MATH7016: 20% VBA Assessment 2

Answer Problem 3 and two out of Problems 1 and 2. If you answer three questions your best two will count.

The digits of your student number will be used to personalise your assessment(!).

You must save your work as `FirstnameSurnameVBA2` (a single macro-enabled Excel workbook) and send it to

`jpmccarthymaths@gmail.com`

c_i is the ith last digit of your student number.

Problem 1: Steady State Temperature of Uninsulated Rod

For the following question:

- transfer coefficient, $h' = (1 + c_1) \cdot 0.1$
- air temperature, $T_a = (1 + c_2) \cdot 2$
- temperature on left, $T_0 = (5 + c_3) \cdot 10$
- temperature on right, $T_1 = (5 + c_4) \cdot 10$
- length of rod, $L = 5 + c_5$

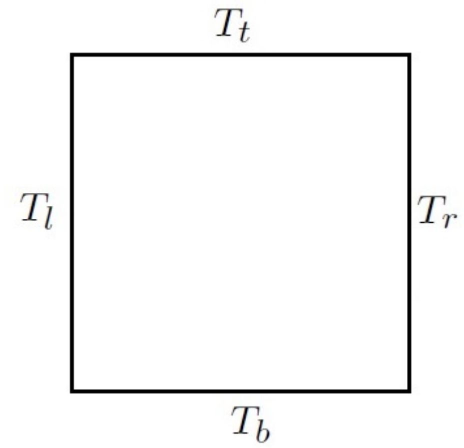
The steady-state temperature of an uninsulated rod of length L, with an air temperature of T_a, subject to boundary conditions, is given by:

$$\frac{d^2T}{dx^2} + h'(T_a - T) = 0; \qquad T(0) = T_0, \qquad T(L) = T_1.$$

1. **Hand Work and Worksheet or Hand Work and VBA**: Use the (Euler) Shooting Method with a step-size $h = 0.1$ to produce a graph of T vs x for $x = 0$ to $x = L$.

   OR

2. **Hand Work and VBA**: *Mesh* the rod into four equal pieces and thus three internal nodes (i.e. $\Delta x = L/4$). Use the finite difference method to approximate the temperature at each of these three points. Use a tolerance of 0.1.



Problem 2: Steady State Temperature of Insulated Plate

For the following question:

- left temperature, $T_l = (1 + c_1) \cdot 10$
- right temperature, $T_r = (1 + c_2) \cdot 10$
- bottom temperature, $T_b = 50 + (1 + c_3) \cdot 10$
- left temperature, $T_t = c_4 \cdot 5$

A thin square plate, insulated at every point except at its edges, is subject to boundary conditions as shown:
The steady state temperature is given as the solution of Laplace's Equation:

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0. \tag{1}$$

Use Finite Differences to approximate the steady-state temperature at four internal points of the plate. Specify whether you use the Jacobi Method or the Gauss-Seidel Method. Use a tolerance of 0.1. This has an element of hand work and a VBA program.

Problem 3: Temperature of an Insulated and initially chilled Rod

For the following question:

- transfer coefficient, $k = (1 + c_1) \cdot 0.1$
- temperature on left, $T_0 = (2 + c_2) \cdot 10$
- temperature on right, $T_1 = (15 + c_3) \cdot 10$
- time step-size, $\Delta t = (1 + c_4) \cdot 0.1$
- distance step-size, $\Delta x = 1 + c_5 \cdot 0.1$
- length of rod, $L = 4\Delta x$

The transient-state temperature of an insulated rod of length L, subject to boundary conditions, is given by:

$$k \cdot \frac{\partial^2 T}{\partial x^2} = \frac{\partial T}{\partial t}.$$

Where $T(x,t)$ is the temperature at a distance x along the rod at time t, the initial and boundary conditions are given by:

$$T(0,0) = T_0, \qquad T(L,0) = T_1, \qquad T(x,0) = 0 \text{ (for } 0 < x < L)$$
$$T(0,t) = T_0, \qquad T(L,t) = T_2,$$

i.e. the rod is initially at a temperature of 0 but the temperatures on the endpoints are fixed at T_0 and T_1.

Use Finite Differences to approximate the transient temperature at three internal points of the rod at time intervals Δt. The program should run until the difference between the transient-state temperatures and the steady-state temperature is less than 0.5.

This has an element of hand work and a VBA program.

Useful Code

```
cells.clear
```

Variables and their Data Types

```
 Dim dblX As Double
 Dim intC As Integer
```

Do Loops

You need starting values and counters — which also need starting values.

```
Do While/Until CONDITION
STUFF
Loop
```

```
Do
STUFF
Loop While/Until CONDITION
```

Functions

```
Function FunctionName ( arguments as DataType ) as DataType
FunctionName =
End Function
```

Arrays

```
Dim ArrayName(i to j) as DataType
```

For Loops

```
For intCounter = 1 To 10 Step N
STUFF
Next intCounter
```

$$\begin{aligned} y_{i+1} &= y_i + h \cdot F(x_i, y_i) \\ &= y_i + h \cdot y_i'. \end{aligned}$$

$$v(0) = v_a + \frac{y(x_1) - y_a}{y_b - y_a}(v_b - v_a).$$

$$\left.\frac{dy}{dx}\right|_{x_i} \approx \frac{y(x_{i+1}) - y(x_i)}{\Delta x}$$

$$\left.\frac{d^2y}{dx^2}\right|_{x_i} \approx \frac{y(x_{i+1}) - 2y(x_i) + y(x_{i-1})}{(\Delta x)^2}$$