University of Nottingham
School of Mathematical Sciences

HG1 M12 　　　　　　　　　　　　　　　　　　　　　　Engineering Mathematics 2

Coursework Assignment 　　　　　　**Submission deadline: 3pm, 15 March 2019**

This assessed coursework should be submitted to your local Student Services Centre. Please show all your workings, add explanations were possible and make sure that the document is reasonably tidy and readable. Marks are assigned for <u>all</u> the following aspects: Methodology, clarity of exposition, correctness of results. Detailed marking criteria can be consulted on Moodle.

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1. Find the value of $m \in \mathbb{R}$ for which the function

$$f(x, y, z, t) = t^m e^{-(x^2+y^2+z^2)/4t}$$

   satisfies

$$\frac{\partial f}{\partial t} = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}.$$

   [10 marks]

2. (a) If $\mathbf{a}_1 = (2, 3, -1)$, $\mathbf{a}_2 = (-2, 3, 7)$ and $\mathbf{a}_3 = (9, -1, 4)$, calculate $\mathbf{a}_1 \times (\mathbf{a}_2 \times \mathbf{a}_3)$ and $(\mathbf{a}_1 \times \mathbf{a}_2) \times \mathbf{a}_3$. Are the results the same? What does it mean?

   (b) If $\mathbf{a}$, $\mathbf{b}$, and $\mathbf{c}$ are three arbitrary vectors, show by direct calculations that

$$\mathbf{a} \times (\mathbf{b} \times \mathbf{c}) = (\mathbf{a} \cdot \mathbf{c})\mathbf{b} - (\mathbf{a} \cdot \mathbf{b})\mathbf{c}.$$

   Hence, or otherwise, deduce that if $\mathbf{n}$ is a unit vector, then $\mathbf{n} \times (\mathbf{a} \times \mathbf{n}) = (\mathbf{n} \times \mathbf{a}) \times \mathbf{n}$ (the common value of these expressions can be written as $\mathbf{n} \times \mathbf{a} \times \mathbf{n}$).

   (c) Consider a plane $\mathcal{P}$ of unit normal $\mathbf{n}$, and the points $O \in \mathcal{P}$ and $A \notin \mathcal{P}$. Let $B \in \mathcal{P}$ be the foot of the perpendicular from A onto $\mathcal{P}$. If $\mathbf{a} = \overrightarrow{OA}$, show that

$$\overrightarrow{OB} = \mathbf{n} \times \mathbf{a} \times \mathbf{n}.$$
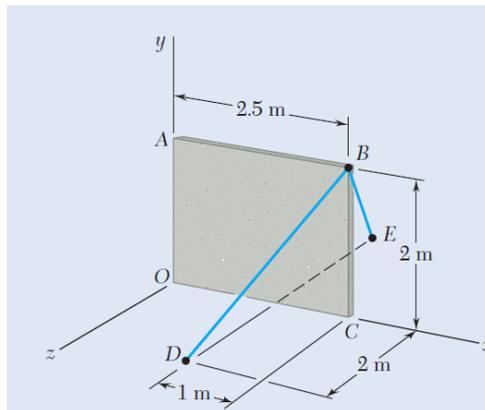
   [20 marks]

3. Consider the function $f = f(x, y)$, given by

$$f(x, y) = \frac{1}{6}x(x^2 + 3y^2).$$

   If the values of x and y increase by 2%, use the Taylor expansion formula to find the relative change in f. 　　　　　　　　　　　　　　　　[10 marks]

4. A precast wall section is temporarily held by two cables as shown. Knowing that the tension in cable BD is 900 N, determine the moment about point O of the force exerted by the cable at B.

<div align="right">[10 marks]</div>

COURSEWORK MARKING CRITERIA

The assignment will be marked out of 50. The questions do not carry equal weight.

You should read the question carefully and ensure that you answer each element of the question.

You do not need to word-process your submitted answers, but you should take care over the neatness and legibility of your solutions. Marks will be awarded for legible and well-presented work.

Examine the way that model solutions are presented in textbooks and the solutions to problem sheets posted on Moodle. Use these as a guide to presenting a finished piece of work. These invariably contain explanations for trickier steps in the calculations, i.e. the maths is often interspersed with written text. You will gain credit for following this practice.

Remember that getting the *right* answer is not enough – the process by which it is obtained is more important and demonstrates understanding. So simply writing down the answers will not gain credit. Likewise, the answer can usually be found in more than one way, so it is important that you *show your workings*. If your argument is flawed, then you will lose credit even if you obtain the correct final answer.