UNIT-4
Probability and statistics.

⇒ **Probability** :-

If an event 'A' can happen in m ways and fail in n ~~ways~~ ways all these ways are equally likely to occur then the probability of ~~the~~ happening of 'A' is,

$$P(A) = \frac{\text{no. of fav. cases}}{\text{~~total~~ total no. of mutually exclusive \& equally likely cases}}$$

~~P(A)~~ =

Probability is measure of success or failure of an event is occur.

Q. From a pack of 52 cards one is drawn at random. Find the probability of getting a king.

Sol ⇒ Given, A = taking king from 52 cards.

no. of fav. outcomes = 4

total no. of mutually exclusive & equally likely outcomes = 52.

So,

$$P(A) = \frac{\text{no. of fav. cases}}{\text{total no. of mutually exclusive \& equally likely cases}}$$

$$= \cancel{\frac{4}{52}} = \frac{1}{13}$$

⇒ **Addition law of probability** :-

If A & B are two events associated with an experiment then,

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

prepare its ~~perform~~ proof by your own.

Multiplication law of probability ⇒

If there are two independent events the respective probability of which are known than the probability that both will happen is the product of probabilities of their happening respectively.

indep. $\boxed{P(A \cap B) = P(A)P(B)}$

⇒ **Conditional probability ⇐**

Let 'A' and 'B' be two events of a sample space & and probability of $B \neq 0$ the conditional probability of event 'A' given 'B' denoted by, $P(A/B)$

$$\boxed{P(A/B) = \frac{P(A \cap B)}{P(B)}}$$

⇒ **Byes theorem ⇐**

If $B_1, B_2, \ldots B_n$ are mutually exclusive events with $P(B_i) \neq 0$, $(i = 1, 2, 3, \ldots n)$ of random experiment then for any arbitrary event of A of sample space of the above experiment, with $P(A) > 0$

$$P(B_i/A) = \frac{P(B_i)P(A/B_i)}{\sum_{i=1}^{n} P(B_i)P(A/B_i)}$$

prepar its proof by your own.

Q. A bag contains 4 white & 2 black balls. and a second bag contains 3 of each colour. A bag is selected at random and a ball is drawn random from chosen bag. What is probability that the ball drawn is white.

Sol⇒ Given,

event A = bag 1 is choosen

event B = bag 2 is choosen.

$P(A) = \frac{1}{2}$

$P(B) = \frac{1}{2}$

Now, let E_1 = white ball choosen from bag 1

& E_2 = white ball choosen from bag 2.

So, E = white ball choosen.

So,

$P(E_1) = \frac{4}{6} = \frac{2}{3} = \frac{\text{white ball in bag 1}}{\text{total balls}}$

$P(E_2) = \frac{3}{6} = \frac{1}{2} = \frac{\text{white ball in bag 2}}{\text{total balls}}$

$P(E) = \frac{2}{3} \times \frac{1}{2} + \frac{1}{2} \times \frac{1}{2} = \frac{7}{12}$.

Q. An article manufactured by a company consist of two parts 'A' and 'B'. In the process of manufacture of part A 9 out of 100 are likely to be defective similarly 5 out of 100 are likely to be defective in manufacture of part B. Calculate the probability that the assembled article not be defective. (Events of finding the part A, non-defective and that of B independent).

Sol⇒ Given,

let E_1 = non-defective part of A.

E_2 = non-defective part of B.

$P(E_1) = 1 - P(\text{Defective of A})$

$P(E_2) = 1 - P(\text{Defective of B})$

$P(E_1) = 1 - \frac{9}{100} \left(\frac{\text{Defective of A}}{\text{total part}}\right)$

$P(E_1) = \frac{91}{100}$

$P(E_2) = 1 - \frac{5}{100} = \frac{95}{100}$

$P(\text{not Defective}) = \frac{91 \times 95}{100 \times 100}$

$= 8.6 \times 10^3 \times 10^{-4}$

$= 8.645 \times 10^{-1} = 0.8645$

Q3. An urn contains 9 balls, ~~two~~ 2 of which are red, 3 blue & 4 black. ~~Three~~ 3 balls are drawn from the urn at random. What is the probability that?

(1) The three balls are of ~~different~~ different colours.

(2) The three balls are of same colour!

