DPP-7 Maths-4 Unit-4

Topic - Poisson Probability Distribution

Q-1- In a certain factory manufacturing razor blades, there is a small chance of 0.002 for any blade to be defective. The blades are supplied in packets of 10. Use suitable distribution to calculate the approximate no. of packets containing no defective, one defective and two defective blades in a consignment of 50,000 packets.

Sol- Probability of defective blade

$P = 0.002$
$n = 10$
$N = 50,000$

$\lambda = np = 0.002 \times 10$

$\boxed{\lambda = 0.02}$

By poisson distribution

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

i) Number of packets containing no defective blades $\Rightarrow P(X=0) = \frac{e^{-0.02} \times (0.02)^0}{01}$

$= e^{-0.02}$

$= 0.9802$

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Number of packets = $50,000 \times 0.9802$
$= 49,010$

ii) $P(X=1) = \frac{e^{-0.02} \times (0.02)^1}{1!}$

$P(X=1) = 0.0196$

No. of packets having 1 blade = $0.0196 \times 50,000$
$= 980$ packets

iii) $P(X=2) = \frac{e^{-0.02} \times (0.02)^2}{2!}$
$= 0.000196$

No. of packets having 2 defective blades = $0.000196 \times 50,000$
$= 9.8$
$= 10$ packets

Q-2 - The distribution of the number of road accidents per day in a city is poisson with mean 4. Find the no. of days out of 100 days there will be i) no accident ii) at least two accident iii) at most 3 accidents iv) b/w 2 and 5 accidents?

Sol - $\lambda = 4$, $N = 100$ days

By poisson distribution

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

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i) $P(X=0) = \frac{e^{-4} \times (4)^0}{0!} = e^{-4}$

$P(X=0) = e^{-4} = 0.0183$

No. of days Having no accident = 0.018×100
$= 1.8$
≈ 2 days

ii) $P(X \geq 2) \Rightarrow$
$1 - [P(X=0) + P(X=1)]$

$= 1 - \left[e^{-4} + \frac{e^{-4} \times 4}{1!} \right]$

$= 1 - e^{-4} \times 5$
$= 1 - 0.0183 \times 5$
$= 1 - 0.091$
$= 0.909$

No. of days having atleast two accidents = 0.909×100
$= 90.9$
≈ 91 days

iii) atmost 3 accidents $\Rightarrow P(X=0) + P(X=1) + P(X=2) + P(X=3)$

$= e^{-4} + e^{-4} \times 4 + \frac{e^{-4} \times 16}{2!} + \frac{e^{-4} \times 64}{3!}$

$= e^{-4} \left[1 + 4 + 8 + \frac{32}{3} \right]$

$= e^{-4} \times 23.66$
$= 0.432$

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No. of days having at most 3 accidents = 100×0.432
$= 43.2$
≈ 43 days

iv) between 2 and 5 accidents $\Rightarrow P(X=3) + P(X=4)$

$$= \frac{e^{-4} \times (4)^3}{3!} + \frac{e^{-4} \times (4)^4}{4!}$$

$$= e^{-4} \left[\frac{64}{6} + \frac{256}{24} \right]$$

$$= e^{-4} \times \frac{64}{3}$$

$$= e^{-4} \times 21.33$$

$$= 0.3903$$

No. of days having accidents between 2 and 5 = 0.390×100
$= 39$ days

Q-3- Fit a poisson distribution for the following data and calculate theoretical frequencies

Deaths	0	1	2	3	4
Frequencies	122	60	15	2	1

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x	f	fx	Theoritical frequencies
0	122	0	121.306
1	60	60	60.653
2	15	30	15.163
3	2	6	2.527
4	1	4	0.315
	$\Sigma f = 200$	$\Sigma fx = 100$	

$$\text{Mean} = \lambda = \frac{\Sigma fx}{\Sigma f} = \frac{100}{200}$$

$$\boxed{\lambda = 0.5}$$

$$\boxed{N = 200}$$

$$\text{Poisson Distribution} = \frac{N e^{-\lambda} \lambda^r}{r!}$$

When $r = 0$, $\frac{200 \times e^{-0.5} \times (0.5)^0}{0!}$

$= 200 \times 0.608$

$= 121.306$

When $r = 1$, $\frac{200 \times e^{-0.5} \times (0.5)^1}{1!}$

$= 200 \times 0.608 \times 0.5$

$= 60.653$

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When $r=2$, $\frac{200 \times e^{-0.5} \times (0.5)^2}{2!}$

$= 15.163$

When $r=3$, $\frac{200 \times e^{-0.5} \times (0.5)^3}{3!}$

$= 2.527$

When $r=4$, $\frac{200 \times e^{-0.5} \times (0.5)^4}{4!}$

$= 0.315$

Q-4- Fit a poisson distribution to the following data given the number of yeast cells per square for 400 squares.

No. of cells per sq:	0	1	2	3	4	5	6	7	8	9	10
No. of Square:	103	143	98	42	8	4	2	0	0	0	0

r	f	f.r	Theoritical frequency
0	103	0	107
1	143	143	141
2	98	196	93
3	42	126	41
4	8	32	13
5	4	20	4
6	2	12	1
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0

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$\Sigma f = N = 400$

$\Sigma fr = 529$

$\text{Mean} = \lambda = \frac{529}{400} = 1.322$

$\text{Poisson Distribution} = N \frac{e^{-\lambda} \times \lambda^r}{r!}$

$= 400 \times \frac{e^{-1.322} \times \lambda^r}{r!}$

$= 107.2 \times \frac{\lambda^r}{r!}$

$r = 0, \quad = 107.2 \times \frac{\lambda^r}{r!}$

$= 107.2 \times \frac{(1.32)^0}{0!}$

$= 107.2 \approx 107$

$r = 1, \Rightarrow 107.2 \times \frac{1.322}{1!}$

$= 141.5 \approx 141$

$r = 2 \Rightarrow 107.2 \times \frac{(1.322)^2}{2!}$

$= 93.4$

≈ 93

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$r=3 \Rightarrow 107.2 \times \frac{(1.322)^3}{3!}$

$= 41.2$

≈ 41

$r=4 \Rightarrow 107.2 \times \frac{(1.322)^4}{4!}$

≈ 13

$r=5 \Rightarrow 107.2 \times \frac{(1.322)^5}{5!}$

$= 4$

$r=6 \Rightarrow 107.2 \times \frac{(1.322)^6}{6!}$

$= 0.80$

≈ 1

$r=7 \Rightarrow 107.2 \times \frac{(1.322)^7}{7!}$

$= 0.14$

≈ 0

$r=8 \Rightarrow 107.2 \times \frac{(1.322)^8}{8!} \approx 0$

$r=9 \Rightarrow 107.2 \times \frac{(1.322)^9}{9!} \approx 0$

$r=10 \Rightarrow 107.2 \times \frac{(1.322)^{10}}{10!} \approx 0$

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