PRACTICAL NO: 1

AIM: Random variable

1.] Find the mean & variance for the foll:-

a.]

x	-1	0	1	2
$p(x)$	0.1	0.2	0.3	0.4

Sol:

X	P(x)	X·P(x)	$E(x)^2$	$[E(x)]^2$
-1	0.1	-0.1	0.1	0.01
0	0.2	0	0	0
1	0.3	0.3	0.3	0.09
2	0.4	0.8	0.16	0.64
TOTAL	$\Sigma=1$	$\Sigma=1$	$\Sigma E(x)^2 = 0.20$	$\Sigma[E(x)]^2 = 0.74$

$\therefore$ Mean $= E(x) = \Sigma xi . P(x) = 1$

$\therefore$ Variance $= V(x) = \Sigma E(x)^2 - \Sigma [E(x)]^2$

$= 2 - 0.74$

$= 1.24$

$\therefore$ Mean $E(x) = 1$ & Variance $V(x) = 1.24$

b)

x	-1	0	1	2
$P(x)$	1/8	1/8	1/4	1/2

Sol:

x	$P(x)$	$xP(x)$	$E(x)^2$	$[E(x)]^2$
-1	1/8	-1/8	1/8	1/64
0	1/8	0	0	0
1	1/4	1/4	1/4	1/16
2	1/2	1	2	1
TOTAL	$\Sigma = 1$	$\Sigma = 9/8$	$\Sigma = 19/8$	$\Sigma = 69/64$

$\therefore$ Mean $= E(x) = \Sigma x.P(x) = 9/8$

$\therefore$ Variance $= V(x) = \Sigma E(x)^2 - \Sigma [E(x)]^2$

$= 19/8 - 69/64$

$= \dfrac{152 - 69}{64}$

$= \dfrac{83}{64}$

$\therefore$ Mean $E(x) = 9/8$ & variance $V(x) = 83/64$.

c]

X	-3	10	15
$P(X)$	0.4	0.35	0.25

Sol:

X	$P(x)$	$X \cdot P(x)$	$E(X)^2$	$[E(X)]^2$
-3	0.4	-1.2	3.6	1.44
10	0.35	3.5	35	12.25
15	0.25	3.75	56.25	14.0625
TOTAL	$\Sigma = 1$	$\Sigma = 6.05$	$\Sigma = 94.85$	$\Sigma = 27.7525$

$\therefore$ Mean $= E(X) = \Sigma X \cdot P(x) = 6.05$

$\therefore$ Variance $= V(X) = \Sigma E(X)^2 - \Sigma [E(X)]^2$

$= 94.85 - 27.7525$

$= 67.0975$

$\therefore$ Mean $E(X) = 6.05$ & Variance $V(X) = 67.0975$

2] If $P(X)$ is pmf of a random variable X. If $P(X)$ represents pmf for random variable X. Find value of K. Then evaluate mean & variance

Sol: As $P(x_i)$ is a pmf it should satisfy the properties of pmf which are

a] $P(x_i) > 0$ for all sample space

b] $\Sigma P(x_i) = 1$

x	-1	0	1	2
p(x)	k+1/13	k/13	1/13	k-4/13

$\Sigma p(x) = 1 = \frac{k+1}{13} + \frac{k}{13} + \frac{1}{13} + \frac{k-4}{13}$

$1 = \frac{k+1+k+1+k-4}{13}$

$13 = 3k - 2$

$15 = 3k$

$\boxed{k = 5}$

x	p(x)	x.p(x)	$E(x)^2$	$[E(x)]^2$
-1	6/13	-6/13	6/13	36/169
0	5/13	0	0	0
1	1/13	1/13	1/13	1/169
2	1/13	2/13	4/13	4/169
Total	$\Sigma = 1$	$\Sigma = -3/13$	$\Sigma = 11/13$	$\Sigma = 41/169$

$\therefore$ Mean $= E(x) = \Sigma x.p(x) = \frac{-3}{13}$

$\therefore$ Variance $= V(x) = \Sigma E(x)^2 - \Sigma [E(x)]^2$

$= \frac{11}{13} - \frac{41}{169}$

$= \frac{143 - 41}{169}$

$= \frac{102}{169}$

$\therefore$ Mean $= -3/13$ & variance $= 102/169$

Q3.] The pmf of random variable X is given by

X	-3	-1	0	1	2	3	5	8
P(X)	0.1	0.2	0.15	0.2	0.1	0.15	0.05	0.05

Obtain cdf find ① $P(-1 \le x \le 2)$
② $P(1 \le x \le 5)$ ③ $P(X \le 2)$ ④ $P(X \ge 0)$

