Marks : 40	SYJC FEB' 19 Subject : Maths – II Regression, Random Variable	Duration : 1.5 Hours. Set – A SOLUTION

Q.1. Solve any Three : (2 Marks each) **(06)**

1. Given : $\bar{x} = 53$, $\bar{y} = 28$, $b_{YX} = -1.5$ and $b_{xy} = -0.2$

Correlations coefficient between X and Y :

$$r = \pm\sqrt{b_{yx} \cdot b_{xy}}$$
$$= \pm\sqrt{(-1.5)(-0.2)}$$
$$= \pm\sqrt{0.3}$$
$$\therefore r = -0.5477 \quad \ldots. (\because b_{yx} \text{ and } b_{xy} \text{ are negative})$$

2. Given : $\bar{x} = 199$, $\bar{y} = 94$, $\sum(x_i - \bar{x})^2 = 1298$, $\sum(y_i - \bar{y})^2 = 600$, $\sum(x_i - \bar{x})(y_i - \bar{y}) = -262$

The line of regression of Y on X :

$$b_{yx} = \frac{\sum(x - \bar{x})\sum(y - \bar{y})}{\sum(x_i - \bar{x})^2}$$
$$= \frac{-262}{1298}$$
$$= -0.2018$$

Now, $y - \bar{y} = b_{yx}(x - \bar{x})$

$\therefore y - 92 = 0.2018(x - 199)$

$\therefore y = -0.2018x + 40.1582 + 94$

$\therefore y = -0.2018x + 134.1582$

$\therefore y = 134.1582 - 0.2018x$

3. Given : $\bar{x} = 10$, $\bar{y} = 90$, $\sigma_x = 3$, $\sigma_y = 12$, $r = 0.8$

(i) Regression equation of Y on X :

$$b_{yx} = r \cdot \frac{\sigma_y}{\sigma_x}$$
$$\therefore b_{yx} = 0.8 \times \frac{12}{3} = 3.2$$

Now, $y - \bar{y} = b_{yx}(x - \bar{x})$

$\therefore y - 90 = 3.2(x - 10)$

$\therefore y = 3.2x - 32 + 90$

$\therefore y = 3.2x + 58$

$\therefore y = 58 + 3.2x$

(ii) Regression equation of X on Y :

$$b_{xy} = r \cdot \frac{\sigma_x}{\sigma_y}$$
$$\therefore b_{xy} = 0.8 \times \frac{3}{12} = 0.2$$

Now, $x - \bar{x} = b_{xy}(y - \bar{y})$

$\therefore x - 10 = 0.2(y - 90)$

$\therefore x = 0.2y - 18 + 10$

$\therefore$ x = 0.2y – 8
$\therefore$ x = – 8 + 0.2y

4. $b_{yx} + b_{xy} = 1.30$, r = 0.75

$$\frac{b_{yx} + b_{xy}}{2} = \frac{1.30}{2}, r = 0.75$$

$$\therefore \frac{b_{yx} + b_{xy}}{2} < r$$

Hence, the data is inconsistent.

5. We know that the co-ordinates of point of intersection of the two lines are $\bar{x}$ and $\bar{y}$, the means of X and Y.

The regression equation are

3x + 2y – 26 = 0
6x + y – 31 = 0 and

Solving these equations simultaneously, we get

6x + 4y – 52 = 0
6x + y – 31 = 0
– – +

3y – 21 = 0
$\therefore$ 3x = 21
i.e. y = 7
and x = 4

hence, the means of X and Y are $\bar{x}$ = 4 and $\bar{y}$ = 7.

