AS Mathematics and Statistics

General Instructions To Markers

1. It is very important that all markers should adhere as closely as possible to the marking scheme. In many cases, however, candidates will have obtained a correct answer by an alternative method not specified in the marking scheme. In general, a correct alternative solution merits all the marks allocated to that part, unless a particular method has been specified in the question. Markers should be patient in marking alternative solutions not specified in the marking scheme.

2. For the convenience of markers, the marking scheme was written as detailed as possible. However, it is likely that candidates would not present their solution in the same explicit manner, e.g. some steps would either be omitted or stated implicitly. In such cases, markers should exercise their discretion in marking candidates’ work. In general, marks for a certain step should be awarded if candidates’ solution indicated that the relevant concept / technique had been used.

3. In marking candidates’ work, the benefit of doubt should be given in the candidates’ favour.

4. Unless the form of the answer is specified in the question, alternative simplified forms of answers different from those in the marking scheme should be accepted if they are correct.

5. Unless otherwise specified in the question, use of notations different from those in the marking scheme should not be penalised.

6. In the marking scheme, marks are classified into the following three categories:

   'M' marks — awarded for applying correct methods
   'A' marks — awarded for the accuracy of the answers
   Marks without 'M' or 'A' — awarded for correctly completing a proof or arriving at an answer given in the question.

   In a question consisting of several parts each depending on the previous parts, ‘M’ marks should be awarded to steps or methods correctly deduced from previous answers, even if these answers are erroneous. (I.e. Markers should follow through candidates’ work in awarding ‘M’ marks.) However, ‘A’ marks for the corresponding answers should NOT be awarded, unless otherwise specified.

7. In the marking scheme, steps which can be skipped are enclosed by dotted rectangles, whereas alternative answers are enclosed by solid rectangles.

8. Marks may be deducted for poor presentation (pp). The symbol \( \text{pp} \) should be used to denote 1 mark deducted for pp.
   (a) At most deduct 1 mark for pp in each section.
   (b) In any case, do not deduct any marks for pp in those steps where candidates could not score any marks.

9. Marks may be deducted for numerical answers with inappropriate degree of accuracy (a). The symbol \( \Delta \) should be used to denote 1 mark deducted for \( a \).
   (a) At most deduct 1 mark for \( a \) in each section.
   (b) In any case, do not deduct any marks for \( a \) in those steps where candidates could not score any marks.

10. Marks entered in the Page Total Box should be the NET total scored on that page.
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<tr>
<th>Solution</th>
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<tbody>
<tr>
<td>1. (a) ( \frac{1}{\sqrt{1-x}} = (1-x)^{-1} )</td>
<td>IM</td>
<td>For any two terms correct</td>
</tr>
<tr>
<td>( = 1 - \frac{1}{2} \cdot \frac{x}{2} + \frac{1}{2} \cdot \frac{(-1)}{2} \cdot \frac{\left(-\frac{1}{2}\right)}{2} \cdot \frac{x^2}{2} - \frac{1}{3!} \cdot \frac{(-1)}{2} \cdot \frac{\left(-\frac{1}{2}\right)}{2} \cdot \frac{\left(-\frac{1}{2}\right)}{2} \cdot \frac{x^3}{2} + \cdots )</td>
<td>IA</td>
<td>(pp-1) if ( \cdots ) was omitted</td>
</tr>
<tr>
<td>( = 1 + \frac{1}{2} \cdot \frac{x}{8} + \frac{3}{16} \cdot \frac{x^2}{2} + \cdots )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) ( \frac{1}{\sqrt{1-\frac{1}{5}}} = 1 + \frac{1}{2} \cdot \frac{\left(\frac{1}{5}\right)}{8} + \frac{3}{16} \cdot \frac{\left(\frac{1}{5}\right)^2}{8} + \frac{5}{16} \cdot \frac{\left(\frac{1}{5}\right)^3}{8} + \cdots )</td>
<td>IA</td>
<td>For L.H.S.</td>
</tr>
<tr>
<td>( \sqrt{\frac{5}{2}} \approx 2.447 )</td>
<td>IA</td>
<td>OR 2.47 ( \frac{200}{200} ) OR 2.235</td>
</tr>
<tr>
<td>( \sqrt{\frac{5}{2}} = \frac{447}{200} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) The expansion in (a) is valid only when (</td>
<td>x</td>
<td>&lt; 1 ). So Josephine cannot put ( x = -4 ) into the expansion and her claim is incorrect.</td>
</tr>
</tbody>
</table>