Sol:

X	-3	-1	0	1	2	3	5	8
P(x)	0.1	0.2	0.15	0.2	0.1	0.15	0.05	0.05
F(x)	0.1	0.3	0.45	0.65	0.75	0.90	0.95	1.0

① $P(-1 \le x \le 2) = P(X \le 2) - P(X \le -1) + P(X = -\ )$
$= F(X_b) - F(X_a) + P(a)$
$= F(2) - F(-1) + P(-1)$
$= 0.75 - 0.3 + 0.2$
$= 0.25$

② $P(1 \le x \le 5) = F(X_b) - F(X_a) + P(a)$
$= F(5) - F(1) + P(1)$
$= 0.95 - 0.65 + 0.2$
$= 0.15$

③ $P(X \le 2) = P(X=-3) + P(X=-1) + P(X=0) + P(X=1) + P(X=2)$
$= 0.1 + 0.2 + 0.15 + 0.2 + 0.1$
$= 0.75$

④ $P(X \ge 0) = 1 - F(0) + P(0)$
$= 1 - 0.45 + 0.15$
$= 0.40.$

Let f be continuous random variable with pdf

$\therefore f(x) = \frac{x+1}{2} \quad -1 < x < 1$

$= 0 \quad$ otherwise

Obtain cdf of x

Sol:

By definition of cdf we have

$F(x) = \int_{-1}^{x+1} f\,dt$

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

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

Hence the cdf of is

$F(x) = 0 \quad$ for $x < 0 -1$

$= \frac{1}{4}x^2 + \frac{1}{2}x \quad$ for $-1 \leq x \leq 1$

$= 0 \quad$ for $x \geq 1$

Q5.] Let f be continuous random variable with pdf

$\therefore f(x) = \frac{x+2}{18} \quad -2 \le x \le 4$

$= 0 \quad$ otherwise

calculate cdf

Sol: By definition of cdf we have

$F(x) = \int_{-2}^{4} f dt$

$= \int_{2}^{4} \frac{x+2}{18} dx$

$= \frac{1}{18}\left(\frac{1}{2}x^2 + 2x\right)$

for $-2 \le x \le 4$

Hence cdf is

$F(x) = 0$ for $x < -2$

$= \frac{1}{18}\left(\frac{1}{2}x^2 + 2x\right)$

for $-2 < x \le 4$

$= 0$ for $x \ge 4$

PRACTICAL NO : 2

Aim : Binomial Distribution

1] An unbiased coin is tossed 4 times calculate the probability of obtaining no head, at least one head & more than one tail

NO HEAD:

> dbinom (0,4,0.5)

[1] 0.0625

ATLEAST ONE HEAD:

> 1- dbinom (0,4,0.5)

[1] 0.9375

MORE THAN ONE TAIL:

> pbinom (1,4,0.5, lower.tail = f)

[1] 0.9375

2] The probability that student is accepted to a prestigious college is 03. If 5 students supply, whats the probability of almost 2 are accepted

> pbinom (2,5,0.3)

[1] 0.83692

3] An unbaised coin is tossed 6 times the probablity of head at any toss = 0.3. Let x be no. of heads that comes up. Calculate P(X=2), P(X=3), P(1<x<5)

```
> dbinom (2,6, 0.3)
[1] 0.324135
> dbinom (3,6,0.3)
[1] 0.18522
> dbinom (2,6,0.3) + dbinom (3,6, 0.3) + dbinom (4,6,0.3)
[1] 0.74373
```

4] For n=10, P=0.6 evaluate binomial probablities & plot the graphs of pmf & cdf

```
> x = seq (0,10)
> y = dbinom (x, 10, 0.6)
> y
[1] 0.0001048576   0.0015728640   0.0106168832
    0.0424673280   0.1114767360   0.200658124
    0.2508226560   0.2149908480   0.120932352
    0.0403107840   0.0060466176

> plot (x, y, xlab = "Sequence", ylab = "probablities", "o", pch = 16
```

```
>x = seq(0,10)
>y = pbinomial (x, 10, 0.6)
>plot (x, y, xlab="sequence" ylab =
 "probabilites ", "o", pch=16)
```