Q.2. Solve any Four : (3 Marks each) **(12)**

1. Here, the regression lines are specified. So, $b_{YX} = \frac{4}{3}$ and $b_{XY} = \frac{1}{3}$

$$\therefore r^2 = b_{YX} \cdot b_{XY} = \frac{4}{3} \cdot \frac{1}{3} = \frac{4}{9}$$

$$\therefore r = +\frac{2}{3} \quad \text{.... } (\because b_{yx} \text{ and } b_{xy} \text{ are positive})$$

You know that

$$b_{YX} = r \cdot \frac{\sigma_Y}{\sigma_X}$$

$$\therefore \frac{4}{3} = \frac{2}{3} \cdot \frac{\sigma_Y}{2}$$

$$\therefore \sigma_Y = 4$$

$$\therefore \sigma_Y^2 = 16$$

2. Here, we need to find line of regression of Y on X, which is given as Y = a + b_{YX} X.

$$\text{Where } b_{YX} = \frac{\text{cov}(X, Y)}{\sigma_X^2}$$

$$= \frac{\frac{\sum (x_i - \bar{x})(x_i - \bar{y})}{n}}{\sigma_X^2}$$

$$= \frac{\frac{1220}{10}}{130}$$

= 0.9384

and a = $\bar{y} - b_{YX}\,\bar{x}$

= 142 – (0.9384) 53

= 92.2615

Therefore, regression equation of Y on X is

Y = 92.2615 + 0.9384X

Now, the estimate of blood pressure of woman with age 47 years is

Y = 92.2615 + 0.9384 x 47

= 136.3692

3. Given : n = 8, $\bar{x} = 20, \bar{y} = 36, \sum(x_i - \bar{x})(y_i - \bar{y}) = 120, \sigma_x = 2, \sigma_y = 3$

$b_{yx} = \frac{Cov(x, y)}{\sigma_x^2}$

Now, Cov (x, y) $= \frac{\sum(x_i - \bar{x})(y_1 - \bar{y})}{n}$

$= \frac{120}{8} = 15$

$\therefore b_{yx} = \frac{15}{(2)^2} = \frac{15}{4}$

= 3.75

Line of regression of Y on X :

$y - \bar{y} = b_{yx}(x - \bar{x})$

$\therefore$ y – 36 = 3.75 (x – 20)

$\therefore$ y = 3.75x – 75 + 36

$\therefore$ y = 3.75x – 39

4. $\bar{x}$ = 53, $\bar{y}$ = 28, b_{yx} = – 1.5, b_{xy} = – 0.2

Using regression equation of Y on X, we estimate Y when X = 50.

Now, $y - \bar{y} = b_{yx}(x - \bar{x})$

$\therefore$ y – 28 = - 1.5(x – 53)

$\therefore$ y = - 1.5x + 79.5 + 28

$\therefore$ y = - 1.5x + 107.5

Estimate of Y when X = 50 :

Put x = 50 in y = - 1.5x + 107.5

$\therefore$ y = - 1.5 x 50 + 107.5

$\therefore$ y = - 75 + 107.5

$\therefore$ y = 32.5

5. Given : b_{yx} = - 0.75, b_{xy} = - 1.1, r = ?

Correlation coefficient :

$r = \pm\sqrt{b_{yx} \cdot b_{xy}}$

$\therefore r = \pm\sqrt{(-0.75) \times (-1.1)}$

$\therefore r = \pm\sqrt{0.825}$

$\therefore$ r = - 0.9082 ($\because$ b_{yx} and b_{xy} are negative)

Q.3. Solve any One : (4 Marks each) **(04)**

1. Given : n = 7, $\sum x_i = 105, \sum y_i = 409, \sum x_i^2 = 1681, \sum y_i^2 = 39350, \sum x_i y_i = 8075$

$\bar{x} = \frac{\sum x_i}{n} = \frac{105}{7} = 15, \bar{y} = \frac{\sum y_i}{n} = \frac{409}{7} = 58.428$

Regression coefficient of Y on X :

$$b_{yx} = \frac{\frac{\sum x_i y_i}{n} - (\bar{x})(\bar{y})}{\frac{\sum x_i^2}{n} - (\bar{x})^2}$$

$$= \frac{\frac{8075}{7} - 15 \text{ x } 58.428}{\frac{1681}{7} - (15)^2}$$

$$= \frac{1153.571 - 876.42}{240.143 - 225}$$

$$= \frac{277.151}{15.143} = 18.3023$$

Regression equation of Y on X :

$y - \bar{y} = b_{yx}(x - \bar{x})$

$\therefore$ y – 58.428 = 18.3023 (x – 15)

$\therefore$ y = 18.3023x – 274.5345 + 58.428

$\therefore$ y = 18.3023x – 216.1065

$\therefore$ y = - 216.1065 + 18.3023x.