Sol

urn

9 Balls $\boxed{\begin{matrix} 2 \text{ Red} \\ 3 \text{ Blue} \\ 4 \text{ Black} \end{matrix}}$

Case I ⇒

$= \frac{2}{9} \times \frac{3}{8} \times \frac{4}{7} =$

$= \frac{12}{9 \times 8 \times 7} = \frac{2}{42} = \frac{1}{21}$

$= 0.48.$

Case II ⇒

$= \frac{3}{9} \times \frac{2}{8} \times \frac{1}{7} + \frac{4}{9} \times \frac{3}{8} \times \frac{2}{7}$

$= \frac{6 + 24}{9 \times 8 \times 7} = \frac{30}{9 \times 8 \times 7} = \frac{5}{24 \times 7}$

$= \frac{5}{84} = 0.06.$

Q An urn first contains three white & 4 red balls & an urn 2nd contains 5 white & 6 red balls. One ball is drawn at random from one of the urns and is found to be white. Find the probability that it was drawn from urn 1st.

Sol ⇒ Given,

$\frac{1}{2}$ = urn 1 Urn 2 → $\frac{1}{2}$

$\frac{3}{7}$ ← { 3 white, 4 Red } 5 white, 6 Red } → $\frac{5}{11}$

$$\frac{\frac{1}{2} \times \frac{3}{7}}{\frac{1}{2} \times \frac{3}{7} + \frac{1}{2} \times \frac{5}{11}} = \frac{\frac{33+35}{77 \times 11}}{\frac{3}{7}}$$

$$= \frac{\frac{3}{7}}{\frac{68}{77}} = \frac{33}{68} = 0.49$$

Q An insurance company insured 2000 scooter drivers 4000 car drivers & 6000 truck drivers. The probability of accidents are 0.01, 0.03 & 0.15 respectively. One of the insured persons meets with an accident. What is the probability that he is a scooter driver.

Sol ⇒

total no. of insured = 2000 + 4000 + 6000
= 12000

P (scooter ins) = $\frac{2}{12} = \frac{1}{6}$ = 0.17

P (car) = $\frac{4}{12} = \frac{1}{3}$ = 0.33

P (truck) = $\frac{1}{2}$ = 0.50

$$= \frac{\frac{1}{6} \times \frac{0.1}{10}}{\frac{1}{6} \times \frac{0.1}{10} \times \frac{0.3 \times 1}{10 \; 3} + \frac{0.15 \times 1}{100 \; 2}}$$

$$= \frac{\frac{1}{60}}{\frac{1}{60} + \frac{1}{10} + \frac{15}{200}}$$

0.0017
0.0099
0.075
= 0.087.

$$= \frac{\frac{1}{606} \; \frac{1}{6}}{\frac{1}{6} + \frac{1}{1} + \frac{3}{4}}$$

$$= \frac{\frac{1}{6}}{\frac{2+12+9}{12}}$$

$$= \frac{1}{6} \times \frac{12}{}$$

Q. 3 urn contains 6R, 4B ; 4R, ~~6B~~ 6B ; 5R, 5B. One of the urns is selected at random & a ball is drawn from it. If the ball drawn is red find the probability that it is drawn from first urn.

Sol:
$$= \frac{\frac{1}{3}\times\frac{6}{10}}{\frac{1}{3}\times\frac{6}{10}+\frac{1}{3}\times\frac{4}{10}+\frac{1}{3}\times\frac{5}{10}}$$

$$= \frac{6}{6+4+5} = \frac{6}{15} = \frac{2}{5}$$

⇒ **Correlation** ⇐
Two variables x and y are so related that an increase in the one is accompanied by an increase or decrease in the other then the variable are said to be correlated. E.g. The yield of crop varies with amount of rainfall.

Types of correlation ⇒

① **Positive Correlation** ⇒ If an increase in the value of X, results in the corresponding increase in the value of other variable Y on an average or if a decrease in value of one variable X, results in the corresponding ~~in~~ decrease in the value of y on an average. Then the correlation is said to positive correlation.

② **Negative Correlation** ⇒ If an increase in the values of one one variable X results in a corresponding decrease in the other value Y. ~~or~~ If the ↓ in the value of one variable X result in the ↑ of one or two values of Y. The correlation said to be -ve.

③ **Linear Correlation** ⇒ All the plotted points lie approximately on a stgt line then the correlation is said to be linear.

④ **Perfect Correlation** ⇒
If ~~the~~ two variable vary in such a way that their ratio always remains constant then the correlation is said to be perfect.

