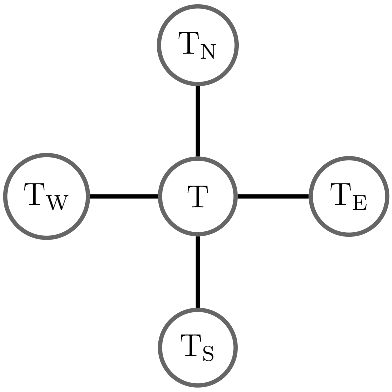
By splitting the component up into intervals of 0.01, we can split the component into a 7x7 grid.

Finite Difference Mesh

There are 3 different types of mesh that need to be created. These are for the A-E-D boundary, the inside of the mesh, and on the B-C boundary.

On the interior of the mesh, each node contains 4 other nodes adjacent to it, and the change in temperature at that node is given by the equation

$$\begin{array}{c} \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0 \\ \frac{\partial}{\partial x}(\frac{\partial T}{\partial x}) + \frac{\partial}{\partial x}(\frac{\partial T}{\partial y}) = 0 \end{array}$$


T_N
T_W
T
T_E
T_S