





- 1 The times taken by members of a large cycling club to complete a cross-country circuit have a normal distribution with mean  $\mu$  minutes. The times taken,  $x$  minutes, are recorded for a random sample of 14 members of the club. The results are summarised as follows, where  $\bar{x}$  is the sample mean.

$$\bar{x} = 42.8$$

$$\sum (x - \bar{x})^2 = 941.5$$

Find a 95% confidence interval for  $\mu$ .

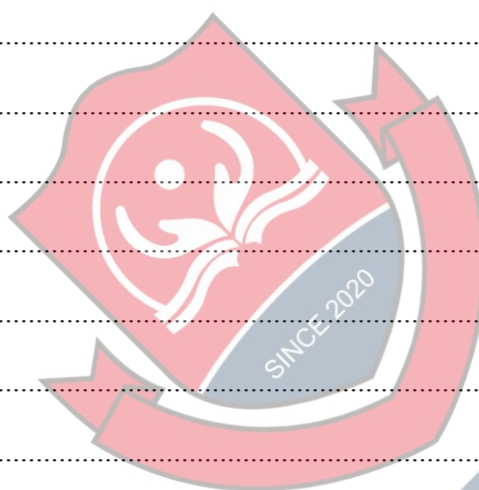
[4]



- 2 A large number of students are taking a Physics course. They are assessed by a practical examination and a written examination. The marks out of 100 obtained by a random sample of 15 students in each of the examinations are as follows.

| Student               | <i>A</i> | <i>B</i> | <i>C</i> | <i>D</i> | <i>E</i> | <i>F</i> | <i>G</i> | <i>H</i> | <i>I</i> | <i>J</i> | <i>K</i> | <i>L</i> | <i>M</i> | <i>N</i> | <i>O</i> |
|-----------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Practical examination | 66       | 63       | 24       | 52       | 59       | 76       | 88       | 51       | 48       | 36       | 91       | 72       | 68       | 67       | 60       |
| Written examination   | 63       | 57       | 39       | 50       | 47       | 71       | 87       | 65       | 56       | 39       | 78       | 70       | 61       | 62       | 70       |

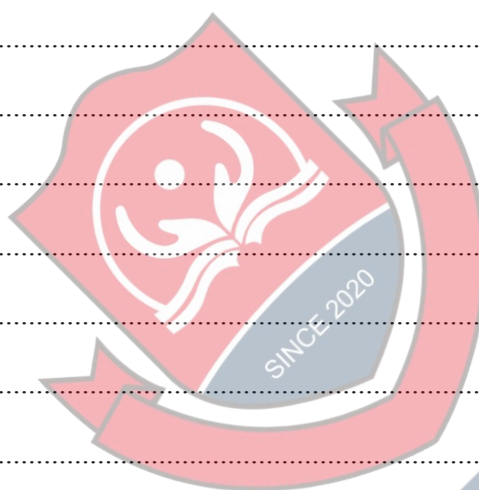
Use a sign test, at the 10% significance level, to test whether, on average, the practical examination marks are higher than the written examination marks. [5]



- 3** A factory produces metal discs. The manager claims that the diameters of these discs have a median of 22.0 mm. The diameters, in mm, of a random sample of 12 discs produced by this factory are as follows.

22.4 20.9 22.8 21.5 23.2 22.9 23.9 21.7 19.8 23.6 22.6 23.0

- (a) Carry out a Wilcoxon signed-rank test, at the 10% significance level, to test whether there is any evidence against the manager's claim. [7]

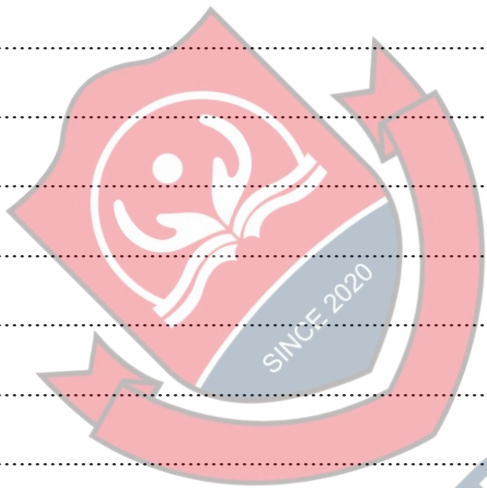


- (b) State an assumption that is necessary for this test to be valid. [1]

