



**KEMENTERIAN  
PENDIDIKAN  
MALAYSIA**

**SM025/2**

**Matriculation Programme Examination**

**Semester 2**

**Session 2018/2019**

1. a) Evaluate  $\int x(1-x)^8 dx$  by using a suitable substitution.  
b) Find the area of the region bounded by the curve  $y = x \cos x$  and  $x$ -axis between  $x = 0$  and  $x = \frac{\pi}{2}$ . Give your solution in term of  $\pi$ .
2. Solve  $\frac{dy}{dx} + 2(x+1)y^2 = 0$ , given that  $y = 1$  when  $x = 1$ . Express  $y$  in terms of  $x$ .
3. Use Newton-Raphson method to solve the equation  $e^x - x - 2 = 0$  correct to four decimal places by taking  $x_1 = 1$  as the first approximation.
4. An ellipse  $Ax^2 + y^2 + Bx + Cy + 1 = 0$  passes through points  $(0,1)$ ,  $(1, -1)$  and  $(2, 1)$ .
  - a) Find the equation of the ellipse in the standard form. Hence, state the centre and vertices of the ellipse.
  - b) Find the foci of the ellipse.
  - c) Sketch the graph of the ellipse.
5. The line  $L_1$  and  $L_2$  passes through the point  $R(2, 4, -3)$  and  $S(8, -5, 9)$  in the direction of  $2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$  and  $\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}$ , respectively.
  - a) State the equations for lines  $L_1$  and  $L_2$  in the vector form. Hence, calculate the acute angle between the lines  $L_1$  and  $L_2$ .
  - b) Find the equation of plane containing the line  $L_1$  and the point  $(7, -3, 5)$  in the Cartesian form.
  - c) Determine whether the line  $L_2$  is parallel to the plane  $x + 5y + 3z = 5$ .
6. **TABLE 1** shows the frequency distribution of the diameter of 100 pebbles which are measured to the nearest millimeter(mm).

TABLE 1

Diameter (mm)	Frequency
10 - 14	22
15 - 19	20
20 - 24	25
25 - 29	15
30 - 34	18

Calculate the

- a) mean.
- b) mode.
- c) median.

7. A committee of 5 is to be selected from a group of 7 men and 6 women. How many different committees could be formed if
- there is no woman in the committee?
  - a particular man must be in the committee and the remaining has equal number of men and women?
  - at least 3 men are in the committee?
8. The probabilities of events  $X$  and  $Y$  are given as  $P(X) = \frac{3}{5}$ ,  $P(X'|Y) = \frac{31}{45}$  and  $P(X \cap Y) = \frac{2}{25}$ .
- Show that  $P(Y) = \frac{9}{35}$
  - Find  $P(X \cup Y')$ .
9. A discrete random variable  $X$  has the probability distribution function
- $$f(x) = \begin{cases} \frac{x+1}{16}, & x = 2, 3, 4 \\ kx, & x = 6, 8 \\ 0, & \text{otherwise} \end{cases}$$
- Show that  $k = \frac{1}{56}$
  - Hence, calculate  $P(3 \leq X < 8)$ .
  - Determine the values of  $E(X)$  and  $Var(X)$ . Thus, evaluate  $Var(\sqrt{3}X - 1)$
10. The number of batteries sold at a service center on any particular day follows a Poisson distribution with mean  $\lambda$ .
- If the probability of selling exactly 4 batteries divided by the probability of selling exactly 2 batteries is  $\frac{225}{12}$ , show that  $\lambda = 15$ .
  - On any particular day, calculate the probability that the service center sells between 5 and 14 batteries.
  - Given that the probability of selling less than  $k$  batteries on any particular day is 0.917, find the value of  $k$ .
  - Find the probability that exactly 40 batteries are sold in 2 working days. Give your answer in four decimal places.

