



**Thursday 15 January 2015 – 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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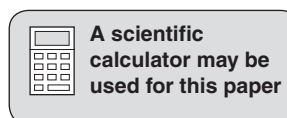
Centre number						Candidate number				
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**INSTRUCTIONS TO CANDIDATES**

- 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 **20** pages. Any blank pages are indicated.



## SECTION A

Answer **all** questions.

- 1 Remove the brackets and simplify the expression  $6(4x + 5) - 8x$ .

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

- 2 Factorise the expression  $x^2 - 10x + 24$ .

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

- 3 Simplify the expression  $[(x + 5)/12] - (x - 4)/3$ .

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

- 4 Solve the equation  $5(2x - 4) = 3(3x - 2)$ .

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

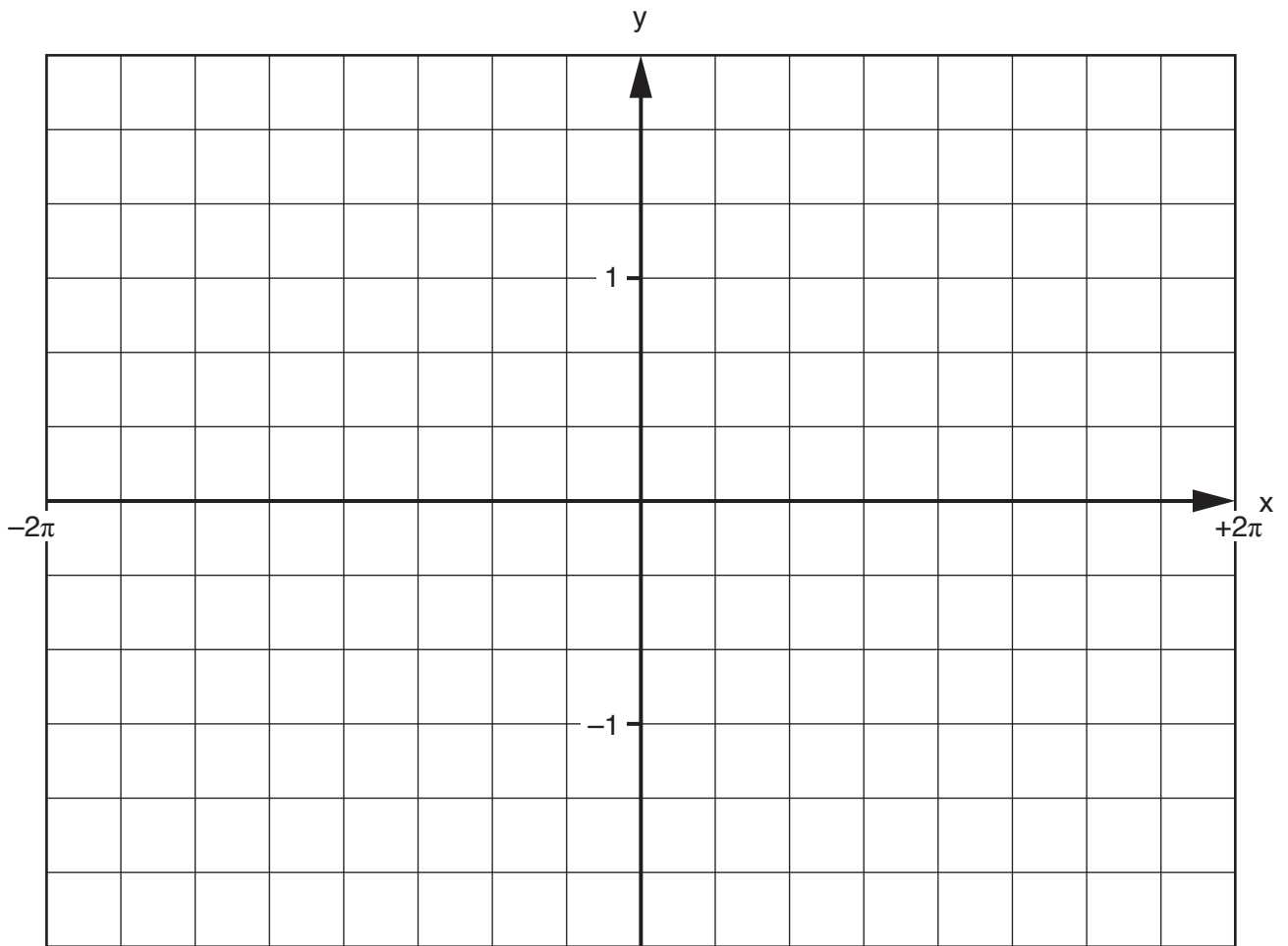
- 5 (a) Convert  $\pi$  radians to degrees.

