SREE VENKATESWARA COLLEGE OF ENGINEERING

II B.TECH – II Semester (2017-18)

SUBJECT: **PROBABILITY & STATISTICS** BRANCH:MECH,CIVIL,CSE

UNIT – I

1. State additive law of probability.

Ans: If A and B are any two events (subsets of a sample space) and are not mutually exclusive, then we have

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

2. From a box containing 10 balls, the number of ways in which 3 balls can be drawn at Random is________ **[Dec2014]**

Ans: Total number of balls = 10.

Then $n(s)$ = Number of ways in which 3 balls can be drawn at Random $= 10c_3$.

3. Define: (i) Independent event. (ii) Conditional probability. **[JUNE 2017]**

Ans: (i) If the occurrence of the event E_2 is not affected by the occurrence or non-occurrence of the event E_1, then the event E_2 is said to be independent of E_1 and

$P\left(\frac{E_2}{E_1}\right)=P(E_2)$.

(ii) If E_1, E_2 are events of a sample space S and if E_2 occurs after the occurrence of E_1, then the event of occurrence of E_2 after the event E_1 is called conditional event of E_2 given E_1. It is denoted by $\frac{E_2}{E_1}$.

4. If $P(A)=\frac{7}{3}$, $P(B)=\frac{9}{13}$ and $P(A\cap B)=\frac{4}{13}$ find $P(\frac{A}{B})$ **[May 2015]**

Ans: Given that

$P(A)=\frac{7}{3}$, $P(B)=\frac{9}{13}$ and $P(A\cap B)=\frac{4}{13}$

$$P(\frac{A}{B})=\frac{P(A\cap B)}{P(B)}=\frac{4/13}{9/13}=\frac{4}{9}.$$

5. The chances of three students A, B and C solving a problem given in mathematics Olympiad are $\frac{1}{2},\frac{1}{3}$ and $\frac{1}{4}$ respectively. What is the probability of the problem being solved? [May 2015]

Ans: Given that

the chances of three students A, B and C solving a problem given in mathematics Olympiad are

$P(A)=\frac{1}{2}, P(B)=\frac{1}{3}, P(C)=\frac{1}{4}$

The probability that the problem is not solved by A,B,C are

$P(\bar{A})=\frac{1}{2}, P(\bar{B})=\frac{2}{3}, P(\bar{C})=\frac{3}{4}$

The probability that the problem is not solved when A,B,C try together (independently)

$= P(\bar{A}\cap\bar{B}\cap\bar{C}) = P(\bar{A})P(\bar{B})P(\bar{C}) = \frac{1}{2}\cdot\frac{2}{3}\cdot\frac{3}{4}=\frac{1}{4}$

∴ The probability that the problem is solved = $1-\frac{1}{4}=\frac{3}{4}$

6. If $P(A)=\frac{1}{3}$, $P(B)=\frac{1}{4}$ and $P(A\cup B)=\frac{1}{2}$ find $P(\frac{B}{A})$ [Dec 2004]

Ans: Given that

$$P(A)=\frac{1}{3},\ P(B)=\frac{1}{4} \text{ and } P(A\cup B)=\frac{1}{2}$$

Now

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

$$=\frac{1}{3}+\frac{1}{4}-\frac{1}{2}$$

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

7. Determine the probability for the event when a non-defective bolt will be found if out of 600 bolts already examined 12 were defective.

Ans: The probability of defective bolt, $P(D)=\frac{12}{600}=\frac{1}{50}$. Therefore,

Probability (finding a non-defective bolt) = $P(\overline{D})=1-P(D)=1-\frac{1}{50}=\frac{49}{50}$

8. Find the probability of getting a sum of 10 if we throw two dice. [JNTU 2007(Set 1)]

Ans: When two dice are thrown, number of possible outcomes = $n(S)=6^2=36$

Let E be the event of getting the sum AS 10.

Favorable outcomes are (4,6),(5,5),(6,4) i.e., $n(E)=3$

Thus $P(E)=\frac{3}{36}=\frac{1}{12}$.

9. The probabilities that X and Y would be alive 10 years from now are 0.5 and 0.8 respectively. What is the probability that both of them will be alive 10 years from now?