2. Given : 10x – 4y = 80, 10 y – 9x = - 40

(i) **$\bar{x}$ and $\bar{y}$:**

10x – 4y	=	80	… (1)
- 9x + 10y	=	- 40	… (2)

Multiplying equation (1) by 9 and equation (2) by 10 and then adding them, we get

90x – 36y	=	720	… (1)
- 90x + 100y	=	- 420	… (2)
$\therefore$ 64y	=	320	
$\therefore$ y	=	$\frac{320}{64} = 5$	

Put y = 5 in equation (1), we get

10x – 4(5) = 80

$\therefore$ 10x = 80 + 20

$\therefore$ $x = \frac{100}{10} = 10$

Hence, $\bar{x} = 10$, $\bar{y} = 5$

(ii) **b_{yx} and b_{xy}**

Let regression equation of X on Y be

10x – 4y = 80

$\therefore$ 10x = 4y + 80

$\therefore$ $x = \frac{4}{10}y + 8$

$\therefore$ $b_{xy} = 0.4$

And another equation 10y – 9x = - 40 be the regression equation of Y on X.

$\therefore$ 10y = 9x – 40

$\therefore\ y = \frac{9}{10}x - 4$

$\therefore\ b_{yx} = \frac{9}{10} = 0.9$

Hence, $b_{yx} = 0.9$ and $b_{xy} = 0.4$.

(iii) Coefficient of correlation r :

$$\begin{aligned} r &= \pm\sqrt{b_{yx} \cdot b_{xy}} \\ &= \pm\sqrt{0.9 \times 0.4} \\ &= \pm\sqrt{0.36} \\ \therefore\ r &= 0.6 \ (\because\ b_{yx} \text{ and } b_{xy} \text{ are positive}) \end{aligned}$$

(iv) V(X) if V(Y) = 36 $\therefore\ \sigma_y = 6$:

Now, $b_{yx} = r \cdot \frac{\sigma_y}{\sigma_x}$

$\therefore\ 0.9 = 0.6 \times \frac{6}{\sigma_x}$

$\therefore\ \frac{0.9}{0.6 \times 6} = \frac{1}{\sigma_x}$

$\therefore\ \frac{1}{4} = \frac{1}{\sigma_x}$

$\therefore\ \sigma_x = 4$

$\therefore\ V(X) = \sigma_X^2 = (4)^2 = 16$

3. Given : $3x + 2y - 26 = 0$, $6x + y - 31 = 0$

(i) Means of X and Y :

$3x + 2y - 26 = 0$ … (1)

$6x + y - 31 = 0$ … (2)

Multiplying equation (2) by 2 and subtracting it from the equation (1), we get

$$\begin{array}{rl} 3x + 2y - 26 = 0 & \dots (1) \\ 12x + 2y - 62 = 0 & \dots (2) \\ - \quad - \quad + & \\ \hline \therefore\ -9x + 36 = 0 & \end{array}$$

$\therefore\ 9x = 36$

$\therefore\ x = \frac{36}{9} = 4$

Put x = 4 in equation (1),

$\therefore\ 3(4) + 2y - 26 = 0$

$\therefore\ 2y + 12 - 26 = 0$

$\therefore\ 2y = 14$

$\therefore y = 7$

Hence, $\bar{x} = 4, \bar{y} = 7$

(ii) Correlation coefficient between X and Y :

Let $3x + 2y - 26 = 0$ be the regression equation of Y on X.