⇒ ~~Coed~~ Karl - Pearson's coefficient of correlation ⇒
Let r, ~~the~~ b/w two variable 'x' & 'y' is defined by,

$$\boxed{r = \frac{\Sigma XY}{\sqrt{\Sigma(X^2)(\Sigma Y^2)}}} \longrightarrow \text{Coefficient of correlation}$$

$$\boxed{r = \frac{P}{6x\,6y} = \frac{\text{cov}(x,y)}{\sqrt{\text{var}\,x}\sqrt{\text{var}\,y}}}$$

P = variance
Cov = covariance.

X, Y are deviation measured by their ~~mean~~ mean.

$$X = x - \bar{x} \quad , \quad Y = y - \bar{y}.$$

→ r always equals ~~to~~ the ±1 including +1 & -1.

Q. 10 Students got the following percentage of marks in economics & statics.

Roll No.	Marks in economics (X)	Marks in statistics (Y)
1	78	84
2	36	51
3	98	91
4	25	60
5	75	68
6	82	62
7	90	86
8	62	58
9	65	53
10	39	47.

Q 1) Let the marks of two subjects be denoted by ~~x~~ & y respectively.

The mean for x marks is $\bar{x}$

$$\bar{x} = \frac{\Sigma x}{n}$$

$$\bar{x} = 65$$

The mean for y marks is $\bar{y}$

$$\bar{y} = \frac{\Sigma y}{n}$$

$$\bar{y} = 66.$$

If X & Y are deviations of x & y from their respective mean then the data may be arranged in the following form.

R.No.	Marks in Gr (x)	Marks Stat (y)	$X = x - \bar{x}$	$Y = y - \bar{y}$	XY	X^2	Y^2
1	78	84	13	18	234	169	324
2	36	51	-29	-15	435	841	225
3	98	91	33	25	~~1485~~ 825	1089	625
4	25	60	-40	-6	240	1600	36
5	75	68	10	2	20	100	4
6	82	62	17	-4	-68	289	16
7	90	86	25	20	500	625	400
8	62	58	-3	-8	24	9	64
9	65	53	0	-13	0	0	169
10	39	47.	-26	-19	494	676	361
					ΣXY = ~~3364~~ 2704	ΣX^2 = 5398	ΣY^2 = 2224

$\sqrt{\Sigma X^2} = 73.471$

$\sqrt{\Sigma Y^2} = 47.159$

So

$$r = \frac{\Sigma XY}{\sqrt{(\Sigma X^2)(\Sigma Y^2)}}$$

So

$$r = \frac{\cancel{3364}\ 2704}{73.471 \times 47.159} = \frac{2704}{3464.818} = \cancel{0.970}\ 0.78$$

Q. Calculate the coefficient of correlation b/w marks obtained by 8 students in mathematics & statistics.

Sl Student	Math (x)	Stati (y)	$X = x - \bar{x}$	$Y = y - \bar{y}$	XY	X^2	Y^2
A	25	8	-10.75	-9.75			
B	30	10	-5.75	-7.5.			
C	32	15	-3.75	-2.75			
D	35	17	-0.75.	-0.75			
E	37	20	1.25	2.25			
F	40	23	4.25.	5.25			
G	42	24	6.25.	6.25			
H	45	25	9.25.	7.25			
Total	286	142	0				

So Let the marks of ...,

$$\bar{x} = \frac{\Sigma x}{n} = \frac{25+30+32+35+37+40+42+45}{8}$$

$$= \frac{286}{8} = 35.75$$

$$\bar{y} = \frac{\Sigma y}{n} = \frac{8+10+15+17+20+23+24+25}{8}$$

$$= 17.75.$$

⇒ ~~Bion~~ Binomial Distribution :

Let there be 'n' independent trials in an experiment, let the random variable X denote the number of success in these (n) trials, let ~~small~~ 'p' be the probability of a success & 'q' that of a failure in a single trial. So that $p+q=1$, let the ~~trials~~ trials be independent and p the constant for every trial. Let us find the probability of r success in 'n' trials. 'r' success can be obtained in 'n' trials in ^nC_r ways.

$$P(x=r) = {}^nC_r \, P(\underbrace{SSSS\ldots}_{r \text{ times}} \underbrace{FFF\ldots F}_{(n-r) \text{ times}})$$

$$= {}^nC_r \underbrace{P(S)(PS)\ldots P(S)}_{r \text{ factors}} \underbrace{P(F)P(F)\ldots P(F)}_{(n-r) \text{ factors}}$$

$$= {}^nC_r \underbrace{ppp\ldots p}_{r\text{-factors}} \underbrace{qqq\ldots q}_{(n-r) \text{ factors}}$$

$$\boxed{P(X=r) = {}^nC_r \, p^r q^{n-r}} \quad r=0,1,2,3\ldots\ldots n.$$

$$\boxed{p+q=1}$$

NOTE ⇒ The successive probabilities p^r in ~~are~~ 1 for $r=0,1,2,\ldots\ldots n$,