Ans: In this problem, it is assumed that the living of X will not influence the living of Y, and hence they are independent. Therefore, we have

P(X and Y will be alive) = P(X will be alive) P(Y will be alive) = (0.5)(0.8) = 0.4

10. Let X denote the number of heads in a single toss of 4 fair coins. Determine P(X<2) [2006]

Ans: The required probability distribution is

X	0	1	2	3	4
P(X)	$\frac{1}{16}$	$\frac{4}{16}$	$\frac{6}{16}$	$\frac{4}{16}$	$\frac{1}{16}$

$$P(X<2)=P(X=0)+P(X=1)=\frac{1}{16}+\frac{4}{16}=\frac{5}{16}$$

11. Let X denote the number of heads in a single toss of 4 fair coins. Determine $P(1<X\le 3)$ [2006]

Ans: The required probability distribution is

X	0	1	2	3	4
P(X)	$\frac{1}{16}$	$\frac{4}{16}$	$\frac{6}{16}$	$\frac{4}{16}$	$\frac{1}{16}$

$$P(1<X\le 3)=P(X=2)+P(X=3)=\frac{6}{16}+\frac{4}{16}=\frac{10}{16}=\frac{5}{8}$$

12. Give any two examples of Binomial distribution.

Ans: (a) The number of defective bolts in a box containing 'n' bolts.

(b) The number of machines lying idle in a factory having 'n' machines.

13. Write mean and variance of the binomial distribution.

Ans: In binomial distribution,

Mean = np

Variance = npq

14. Comment on the following: The mean of a binomial distribution is 3 and variance is 4.

Ans: Given that mean = np=3

and variance npq=4

Consider $\frac{npq}{np} = \frac{4}{3}$ or

$q=1.33>1$

Which is not possible. Hence, there cannot be a binomial distribution with mean 3 and variance 4.

15. Determine the binomial distribution for which mean is 4 and variance is 3.

Ans: Given that mean = np=4

and variance npq=3

Consider $\frac{npq}{np} = \frac{3}{4}$ or

$q= \frac{3}{4}$

$p = 1-q$

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

np = 4 or n = 16

Therefore, the given binomial distribution has parameter n = 16 and $p = \frac{1}{4}$. That is, the random variable X ~ B(16, ¼). Then

$P(X=x) = 16C_x(\frac{1}{4})^x (\frac{3}{4})^{16-x}$, x = 0,1,2,3,.........., 16

16. The mean of a binomial distribution is 18 and the variance is 6, then the number of trials conducted is :________

Ans: Given that mean = np=18

and variance npq=6

Consider $\frac{npq}{np} = \frac{6}{18}$

$\therefore$ n=27

17. Give any two examples of Poisson distribution.

Ans: (a) The number of defective bulbs manufactured by a reputed company.

(b) The number of telephone calls per minute at a switch board.

18. Write mean, variance and mode of the Poisson distribution.

Ans: In Poisson Distribution,

Mean = λ

Variance = λ

Mode of the Poisson Distribution lies between λ-1 and λ.

19. Write mean, variance, mode and median of the normal distribution.

Ans: mean, μ = b

Variance = σ^2

Mode x = μ

Median μ = M.

20. Write any two characteristics of the normal distribution.

Ans: (a) The graph of the normal distribution y = f(x) in the xy-plane is known as the normal curve.

(b) The curve is bell shaped and symmetrical about the line x = μ and the two tails on the right and the left sides of the mean (μ) extends to infinity.

UNIT – II

1. Write about, (i) Null hypothesis (ii) Alternative hypothesis.

Ans: (i) Null hypothesis :-

The null hypothesis is generally assumed to be true until evidence indicates otherwise.

In statistics, it is often denoted H_0 (read "H-naught", "H-null", or "H-zero").

(ii) Alternative hypothesis:-

In statistical hypothesis testing, the alternative hypothesis (or maintained hypothesis or research hypothesis) and the null hypothesis are the two rival hypotheses which are compared by a statistical hypothesis test.

