



12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

SURNAME:

Perry

FORENAME(S):

Matthew

1	Student Number	
2	Title of Examination Paper	Further ENG Maths.
3	Module Code	5001
4	Date and Time of Examination	05-04-22 09:30 - 12:00
5	Examination Venue	G43
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
A	25
B1	25
3	25
4	19
Total	94

a)

x	f	xf	$f(x - \bar{x})^2$
6	23	138	$23(6 - 8.77)^2 = 176.48$
7	56	392	$56(7 - 8.77)^2 = 175.44$
8	65	520	$65(8 - 8.77)^2 = 38.54$
9	53	477	$53(9 - 8.77)^2 = 2.80$
10	47	470	$47(10 - 8.77)^2 = 71.11$
11	37	407	$37(11 - 8.77)^2 = 183.184$
12	19	228	$19(12 - 8.77)^2 = 198.22$

$$\Sigma = 300 \quad \Sigma = 2632 \quad \Sigma = 846.59$$

$$\bar{x} = \frac{\Sigma fx}{\Sigma f} = \frac{2632}{300} = 8.77$$

$$\sigma = \sqrt{\frac{\Sigma f(x - \bar{x})^2}{\Sigma f}} = \sqrt{\frac{846.59}{300}} = 1.68$$

7.

b) 2.25

(i) 3 goals are scored.

$$p(x=3) = \frac{e^{-2.25} (2.25)^3}{3!} = 0.2$$

(ii) more than 1, i.e. 0 and 1.

$$p(x=0) = \frac{e^{-2.25} (2.25)^0}{0!} = 0.1054$$

$$p(x=1) = \frac{e^{-2.25} (2.25)^1}{1!} = 0.2371$$

$$p(x = \text{more than 1}) = 1 - (0.1054 + 0.2371) = 0.6575$$

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25/25

1. $R = 30, C = 1/30, E = 30e^{-3t}, I(0) = 0.$

$$\frac{dI}{dt} = 30e^{-3t} - 90e^{-3t} \quad \checkmark$$

$$E(t) = RI + \frac{1}{C} \int I dt.$$

$$30I + \frac{1}{1/30} = -90e^{-3t}$$

$$30I + 30 = -90e^{-3t} \quad \checkmark$$

$$30 \frac{dI}{dt} + 30I = -90e^{-3t}$$

$$\frac{dI}{dt} + \frac{30}{30}I = \frac{-90}{30}e^{-3t}$$

$$\frac{dI}{dt} + I = -3e^{-3t}$$

$$\frac{dy}{dx} + py = Q.$$

$$P = 1, Q = -3e^{-3t}$$

$$p dt = 1 dt$$

$$e^{\int p dt} = e^{1t} \quad \checkmark$$

$$Ie^{1t} = \int -3e^{-3t} dt.$$

$$Ie^{1t} = -3e^{-2t} dt.$$

$$Ie^{1t} = \frac{-3}{-2} e^{-2t}$$

$$Ie^{1t} = 1.5e^{-2t} + C$$

$$\text{when } I(0) = 0.$$

$$Ie^0 = 1.5e^0 + C$$

$$C = -1.5 \quad \checkmark$$

$$Ie^{1t} = 1.5e^{-2t} - 1.5 \quad \checkmark$$

25
25

3. $y'' + 4y' + 3y = e^{-2t}$ $y=0, y'=3$ when $t=0$.

$$s^2 \bar{y} - s\bar{y}_0 - \bar{y}_1 + 4(s\bar{y} - \bar{y}_0) + 3\bar{y} = \frac{1}{s+2}$$