$^nC_0 q^n, {}^nC_1 pq^{n-1}, {}^nC_2 q^{n-2}p^2 + \ldots, {}^nC_n p^n$.

which are the successive terms of the binomial expansion of $(q+p)^n$ therefore this distribution is kla binomial probability distribution.

Q. Prove that in Binomial P.D. mean is ~~np~~ np and variance is npq respectively.

Sol ⇒ r success in B.P.D is given by,

$$P(r) = {}^nC_r \, p^r q^{n-r}, \quad r = 0,1,2,\ldots\ldots n.$$

Mean ⇒ $\mu = \sum_{r=0}^{n} r P(r)$ $\quad \left[\because \mu = \sum_{x=0}^{n} x f(x) \right]$

$$\Rightarrow \mu = \sum_{r=0}^{n} r \left[{}^nC_r p^r q^{n-r}\right]$$

$$= 0 + \left[{}^nC_1 p^1 q^{n-1}\right] + {}^nC_2 q^{n-2}p^2 + \ldots\ldots {}^nC_n p^n.$$

$$= \frac{npq^{n-1}}{1} + \frac{n(n-1)p^2q^{n-2}}{2} + \frac{(n)(n-1)(n-2)}{6} p^3 q^{n-3} + \ldots + np^n.$$

$$= np\left[q^{n-1} + \frac{(n-1)pq^{n-2}}{2} + \frac{(n-1)(n-2)p^2q^{n-3}}{6} + \ldots\ldots p^{n-1}\right]$$

$$= np\left[{}^{n-1}C_0 p^0 q^{n-1} + {}^{n-1}C_1 pq^{n-2} + \ldots\ldots + {}^{n-1}C_{n-1} p^{n-1}\right]$$

$$= np\,[q+p]^{n-1}$$

$$= np \times 1$$

$$\boxed{\mu = np}$$ Hence proved.

⇒ Variance is denoted by σ^2,

$$\sigma^2 = \sum_{r=0}^{n} r^2 p(r) - \mu^2$$

$$= \sum_{r=0}^{n}\left[r + r(r-1)\right]p(r) - \mu^2$$

$$= \sum_{r=0}^{n} r p(r) + \sum_{r=0}^{n} r(r-1)p(r) - \mu^2$$

$$= np + \sum_{r=0}^{n} r(r-1) P(r) - \mu^2$$

Here,

$$G = \sum_{x=0}^{n} x(x-1)\, {}^nC_x\, p^x q^{n-x}$$

$$= 0 + 0 + \frac{(n)(n-1)}{2!} p^2 q^{n-2} + \frac{n(n-1)(n-2)}{6} p^3 q^{n-3}$$

$$+ \dots\dots + n(n-1)\, p^n$$

$$= n(n-1)\left[p^2 q^{n-2} + (n-2) p^3 q^{n-3} + \dots (n-1) p^n\right]$$

$$= np\left[np\, q^{n-2} + (n-2)(n-1) p^2 q^{n-3} + \dots (n-1) p^{n-1}\right]$$

$$= np\left[\sum_{x=1}^{n-1} (p+q)\right]$$

$$= npq\left[(n-1) pq^{n-1} + (n-1)(n-2) p^2 q^{n-2} + \dots (n-1) p^{n-1}\right]$$

$$= npq.\left[\sum_{r=0}^{n-1} (p+q)\right]$$

$$G = npq$$

So,

$$\sigma^2 = np + npq - n^2p^2$$

$$= np(1 + q - np)$$

Q. Assume that on the average one telephone number out of 15 called b/w 2pm & 3pm on week days is busy. What is the probability that if 6 randomly selected telephone num. are called
(i) not more than 3.
(ii) at least three of them will be busy.