2. Write a short note on Type I and Type II errors.

Ans: Type 1 and type II errors are mistakes in testing a hypothesis. A type I error occurs when the results of research show that a difference exists but in truth there is no difference; so, the null hypothesis H_0 is wrongly rejected when it is true. A type II error occurs when the null hypothesis is accepted, but the alternative is true; that is, the null hypothesis, is not rejected when it is false. Type II errors frequently arise when sample sizes are too small. The probability of a type I error is designated by the Greek letter alpha (α) and the probability of a type II error is designated by the Greek letter beta (β).

		Truth	
	Hypothesis Testing	The Null Hypothesis Is True	The Alternative Hypothesis Is True
Research	The Null Hypothesis Is True	Accurate	Type II Error
Research	The Alternative Hypothesis Is True	Type I Error	Accurate

3. Write a short note on critical region.

Ans: The region of rejecting H_0 then H_0 is true if the sample point falls with in the region is called critical region. The total sample space S can be split into two complementary subsets w and $\bar{w}$.

If the sample point falls in w, H_0 is rejected otherwise H_0 is accepted.

4. What is meant by level of significance?

Ans: The level of significance refers to the probability of containing a statistic random value 't' in the critical region. (OR) The level of significance also refers to the size of type I error. The most commonly used levels of significance during the testing of hypothesis are 1% and 5%. Before gathering the information about the samples, the level of significance must be set up.

5. Write about one-tailed and two-tailed tests.

Ans: One-tailed test:-

In a statistical hypothesis test, if an alternative hypothesis is denoted by '>' (right-tailed) or '<'(left-tailed) symbol then this hypothesis test is referred to as a one-tailed test.

For example,

$H_1: \mu > \mu_0$ refers to the right-tailed test and

$H_2: \mu < \mu_0$ refers to the left -tailed test

Two-tailed test:-

In a statistical hypothesis test, if an alternative hypothesis is represented by a 'not equal to (≠)' symbol then this test is referred o as a two-tailed test because the critical region (which is divided into two parts) is placed in both (right-tailed and left-tailed) the tails of distribution.

6. Explain the procedure generally followed in testing of hypothesis.

Ans: (i) Select an appropriate sample size and identify the parameters.

(ii) Set up the null hypothesis.

(iii) Set up the alternative hypothesis. It enables us to decide whether we use one-tailed (or) two-tailed test.

(iv) Compute the test statistic $z = \frac{t - E(t)}{S.E(t)}$

(v) Calculate |z| value

(vi) Specify the level of significance 'α' and identify the critical value of z.

(vii) |z| is considered as z calculated value and compare with critical value of 'z'.

If $z_{cal} > z_{cri}$, we reject H_0.

If $z_{cal} < z_{cri}$, we accept H_0.

7. In a random sample of 160 workers exposed to a certain amount of radiation, 24 experienced some ill effects. Construct a 99% confidence interval for the corresponding true percentage.

Ans: We have,

x=24, n= 160 and

$p = \frac{x}{n} = \frac{24}{160} = 0.15$

q= 1-p=1-0.15=0.85

confidence interval at 99% level of significance is,

$(p - 3\sqrt{\frac{pq}{n}}, p + 3\sqrt{\frac{pq}{n}}) = (0.065, 0.234)$

8. If 80 patients are treated with an antibiotic 59 got cured. Find a 99% confidence limits to the true population of cure. **[DEC 2017 S]**

Ans: We have,

x=59, n= 80 and

$p = \frac{x}{n} = \frac{59}{80} = 0.7375$

q= 1-p=1-0.7375=0.2625

confidence interval at 99% level of significance is,

$(p - 3\sqrt{\frac{pq}{n}}, p + 3\sqrt{\frac{pq}{n}}) = (0.59, 0.88)$

9. If sample size n=144, standard deviation σ = 4 and the mean = 150, then 95% confidence interval for μ **[Dec2014]**

Ans: Given

Sample size, n=144

σ = 4

Sample mean, $\bar{x} = 150$

and α = 0.05

$z_\alpha = 1.96$ (for 95%)

95% confidence interval for μ is, $[\bar{x} \pm 1.96 \frac{\sigma}{\sqrt{n}}]$

10. A sample of size 10 and standard deviation 0.03 is taken from a population. Find the maximum error with 99% confidence. **[May 2015]**

Ans: Given

Sample size, n=10

S = 0.03

α = 0.01

$\therefore\ t_{\frac{\alpha}{2}} = 3.250$(for 99%)

Maximum error, $E = t_{\frac{\alpha}{2}} \cdot \frac{S}{\sqrt{n}}$

11. Define two sample mean Z −test statistics **[May 2015]**

Ans:. two sample mean t −test statistics

$$Z = \frac{|x - y|}{\sqrt{\frac{\sigma1^2}{n1} + \frac{\sigma2^2}{n2}}}$$

12. It is claimed that a random sample of 49 tyros has a mean life of 15200 Km. this sample was drawn from a population whose mean is 15150 kms and a standard deviation of 1200 Km. Test the significance at 0.05 level.