$\therefore\ 2y = -3x + 26$

$\therefore\ y = -\frac{3}{2}x + 13$

$\therefore\ b_{yx} = -\frac{3}{2}$ ($\because$ it is coefficient of x) and the other equation $6x + y - 31 = 0$ be the regression equation of X and Y.

$\therefore 6x = -y + 31$

$\therefore x = -\frac{1}{6}y + \frac{31}{6}$

$\therefore b_{xy} = -\frac{1}{6}$ ($\because$ it is coefficient of y)

Now, r $= \pm\sqrt{b_{yx} \cdot b_{xy}}$

$= \pm\sqrt{\left(-\frac{3}{2}\right) x \left(-\frac{1}{6}\right)} = \pm\sqrt{\frac{1}{4}}$

$= \pm\frac{1}{2}$

$\therefore$ r = - 0.5 ($\because$ b_{yx} and b_{xy} are negative)

(iii) Estimate of Y for X = 2 :

Regression line of Y on X is,

$y - \bar{y} = b_{yx}(x - \bar{x})$

$\therefore y - 7 = -\frac{3}{2}(x - 4)$

$\therefore y = -\frac{3}{2}x + 6 + 7$

$\therefore y = -\frac{3}{2}x + 13$

Put x = 2 in $y = -\frac{3}{2}x + 13$

$\therefore y = -\frac{3}{2} \times 2 + 13$

$\therefore y = -3 + 13$

$\therefore y = 10$

(iv) V(Y) = 36 = σ_y^2

$\therefore \sigma_y = 6$, Var (X) = ?

Now, $b_{yx} = r.\ \frac{\sigma_y}{\sigma_y}$

$\therefore -\frac{3}{2} = -\frac{1}{2} \times \frac{6}{\sigma_x}$

$\therefore 3 = \frac{6}{\sigma_x}$

$\therefore \sigma_x = \frac{6}{3} = 2$

$\therefore$ Var (X) = σ_x^2 = 4.

Q.4. Attempt any Two : (2 Marks each) **(04)**

1. Here, we define r.v. X = number of points appearing on the uppermost face of a fair die. X can take values 1, 2, 3, 4, 5, 6.

Since die is fair, each number has equal probability distribution of X is as shown in the following table.

X = x	1	2	3	4	5	6
P[X = x]	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

2. Define X = number of defective batteries selected by the person.

$\therefore$ Range set of X = {0, 1, 2}. The p.m.f. of X is as follows :

$$P(X = 0) = \frac{{}^3C_0 \times {}^5C_2}{{}^8C_2} = \frac{10}{28}$$

$$P(X = 1) = \frac{{}^3C_1 \times {}^5C_1}{{}^8C_2} = \frac{15}{28}$$

$$P(X = 2) = \frac{{}^3C_2 \times {}^5C_0}{{}^8C_2} = \frac{3}{28}$$

Thus, the probability distribution of X is :

X = x	0	1	2
P[X = x]	$\frac{10}{28}$	$\frac{15}{28}$	$\frac{3}{28}$

3. 3 fair coins are tossed simultaneously.

$\therefore$ s = {HHH, HHT, HTH, THH, HTT, THT, TTH, TTT}

$\therefore$ total outcomes n = 8

X = the number of heads

$\therefore$ Range set of X = {0, 1, 2, 3}

$\therefore$ $P(x = 0) = P\{TTT\} = \frac{1}{8}$

$P(x = 1) = P\{HTT, THT, TTH\} = \frac{3}{8}$

$P(x = 2) = P\{HHT, HTH, THH\} = \frac{3}{8}$

$\therefore$ $P(x = 3) = P\{HHH\} = \frac{1}{8}$

Hence, the probability distribution of X is as shown in the following table :