- 4 The random variable  $Y$  is the sum of two independent observations of the random variable  $X$ . The probability generating function  $G_Y(t)$  of  $Y$  is given by

$$G_Y(t) = \frac{t^2}{(4-3t)^4}.$$

- (a) Find  $E(Y)$ . [3]

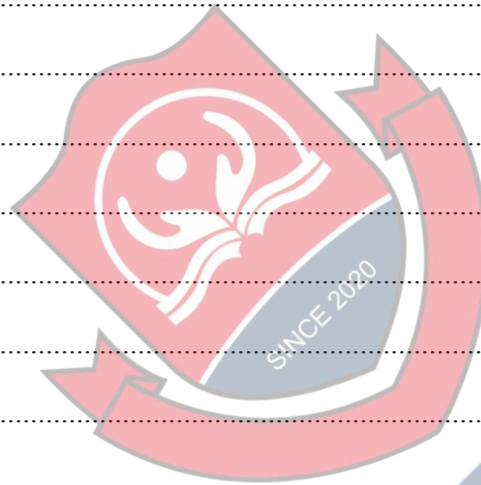


- (b) Write down an expression for the probability generating function of  $X$ . [1]

[illegible]

(c) Find  $P(X = 4)$ .

[3]

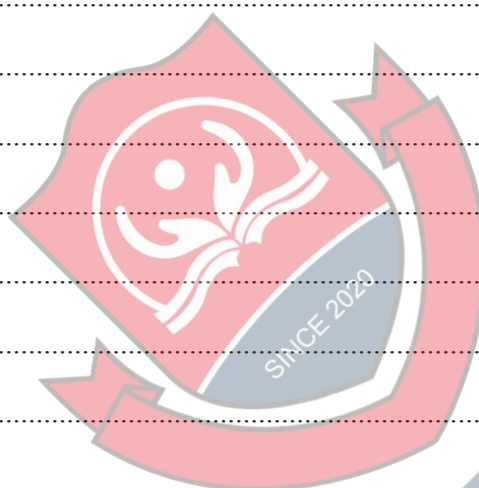


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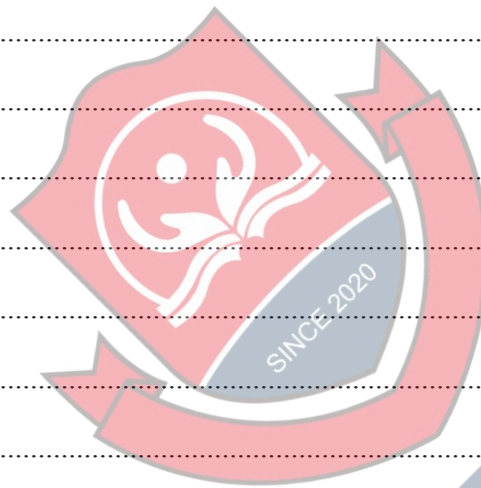
- 5 Two companies,  $P$  and  $Q$ , produce a certain type of paint brush. An independent examiner rates the quality of the brushes produced as poor, satisfactory or good. He takes a random sample of brushes from each company. The examiner's ratings are summarised in the table.

| Company | Poor | Satisfactory | Good |
|---------|------|--------------|------|
| $P$     | 18   | 43           | 64   |
| $Q$     | 22   | 22           | 31   |

- (a)** Test, at the 5% significance level, whether quality of brushes is independent of company. [7]







(b) Compare the quality of the brushes produced by the two companies.

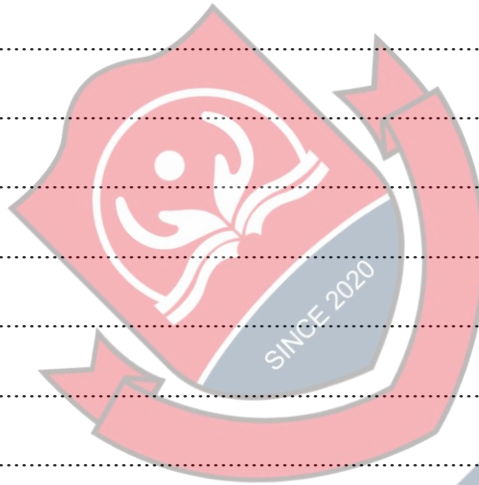
[1]

