

CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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FURTHER MATHEMATICS

9231/11

Paper 1

May/June 2018

3 hours

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF10)

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

The use of a calculator is expected, where appropriate.

Results obtained solely from a graphic calculator, without supporting working or reasoning, will not receive credit.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **27** printed pages and **1** blank page.



3 The curve C has polar equation $r = \cos 2\theta$, for $-\frac{1}{4}\pi \leq \theta \leq \frac{1}{4}\pi$.

(i) Sketch C .

[2]

(ii) Find the area of the region enclosed by C , showing full working.

[3]

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(iii) Find a cartesian equation of C . [3]

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(iii) Justifying your answer, find the number of stationary points on C . [2]

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(iv) Sketch C . Your sketch should indicate the coordinates of any points of intersection with the y -axis. You do not need to find the coordinates of any stationary points. [3]

When $\alpha = 0$ the null space of T is denoted by K_2 .

(ii) Find a basis for K_2 . [3]

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(iii) Determine, justifying your answer, whether K_1 is a subspace of K_2 . [2]

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9 (i) Using the substitution $u = \tan x$, or otherwise, find $\int \sec^2 x \tan^2 x \, dx$. [2]

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It is given that, for $n \geq 0$,

$$I_n = \int_0^{\frac{1}{4}\pi} \sec^n x \tan^2 x \, dx.$$

(ii) Using the result that $\frac{d}{dx}(\sec x) = \tan x \sec x$, show that, for $n \geq 2$,

$$(n + 1)I_n = (\sqrt{2})^{n-2} + (n - 2)I_{n-2}. \quad [5]$$

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- (iii) Hence find the mean value of $\sec^4 x \tan^2 x$ with respect to x over the interval $0 \leq x \leq \frac{1}{4}\pi$, giving your answer in exact form. [3]

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