04] generate a random sample of size 10 for a B.D → (8, 0.3) find the mean & the variance of the sample

```
> x = rbinom (8, 10, 0.3)
 [1] 2 2 3 4 3 4 2 3
> rbinom (8, 10, 0.3)) summary(x)
[1] 2.375
> var (x)
[1] 3.125
```

5] The probability of mean hitting the target is 1/4 if he shoot 10 times what is the probability that he hear the target exactly 3 times, probability that he hits target atleast one times

```
> dbinom (3, 10, 0.25)
 [1] 0.2502823
> 1- dbinom (1, 10, 0.25)
[1] 0.8122883
```

Q7) Bits are send for communication channel in packet of 12.
the probability of bit being corrupted is 0.1. what is the probability of no more than 2 bits are corrupted in packet?

```
> Pbinom (2, 12, 0.1 , lower.tail = F) + dbinom (2, 12, 0.1)
[1] 0.3409977
```

PRACTICAL NO: 3

Topic : Normal Distribution.

A normal distribution of 100 students with mean = 40, SD = 15
find no of students where marks are
① P(x<30) ② P(40<x<70) ③ P(25<x<35)
④ P(x>60)

```
> Pnorm (30,40,15)
[1] 0.2524925

> Pnorm (70,40,15) - pnorm (40,40,15)
[1] 0.4772499

> Pnorm (35,40,15) - pnorm (25,40,15)
[1] 0.2107861

> 1 - Pnorm (60,40,15)
[1] 0.09121122
```

Q2] If the random variable x follows the normal distribution with mean = 50, v = 100. Find ① P(x ≤ 70) ② P(x > 65) ③ P(X ≤ 32) ④ P(35 < x < 60) ⑤ P(20 < x < 30)

```
> pnorm(70,50,10)
[1] 0.9772499

> 1-pnorm (65,50,10)
[1] 0.0668072

> pnorm (32,50,10)
[1] 0.03593032

> pnorm (60,50,10) - pnorm (20,50,10)
[1] 0.02140023
```

Q3] Let X~N (160,400) find k1 & k2 such that P(X < k1) = 0.6 & P(X > k2) = 0.8

```
> qnorm (0.6 ,160,20)
[1] 165.0669

> qnorm (0.8,160,20)
[1] 176.8324
```

Q3) A random variable x follows normal distribution with $\mu = 10$, $\sigma = 2$. Generate 100 observation & evaluate its mean, median & variance

```
> x = rnorm(100,10,2)
> summary(x)
[1] Min    1st Q    Median   Mean    3rd Q    Max
    5.718  8.414    9.773    9.914   11.325   14.239
> var(x)
[1] 3.648984
```

Q4) Write a command to generate 10 random numbers for normal distribution with $\mu = 50$, $\sigma = 4$. Find the sample mean & median

```
> x = rnorm(10,50,4)
> summary(x)
Min     1st Q    Median   Mean    3rd Q    Max
46.73   50.46    52.01    52.35   54.39    58.85
```

FRO

PRACTICAL NO: 4.

No.

TOPIC : Sample mean & std. deviation given single population

Q1) Suppose the food level on the cookie bag & states that it has almost 2gm of saturated fat in a single cooking. In a sample of 35 cookies, it was found that mean and of saturated fat per cookie is 2.1gm. Assume that the sample std. deviation is 0.3 at 15% level of significance can be rejected the claim on food level.

$\sigma = 0.3$

$n = 35$

$\bar{x} = 2.1$

$\mu = 2$

H_0 (null Hypothesis) = $\mu \leq 2$

H_1 (alt. hypothesis) = $\mu > 2$

$$z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

$$\therefore z = \frac{2.1 - 2}{\frac{0.3}{\sqrt{35}}} = \underline{1.972027}$$

pvalue = 1 − pnorm (z)

= $\underline{0.0243}$

∴ Reject the null hypothesis ∵ pvalue < 0.5

∴ Accepted alternate hypothesis

A sample of 100 customers was randomly selected & was found that average spending was 275/. The SD: 30 048 using 0.05 level of significance, would you conclude that the amt. spent by the customer is more than 250/- whereas the restaurant claims that it is not 250/.