..... [1]

- (b) Convert  $60^\circ$  to radians.

..... [1]

6 Sketch a graph of  $y = \sin x$  for angles from  $-2\pi$  to  $+2\pi$  on the grid below.



[2]

7 In the triangle ABC angle  $A = 30^\circ$ , angle  $B = 70^\circ$  and side  $b = 2$  m.

Calculate the length of side a.

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

8 In a right-angled triangle the sine of angle  $x$  is  $4/5$ .

Draw the triangle and find the exact value of  $\tan x$ .

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

9 Differentiate  $y = \sqrt{x^3}$  with respect to  $x$ .

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

10 Differentiate  $y = 2e^{6x} + \sin x$  with respect to  $x$ .

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

11 Integrate  $\sin 3x$  with respect to  $x$ .

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

12 Calculate the value of the definite integral  $\int_1^3 15x^4 dx$ .

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

13 Name the curve shown in Fig. 1.

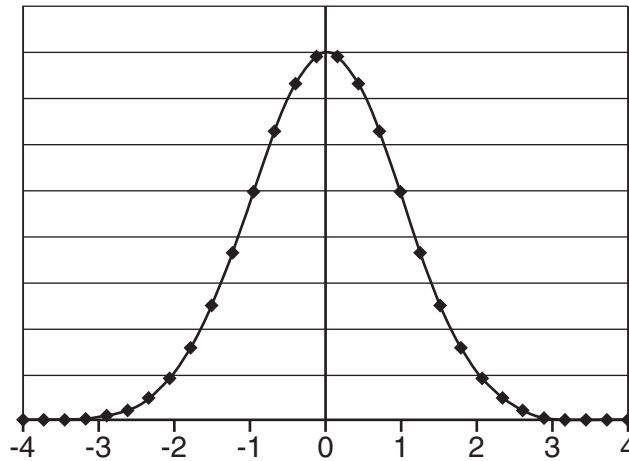


Fig. 1

..... [1]

14 Determine the arithmetic mean and the median for the set of ungrouped data given:

30 27 26 28 29

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

15 Given the probability law  $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$ , state the meaning of:

$P(A \text{ or } B)$  .....  
 ..... [1]

$P(A \text{ and } B)$  .....  
 ..... [1]

[Total: 30]

SECTION B

Answer any **three** questions.

- 1 (a) Given that  $A = \pi d^2/4$ .

Calculate the value of A when  $d = 10$ .

.....  
.....  
..... [1]

- (b) Transpose the formula  $V = V_0(1 + 3aT)$  to make T the subject.

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

- (c) Transpose the formula  $F = m(V^2 - U^2)/2$  to make U the subject.

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

- (d) Given that  $y = x/(x + 1)$ .

Transpose the formula to make x the subject.

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

[Total: 10]



3 (a) An alternating current is represented by  $i = I \sin 314.2 t$ .

Determine:

(i) the frequency  $f$  of the supply in hertz

.....  
..... [1]

(ii) the instantaneous current  $i$  when the peak current  $I = 20 \text{ A}$  at a time of  $0.002 \text{ s}$

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

(iii) the peak current  $I$  when the instantaneous current  $i$  is  $4 \text{ A}$  at a time of  $0.008 \text{ s}$ .

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

(b) The sides of a triangle ABC are  $a = 3 \text{ m}$ ,  $b = 5 \text{ m}$  and  $c = 6 \text{ m}$ .

Calculate:

(i) the angle B

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

(ii) the area of the triangle.

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

[Total: 10]



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**Question 4 begins on page 10**

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4 (a) Solve the equation  $\sin^2 x - \cos^2 x = \frac{1}{4}$  for angles  $x$  between  $0$  and  $360^\circ$ .

.....  
.....  
.....  
.....  
.....  
.....  
..... [5]

(b) Fig. 2 shows the details of a door wedge. The faces  $ACFD$ ,  $ABED$  and  $CBEF$  are rectangles.