END OF QUESTION PAPER

1. a) Evaluate  $\int x(1-x)^8 dx$  by using a suitable substitution.  
b) Find the area of the region bounded by the curve  $y = x \cos x$  and  $x$ -axis between  $x = 0$  and  $x = \frac{\pi}{2}$ . Give your solution in term of  $\pi$ .

**SOLUTION**

(a)  $\int x(1-x)^8 dx$

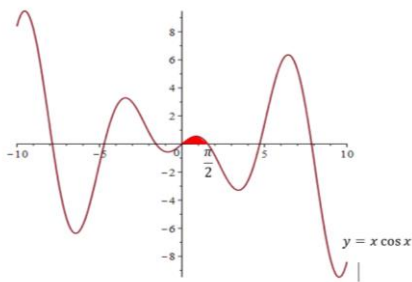
$$u = 1 - x \quad \rightarrow \quad x = 1 - u$$

$$\frac{du}{dx} = -1$$

$$dx = -du$$

$$\begin{aligned} \int x(1-x)^8 dx &= \int (1-u)u^8(-du) \\ &= -\int (1-u)u^8 du \\ &= -\int u^8 - u^9 du \\ &= -\left[\frac{u^9}{9} - \frac{u^{10}}{10}\right] + C \\ &= -\left[\frac{(1-x)^9}{9} - \frac{(1-x)^{10}}{10}\right] + C \\ &= \frac{(1-x)^{10}}{10} - \frac{(1-x)^9}{9} + C \end{aligned}$$

(b)



$$\text{Area} = \int_0^{\frac{\pi}{2}} x \cos x \, dx$$

$$\int x \cos x \, dx$$

$$u = x$$

$$dv = \cos x \, dx$$

$$\frac{du}{dx} = 1$$

$$\int dv = \int \cos x \, dx$$

$$du = dx$$

$$v = \sin x$$

$$\int u \, dv = uv - \int v \, du$$

$$\text{Area} = (x)(\sin x) - \int (\sin x) (dx)$$

$$= x \sin x - (-\cos x)$$

$$= x \sin x + \cos x$$

$$\text{Area} = \int_0^{\frac{\pi}{2}} x \cos x \, dx$$

$$= [x \sin x + \cos x]_0^{\frac{\pi}{2}}$$

$$= \left[ \frac{\pi}{2} \sin \left( \frac{\pi}{2} \right) + \cos \left( \frac{\pi}{2} \right) \right] - [0 \sin 0 + \cos(0)]$$

$$= \left[ \frac{\pi}{2} + 0 \right] - [0 + 1]$$

$$= \frac{\pi}{2} - 1 \text{ unit}^2$$

2. Solve  $\frac{dy}{dx} + 2(x+1)y^2 = 0$ , given that  $y = 1$  when  $x = 1$ . Express  $y$  in terms of  $x$ .

**SOLUTION**

$$\frac{dy}{dx} + 2(x+1)y^2 = 0$$

$$\frac{dy}{dx} = -2(x+1)y^2$$

$$y^{-2}dy = -2(x+1)dx$$

$$\int y^{-2}dy = -2 \int (x+1)dx$$

$$\frac{y^{-1}}{-1} = -2\left(\frac{x^2}{2} + x\right) + C$$

$$-\frac{1}{y} = -x^2 - 2x + C$$

When  $x = 1, y = 1$

$$-\frac{1}{1} = -1^2 - 2(1) + C$$

$$-1 = -1 - 2 + C$$

$$C = 2$$

$$-\frac{1}{y} = -x^2 - 2x + 2$$

$$-1 = (-x^2 - 2x + 2)y$$

$$y = \frac{1}{x^2 + 2x - 2}$$

3. Use Newton-Raphson method to solve the equation  $e^x - x - 2 = 0$  correct to four decimal places by taking  $x_1 = 1$  as the first approximation.