X = x	0	1	2	3
P(X = x)	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$

4. Given : $f(x) = \begin{cases} kx^2(1-x), & 0 < x < 1; \\ 0, & \text{otherwise} \end{cases}$

Here, $f(x)$ is a pdf of r.v. X

$$\therefore \int_0^1 kx^2(1-x)\,dx = 1$$

$$\therefore \int_0^1 x^2dx - \int_0^1 x^3dx = \frac{1}{k}$$

$$\therefore \left[\frac{x^3}{3}\right]_0^1 - \left[\frac{x^4}{4}\right]_0^1 = \frac{1}{k}$$

$$\therefore \left(\frac{1}{3} - 0\right) - \left(\frac{1}{4} - 0\right) = \frac{1}{k}$$

$$\therefore \frac{1}{3} - \frac{1}{4} = \frac{1}{k}$$

$\therefore \quad \frac{4-3}{12} = \frac{1}{k}$

$\therefore \quad k = 12$

Hence, k = 12

Q.5. Attempt any Four : (3 Marks each) (12)

1. Given pdf of r.v. X is

$f(x) = \frac{k}{\sqrt{x}}, \; 0 < x < 4$

$= 0, \quad$ elsewhere

We know that,

$$\int_{-\infty}^{\infty} f(x)\, dx = 1$$

$$\therefore \int_0^4 \frac{k}{\sqrt{x}}\, dx = 1$$

$$\therefore k\int_0^4 x^{-\frac{1}{2}}\, dx = 1$$

$$\therefore k\left[\frac{x^{\frac{1}{2}}}{1/2}\right]_0^4 = 1$$

$$\therefore k\left[\frac{4^{\frac{1}{2}}}{1/2} - 0\right] = 1$$

$$\therefore k \times 4 = 1$$

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

2. Let X = No. of defective bulbs in a sample of 5 bulbs

$\therefore p \quad =$ Probability of defective bulb

$= \frac{5}{25} = \frac{1}{5}$

$\therefore q \quad = 1 - p = 1 - \frac{1}{5} = \frac{4}{5}$

Given : n = 5 (No. of bulbs in a sample)

$\therefore X \sim B\left(5, \frac{1}{5}\right)$

Now, $p(x) = {}^nC_x p^x q^{n-x}$

$\therefore p(x) = {}^5C_x \left(\frac{1}{5}\right)^x \left(\frac{4}{5}\right)^{5-x}$

(i) P [Exactly one defective bulb] i.e. P[X = 1]

$\therefore p(1) = {}^5C_1 \left(\frac{1}{5}\right)^1 \left(\frac{4}{5}\right)^4$

$= 5 \times \frac{1}{5} \times \frac{256}{625}$

$= 0.4096$

Hence, the probability that exactly one bulb is defective in a sample is 0.4096.

(ii) P[At least one bulb is defective] i.e. $P[X \geq 1]$

$P[X \geq 1] = 1 - P[X < 1]$

$= 1 - P(0)$
$= 1 - p(0)$
$= 1 - {}^5C_0\left(\frac{1}{5}\right)^0\left(\frac{4}{5}\right)^5$
$= 1 - 1 \times \frac{1024}{3125}$
$= 1 - 0.32768$
$= 0.67232$

Hence, the probability that at least one bulb is defective in a sample of 5 bulbs is 0.67232.

3. $X \sim P(m = 5)$, $e^{-5} = 0.0067$

Hence, $p(x) = \frac{e^{-m}m^x}{x!}$

$\therefore\ p(x) = \frac{e^{-5}5^x}{x!} = 0.0067 \times \frac{5^x}{x!}$

(i) P[X = 5] :

$P[X = 5] = p(5) = 0.0067 \times \frac{(5)^5}{5!}$
$= 0.0067 \times \frac{3125}{120}$
$= \frac{20.9375}{120} = 0.1745$

$\therefore\ P[X = 5] = 0.1745$

(ii) $P[X \geq 2]$:

$P[X \geq 2] = 1 - [P(0) + P(1)] = 1 - [p(0) + p(1)]$
$= 1 - \left[0.0067 \times \frac{5^0}{0!} + 0.0067 \times \frac{5^1}{1!}\right]$
$= 1 - 0.0067\ (1 + 5)$
$= 1 - 0.0067 \times 6$
$= 1 - 0.0402 = 0.9598$

