

University of Nottingham  
School of Mathematical Sciences

MM1MTE

Maths for Engineers

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**Coursework Assignment**

**Submission deadline: before 3pm, 20 March 2019**

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

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1. The position vector of a particle that moves in space is given by

$$\mathbf{r} = 3u\mathbf{i} + 3u^2\mathbf{j} + 2u^3\mathbf{k},$$

where  $u = u(t)$  is a differentiable function. Knowing that the particle moves in the direction corresponding to increasing  $u$  and with a constant speed of 6, find the velocity and acceleration of the particle when it is at the point  $(3, 3, 2)$ . [10 marks]

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

$$f(x, y) = \frac{xy}{x + y}, \quad (x, y > 0),$$

identically satisfies (i.e., for all  $x > 0$  and  $y > 0$ )

$$x^m \frac{\partial^2 f}{\partial x^2} + 2(xy)^{m-1} \frac{\partial^2 f}{\partial x \partial y} + y^m \frac{\partial^2 f}{\partial y^2} = 0.$$

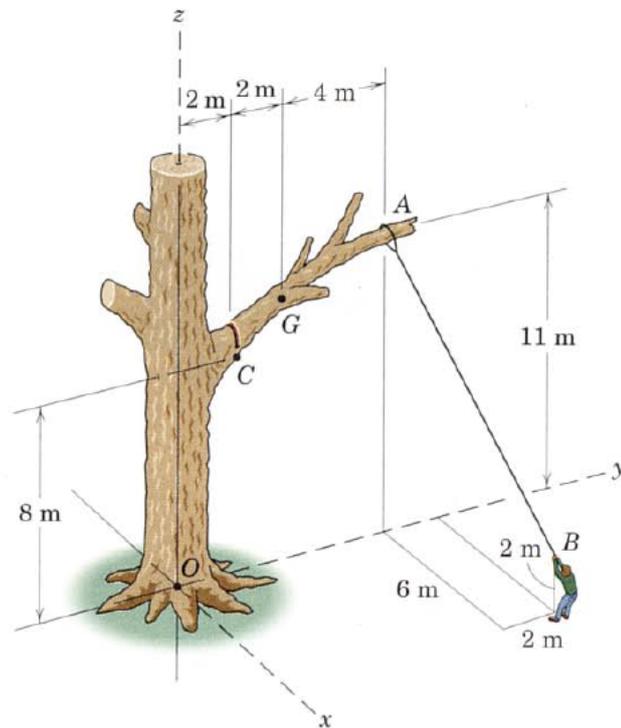
[13 marks]

3. The total resistance  $R$  (in ohms) of three resistors with resistances  $R_1$ ,  $R_2$ , and  $R_3$  ohms connected in parallel is given by

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

If  $R_1$ ,  $R_2$ , and  $R_3$  are measured as 20, 30, and 50 ohms, respectively, with a maximum error of 0.5% in each measurement, find the maximum percentage error in the calculated value of  $R$ . [10 marks]

4. In an attempt to pull down a nearly sawn-through branch, the tree surgeon exerts a 400-N pull on the line which is looped around the branch at  $A$  (see attached sketch). Determine the vector moment about point  $C$  of the force exerted on the branch and calculate the magnitude of this moment.



[9 marks]

5. The vector equations of two lines are (in the usual notation)

$$\mathbf{r} = \mathbf{a} + \lambda \mathbf{d}_1 \quad \text{and} \quad \mathbf{r} = \mathbf{b} + \mu \mathbf{d}_2, \quad (-\infty < \lambda, \mu < +\infty).$$

If these lines intersect, show that

$$[\mathbf{a} - \mathbf{b}, \mathbf{d}_1, \mathbf{d}_2] = 0.$$

Use this result to decide whether the following two lines intersect,

$$\frac{x-2}{3} = -y = 1-z \quad \text{and} \quad 4x = y = z.$$

[8 marks]

## 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.