**SOLUTION**

$$e^x - x - 2 = 0$$

$$f(x) = e^x - x - 2$$

$$f'(x) = e^x - 1$$

$$x_{n+1} = x_n - \frac{f(x)}{f'(x)}$$

$$x_{n+1} = x_n - \frac{e^x - x - 2}{e^x - 1}$$

$$x_1 = 1$$

$$x_2 = 1 - \frac{e^1 - 1 - 2}{e^1 - 1} = 1.16395$$

$$x_3 = 1.16395 - \frac{e^{1.16395} - 1.16395 - 2}{e^{1.16395} - 1} = 1.14642$$

$$x_4 = 1.14642 - \frac{e^{1.14642} - 1.14642 - 2}{e^{1.14642} - 1} = 1.14619$$

$$x_4 = 1.14619 - \frac{e^{1.14619} - 1.14619 - 2}{e^{1.14619} - 1} = 1.14619$$

$$\therefore x = 1.1462$$

4. An ellipse  $Ax^2 + y^2 + Bx + Cy + 1 = 0$  passes through points  $(0,1)$ ,  $(1, -1)$  and  $(2, 1)$ .
- Find the equation of the ellipse in the standard form. Hence, state the centre and vertices of the ellipse.
  - Find the foci of the ellipse.
  - Sketch the graph of the ellipse.

**SOLUTION**

$$Ax^2 + y^2 + Bx + Cy + 1 = 0$$

At  $(0,1)$

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

$$C = -2$$

At  $(1, -1)$  and  $C = -2$

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

$$A + 1 + B + 2 + 1 = 0$$

$$A + B = -4 \quad \dots\dots\dots (1)$$

At  $(2,1)$  and  $C = -2$

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

$$4A + 1 + 2B - 2 + 1 = 0$$

$$4A + 2B = 0 \quad \dots\dots\dots (2)$$

$(1) \times 2$

$$2A + 2B = -8 \quad \dots\dots\dots (3)$$

$(2) - (3)$

$$2A = 8$$

$$A = 4$$

$$B = -8$$

The equation of ellipse:

$$4x^2 + y^2 - 8x - 2y + 1 = 0$$

$$4x^2 - 8x + y^2 - 2y = -1$$

$$4(x^2 - 2x) + (y^2 - 2y) = -1$$

$$4(x^2 - 2x + 1^2 - 1^2) + (y^2 - 2y + 1^2 - 1^2) = -1$$



$$4[(x-1)^2 - 1] + [(y-1)^2 - 1] = -1$$

$$4(x-1)^2 - 4 + (y-1)^2 - 1 = -1$$

$$4(x-1)^2 + (y-1)^2 = 4$$

$$\frac{4(x-1)^2}{4} + \frac{(y-1)^2}{4} = \frac{4}{4}$$

$$\frac{(x-1)^2}{1^2} + \frac{(y-1)^2}{2^2} = 1$$

### Standard Equation of Ellipse

$$\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$$

$$a = 1, b = 2, h = 1, k = 1$$

$$\text{Centre: } C(h, k) = C(1, 1)$$

$$\text{Vertices: } V(h, k \pm b) \Rightarrow V_1(1, 1+2), V_2(1, 1-2)$$

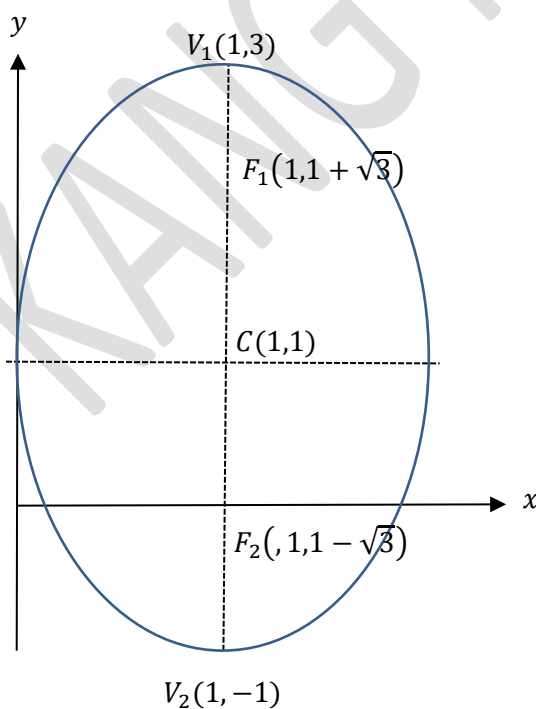
$$V_1(1, 3), V_2(1, -1)$$

(4b)