2) $\bar{x} = 275$, $\mu = 250$, $\sigma = 30$, $n = 100$

$H_0 = \mu \leq 250$

$H_1 = \mu > 250$

>> $$z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

$$= \frac{\frac{275 - 250}{30}}{\sqrt{100}} = \underline{8.333}$$

>> pt (z, 99, lower.tail = F)

∴ pvalue = 2.305736e−13

>> Reject the null hypothesis ∵ pvalue < 0.05

∴ Accept the alternate hypothesis ($\mu > 250$)

Q) A quality control engineer find that sample of 100 have average life of 470 hours assuming population sd. test whether the population mean is 480 hours vs population mean < 480 hrs. at los → 0.05

$n = 100$, $\bar{x} = 470$, $\mu < 480$, $\sigma = 25$, $\mu = 480$

>> $$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} = -4$$

Q4) A principal at school claims that the IQ is 100 of the students. A random sample of 30 students whose IQ was found to be 112. The SD of population is 15. Test the claim of principal.

→ METHOD 1: 1 tail test

→ $H_0 : \mu = 100$

$H_1 : \mu - 100$

$\bar{x} = 112, SD = 15, \mu = 100; n = 30$

$$z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

$$= \frac{112 - 100}{\frac{15}{\sqrt{30}}}$$

$z = 4.38178$

pvalue = 6.885678 - 06

→ Reject the null hypothesis = claims of principal [$\mu = 100$]

METHOD 2: 2 TAIL TEST

$H_0 = \mu = 100$

$H_1 = \mu = 100$

→ pvalue = 2 × (1 − pnorm (abs(z))) = 1.177134 8.05

→ Reject the null hypothesis ∵ pvalue < 0.05

★ SINGLE POPULATION PORTION:

Q) It is believed that coin is fair. The coin is tossed 40 times 28 times - head occurs. Indicate whether the coin is fair or not at 95% LOC.

>> $z = \frac{p - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$ p → Probability of sample, p_0 → Probability of population

$p_0 = 0.5$

$q_0 = 1 - p_0 = 0.5$

$p = \frac{28}{40} = 0.7$

$n = 40.$

>>> $z = \frac{0.7 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{40}}}$

$H_0 = \mu = 0.5$

$H_1 = \mu \neq 0.5$

>>> Pvalue = 2 × (1 pnorm (abs (z))

∴ pvalue = 0.01/4 /209

→ Reject the null hypothesis ∵ $p < 0.05$

Accept the alternate hypothesis

* SINGLE POPULATION PORTION :-

Q] It is believed that coin is fair the coin is tossed 40 times 25 times - head occurs. Indicate whether the coin is fair or not at 95% coc-

→ $2 = \dfrac{p - p_0}{\sqrt{\dfrac{p_0 q_0}{n}}}$

$\therefore$ $p_0 = 0.5$

$q_0 = 1 - p_0 = 0.5$

$p = \dfrac{28}{40} = 0.7$

$n = 90$

$\therefore 2 = \dfrac{0.7 - 0.5}{\sqrt{\dfrac{0.5 \times 0.5}{40}}}$

$H_0 = \mu = 0.5$

$H_1 = \mu \neq 0.5$

pvalue = 2x [1-pnorm (abs (2a))

$\therefore$ pvalue = 0.0114209

→ Reject the null hypothesis $\because p < 0.05$

Accept the alternate hypothesis

120

PRACTICAL NO: 5

No.

TITLE : CHISQUARE TEST

Q1] Use the foll. data to test whether the condition of home & child are independent

condition of child	condition of home: clean	clean	dirty
Clean		70	50
fairly clean		80	20
dirty		35	45

H_0 = Both are independent H_1 = Both are dependent

```
> x = c(70, 80, 35)
> y = c(50, 20, 45)
> z = data.frame(x, y)
> z
[1]
   x   y
1  70  50
2  80  20
3  35  45
> chisq.test(z)
Pearsons chi square test data : z
X-squared = 25.846, df = 2, p-value
```

∴ Reject the null hypothesis

∴ Both are dependent

Q2] A dice is tossed 120 times & foll results are obtained

052

No of face	frequency
1	30
2	25
3	18
4	10
5	22
6	15

Test the hypothesis the die is unbiased

∴ H_0 = dice is unbiased

∴ H_1 = dice is biased

```
> obs = c(30, 25, 18, 10, 22, 15)
> exp = sum(obs) / length(obs)
> exp
[1] 20
> z = sum((obs - exp)^2 / exp)
> pchisq(z, df = length(obs) - 1)
[1] 0.956659
```

∴ Accept the null hypothesis

∴ dice is unbiased

(3) An IQ test was conducted & the students were observed before & after training the result are foll.

before	After
110	120
120	110
123	125
132	136
125	121

Test whether there is change in the IQ after the training

S[?]