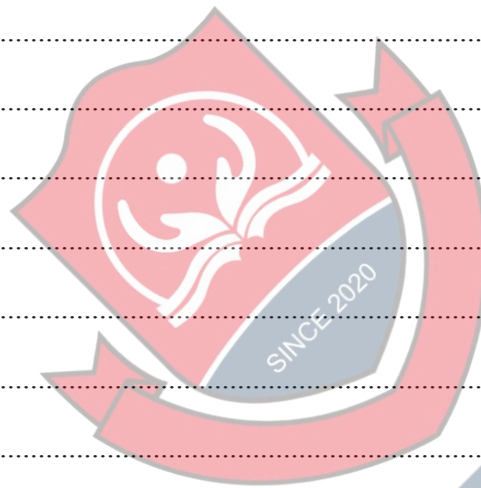
- 6 Jade is a swimming instructor at a sports college. She claims that, as a result of an intensive training course, the mean time taken by students to swim 50 metres has reduced by more than 1 second. She chooses a random sample of 10 students. The times taken, in seconds, before and after the training course are recorded in the table.

| Student            | <i>A</i> | <i>B</i> | <i>C</i> | <i>D</i> | <i>E</i> | <i>F</i> | <i>G</i> | <i>H</i> | <i>I</i> | <i>J</i> |
|--------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Time before course | 54.2     | 47.4     | 52.1     | 59.0     | 55.3     | 51.0     | 48.9     | 52.2     | 58.4     | 51.4     |
| Time after course  | 50.1     | 46.3     | 52.5     | 58.8     | 51.4     | 48.4     | 49.5     | 48.7     | 58.3     | 51.4     |

- (a) Test, at the 10% significance level, whether Jade's claim is justified.

[7]





(b) State an assumption that is necessary for this test to be valid.

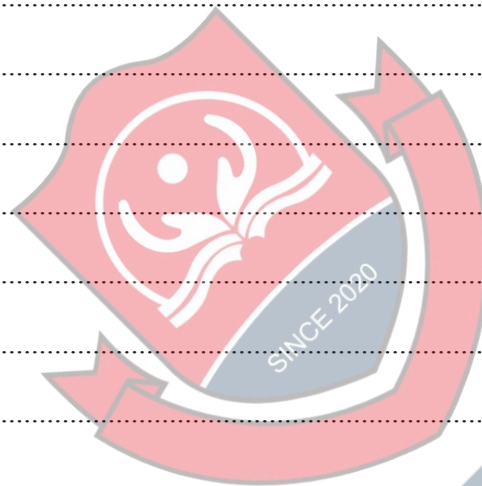
[1]

- 7 The continuous random variable  $X$  has probability density function  $f$  given by

$$f(x) = \begin{cases} \frac{x}{4}(4-x^2) & 0 \leq x \leq 2, \\ 0 & \text{otherwise.} \end{cases}$$

- (a) Find  $\text{Var}(\sqrt{X})$ .

[4]



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The continuous random variable  $Y$  is defined by  $Y = X^2$ .

- (b)** Find the probability density function of  $Y$ . [4]

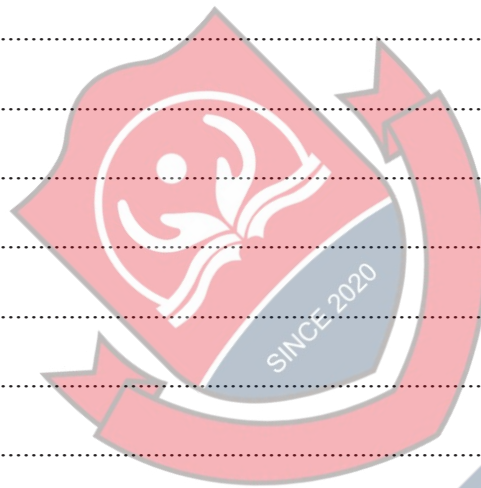


- (c) Find the exact value of the median of  $Y$ . [2]

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**Additional page**

If you use the following page to complete the answer to any question, the question number must be clearly shown.



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