$$c = \sqrt{2^2 - 1^2} = \sqrt{3}$$

$$\text{Foci: } F(h, k \pm c) = F(1, 1 \pm \sqrt{3})$$

(4c)



5. The line  $L_1$  and  $L_2$  passes through the point  $R(2, 4, -3)$  and  $S(8, -5, 9)$  in the direction of  $2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$  and  $\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}$ , respectively.
- State the equations for lines  $L_1$  and  $L_2$  in the vector form. Hence, calculate the acute angle between the lines  $L_1$  and  $L_2$ .
  - Find the equation of plane containing the line  $L_1$  and the point  $(7, -3, 5)$  in the Cartesian form.
  - Determine whether the line  $L_2$  is parallel to the plane  $x + 5y + 3z = 5$ .

**SOLUTION**

(5a)

$$L_1: \mathbf{a}_1 = 2\mathbf{i} + 4\mathbf{j} - 3\mathbf{k}; \quad \mathbf{v}_1 = 2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$$

$$L_2: \mathbf{a}_2 = 8\mathbf{i} - 5\mathbf{j} + 9\mathbf{k}; \quad \mathbf{v}_2 = \mathbf{i} - 2\mathbf{j} + 3\mathbf{k}$$

$$\mathbf{r} = \mathbf{a} + t\mathbf{v}$$

**Equation of  $L_1$  and  $L_2$** 

$$L_1: \mathbf{r}_1 = (2\mathbf{i} + 4\mathbf{j} - 3\mathbf{k}) + t_1(2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k})$$

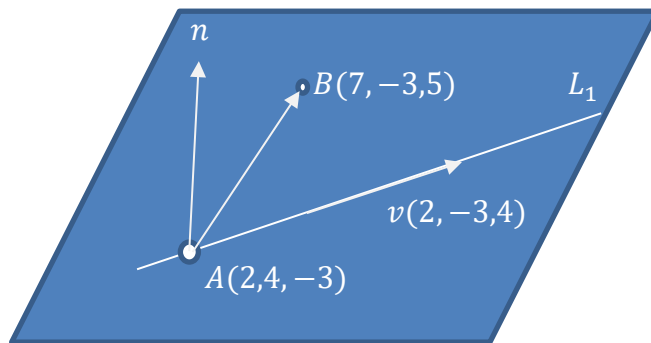
$$L_2: \mathbf{r}_2 = (8\mathbf{i} - 5\mathbf{j} + 9\mathbf{k}) + t_2(\mathbf{i} - 2\mathbf{j} + 3\mathbf{k})$$

**Angle between  $L_1$  and  $L_2$  ( $\theta$ )**

$$\cos \theta = \frac{\mathbf{v}_1 \cdot \mathbf{v}_2}{|\mathbf{v}_1| |\mathbf{v}_2|}$$

$$\begin{aligned} \cos \theta &= \frac{(2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}) \cdot (\mathbf{i} - 2\mathbf{j} + 3\mathbf{k})}{|2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}| |\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}|} \\ &= \frac{(2)(1) + (-3)(-2) + (4)(3)}{\sqrt{(2)^2 + (-3)^2 + (4)^2} \sqrt{(1)^2 + (-2)^2 + (3)^2}} \\ &= \frac{20}{\sqrt{29}\sqrt{14}} \\ &= 0.9926 \\ \theta &= \cos^{-1}(0.9926) \\ &= 6.98^\circ \end{aligned}$$

(5b)