(6)

2. (a) \( \frac{dP}{dt} = \frac{-0.09}{\sqrt{3t+1}} \) | IM+1A | Withhold 1A if C was omitted |
| \( P = \int \frac{-0.09}{\sqrt{3t+1}} \, dt \) | | |
| \( = -0.06 \sqrt{3t+1} + C \) | | |
| When \( t = 0 \), \( P = 1 \). \( \therefore \) \( 1 = -0.06 \sqrt{1} + C \) | IA | |
| \( C = 1.06 \) | | |
| i.e. \( P = -0.06 \sqrt{3t+1} + 1.06 \) | IA | |
| (b) When \( t = 5 \), \( P = -0.06 \sqrt{3(5)+1} + 1.06 = 0.82 \) | IM | |
| Thus, 18% of the population has died off. | 1A | |
| (c) When \( P = 0 \), \( 0 = -0.06 \sqrt{3T+1} + 1.06 \) | 1A | OR 103.7037 |
| \( T = 103 \frac{19}{27} \) | | |

(6)

3. (a) \( x = y^4 - y \) | IM | For finding \( \frac{dx}{dy} \) |
| \( \frac{dx}{dy} = 4y^3 - 1 \) | IM+1A | IM for \( \frac{dy}{dx} = \frac{1}{\frac{dx}{dy}} \) |
| \( \therefore \frac{dy}{dx} = \frac{1}{4y^3 - 1} \) | IM+IM | IM for finding \( \frac{dy}{dx} \) |
| Alternative Solution | 1A | IM for chain rule |
| \( 1 = 4y^3 \frac{dy}{dx} - \frac{dy}{dx} \) | | |
| \( \therefore \frac{dy}{dx} = \frac{1}{4y^3 - 1} \) | | |
(b) \[ \frac{1}{4y^3 - 1} = \frac{1}{3} \]

\[ y = 1 \]

\[ x = 1^4 - 1 = 0 \]

Hence the required equation of the tangent is

\[ y - 1 = \frac{1}{3}(x - 0) \]

\[ i.e. \ x - 3y + 3 = 0 \]

4. (a) \[ P(A \cup B) = P(A) + P(B) - P(A \cap B) \]

\[ \therefore \frac{5}{12} = a + \frac{1}{4} - P(A \cap B) \]

\[ i.e. \ P(A \cap B) = a - \frac{1}{6} \]

(b) \[ P(B'|P(A \mid B') = P(A \cap B') \]

\[ (1 - P(B)) \cdot P(A \mid B') = P(A) - P(A \cap B) \]

\[ \therefore \left(1 - \frac{1}{4}\right)k = a - \left(a - \frac{1}{6}\right) \]

\[ i.e. \ k = \frac{2}{9} \]

(c) Since \( A \) and \( B \) are independent, \( P(A \cap B) = P(A) \times P(B) \).

\[ \therefore \ a - \frac{1}{6} = a \times \frac{1}{4} \]

\[ a = \frac{2}{9} \]

**Alternative Solution**

Since \( A \) and \( B \) are independent, \( P(A \mid B') = P(A) \).

\[ \therefore \ a = k \]

\[ = \frac{2}{9} \]

5. (a) The required probability

\[ = 1 - (0.64)^{15} - C_1^{15} (0.36)(0.64)^{14} - C_2^{15} (0.36)^2 (0.64)^{13} - C_3^{15} (0.36)^3 (0.64)^{12} \]

\[ \approx 0.8469 \]

