**ECSE 543**

**Assignment 3**

**Numerical Methods in Electrical Engineering**

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## Question 1

### (a)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Point 6 |
| B (T) | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| H (A/m) | 0.0 | 14.7 | 36.5 | 71.7 | 121.4 | 197.4 |

Table : The first 6 points to be interpolated

Using Wolfram Alpha to expand this expression gives:

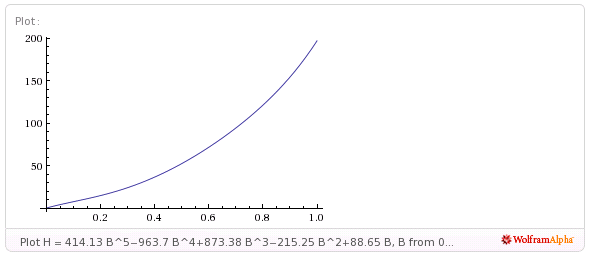


Figure : Plot of H (A/m) versus B (T) Interpolation (first 6 points)

Yes, this interpolation and its associated plot lie close to the true B versus H over this range as the chosen 6 adjacent points are closely spaced. Moreover, the plot resembles a theoretical H versus B plot in a hysteresis loop.

### (b)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Point 6 |
| B (T) | 0.0 | 1.3 | 1.4 | 1.7 | 1.8 | 1.9 |
| H (A/m) | 0.0 | 540.6 | 1062.8 | 8687.4 | 13924.3 | 22650.2 |

Table 2: The given 6 points to be interpolated

The Lagrange polynomial for the points above is given by:

Using Wolfram Alpha to expand this expression gives:

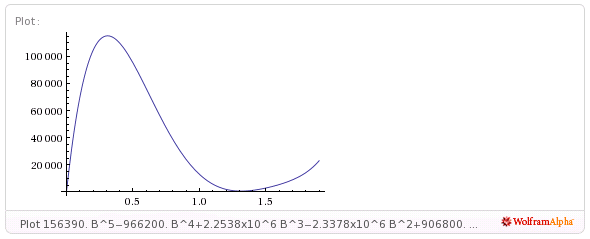


Figure 2: Plot of H (A/m) versus B (T) Interpolation (given 6 points)

No, this interpolation and its associated graph are not plausible H versus B relations as the chosen points to generate the Lagrange polynomial were widely spaced (leading to a divergent polynomial).

### (c)

## Question 2

### (a)

The magnetic circuit suggests the following relation:

The reluctance of a magnetically uniform magnetic circuit element can be calculated as:

Thus, substituting the reluctance expressions into our original relation, we obtain:

Then, substituting the given values in the problem statement yields:

### (b)

We are to use the relation between B and H from Table 1 in the assignment instructions. To link to H, we know that , hence, we need only divide to get to B. In other words, we can use our table with:

For the Newton-Raphson method, we solve for in the following relation:

Where:

Since , , then:

The relation between H and B in the steel core is described with a piecewise interpolation of the following points:



is given by:

## Question 3

### (a)

## Question 4

### (a)

## Appendix