**Equation of plane**

$$\mathbf{r} \cdot \mathbf{n} = \mathbf{a} \cdot \mathbf{n}$$

$$\mathbf{a} = 7\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$$

$$\mathbf{n} = \mathbf{v} \times \overrightarrow{AB}$$

$$\mathbf{v} = 2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$$

$$\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$$

$$= (7\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}) - (2\mathbf{i} + 4\mathbf{j} - 3\mathbf{k})$$

$$= (5\mathbf{i} - 7\mathbf{j} + 8\mathbf{k})$$

$$\mathbf{n} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 2 & -3 & 4 \\ 5 & -7 & 8 \end{vmatrix}$$

$$= (-24 + 28)\mathbf{i} - (16 - 20)\mathbf{j} + (-14 + 15)\mathbf{k}$$

$$= 4\mathbf{i} + 4\mathbf{j} + \mathbf{k}$$

**Equation of plane**

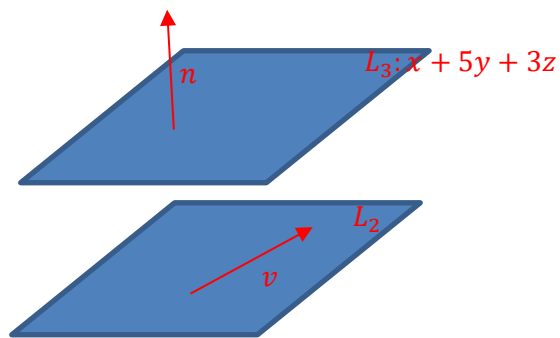
$$\mathbf{r} \cdot \mathbf{n} = \mathbf{a} \cdot \mathbf{n}$$

$$(x\mathbf{i} + y\mathbf{j} + z\mathbf{k}) \cdot (4\mathbf{i} + 4\mathbf{j} + \mathbf{k}) = (7\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}) \cdot (4\mathbf{i} + 4\mathbf{j} + \mathbf{k})$$

$$4x + 4y + z = 28 - 12 + 5$$

$$4x + 4y + z = 21$$

(5c)



From the diagram, if  $L_2$  is parallel to  $L_3$ , then  $v$  must be perpendicular to  $n$

$$v = i - 2j + 3k$$

$$n = i + 5j + 3k$$

$$v \cdot n = (i - 2j + 3k) \cdot (i + 5j + 3k)$$

$$= 1 - 10 + 9$$

$$= 0$$

Since  $v \cdot n = 0$ , there for line  $L_1$  is parallel to the plane  $x + 5y + 3z = 5$ .

6. TABLE 1 shows the frequency distribution of the diameter of 100 pebbles which are measured to the nearest millimeter (mm).

TABLE 1

Diameter (mm)	Frequency
10 – 14	22
15 – 19	20
20 – 24	25
25 – 29	15
30 - 34	18

Calculate the

- mean.
- mode.
- median.

## SOLUTION

Diameter (mm)	Class Boundary	Mid Point (x)	Frequency (f)	Cummulative Frequency (F)
10 – 14	9.5 – 14.5	12	22	22
15 – 19	14.5 – 19.5	17	20	42
20 – 24	19.5 – 24.5	22	25	67
25 – 29	24.5 – 29.5	27	15	82
30 - 34	30.5 – 34.5	32	18	100
			$\sum f$	100

(6a)

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Mean} = \frac{(12)(22) + (17)(20) + (22)(25) + (27)(15) + (32)(18)}{100}$$

$$= \frac{2135}{100}$$

$$= 21.35$$

(6b)

$$\text{Mode} = L_m + \left[ \frac{d_1}{d_1 + d_2} \right] C$$

$$\begin{aligned}\text{Mode} &= 19.5 + \left[ \frac{5}{5 + 10} \right] 5 \\ &= 21.17\end{aligned}$$

(6c)

$$\text{Median} = L_m + \left[ \frac{\frac{n}{2} - F_{k-1}}{f_k} \right] C$$

$$\begin{aligned}\text{Median} &= 19.5 + \left[ \frac{\frac{100}{2} - 42}{25} \right] 5 \\ &= 21.1\end{aligned}$$

7. A committee of 5 is to be selected from a group of 7 men and 6 women. How many different committees could be formed if
- there is no woman in the committee?
  - a particular man must be in the committee and the remaining has equal number of men and women?
  - at least 3 men are in the committee?