$$s^2 \bar{y} - 0 - 3 + 4s\bar{y} + 3\bar{y} = \frac{1}{s+2}$$

$$s^2 \bar{y} + 4s\bar{y} + 3\bar{y} = \frac{1}{s+2} + 3$$

$$s^2 \bar{y} + 4s\bar{y} + 3\bar{y} = \frac{1 + 3(s+2)}{s+2}$$

$$s^2 \bar{y} + 4s\bar{y} + 3\bar{y} = \frac{1 + 3s + 6}{s+2}$$

$$s^2 \bar{y} + 4s\bar{y} + 3\bar{y} = \frac{7 + 3s}{s+2}$$

$$\bar{y}(s+1)(s+3) = \frac{7+3s}{s+2} \quad \checkmark$$

$$\frac{A}{s+2} + \frac{B}{s+1} + \frac{C}{s+3}$$

$$7+3s = A(s+1)(s+3) + B(s+2)(s+3) + C(s+2)(s+1)$$

put $s = -2$

$$7+3(-2) = A(-2+1)(-2+3) + B(-2+2)(-2+3) + C(-2+2)(-2+1)$$

$$1 = A(-1)(1) + B(0)(1) + C(0)(-1)$$

$$1 = -1A \quad A = \frac{1}{-1} \quad A = -1 \quad \checkmark$$

put $s = -1$

$$7+3(-1) = A(-1+1)(-1+3) + B(-1+2)(-1+3) + C(-1+2)(-1+1)$$

$$4 = A(0)(2) + B(1)(2) + C(1)(0)$$

$$4 = 2B \quad \frac{4}{2} = B \quad B = 2 \quad \checkmark$$

put $s = -3$

$$7+3(-3) = A(-3+1)(-3+3) + B(-3+2)(-3+3) + C(-3+2)(-3+1)$$

$$-2 = A(-2)(0) + B(-1)(0) + C(-1)(-2)$$

$$-2 = 2C \quad \frac{-2}{2} = C \quad C = -1 \quad \checkmark$$

$$A = -1$$

$$B = 2$$

$$C = -1$$

$$\mathcal{L}^{-1} \left\{ \frac{-1}{s+2} + \frac{2}{s+1} + \frac{-1}{s+3} \right\}$$

$$= -e^{-2t} + 2e^{-t} - e^{-3t}$$

4.

$$I(0) = 0 \quad \text{and} \quad I'(0) = 25$$

$$R = 65 \quad L = 3.5 \quad C = 1/50 \quad E = 70$$

$$E = RI + L \frac{dI}{dt} + \frac{1}{C} \int I dt$$

$$\frac{dE}{dt} = 60 = 0$$

$$L \frac{dI}{dt} + RI + \frac{1}{C} = 0$$

$$3.5 \frac{dI}{dt} + 65I + \frac{1}{1/50} = 0$$

$$3.5 \frac{dI}{dt} + 65I + 50 = 0$$

$$3.5 \frac{d^2 I}{dt^2} + 65 \frac{dI}{dt} + 50I = 0$$

$$3.5m^2 + 65m + 50 = 0$$

$$m = \frac{-65 \pm \sqrt{65^2 - 4(3.5)(50)}}{2(3.5)}$$

$$m = \frac{-65 \pm \sqrt{4225 - 700}}{7}$$

$$m = \frac{-65 \pm \sqrt{3525}}{7}$$

$$m = -0.8040 \quad \text{or} \quad m = 17.7674$$

Case 1, real and different.

25
25

$$I = Ae^{-0.8040t} + Be^{17.7674t}$$

when $I(0) = 0$.

$$0 = Ae^0 + Be^0$$

$$0 = A + B$$

$$\frac{dI}{dt} = I = -0.8040Ae^{-0.8040t} + 17.7674Be^{17.7674t}$$

when $I(0) = 25$

$$25 = -0.8040Ae^0 + 17.7674Be^0$$

$$25 = -0.8040A + 17.7674B$$

times ① by $= 0.8040$

$$0 = 0.8040A + 0.8040B$$

$$+ 25 = -0.8040A + 17.7674B$$

$$25 = 18.5714B$$

$$B = \frac{25}{18.5714} = 1.3461$$

Sub into ①

$$0 = A + 1.3461$$

$$-1.3461 = A$$

$$A = -1.3461$$

$$I = -1.3461e^{-0.8040t} + 1.3461e^{17.7674t}$$

$$\frac{19}{25}$$