(b) The required probability

\[ \frac{3 \times C_4^5 (0.36)(0.64)^4 \times C_2^5 (0.36)(0.64)^4 \times C_5^5 (0.36)(0.64)^2 (0.64)^3}{C_4^{15} (0.36)^4 (0.64)^{11}} \]

\[ = \frac{80}{91} \]

\[ \therefore \frac{50}{91} \]

\[ \text{OR} \frac{4! \cdot 11!}{3! \cdot 4! \cdot 15!} = \frac{5495}{5! \cdot 5!} \]

\[ \text{OR} 0.5495 \]
6. (a) Let \( a_i, b_j \) be the salaries in groups \( A \) and \( B \) respectively and \( \bar{x} \) be the common mean.

Let \( \sigma_A, \sigma_B, \sigma_{\text{total}} \) be the s.d. of the two groups and the pooled group respectively.

\[
\sigma_A^2 = \frac{\sum_{i=1}^{11} (a_i - \bar{x})^2}{11} \quad \text{and} \quad \sigma_B^2 = \frac{\sum_{i=1}^{7} (b_i - \bar{x})^2}{7}
\]

\[
\sigma_{\text{total}}^2 = \frac{11\sum_{i=1}^{11} (a_i - \bar{x})^2 + 7\sum_{i=1}^{7} (b_i - \bar{x})^2}{11 + 7}
\]

\[
\approx \sigma_{\text{total}} = \sqrt{\frac{11(2.5)^2 + 7(2.8)^2}{18}}
\]

\[\approx 2.6208 \text{ thousand dollars}\]

(b) (i) The salary of the manager with the second highest salary in group \( A \) is at least \$40000\) and that in group \( B \) is exactly \$40000\). Hence, the salary of the manager with the second highest salary in group \( A \) is not lower than that in group \( B \).

(ii) The upper quartile will be changed from the 6th observation to the 5th one and so it will be less than or equal to the original one.

The lower quartile will be unchanged (the 2nd observation).

Hence, the inter-quartile range will be unchanged or decreased.

7. (a) (i) The vertical asymptote of \( C_1 : y = \frac{2x-1}{hx-1} \) is \( x = \frac{1}{h} \).

Hence, \( \frac{1}{h} = 1 \)

i.e. \( h = 1 \)

The horizontal asymptote of \( C_1 : y = \frac{2x-1}{hx-1} \) is \( y = \frac{2}{h} \).

Hence, \( \frac{2}{(1)} = k \)

i.e. \( k = 2 \)

(ii) The graph of \( C_1 \) is shown below.

(For asymptotes, intercepts, shape)

(PP1) for all labels of axes and origin omitted
(b) (i) Since $C_2 : y = -x^2 + px + q$ passes through $\left(\frac{1}{2}, 0\right)$, 

\[
\frac{-1}{4} + \frac{p}{2} + q = 0 \quad \text{(**)}
\]

\[
\frac{d}{dx} \left( 2x-1 \right) = \frac{(x-1)(2)-(2x-1)(1)}{(x-1)^2} = \frac{-1}{(x-1)^2}
\]

\[
\frac{d}{dx} (-x^2 + px + q) = -2x + p
\]

Since the tangents of $C_1$ and $C_2$ at $\left(\frac{1}{2}, 0\right)$ are perpendicular to each other,

\[
\left(\frac{-1}{\left(\frac{1}{2}-1\right)^2}\right) \cdot \left[-2 \left(\frac{1}{2}\right) + p\right] = -1
\]

\[
p = \frac{5}{4}
\]