Ans: Given n=49, $\bar{x}$ = 15200, μ = 15150 and σ = 1200

Null hypothesis H_0: μ =15150

Alternative hypothesis H_1: μ ≠ 15150

Level of significance, α = 0.05

$z_{\frac{\alpha}{2}} = |Z_{tab}| = 1.96$

under H_0,

The test statistic is, $z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = 0.2917$

Since $|Z_{cal}| < |Z_{tab}|$, we accept the null hypothesis.

13. Write any two properties of normal distribution.

Ans: (i) The shape of the normal distribution is **bell −shaped**and is symmetrical about the mean.

(ii) this distribution mean ,mode median are equal

14. Write any two properties of normal distribution.

Ans: (i) normal distribution odd moments zero and even moments are exits

(ii) normal is a asymptotes cure

15. Write any two properties of normal distribution.

Ans:- (i) normal distribution skewness zero kurtosis is 3

(ii) point of inflexions are $\mu \pm \sigma$

16. Suppose that we observe a random sample of size *n* from a normally distributed population. If we are able to reject $H_0: \mu = \mu_0$ in favor of $H_a: \mu \neq \mu_0$ at the 5% significance level, is it true that we can definitely reject H_0 in favor of the appropriate one-tailed alternative at the 2.5% significance level? Why or why not?

Ans: This is not true for certain. Suppose $\mu_0 = 50$ and the sample mean we observe

is
$\bar{x} = 55$. If the alternative for the one-tailed test is $H_a: \mu < 50$, then we obviously can't reject the null because the observed sample mean $\bar{x}$ is in the wrong direction. But if the alternative is $H_1: \mu > 50$, we *can* reject the null at the 2.5% level. The reason is that we know the *p*-value for the two-tailed test was less than 0.05. The *p*-value for a one- tailed test is half of this, or less than 0.025, which implies rejection at the 2.5% level.

QUESTIONS 17 THROUGH 20 ARE BASED ON THE FOLLOWING INFORMATION:

BatCo (The Battery Company) produces your typical consumer battery. The company claims that their batteries last at least 100 hours, on average. Your experience with the BatCo battery has been somewhat different, so you decide to conduct a test to see if the companies claim is true. You believe that the mean life is actually less than the 100 hours BatCo claims. You decide to collect data on the average battery life (in hours) of a random sample and the information related to the hypothesis test is presented below.

Test of $\mu \geq 100$ versus one-tailed alternative

Hypothesized mean	100.0
Sample mean	98.5
Std error of mean	0.777
Degrees of freedom	19
t-test statistic	-1.932
p-value	0.034

17. Can the sample size be determined from the information above? Yes or no? If yes, what is the sample size in this case?
Ans: Yes. 19 + 1 = 20.
18. You believe that the mean life is actually less than 100 hours, should you conduct a one-tailed or a two-tailed hypothesis test? Explain your answer.
Ans: One-tailed test. You are interested in the mean being less than 100.
19.What is the sample mean of this data? If you use a 5% significance level, would you conclude that the mean life of the batteries is typically more than 100 hours? Explain your answer.
Ans: 98.5 hours. No. You would reject the null hypothesis in favor of the alternative, which is less than 100 hours (0.034 < 0.05).
20.If you were to use a 1% significance level in this case, would you conclude that the mean life of the batteries is typically more than 100 hours? Explain your answer.
Ans: Yes. You cannot reject the null hypothesis at a 1% level of significance (0.034 > 0.01).

UNIT – III

1.write text procedure of small samples test.
Ans. set up null hypothesis ,alternative hypothesis
Select the Appropriate test statistics

Compute test statistics and compare with table values and draw conclusions.

