

Thursday 17 January 2013 – Morning

**PRINCIPAL LEARNING LEVEL 3
ENGINEERING**

F563/01 Mathematical Techniques and Applications for Engineers

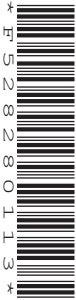
Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:

- Scientific calculator

Duration: 2 hours



| | | | |
|-----------------------|--|----------------------|--|
| Candidate forename | | Candidate surname | |
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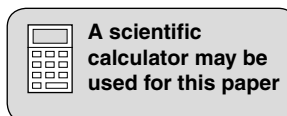
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|---------------|--|--|--|--|--|------------------|--|--|--|--|
| Centre number | | | | | | Candidate number | | | | |
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INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions in **Section A** and any **three** questions from **Section B**.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.



SECTION A

Answer **all** questions in the spaces provided.

- 1 Remove the brackets and simplify $-4(-3x - 5)$.

.....
..... [2]

- 2 Factorise the expression $x^2 - 25$.

.....
..... [2]

- 3 Simplify the expression $(x + 6)/4 - (x + 5)/8$.

.....
.....
..... [2]

- 4 Solve the equation $(2x - 3)/4 = (x - 1)/3$.

.....
.....
..... [2]

- 5 Calculate the area of a sector having a radius of 100 mm with an angle 1.2 radians subtended at the centre.

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.....
..... [2]

- 6 In a right-angled triangle ABC, length AC = 1.5 m, angle A = 30° and B is the right angle. Calculate the length BC.

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..... [2]

7 An alternating e.m.f. is represented by $v = 50 \sin \theta$. Determine the value of v when $\theta = 210^\circ$.

.....
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..... [2]

8 An iron casting has a uniform triangular cross-section with the following dimensions:

length of base of triangle = 0.8 m
perpendicular height of triangle = 0.5 m.

Calculate the cross-sectional area of the casting.

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..... [2]

9 Differentiate $y = 5x^4 + \sin x$ with respect to x .

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.....
..... [2]

10 Differentiate $y = \cos x + \ln (5x)$ with respect to x .

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..... [2]

11 Integrate $\cos (4x)$ with respect to x .

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.....
..... [2]

12 Calculate the value of the definite integral $\int_4^6 4x^3 \, dx$.

.....
.....
..... [2]

13 Determine the mean and median for the set of given values:

5, 9, 7, 15, 8, 12, and 7.

Mean

Median [2]

14 Draw a distribution curve with a positive skew in the space below.

[2]

15 A box of fuses are all the same shape and size. There are forty 3A fuses, five 5A fuses and ten 7A fuses. Determine the probability of selecting at random:

(a) a 3A fuse

..... [1]

(b) a 5A or a 7A fuse.

..... [1]

5
SECTION B

Answer any **three** questions in the spaces provided.

- 1 (a) The resistance $R\Omega$ of a length of wire at a specific temperature $t^\circ\text{C}$ is given by $R = R_0(1 + \alpha t)$.

Calculate the resistance R of the wire when $R_0 = 10$, $\alpha = 0.006$ and $t = 100$.

.....
.....
..... [2]

- (b) (i) Transpose the formula $R = R_0(1 + \alpha t)$ to make t the subject.

.....
.....
..... [3]

- (ii) Calculate the value of t when $R = 25$, $R_0 = 12.5$ and $\alpha = 0.006$.

.....
.....
..... [3]

- (c) The energy stored in a capacitor is given by $W = \frac{1}{2}CV^2$.

Transpose the formula to make V the subject.

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.....
..... [2]

[Total: 10]

2 (a) Solve the equation $3x^2 + 14x + 8 = 0$ by factorisation.

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..... [3]

(b) Solve the equation $x^2 - 4x = 5$ by completing the square.

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..... [3]

(c) Solve the quadratic equation $x^2 - 4x - 12 = 0$ using the formula method.

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..... [4]

[Total: 10]

- 3 (a) The instantaneous value of an alternating voltage v at time t seconds is given by $v = 200 \sin (100\pi t)$.

Determine the following quantities:

- (i) the peak value of the voltage in volts

..... [1]

- (ii) the frequency of supply in hertz

.....
 [1]

- (iii) the periodic time in seconds

.....
 [2]

- (iv) the voltage, in volts, when $t = 0.015$

.....