By (**) $q = \frac{-3}{8}$

(iii) The required area is 

\[
\int_{\frac{1}{2}}^{\frac{3}{2}} \left[ \frac{2x-1}{x-1} \left( -x^2 + \frac{5}{4}x - \frac{3}{8} \right) \right] dx
\]

\[
= \int_{\frac{1}{2}}^{\frac{3}{2}} \left( 2 + \frac{1}{x-1} + x^2 - \frac{5}{4}x + \frac{3}{8} \right) dx
\]

\[
= \left[ \ln|x-1| + \frac{x^3}{3} - \frac{5x^2}{8} + \frac{19x}{8} \right]_0^{\frac{3}{2}}
\]

\[
= 10\frac{3}{96} - \ln 2
\]

For $x^3$ $\frac{5x^2}{8} + 19x^8$, OR 0.3798

<table>
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<tr>
<th>Solution</th>
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<th>Remarks</th>
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<tbody>
<tr>
<td>$-\frac{1}{4} + \frac{p}{2} + q = 0$</td>
<td>1M</td>
<td></td>
</tr>
<tr>
<td>$\frac{d}{dx} (-x^2 + px + q)$</td>
<td>1M</td>
<td></td>
</tr>
<tr>
<td>$\frac{d}{dx} \left( 2x-1 \right)$</td>
<td>1A</td>
<td></td>
</tr>
<tr>
<td>$-\frac{1}{(x-1)^2}$</td>
<td>1A</td>
<td>For both</td>
</tr>
<tr>
<td>$\left(\frac{-1}{\left(\frac{1}{2}-1\right)^2}\right) \cdot \left[-2 \left(\frac{1}{2}\right) + p\right] = -1$</td>
<td>1M</td>
<td></td>
</tr>
<tr>
<td>$p = \frac{5}{4}$</td>
<td>1A</td>
<td>For the shape of $C_2$</td>
</tr>
<tr>
<td>$q = \frac{-3}{8}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\int_{\frac{1}{2}}^{\frac{3}{2}} \left( 2 + \frac{1}{x-1} + x^2 - \frac{5}{4}x + \frac{3}{8} \right) dx$</td>
<td>1M</td>
<td>For $2 + \frac{1}{x-1}$</td>
</tr>
<tr>
<td>$= \left[ \ln</td>
<td>x-1</td>
<td>+ \frac{x^3}{3} - \frac{5x^2}{8} + \frac{19x}{8} \right]_0^{\frac{3}{2}}$</td>
</tr>
<tr>
<td>$= 10\frac{3}{96} - \ln 2$</td>
<td>1A</td>
<td>OR 0.3798</td>
</tr>
<tr>
<td></td>
<td>(10)</td>
<td></td>
</tr>
</tbody>
</table>
8. (a) (i) \[ R = k^2 e^{0.20} \]
\[
\ln R = \ln k + 1.2 \ln t + \frac{\lambda t}{20}
\]
\[
\ln R - 1.2 \ln t = \frac{\lambda}{20} t + \ln k \quad \text{which is a linear function of } t
\]

\[ \lambda = -1 \]

(ii) intercept on the vertical axis = \( \ln k = 2.89 \)

\[ k \approx 18 \quad \text{(correct to the nearest integer)} \]

slope = \[ \frac{\lambda}{20} = -0.05 \]

\[ \frac{\lambda}{20} = -1 \]

(iii) \[ \therefore R = 18t^{1.2} e^{-0.05t} \]
\[
\frac{dR}{dr} = 18[1.2t^{0.2} e^{-0.05t} + t^{1.2} e^{-0.05t}(-0.05)]
\]
\[
-0.9t^{0.2} e^{-0.05t}(24 - t)
\]

<table>
<thead>
<tr>
<th>(0 &lt; t &lt; 24)</th>
<th>(t = 24)</th>
<th>(24 &lt; t \leq 30)</th>
</tr>
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<tbody>
<tr>
<td>(\frac{dR}{dt})</td>
<td>&gt; 0</td>
<td>0</td>
</tr>
</tbody>
</table>

Hence, \( R \) will attain maximum after 24 months.

\[ R = 18(24)^{1.2} e^{-0.05(24)} = 245.68 \]

Hence, the maximum population size is 246 hundreds.

