



**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.

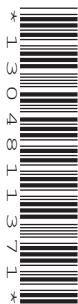
**OCR supplied materials:**

- 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**

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