$\therefore\ P[X \geq 2] = 0.9598$

4. Here, $X \sim P(m)$

$\therefore\ p(x) = \frac{e^{-m}m^x}{x!}$

(i) Mean of the distribution :

Given : P[X = 1] = P[X = 2]

$\therefore\ p(1) = p(2)$

$\therefore\ \frac{e^{-m}m^1}{1!} = \frac{e^{-m}m^2}{2!}$

$\therefore\ m = \frac{m^2}{2}$

$\therefore\ 1 = \frac{m}{2}$

$\therefore\ m = 2$

Hence, mean of the distribution is 2.

(ii) P(X = 0) :

$P(x) = \frac{e^{-2}2^x}{x!}, e^{-2} = 0.1353$

$\therefore p(x) = 0.1353 \times \frac{2^x}{x!}$

$\therefore P[X = 0] = p(0) = 0.1353 \times \frac{2^0}{0!}$

$\therefore P[X = 0] = 0.1353$

5. Let X = No. of days it rains in a week

p = Probability that it rains

$= \frac{12}{30} = \frac{2}{5}$

$\therefore \quad q = 1 - p = 1 - \frac{2}{5} = \frac{3}{5}$

Given : n = 7 (No. of days in a week)

$\therefore X \sim B\left(7, \frac{2}{5}\right)$

Hence, $p(x) = {}^nC_x p^x q^{n-x}$

$\therefore p(x) = {}^7C_x \left(\frac{2}{5}\right)^x \left(\frac{3}{5}\right)^{7-x}$

P [It rains on exactly 3 days of the week] i.e. P[X = 3] :

$\therefore P[X = 3] = p(3) = {}^7C_3 \left(\frac{2}{5}\right)^3 \left(\frac{3}{5}\right)^{7-3}$

$= \frac{7 \times 6 \times 5}{3 \times 2 \times 1} \times \frac{8}{125} \times \frac{81}{625}$

$= \frac{35 \times 8 \times 81}{125 \times 625}$

$= \frac{22680}{78125} = 0.290304$

$\therefore P[X = 3] = 0.290304$

Hence, the probability that it rains on exactly 3 days of week is 0.290304.

6. Given, $X \sim B(n, p)$

$\therefore p(x) = {}^nC_x p^x q^{n-x}$

Given : n = 5, p(1) = 0.4096, p(2) = 0.2048, p = ?

Now, $p(x) = {}^5C_x p^x q^{n-x}$

$\therefore p(1) = {}^5C_1 p^1 q^4$

$\therefore p(1) = 5pq^4$

and $p(2) = {}^5C_2 p^2 q^3$

$\therefore p(2) = 10.\ p^2 q^3$

Now, $\frac{P(X=1)}{P(X=2)} = \frac{P(1)}{P(2)} = \frac{5pq^4}{10p^2q^3}$

$\therefore \frac{0.4096}{0.2048} = \frac{q}{2p}$

$\therefore 2 = \frac{q}{2p}$

$\therefore 4p = q$

$\therefore 4p = 1 - p$

$\therefore$ 5p = 1

$\therefore$ p = $\frac{1}{5}$

Hence, the probability of success is $\frac{1}{5}$.

Q.6. Attempt any One : (4 Marks each) **(12)**

1. Given that,

$f(x) = \frac{1}{x^2}, 1 < x > \infty$

= 0, otherwise.