(b) (i) When \( t = 0 \), \( L = 20(6e^0 + 0^3) = Q = 240 \)

\[ L = 360 \]

\[ e^{-t} = 1 + (-t) + \frac{(-t)^2}{2!} + \frac{(-t)^3}{3!} + \ldots \]

\[ = 1 - t + \frac{t^2}{2} - \frac{t^3}{6} + \ldots \]

\[ \therefore Q = 360 - 20 \left[ \frac{t^2}{2} - \frac{t^3}{6} + \ldots \right] + t^3 \]

\[ = 360 - 20(6 - 6t + 3t^2 + \ldots) \]

\[ = 240 + 120t - 60t^2 \quad \text{which is a quadratic polynomial} \]

\[ Q = L - 20(6e^{-t} + t^3) \]

\[ = 360 - 20 \left[ \frac{t^2}{2!} - \frac{t^3}{3!} + \frac{t^4}{4!} - \frac{t^5}{5!} + \frac{t^6}{6!} - \frac{t^7}{7!} + \ldots \right] + t^3 \]

\[ = 240 + 120t - 60t^2 - 120 \left[ \frac{t^4}{4!} - \frac{t^5}{5!} + \frac{t^6}{6!} - \frac{t^7}{7!} + \ldots \right] \]
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<tbody>
<tr>
<td>[ 7 = 300 - 60(t-1)^2 - 120 \left( \frac{t^4}{5!} (5-t) + \frac{t^6}{7!} (7-t) + \cdots \right) ]</td>
<td>IM+IM</td>
<td>IM for completing square. IM for factorization</td>
</tr>
<tr>
<td>Since ( 0 \leq t \leq 2 ), ( Q &lt; 300 ) and so the conclusion in (b)(iii) is no more valid.</td>
<td>IA</td>
<td>Follow through</td>
</tr>
</tbody>
</table>

9. (a) (i) \( R_6 = \int_0^6 \ln(2t+1) \, dt \) \[ = \frac{1}{2} \{ \ln(2 \cdot 0 + 1) + 2[\ln(2 \cdot 1 + 1) + \ln(2 \cdot 2 + 1) + \ln(2 \cdot 3 + 1) + \ln(2 \cdot 4 + 1) + \ln(2 \cdot 5 + 1)] + \ln(2 \cdot 6 + 1) \} \] \[ = 10.53155488 \] The total amount of revenue in the first 6 weeks is 10.5316 million dollars. | IM | |

(ii) Let \( f(t) = \ln(2t+1) \) \[ f'(t) = \frac{2}{2t+1} \] \[ f''(t) = \frac{-4}{(2t+1)^2} \] \[ < 0 \text{ for } 0 \leq t \leq 6 \] \[ \therefore f(t) \text{ is concave downward for } 0 \leq t \leq 6 \] Hence the estimate in (a)(i) is an under-estimate. | IA | Follow through |

(b) (i) \( Q_1 = \int_0^6 45(1-t) + \frac{1.58}{t+1} \, dt \) \[ = \left[ 45 \left( \frac{t^2}{2} - \frac{t^3}{3} \right) + 1.58 \ln|t+1| \right]_0^6 \] \[ = \frac{15}{2} + 1.58 \ln 2 \] \[ \approx 8.595172545 \] The total amount of revenue in the first week is 8.5952 million dollars. | IA | |