**SOLUTION**

(7a)

*if there is no woman in the committee.*

$${}^7C_5 \cdot {}^6C_0 = 21$$

(7b)

$${}^1C_1 \times {}^6C_2 \times {}^6C_2 = 225$$

(7c)

*At least 3 men in the committee.*

Men	Women	Total
3	2	${}^7C_3 \cdot {}^6C_2 = 525$
4	1	${}^7C_4 \cdot {}^6C_1 = 210$
5	0	${}^7C_5 \cdot {}^6C_0 = 21$
Total		756

The number of different committee could be formed = 756

8. The probabilities of events X and Y are given as  $P(X) = \frac{3}{5}$ ,  $P(X'|Y) = \frac{31}{45}$  and

$$P(X \cap Y) = \frac{2}{25}.$$

a) Show that  $P(Y) = \frac{9}{35}$

b) Find  $P(X \cup Y')$ .

**SOLUTION**

(8a)

$$P(X) = \frac{3}{5}$$

$$P(X \cap Y) = \frac{2}{25}$$

$$P(X'|Y) = \frac{31}{45}$$

$$\frac{P(X' \cap Y)}{P(Y)} = \frac{31}{45}$$

$$\frac{P(Y) - P(X \cap Y)}{P(Y)} = \frac{31}{45}$$

$$\frac{P(Y) - \frac{2}{25}}{P(Y)} = \frac{31}{45}$$

$$1 - \frac{\frac{2}{25}}{P(Y)} = \frac{31}{45}$$

$$\frac{\frac{2}{25}}{P(Y)} = 1 - \frac{31}{45}$$

$$\frac{\frac{2}{25}}{P(Y)} = \frac{14}{45}$$

$$P(Y) = \frac{2}{25} \times \frac{45}{14}$$

$$P(Y) = \frac{9}{35}$$



(8b)

$$P(X \cup Y') = P(X) + P(Y') - P(X \cap Y')$$

$$P(Y') = 1 - P(Y) = 1 - \frac{9}{35} = \frac{26}{35}$$

$$P(X \cap Y') = P(X) - P(X \cap Y) = \frac{3}{5} - \frac{2}{25} = \frac{13}{25}$$

$$\begin{aligned} P(X \cup Y') &= \frac{3}{5} + \frac{26}{35} - \frac{13}{25} \\ &= \frac{144}{175} \end{aligned}$$

9. A discrete random variable  $X$  has the probability distribution function

$$f(x) = \begin{cases} \frac{x+1}{16}, & x = 2, 3, 4 \\ kx, & x = 6, 8 \\ 0, & \text{otherwise} \end{cases}$$

- Show that  $k = \frac{1}{56}$
- Hence, calculate  $P(3 \leq X < 8)$ .
- Determine the values of  $E(X)$  and  $Var(X)$ . Thus, evaluate  $Var(\sqrt{3}X - 1)$

**SOLUTION**

$$f(x) = \begin{cases} \frac{x+1}{16}, & x = 2, 3, 4 \\ kx, & x = 6, 8 \\ 0, & \text{otherwise} \end{cases}$$

$x$	2	3	4	6	8
$P(X = x)$	$\frac{3}{16}$	$\frac{4}{16}$	$\frac{5}{16}$	$6k$	$8k$

(9a)

$$\sum P(X = x) = 1$$

$$\frac{3}{16} + \frac{4}{16} + \frac{5}{16} + 6k + 8k = 1$$

$$\frac{12}{16} + 14k = 1$$

$$14k = \frac{1}{4}$$

$$k = \frac{1}{56}$$

(9b)