Sol (i)

P, be the probability of a telephone number being busy b/w 2p.m to 3p.m. on week days which is

$$= \frac{1}{15} \qquad \boxed{p = \frac{1}{15}}$$

q, be the probability of a telephone number being not busy b/w 2p.m & 3pm on week days i.e.

$$1 - \frac{1}{15} = \frac{14}{15}.$$

So,

$$\boxed{q = \frac{14}{15}}$$

$$p = \frac{1}{15}, \quad q = \frac{14}{15}, \quad n = 6$$

(i) This implies that the probability that not more than 3 will be busy.

$$x \le 3$$

$$x = 0, 1, 2 \,\&\, 3.$$

So,

$$P(x) = P(0) + P(1) + P(2) + P(3)$$

$$P(x) = {}^6C_0\left(\frac{1}{15}\right)^0\left(\frac{14}{15}\right)^6 + {}^6C_1\left(\frac{1}{15}\right)^1\left(\frac{14}{15}\right)^5$$

$$+ {}^6C_2\left(\frac{1}{15}\right)^2\left(\frac{14}{15}\right)^4 + {}^6C_3\left(\frac{1}{15}\right)^3\left(\frac{14}{15}\right)^3$$

$$P(x) = $$

$$P(x) = \frac{(14)^3}{(15)^6}\left[{}^6C_0 (14)^3 + {}^6C_1 (14)^2 \times 1 + {}^6C_2 \times (14)^1 + {}^6C_3\, 1\right]$$

$$= \left[(14)^3 + 6(14)^2 + 15(14) + 20\right] \frac{(14)^3}{(15)^6}$$

$$= 4150 \times \frac{(14)^3}{(15)^6}$$

$$= \frac{4150 \times 2744}{(15)^6} = \frac{11387600}{11390625} = 0.9997.$$

(0.005)

(ii) $r \geq 3.$

$$p(r) = p(3) + \underbrace{p(4) + p(5)}_{} + p(6)$$

$$= \cancel{p(3)+} \ \cancel{0.95} \cdot (\cancel{1 - 0.9997})$$

$$= p(3) + p(4) + p(5) + p(6)$$

$$= {}^6C_3\left(\frac{1}{15}\right)^3\left(\frac{14}{15}\right)^3 + {}^6C_4\left(\frac{1}{15}\right)^4\left(\frac{14}{15}\right)^2$$

$$+ {}^6C_5\left(\frac{1}{15}\right)^5\left(\frac{14}{15}\right)^1 + {}^6C_6\left(\frac{1}{15}\right)^6$$

$$p(r) = \frac{20(14)^3 + 15(14)^2 + 6(14) + 1}{15^6}$$

$$p(r) = \frac{20 \times 2744 + 15 \times 196 + 85}{15^6}$$

$$\boxed{P(r) = 0.0050}$$

Q. If the probability of hitting a target is 10% and ten shots are fired independently what is the probability that the target will be hit atleast once.

Sol. $p = \frac{1}{10}$, $q = \frac{9}{10}$, $n = 10$, $r \geq 1$

$$p(r) = 1 - p(0)$$

$$= 1 - {}^{10}C_0\left(\frac{9}{10}\right)^{10}$$

$$= 1 - \left(\frac{9}{10}\right)^{10} = 0.6513.$$

⇒ Poisson's Probability distributione

Q. Prove that Poisson's probability distribution is a limiting case of bionomial probability distribution.

Sol. If the parameters 'a' and 'b' of a ~~bio~~ binomial distribution are known we can find the distribution but in a such situation that 'n' is very large & 'p' is very small application of binomial distribution become complicated however if we assume ~~that~~ that $n \to \infty$, $p \to 0$ such that, np always remains finite say, $np = \lambda$ then we get the Poissons approximation to the bino. prob. distr.

We know that in BPD,

$$P(r) = {}^nC_r q^{n-r} p^r$$

$$P(r) = \frac{n(n-1)\cdots[n-(r-1)]}{r!} q^{n-r} p^r.$$

$$P(r) = \frac{n(n-1)\cdots(n-r+1)}{r!} (1-p)^{n-r} p^r.$$

$$[np = \lambda \Rightarrow p = \lambda/n]$$

$$P(r) = \left[\frac{n(n-1)\cdots(n-r+1)}{r!}\right]\left(1-\frac{\lambda}{n}\right)^{n-r}\left(\frac{\lambda}{n}\right)^r$$

$$P(r) = \frac{\lambda^r}{r!}\left\{\frac{n(n-1)(n-2)\cdots(n-r+1)}{n^r}\right\}\frac{(1-\lambda/n)^n}{[1-(\lambda/n)]^r}$$

$$p(r) = \frac{\lambda^r}{r!}\left\{\left(\frac{n}{n}\right)\left(\frac{n-1}{n}\right)\cdots\cdots\left(\frac{n-r+1}{n}\right)\right\}\frac{\left[\left[1-(\lambda/n)\right]^{-n/\lambda}\right]^{-\lambda}}{(1-\lambda/n)^r}$$

$$p(r) = \frac{\lambda^r}{r!}\left\{1\left(1-\frac{1}{n}\right)\left(1-\frac{2}{n}\right)\cdots\cdots\left(1-\frac{(r-1)}{n}\right)\right\}\left[\frac{\left[(1-\lambda/n)\right]^{-n/\lambda}}{(1-\lambda/n)^r}\right]^{-\lambda}$$

