



**Tuesday 24 June 2014 – Morning**

**A2 GCE MATHEMATICS (MEI)**

**4798/01 Further Pure Mathematics with Technology (FPT)**

**QUESTION PAPER**

Candidates answer on the Printed Answer Book.

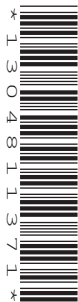
**OCR supplied materials:**

- Printed Answer Book 4798/01
- MEI Examination Formulae and Tables (MF2)

**Other materials required:**

- Scientific or graphical calculator
- Computer with appropriate software

**Duration:** Up to 2 hours



**INSTRUCTIONS TO CANDIDATES**

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

**INFORMATION FOR CANDIDATES**

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets [ ] at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

**COMPUTING RESOURCES**

- Candidates will require access to a computer with a computer algebra system, a spreadsheet, a programming language and graph-plotting software throughout the examination.

**INSTRUCTION TO EXAMS OFFICER/INVIGILATOR**

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

1 This question concerns curves with equation

$$y = \frac{x^3 + ax^2 + 1}{x^n}$$

for various values of  $a$  and  $n$ .

- (i) For the case  $n = 1$ , sketch the curves when  $a = 2$ ,  $a = 3$  and  $a = 4$ . Describe two common features of these three curves. [6]
- (ii) For the case  $n = 1$  and  $a = 3$ , find the number of stationary points and identify their nature, justifying your answers. [5]
- (iii) For the case  $a = 3$ , sketch the curves when  $n = 2$  and  $n = 3$ . [4]
- (iv) Given that  $a > 0$ , find the equations of the asymptotes for each of the cases  $n = 2$  and  $n = 3$ . For any non-vertical asymptotes, state whether they are approached from above or below, justifying your answers. [8]

2 (i) The function  $f$  is defined by  $f(z) = z^3 + (2 - 2i)z^2 + (7 - 12i)z + 6 - 10i$ . Solve the equation  $f(z) = 0$  and plot the roots as points on an Argand diagram.

Show that these points lie on a straight line. [6]

(ii) Find the roots of  $f'(z) = 0$ . Plot these roots on the Argand diagram drawn in part (i).

Show that the roots of  $f'(z) = 0$  lie on the same straight line as the roots of  $f(z) = 0$ . [6]

(iii) The function  $g$  is defined by  $g(z) = z^3 - (k + 1)az^2 + ka^2z$  where  $a \in \mathbb{C}$ ,  $k \in \mathbb{R}$ .

Show that the roots of  $g(z) = 0$  lie on a straight line.

Show that the roots of  $g'(z) = 0$  lie on this same line. [8]

(iv) Now consider a function  $h$  which is a cubic with real coefficients. Identify the two distinct conditions under which the roots of  $h(z) = 0$  lie on a straight line in the Argand diagram. Give, in expanded form, an example of such a cubic for each case. [5]

3 This question concerns Pythagorean triples: positive integers  $a$ ,  $b$  and  $c$  such that  $a^2 + b^2 = c^2$ . The integer  $n$  is defined by  $c = b + n$ .

(i) Create a program that will find all such triples for a given value of  $n$ , where both  $a$  and  $b$  are less than or equal to a maximum value,  $m$ . You should write out your program in full.

For the case  $n = 1$ , find all the triples with  $1 \leq a \leq 100$  and  $1 \leq b \leq 100$ .

For the case  $n = 3$ , find all the triples with  $1 \leq a \leq 200$  and  $1 \leq b \leq 200$ . [9]

(ii) For the case  $n = 1$ , prove that there is a triple for every odd value of  $a$  where  $a > 1$ . [4]

(iii) For the case  $n = p$ , where  $p$  is prime, show that  $a$  must be a multiple of  $p$ . [3]

(iv) For the case  $n = b$ , determine whether there are any triples. [4]

(v) Edit your program from part (i) so that it will only find values of  $a$  and  $b$  where  $b$  is not a multiple of  $n$ . Indicate clearly all the changes to your program.

Use the edited program to find all such triples for the case  $n = 2$  with  $1 \leq a \leq 100$  and  $1 \leq b \leq 100$ . [4]

**END OF QUESTION PAPER**

**Copyright Information**

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.