2.Write assumptions of small samples test

Ans. Small size n<30

A small is drawn from normal population at random manner

3.write properties three of F-distribution

Ans. i) F-distribution is free from population parameters and depends upon degrees of freedom only.

ii) F- Distribution curve lies entirely in first quadrant

iii) $F_{1-\alpha} = \frac{1}{F_{\alpha}(V, V)}$

4. Test procedure of paired t test statistics in small samples test.

Ans. i set up null hypothesis,

ii appropriate test statistics

iii $t = \frac{|d|}{\frac{S_d}{\sqrt{n}}}$

Compute above statistics and draw the conclusions

5. Write confidence limits for means

Ans The confidence interval to means is given by

$$\left((x - y) - t_{\alpha} \sqrt{\frac{s1^2}{n1} + \frac{s2^2}{n2}} ; (x - y) + t_{\alpha} \sqrt{\frac{s1^2}{n1} + \frac{s2^2}{n2}} \right)$$

6. Define degree of freedom

Ans a statistics which can make free number of sample observations is called degrees of freedom .this is denoted by υ

7. Explain any three properties of t –distribution

Ans The shape of t-distribution is bell –shaped which is similar to that of a normal distribution and is symmetrical about the mean.

The t- distribution curve is also asymptotic to the t- axis , i.e the two tails of the curve on both sides of t=0 extends to infinity.

It is symmetrical about the line t=0

8. Explain any three properties of F –distribution

Ans i F-distribution is free from population parameters and depends upon degrees of freedom only.

ii F- Distribution curve lies entirely in first quadrant

iii $F_{1-\alpha} = \frac{1}{F_{\alpha}(V, V)}$

9. Explain any three properties of χ^2 –distribution

Ans i x^2- distribution curve is not symmetrical , lies entirely in the first quadrant, and hence not a normal curve , since x^2 varies from o to ∞

ii it depends only on the degrees of freedom υ

iii mean $=\upsilon$, variance $=2\upsilon$

10.one sample mean t –test statistics

Ans:- one sample mean t –test statistics given by $t = \frac{|x - \mu|}{\sqrt{\sigma}/n}$

11. Define two sample mean t –test statistics

Ans:- $t = \frac{|x - y|}{\sqrt{\frac{s1^2}{n1} + \frac{s2^2}{n2}}}$

12. Define confidence interval mean

Ans:- the confidence interval mean given by $(\bar{x} - t_\alpha \sqrt{\frac{S}{n}}; \bar{x} - t_\alpha \sqrt{\frac{S}{n}})$

13. Discuss paired t- test.

Ans:-:- $t = \frac{|\bar{d}|}{\frac{S_d}{\sqrt{n}}}$

14. Discuss confidence interval paired t- test

Ans: confidence interval paired t- test $(\bar{d} - t_\alpha \sqrt{\frac{s}{n}}.; \bar{d} + t_\alpha \sqrt{\frac{s}{n}}.;)$

15. Define the F-statistics

Ans F- test statistics to compare the two variance

$$F = \frac{S1^2}{S2^2}$$

16. Define χ^2 **test statistics for variance**

Ans. χ^2**test statistics**$\chi^2 = \frac{(n-1)S^2}{\sigma^2}$

17. write χ^2 test statistics for attribute

Ans. $\chi^2 = \Sigma \frac{(O_{ij} - E_{ij})2}{E_{ij}}$

18. Give contingency table for two attributes A and B write the expected frequencies. [May 2015]

Ans:

A	a	b
B	c	d

a	b	a+b
c	d	c+d
a+c	b+d	N= a+b+c+d

The expected frequencies are given by

$E(a) = \frac{(a+c)(a+b)}{N}$	$E(b) = \frac{(b+d)(a+b)}{N}$	a+b
$E(c) = \frac{(a+c)(c+d)}{N}$	$E(d) = \frac{(b+d)(c+d)}{N}$	c+d
a+c	b+d	N= a+b+c+d

19. Define the χ^2 test statistics for goodness of fit.

Ans. $\chi^2 = \Sigma \frac{(O_i - E_i)2 \quad (O_i - E_i)^2}{E_i}$

20. When we apply F-test of significance? **[DEC 2017 S]**

Ans: Test for equality of two population variances.