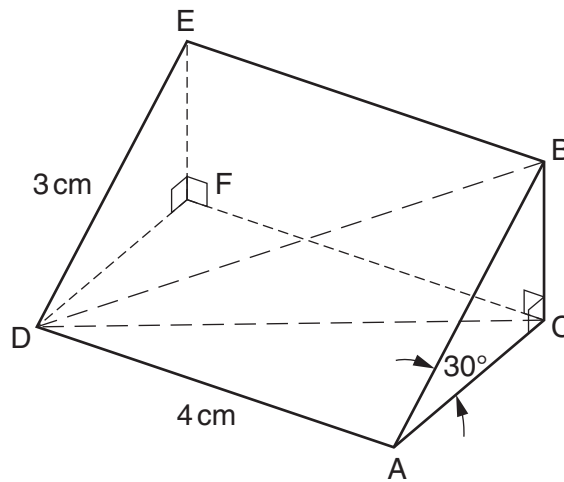


Fig. 2

Calculate:

(i) the length of AC

.....  
.....  
..... [1]

(ii) the length of BC

.....  
.....  
..... [1]

(iii) the angle between the lines DA and DC

.....  
.....  
..... [1]

(iv) the length of DC

.....  
.....  
..... [1]

(v) the angle between the lines DC and DB.

.....  
.....  
..... [1]

[Total: 10]

5 (a) Complete the table below for the equation  $y = x^2$  for values of  $x$  from  $-2$  to  $+2$ .

x	-2	-1.5	-1	0	1	1.5	2
y							

[1]

(b) Fig. 3 shows a pair of axes.