(ii) \( Q_n = Q_1 + \int_1^n \frac{30e^{-t}}{(3 + 2e^{-t})^2} \, dt \) \[ \text{Let } u = 3 + 2e^{-t} \] \[ du = -2e^{-t} \, dt \] \[ \therefore Q_n = Q_1 + \int_{3 + 2e^{-1}}^{3 + 2e^{-n}} \frac{15}{u^2} \, du \] \[ = Q_1 + \left[ \frac{15}{u} \right]_{3 + 2e^{-1}}^{3 + 2e^{-n}} \] \[ = \frac{15}{2} + 1.58 \ln 2 + \frac{15}{3 + 2e^{-n}} - \frac{15}{3 + 2e^{-1}} \] Hence the total amount of revenue in the first \( n \) weeks is \( \frac{15}{2} + 1.58 \ln 2 + \frac{15}{3 + 2e^{-n}} - \frac{15}{3 + 2e^{-1}} \) million dollars, where \( n > 1 \). | IM | For \( -\frac{15}{u^2} \) \[ \text{For } \left[ \frac{15}{u} \right]_{3 + 2e^{-1}}^{3 + 2e^{-n}} \] | For \( \frac{15}{3 + 2e^{-n}} \) | Accept 4.5799 + \frac{15}{3 + 2e^{-n}} | (6) |
### Solution

<table>
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<tr>
<td>1M</td>
<td>For (\int_0^\infty 0,dt = 0)</td>
</tr>
<tr>
<td>IM</td>
<td>For (e^{-n} \to 0)</td>
</tr>
<tr>
<td>1A</td>
<td>(Q_n \to 4.5799 + \frac{15}{3+0} = 9.5799)</td>
</tr>
</tbody>
</table>

Therefore, over a long period of time, plan \(A\) produces approximately 10.5316 million dollars and plan \(B\) produces 9.5799 million dollars of revenue. Moreover, the revenue of plan \(A\) is even an under-estimate. Hence, plan \(A\) will produce more revenue over a long period of time.

### (5)

#### 10. (a) (i) The required probability

\[
\frac{1}{C_3^9} = \frac{1}{84}
\]

#### 1A OR 0.0119

#### (2)

#### (b) \((1-p)\left(\frac{1}{84}\right) + p\left(\frac{1}{21}\right) \leq \frac{1}{60}\)

\[5 - 5p + 20p \leq 7\]

\[p \leq \frac{2}{15}\]

Hence, the largest value of \(p\) should be \(\frac{2}{15}\).

#### 1A OR 0.1333

#### (3)

#### (c) (i) The required probability

\[
\frac{2}{15} \cdot \frac{1}{C_3^9} = \frac{1}{945}
\]

#### 1M For using (b)

#### 1A OR 0.0011

#### (i) The required probability

\[
\left(1 - \frac{2}{15}\right) \cdot \frac{C_2^3 C_6^5}{C_4^9} + \frac{2}{15} \cdot \frac{C_4^4 C_5^5}{C_4^9} = \frac{59}{945}
\]

#### 1M+1A

#### 1A OR 0.0624

#### (iii) The probability of exactly 2 logos are found on 1 card

\[
\frac{47}{126}
\]

Hence, the required probability

\[
\left(\frac{1}{945} + \frac{59}{945}\right)^2 + 2 \left(\frac{1}{945} + \frac{59}{945}\right) \left(1 - \frac{1}{945} - \frac{59}{945}\right) + \left(\frac{47}{126}\right)^2
\]

\[
= \frac{1387}{5292}
\]

#### 1M+1A

#### 1A OR 0.2621
11. Let \( X_N \) cm and \( X_D \) cm be the widths of the tongue of a normal baby and a baby having inherited disease \( A \) respectively.

(a) \( P(X_N < 2.22) = 0.242 \)
\[
\begin{align*}
2.22 - \mu &= -0.7 \\
\frac{0.4}{0.4} &= 2.5
\end{align*}
\]

(b) (i) The required probability
\[
= P(X_N > 2.5 + 0.5)
= P\left(Z > \frac{3 - 2.5}{0.4}\right)
= 0.5 - 0.3944
= 0.1056
\]

(ii) The required probability
\[
= 0.05 \times P(X_D < 2.5 + 0.5) + 0.95 \times P(X_N > 2.5 + 0.5)
= 0.05 \times P\left(Z < \frac{0.2}{0.2}\right) + 0.95 \times 0.1056
= 0.05 \times 0.8413 + 0.95 \times 0.1056
= 0.142385
\]