$x$	2	3	4	6	8
$P(X = x)$	$\frac{3}{16}$	$\frac{4}{16}$	$\frac{5}{16}$	$\frac{3}{28}$	$\frac{1}{7}$

$$\begin{aligned}
 P(3 \leq X < 8) &= P(X = 3) + P(X = 4) + P(X = 6) \\
 &= \frac{4}{16} + \frac{5}{16} + \frac{3}{28} \\
 &= \frac{75}{112}
 \end{aligned}$$

(9c)

$$E(X) = \sum x P(X = x)$$

$$\begin{aligned}
 E(X) &= (2) \left( \frac{3}{16} \right) + (3) \left( \frac{4}{16} \right) + (4) \left( \frac{5}{16} \right) + (6) \left( \frac{3}{28} \right) + (8) \left( \frac{1}{7} \right) \\
 &= \frac{233}{56}
 \end{aligned}$$

$$E(X^2) = \sum x^2 P(X = x)$$

$$\begin{aligned}
 E(X^2) &= (2)^2 \left( \frac{3}{16} \right) + (3)^2 \left( \frac{4}{16} \right) + (4)^2 \left( \frac{5}{16} \right) + (6)^2 \left( \frac{3}{28} \right) + (8)^2 \left( \frac{1}{7} \right) \\
 &= 21
 \end{aligned}$$

$$\text{Var}(X) = E(X^2) - [E(X)]^2$$

$$\begin{aligned}
 &= 21 - \left( \frac{233}{56} \right)^2 \\
 &= 3.688
 \end{aligned}$$

$$\text{Var}(ax + b) = a^2 \text{Var}(x)$$

$$\begin{aligned}
 \text{Var}(\sqrt{3}x - 1) &= \sqrt{3}^2 \times 3.688 \\
 &= 11.065
 \end{aligned}$$

10. The number of batteries sold at a service center on any particular day follows a Poisson distribution with mean  $\lambda$ .
- If the probability of selling exactly 4 batteries divided by the probability of selling exactly 2 batteries is  $\frac{225}{12}$ , show that  $\lambda = 15$ .
  - On any particular day, calculate the probability that the service center sells between 5 and 14 batteries.
  - Given that the probability of selling less than  $k$  batteries on any particular day is 0.917, find the value of  $k$ .
  - Find the probability that exactly 40 batteries are sold in 2 working days. Give your answer in four decimal places.

**SOLUTION**

(10a)

**For Poisson Distribution**

$$P(X = x) = \frac{e^{-\lambda} \lambda^x}{x!}$$

$$\frac{P(X = 4)}{P(X = 2)} = \frac{225}{12}$$

$$\frac{\frac{e^{-\lambda} \lambda^4}{4!}}{\frac{e^{-\lambda} \lambda^2}{2!}} = \frac{225}{12}$$

$$\left(\frac{e^{-\lambda} \lambda^4}{4!}\right) \left(\frac{2!}{e^{-\lambda} \lambda^2}\right) = \frac{225}{12}$$

$$\frac{\lambda^2}{12} = \frac{225}{12}$$

$$\lambda^2 = 225$$

$$\lambda = 15$$

(10b)

$$X \sim Po(15)$$

$$\begin{aligned} P(5 < X < 14) &= P(X \geq 6) - P(X \geq 14) \\ &= 0.9975 - 0.6368 \\ &= 0.3604 \end{aligned}$$

(10c)

$$P(X < k) = 0.917$$

$$1 - P(X \geq k) = 0.917$$

$$P(X \geq k) = 0.0830$$

From statistical table:

$$k = 21$$

(10d)

$$X \sim Po(30)$$

$$\begin{aligned} P(X = 40) &= \frac{e^{-30}(30)^{40}}{40!} \\ &= 0.0139 \end{aligned}$$