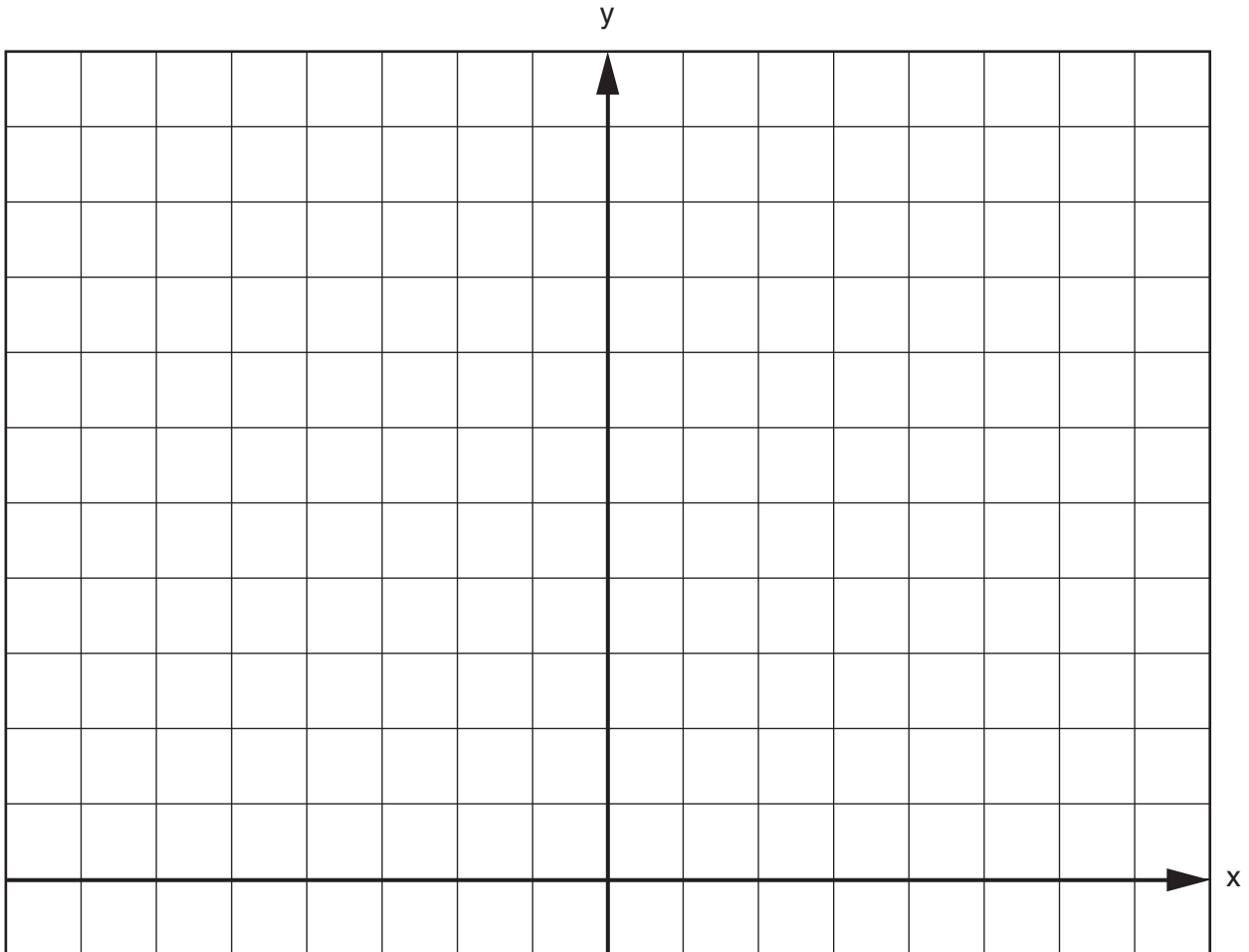


Fig. 3

(i) Using the values from the completed table draw a graph on Fig. 3 of  $y = x^2$  for values of  $x$  from  $-2$  to  $+2$ . [2]

(ii) Draw a tangent to the graph at the point when  $x = -1.5$  and then determine the gradient of the curve at this point.

..... [1]

(c) The distance  $s$  metres moved by a body in  $t$  seconds is given by the formula  $s = 2t^3 + 4t^2 + 6t$ .

(i) Determine the initial velocity of the body.

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

(ii) Determine the velocity of the body after 5 seconds.

.....  
.....  
..... [1]

(iii) Determine the acceleration of the body after 3 seconds.

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

[Total: 10]

- 6 (a) Calculate the area bounded by the curve  $y = \cos 3x$  and the x-axis between  $x = 0$  and  $x = \pi/6$ .

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [4]

- (b) Integrate  $y = (1 - x)^2$  with respect to  $x$ .

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

- (c) Integrate  $y = (x^3 - 2x)/3x$  with respect to  $x$ .

.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [4]

[Total: 10]

- 7 (a) The time taken, in minutes, by 30 people to complete a task in a workshop gave the following results:

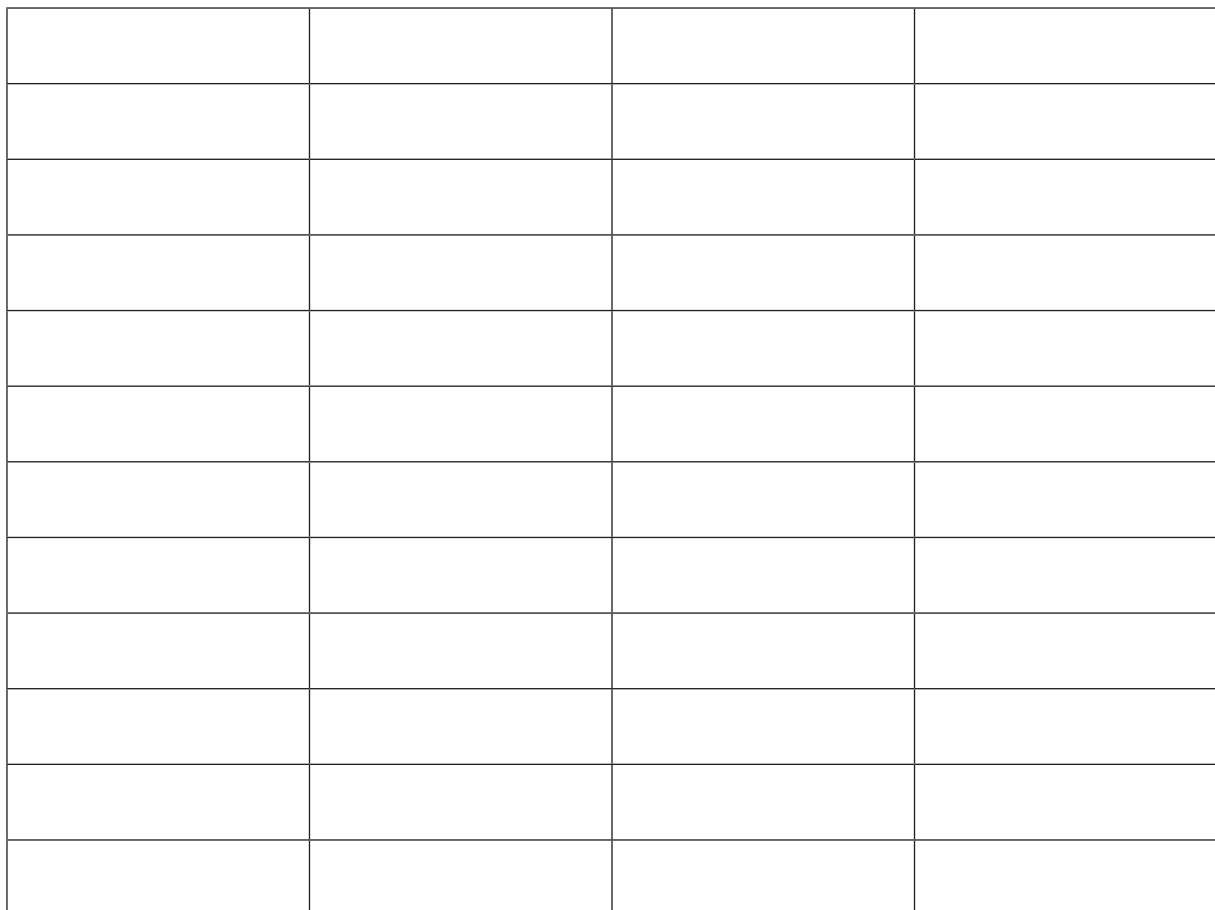
26 23 52 48 33 51 52 37 39 23  
 44 54 21 29 37 59 26 39 29 21  
 40 31 45 52 26 31 39 33 60 48