Cdf of a continuous r.v. X is given by

$F(x) = \int_{-\infty}^{x} f(x)\,dx$

Now range of X starts at 1

$$\therefore \quad F(x) = \int_{1}^{x} f(x)\,dx$$

$$= \int_{1}^{x} \frac{1}{x^2}\,dx$$

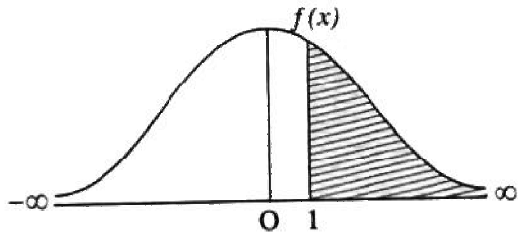
$$= \left[-\frac{1}{x}\right]_1^x$$

$$= -\frac{1}{x} - (-1)$$

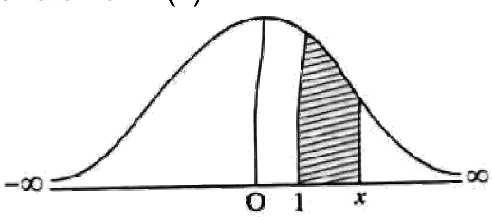
$$= 1 - \frac{1}{x}$$

Hence, cdf of X, F(x) = $1 - \frac{1}{x}$

Sketch of $f(x)$:



Sketch of F (x) :



2. Let X = No. of workers suffering from occupational disease.

p = Probability that worker suffering from the disease

= 25% = $\frac{25}{100} = \frac{1}{4}$

$\therefore$ q = 1 – p = 1 - $\frac{1}{4} = \frac{3}{4}$

Given : n = 6 (No. Of workmen)

$\therefore$ X ~ B $\left(6, \frac{1}{4}\right)$

Now, p(x) = $^nC_x p^x q^{n-x}$

$\therefore$ p(x) = $^6C_x \left(\frac{1}{4}\right)^x \left(\frac{3}{4}\right)^{6-x}$

P [Four or more workmen] i.e. P[X $\geq$ 4] :

$\therefore$ P[X $\geq$ 4] = P(4) + P(5) + P(6)

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

$$= {}^6C_4\left(\frac{1}{4}\right)^4\left(\frac{3}{4}\right)^2 + {}^6C_5\left(\frac{1}{4}\right)^5\left(\frac{3}{4}\right)^1 + {}^6C_6\left(\frac{1}{4}\right)^6\left(\frac{3}{4}\right)^0$$

$$= \frac{6\times5}{2\times1}\times\frac{1}{256}\times\frac{9}{16} + 6\times\frac{1}{1024}\times\frac{3}{4} + 1\text{x}\frac{1}{4096}\text{x}1$$

$$= \frac{15\times9}{4096} + \frac{18}{4096} + \frac{1}{4096}$$

$$= \frac{135+18+1}{4096}$$

$$= \frac{154}{4096} = 0.0376$$

$\therefore$ P[X $\geq$ 4] = 0.0376

Hence, the probability that 4 or more workmen will contact the disease is 0.0376.

3. X = No. of accidents

10 accidents take place in 50 days is given.

$\therefore$ average no. of accidents per day m = $\frac{10}{50}$ = 0.2

$\therefore$ X ~ P(m = 0.2); $e^{-0.2}$ = 0.8187

Hence, p(x) = $\frac{e^{-m}m^x}{x!}$

$\therefore$ $\frac{e^{-0.2}(0.2)^x}{x!} = 0.8187 \times \frac{(0.2)^x}{x!}$

P[X $\geq$ 3] = 1 - P[X = 0] + P(X = 1) + P(X = 2)]

$$= 1 - [p(0) + p(1) + p(2)]$$

$$= 1 - \left[0.8187\times\frac{(0.2)^0}{0!} + 0.8187\times\frac{(0.2)^x}{1!} + 0.8187\times\frac{(0.2)^2}{2!}\right]$$

$$= 1 - \left[0.8187\left(1 + 0.2 + \frac{0.04}{2}\right)\right]$$

$$= 1 - [0.8187(1.2 + 0.02)]$$

$$= 1 - [0.8187 \times 1.22]$$

$$= 1 - 0.9988$$

$$= 0.0012$$

Hence, the probability that there are three or more accidents per day is 0.0012.

❑❑❑