UNIT – IV

1. Define S.Q.C. **[Dec 2014]**

Ans:- SQC means planned collection and effective use of data for studying causes of variations in quality either as between processes, procedures, materials, machines, etc., or over periods of time.

2. Discuss about the importance of S.Q.C. in industry?

Ans:- SQC proves better quality assurance at lower inspection cost. Quality control find its applications not only in the sphere of production, but also in other areas like

packaging, scrap and spoilage, recoveries, advertising, etc.

3. List the advantages of S.Q.C.

Ans:- (i) The act of getting a process in statistical control involves the identification and elimination of assignable causes of variation and possibly the inclusion of good ones viz., new material or methods.

(ii) SQC proves better quality assurance at lower inspection cost.

(iii) Quality control find its applications not only in the sphere of production, but also in other areas like packaging, scrap and spoilage, recoveries, advertising, etc.

4. What is control chart?

Ans:- Control charts, also known as Shewhart charts (after Walter A. Shewhart) or process-behavior charts, in statistical process control are tools used to determine if a manufacturing or business process is in a state of statistical control.

5. Write a short note on control charts for measurements.

Ans:- These charts may be applied to any quality characteristic that is measurable. In order to control a measurable characteristic we have to exercise control on the measure of location as well as the measure of dispersion. Usually $\bar{x}$ and R charts are employed to control the mean(location)and standard deviation (dispersion) respectively of the characteristic. **[DEC 2017 S]**

6. Explain control charts for attributes.

Ans:- These charts are used to monitor characteristics that have discrete values and can be counted.

Eg: (i) defective number of flows in a shirt.

(ii) Number of broken eggs in a box.

7. What are 3-σ control limits?

Ans:- 3-σ limits were proposed by Dr. Shewart for his control charts from various considerations, the main being probabilistic considerations. Consider the statistic $t = t(x_1, x_2, x_3, \ldots x_n)$, a function of the sample observations $x_1, x_2, x_3, \ldots x_n$.

A statistical calculation that refers to data within three standard deviations from a mean. Three-sigma limits (3-sigma limits) are used to set the upper and lower control limits in statistical quality control charts. Control charts are used to establish limits for a manufacturing or business process that is in a stateof statistical control.

8. What are shewhart control charts? **[Dec 2014]**

Ans:- Control charts, also known as Shewhart charts (after Walter A. Shewhart) or process-behavior charts, in statistical process control are tools used to determine if a manufacturing or business process is in a state of statistical control.

9. Explain the three categories of statistical quality control (SQC). How are they different, what different information do they provide, and how can they be used together?

Ans:- The three categories of SQC are traditional statistical tools, acceptance sampling and statistical process control (SPC). Traditional statistical tools are descriptive statistics, such as the mean and range, used to describe quality characteristics. Acceptance sampling is a process of taking a random sample or portion of a batch and deciding whether to accept or reject the whole batch or lot. SPC is a process that uses samples to determine whether a process is functioning normally or not. Traditional statistical tools describe the quality characteristics, but do not tell us whether quality is good or bad. Acceptance sampling tells us whether an entire batch or lot produced should be accepted or rejected after the goods have been produced, while SPC tracks the process over time to ensure it is functioning properly. These tools can be used together effectively. We use the traditional statistical tools as inputs into SPC, which is updated frequently enough to ensure that quality problems are caught in a timely manner. Finally, after a batch has been produced, we use acceptance sampling to determine whether or not the batch can be sold to the customer.

10. Discuss the key differences between common and assignable causes of

variation. Give examples.

Ans:- Common causes of variation are random, which means that there is not a specific reason for the variation, such as a malfunctioning machine. If you look at 2-liter bottles of a soft drink on a shelf at a retailer, you will notice that they are not filled to the exact same level. That is to be expected, since a machine cannot fill each one to exactly 2 liters every time. Assignable causes of variation are not random. Some examples of assignable causes are a machine in need of repair and defective raw materials from our supplier.

11. Explain the use of p-charts and c-charts. When would you use one rather than the other? Give examples of measurements for both p-charts and c-charts.