(iii) The required probability
\[
= \frac{0.05(0.8413)}{0.05(0.8413) + 0.95(1 - 0.1056)}
\approx 0.0472
\]

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<tr>
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<tbody>
<tr>
<td>(a)</td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>(b) (i)</td>
<td>1M</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>1M+1A</td>
<td>OR 0.1424</td>
</tr>
<tr>
<td>(iii)</td>
<td>1M+1A</td>
<td></td>
</tr>
<tr>
<td>(c) (i)</td>
<td>1M</td>
<td>OR 0.1387</td>
</tr>
<tr>
<td>(ii)</td>
<td>1M+1M+1A</td>
<td></td>
</tr>
</tbody>
</table>
12. (a) (i) \( e^{-\lambda} \frac{\lambda^4}{4!} = \frac{41.04}{200} \)

\[ (1) \]

\( e^{-\lambda} \frac{\lambda^4}{4!} = \frac{26.72}{200} \)

\[ (2) \]

(2) + (1):

\[ \lambda^2 = 334 \]

\[ 24 = 513 \]

\[ \lambda \approx 2.5 \] (correct to 1 decimal place)

(ii) \( a = 7.22 \), \( b = 16.42 \), \( c = 51.30 \), \( d = 42.75 \), \( e = 13.36 \)

(iii) For the number of passengers > 5, the expected frequency by Po(2) is

\[ 200 - 27.07 - 54.13 - 54.13 - 36.09 - 18.04 - 7.22 = 3.32 \]

For the number of passengers > 5, the expected frequency by Po(2.5) is

\[ 200 - 16.42 - 41.04 - 51.30 - 42.75 - 26.72 - 13.36 = 8.41 \]

The sum of errors for model fitted by Po(2) is

\[ E_1 = [28 - 27.07] + [50 - 54.13] + [52 - 54.13] + [40 - 36.09] + [24 - 18.04] + [6 - 7.22] + [0 - 3.32] \]

\[ = 21.6 \]

The sum of errors for model fitted by Po(2.5) is

\[ E_2 = [28 - 16.42] + [50 - 41.04] + [52 - 51.30] + [40 - 42.75] + [24 - 26.72] + [6 - 13.36] + [0 - 8.41] \]

\[ = 42.48 \]

Since \( E_1 < E_2 \), Po(2) fits the observed data better.

(b) Let \( X_i \) be the number of passengers waiting at the \( i \)th stop.

(i) The required probability

\[ = P(X_i \geq 4) \]

\[ = 1 - \frac{e^{-2}}{0!} - \frac{e^{-2} \cdot 2^1}{1!} - \frac{e^{-2} \cdot 2^2}{2!} - \frac{e^{-2} \cdot 2^3}{3!} \]

\[ \approx 0.1429 \]

(ii) The required probability

\[ = P(X_1 \leq 2) \cdot P(X_2 \geq 2) \]

\[ = \left( \frac{e^{-2} \cdot 2^0}{0!} + \frac{e^{-2} \cdot 2^1}{1!} + \frac{e^{-2} \cdot 2^2}{2!} \right) \left( 1 - \frac{e^{-2} \cdot 2^0}{0!} - \frac{e^{-2} \cdot 2^1}{1!} \right) \]

\[ \approx 0.4019 \]

(iii) The required probability

\[ = [P(X_1 = 1) \cdot P(X_2 = 1)] + [P(X_1 = 1) \cdot P(X_2 = 2)] + [P(X_1 = 2) \cdot P(X_2 = 1)] - [1 - P(X_3 = 0)] \]

\[ = \left( \frac{e^{-2} \cdot 2^1}{1!} \right) \left( \frac{e^{-2} \cdot 2^1}{1!} \right) \left( 1 - \frac{e^{-2} \cdot 2^0}{0!} \right) \times 2 \]

\[ \approx 0.1900 \]