∴ H_0 - no change in IQ

∴ H_1 = IQ [illegible] (after training)

>a = c(100, [illegible], 105, [illegible], [illegible])

>b = c([illegible], 100, 125, [illegible], 120)

>z = sum(((b - a)^2) [illegible])

>pchisq (z, df = length(b) - 1)

[1] 0.125[illegible]

Accept the Null Hypothesis

∴ There is change in IQ after training

Q4]

	Graduate	Undergraduate
Online free	20	25
Offline free	40	5

Is there any association between student preferred for type of education & method

∴ H_0 - Independent

H_1 : Dependent

>x = c(20, 40, 25, 5)

>z = matrix (x, nrow = 2)

> chisq.test (z)

Pearson's chi-squared test with continuity correction

data : z

X - squared = 12.03, df = 1, p value = 2.27[illegible]

∴ Reject null hypothesis

∴ Both are dependent

Q5] A dice is tossed 180 times

No of turns	frequency
1	20
2	30
3	35
4	40
5	12
6	43

Test the hypothesis that dice is unbiased

H_0 :- dice is biased

H_1 = dice is unbiased

>x = c(20, 30, 35, 40, 12, 43)

> chisq.test (x)

Chi squared test for given probabilities

data : x

X - squared = 23.433, df = 5, p value = 0.0[illegible]

∴ Reject null hypothesis

∴ dice is unbiased

hypothesis true mean is greater than 3400
3367.37 and
Sample estimate :
Mean of x :
3373.95
∴ Accept H_1

③ H_0: $\mu = 3400$
H_1: $\mu < 3400$

> t.test (x, mu = 3400, alter = "less", conf.level = 0.95)
One sided t-test

data = x

t = -4.4865, df = 19, P-value = 0.0001264;

alternative hypothesis true mean is less than 3400
95 percent level of confidence

- Inf 3383.99

Sample estimate

∴ mean of x 3323.95

∴ Reject H_0. Accept H_1

> t.test (x, mu = 3400, alter = "less", conf.level = 0.99)

One sample test

data = x

t = -4.4865, df = R, P-value = 0.001264

alternative hypothesis : true mean is less than 3400
99 Percent level of confidence

- Inf 3385.563

Sample estimate

Mean of x
3373.95

∴ Reject H_0, Accept H_1.

Q] Below are the data of gain in weight of 2 diff diets A & B

Diet A : 25, 32, 30, 43, 24, 14, 32, 24, 31, 31, 35, 25.
Diet B : 44, 34, 22, 10, 47, 31, 40, 30, 32, 35, 18, 21

∴ $H_0 = a - b = 0$
$H_1 = a - b = 0$
$H_1 = a - b \neq 0$

> a = c (25, 32, 30, 43, 24, 14, 32, 24, 31, 31, 18, 21)
> a = c (44, 34, 22, 10, 47, 31, 40, 30, 34, 35, 18, 21)
t.test (a, b, Paired = T, alter = "two sided", conf.level 0.95)

Pair t-test
data a = a and b
t = -1.4832, df = 10, P-value : 0.0841
alternative hypothesis true diff in means is less than 0.99, percent confidence interval
: Df 0.363333

Sample estimate
mean of the diff

∴ Accept H_0, Reject the

Q] $H_0 : d_1 = d_2$

$H_1 : d_1 \neq d_2$

>d_1 = c(0.7, -1.00, 1 - 0.2, -1.2, - 0.1, 3.4, 3.7, 0.6, 2.87

>d_2 = c(7.0, 0.8, 1.1, 0.1, - 0.1, 4.4, 5.5, 1.6, 4.6, 3.4)

>t.test (d1, d2, alter= "two sided", conf level. Paired t-t

data: d1 add.

t = -4.0621, df, 9. p-value = 0.002833

alternative hypothesis : true diff in means

is not Equal to 0

95 percent conf. interval

Mean of the difference -1.58

∴ Reject H_0

Accept H_1