 [3]

- (b) For the formula $v = 200 \sin (100\pi t)$ sketch a sine wave for the relationship between v and t .

[3]

[Total: 10]

- 4 Fig. 1 shows two pathways BA and CA meeting at the top of a hill, point A. Points B, C and D are in the same horizontal plane. The vertical height of the hill AD, is 200 m. The pathways make angles of 32° and 45° with the horizontal as shown.

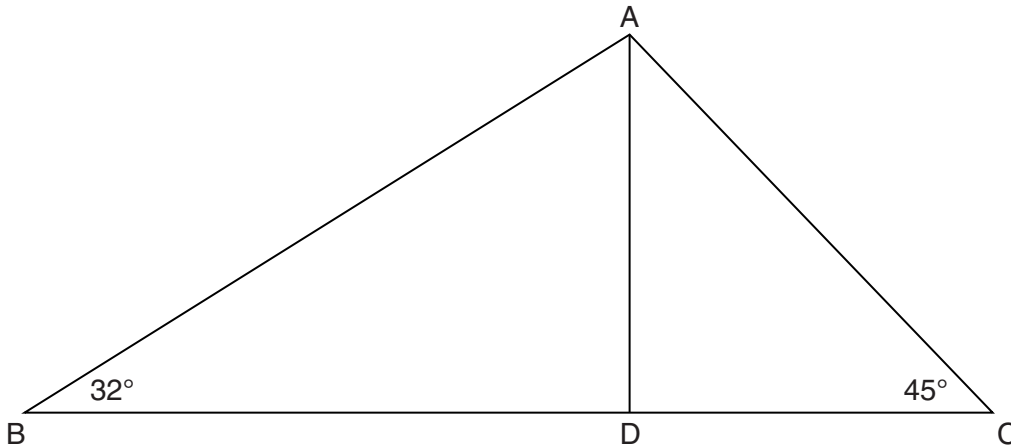


Fig. 1

- (a) Calculate the length of path BA.

.....

 [3]

- (b) Calculate the distance between the starting points B and C of the paths.

.....

 [4]

- (c) Calculate the angle BAC.

.....

 [3]

[Total: 10]

5 The volume V of a cone is given by the formula $V = \frac{1}{3} \pi r^2 h$ where h is the height of the cone and r the radius of its base. For a particular cone $r + h = 6$.

(a) Rewrite the formula for V in terms of r only.

..... [1]

(b) Differentiate the new formula for V with respect to r .

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.....
..... [2]

(c) State the value of dV/dr at a turning point.

..... [1]

(d) Calculate a value for r at each turning point.

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..... [2]

(e) By finding d^2V/dr^2 determine the value for r when the volume of the cone is a maximum.

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..... [4]

[Total: 10]

- 6 (a) A vehicle moves along a straight line so that its velocity v at time t is $v = 3 \sin(3t) + 4t^3$. Calculate how far the vehicle travels between times $t = 0$ and $t = 2$ seconds.

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..... [5]

- (b) Calculate the area bounded by the curve $y = x^3 + 4$, the x -axis and the lines $x = 1$ and $x = 5$.

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..... [5]

[Total: 10]

7 (a) State the addition law for probability, explaining the conditions under which it is valid.

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..... [2]

(b) State the multiplication law for probability, explaining the conditions under which it is valid.

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..... [2]

(c) A box contains 36 screws, 74 washers and 90 nuts.

Determine the probability that there are two screws and either a washer or a nut when three items are drawn at random, without replacement.

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..... [6]

[Total: 10]

8 (a) Explain what is meant by the term 'data handling'.

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..... [2]

(b) The table shows the number of castings per box in a sample of 24 boxes.

| | | | | |
|------------------------|----|----|----|----|
| Number in Box | 40 | 41 | 42 | 43 |
| Number of Boxes | 2 | 4 | 12 | 6 |

Draw a labelled bar chart representing this data in the space below.

[2]

(c) The number of components made each day by a machine over five days is 20, 30, 40, 50 and 60.

For this data, calculate the mean and standard deviation.

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..... [6]

[Total: 10]

END OF QUESTION PAPER

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