As $\lim_{n\to\infty}$ so, $1-\frac{1}{n} \to 1,\ 1-\frac{2}{n} \to 1 \cdots\cdots 1-\frac{(r-1)}{n} \to 1$

$\lambda\ (1-\lambda/n)^r \to 1$

so,

$$p(r) = \frac{\lambda^r}{r!}\Big[\lim_{n\to\infty}\underbrace{\left[(1-\lambda/n)\right]^{-n/\lambda}}_{e}\Big]^{-\lambda}$$

$$p(r) = \frac{\lambda^r}{r!}e^{-\lambda} \quad \text{where } r = 0, 1, 2, \cdots\cdots \infty$$

So,

$$\boxed{p(r) = \frac{\lambda^r}{r!}e^{-\lambda}}$$

Q. prove that in poissons Prob. distribution mean & variance both are equals to λ.

Sol.) we know that r success in poissons prob. dist. given by,

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

$$\text{mean } \mu = \sum_{r=0}^{\infty} r\,p(r)$$

$$= \sum_{r=0}^{\infty} \frac{r e^{-\lambda}\lambda^r}{r!}$$

$$= e^{-\lambda}\sum_{r=0}^{\infty}\frac{\lambda^r}{(r-1)!}$$

$$= ~~e^{-\lambda}\Sigma~~$$

$$= e^{-\lambda}\left[\lambda + \frac{\lambda^2}{1!} + \frac{\lambda^3}{2!} + \cdots\cdots\right]$$

$$= \lambda e^{-\lambda}\left[1 + \lambda + \frac{\lambda^2}{2!} + \frac{\lambda^3}{3!} + \cdots\right]$$

$$= \lambda e^{-\lambda}e^{\lambda}$$

$$\boxed{\mu = \lambda}$$

Now,

$$\text{variance } \sigma^2 = \sum_{r=0}^{\infty} r^2 p(r) - \mu^2$$

$$= \sum_{r=0}^{\infty} r^2 p(r) - \sum_{r=0}^{\infty} r^2[p(r)]^2$$

$$= \cancel{\sum_{r=0}^{\infty} r^2 p(r) - r^2 p(r)^2}$$

$$= \cancel{\sum_{r=0}^{\infty} r^2 p(r)\left[1 - p(r)\right]}$$

$$= \sum_{r=0}^{\infty} r^2 p(r) - \lambda^2$$

$$= \sum_{r=0}^{\infty} r^2 \frac{e^{-\lambda}\lambda^r}{r!} - \lambda^2$$

$$= e^{-\lambda}\sum_{r=0}^{\infty}\frac{r\lambda^r}{(r-1)!} - \lambda^2$$

$$= e^{-\lambda}\left[1 + \lambda + \frac{2\lambda^2}{1!} + \frac{3\lambda^3}{2!} + \cdots\right] - \lambda^2$$

$$\boxed{\sigma^2 = \lambda}$$

Q11. Assume that the probability of an individual coal miner will killed in a mine accident during a year is ~~is~~ $\frac{1}{2400}$. Use poissons distribution to calculate the probability that in a mine employing 200 minors their ~~is~~ will be atleast 1 fatal accident in a year.

d(1) Given,

~~$p(\text{minor killed}) = \frac{1}{2400}$~~

p be the probability of an individual coal minner being killed $= \frac{1}{2400}$

no. of coal miners $= 200$

$$\lambda = np = \frac{1}{2400} \times 200 = \frac{1}{12} = 0.083$$

So,

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

p(at least one fatal Accident) = 1 − p(No fatal accident)

$$= 1 - p(0)$$

$$= 1 - \frac{\lambda^0}{0!} e^{-0.083}$$

$$= 1 - e^{-0.083}$$

$$= 1 - \cancel{0.436}\ 0.9203$$

$$= 0.079$$

$$= 0.08.$$