- (i) Complete the tally table below for the given times.

Time (minutes)	Tally	Frequency (f)
21 – 30		
31 – 40		
41 – 50		
51 – 60		

[2]

- (ii) Draw a histogram to represent the information from the tally table, on the grid below.



20.5                      30.5                      40.5                      50.5                      60.5

[4]

(b) Fig. 4 shows a cumulative frequency curve for the time taken by 40 people to complete a different task in the workshop.

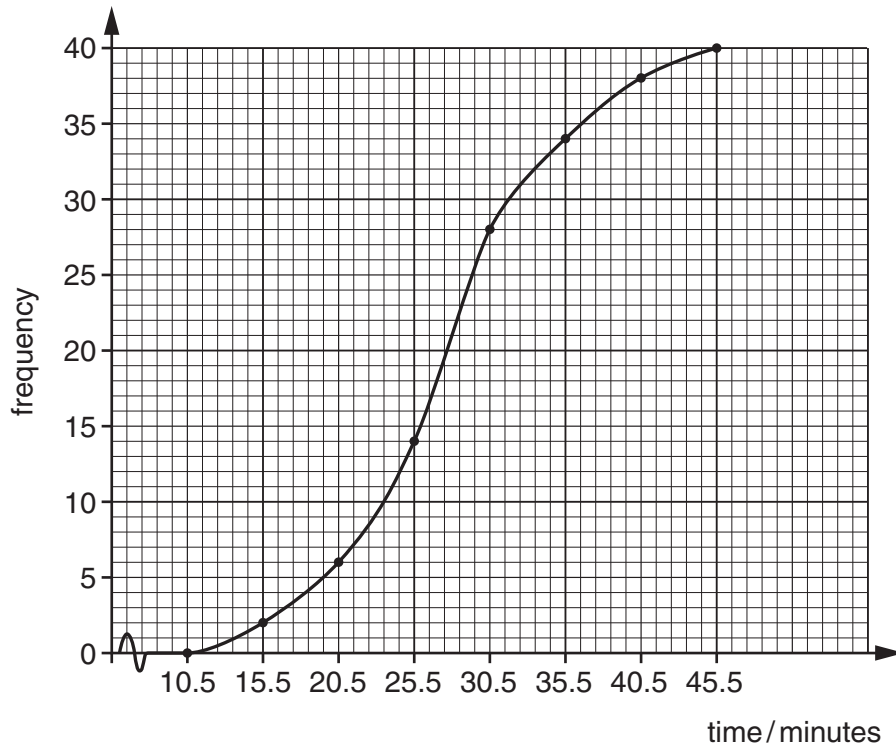


Fig. 4

(i) Estimate the first and third quartile.

First quartile = .....

Third quartile = .....

[2]

(ii) Estimate the interquartile range.

..... [2]

[Total: 10]



8 (a) With reference to probability, give the meaning of the terms:

(i) Trial

.....  
.....

(ii) Outcome

.....  
.....

(iii) Event.

.....  
.....

[3]

(b) An engineering organisation has decided to give each of its clients an eight-character code. The first three characters in this code are the letters X, Y and Z in any order and the remaining five are the digits 1 to 5 in any order. Each letter and each digit can only occur once. Determine how many clients the organisation can code in this way.

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

(c) When three six-sided dice are shaken and then thrown together, what is the probability of obtaining:

(i) three fives

.....  
..... [1]

(ii) only one five

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

(iii) at least one five?

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

[Total: 10]

END OF QUESTION PAPER

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