Ans:- The p-charts and c-charts are both used when the data is an attribute. Data is an attribute when we ask a yes or no question or count the number of defects. For example, is the bottle of Coca-Cola full or not? How many of the Hershey's kisses in the bag are not covered in foil? The p-chart is used to determine whether the proportion of defective units in a sample is in control or not. The c-chart is used to determine whether the number of defects on each item is in control or not. The key difference is that the sample size for the c-chart is always one. In other words, each plot represents the number of defects on one item, such as the number of spelling errors in a report.

12. What are causes of variations?
[May2015]

Ans:- The variation of a quality characteristic can be divided into two categories:
(i) Chance variation (ii) Assignable variation.

13. Explain the $\overline{x}$ - chart.

Ans:- The $\overline{x}$ –chart is used to show the quality averages of the periodic samples from a given process.

The contol limits are set as:

$$UCL = \overline{\overline{x}} + 3\frac{\sigma}{\sqrt{n}}$$

$$LCL = \overline{\overline{x}} - 3\frac{\sigma}{\sqrt{n}}$$

14. What are the 3σ control limits for $\overline{x}$ - chart? **[May2015]**

Ans:- $UCL = \overline{\overline{x}} + 3\frac{\sigma}{\sqrt{n}}$

$$LCL = \overline{\overline{x}} - 3\frac{\sigma}{\sqrt{n}}$$

15. What are the 3σ control limits for R-chart?

Ans:- $UCL = \overline{R} + 3\,\sigma_R$

$$LCL = \overline{R} - 3\,\sigma_R$$

16. What are the 3σ control limits forC-chart.

Ans:- $UCL = \overline{c} + 3\sqrt{\overline{c}}$

$$LCL = \overline{c} - 3\sqrt{\overline{c}}$$

17. Explain the C-chart.

Ans:- This chart is used for discrete defects when there can be more than one defect per unit. i.e., to monitor the actual number of defects in a sample.

The 3σ control limits for C-chart.

$$UCL = \overline{c} + 3\sqrt{\overline{c}}$$

$$LCL = \overline{c} - 3\sqrt{\overline{c}}$$

18. Define chance cause, assignable cause.
[JUNE 2017]

Ans:- Chance cause:- This variation results from many minor causes of random nature which cannot be completely eliminated and indeed, it is inevitable in manufacturing.

Assignable cause:- These variation, due to non-random causes, can be the results of several factors such as a chance in the raw material, a new operation, improper machine setting, broken or worn parts, poorly trained operators and the like.

19. What is p- chart.

Ans:- The p-chart is designed to control the percentage (or) proportion of defectives per sample. i.e., the number of defectives can be converted into a percentage expressed as a decimal fraction.

20. What is np- chart.

Ans:- Instead of plotting the fraction defective in a sample of size n, the number of defectives can be plotted directly. Such a chart is called control chart for number of defectives (or) np-chart.

UNIT – V

1. Define customers and servers in queuing theory.

Ans:-

Customers:-

Customersfrom a population or source entering a queuing system to receive some type of service.

Servers:-

A server is an entity capable of performing the required service for a customer. In case if all the available servers or service centers are busy when a customer enters the queuing system, the customer must join the queue until a server is free.

2. Write any two applications ofqueuing theory.

Ans: (i) In cinema theatres, people form a queue and wait to get their tickets.

(ii) In hair saloon, people form a queue and wait to get their hair cut.

3. If the service rate is 2 sets/hour and arrival rate is 5/4 sets/hour, then find the traffic intensity?

Ans:- Given that,

service rate, μ = 2 sets/hour

arrival rate, λ = 5/4 sets/hour

$$\therefore \text{traffic intensity}, \rho = \frac{\lambda}{\mu} = \frac{5}{4}\cdot\frac{1}{2} = \frac{5}{8}$$

4. If the average service rate is 1 customer/minute and average arrival rate is 8/10 customers/minute, then find the traffic intensity?

Ans:- Given that,

Average service rate, μ = 1 customer/minute

Average arrival rate, λ = 8/10 customers/minute

$$\therefore \text{traffic intensity}, \rho = \frac{\lambda}{\mu} = \frac{8}{10}\cdot\frac{1}{1} = \frac{4}{5}$$

5. Explain Kendal's notation for representing queuing model [Dec 2014, May2015]

Ans:- The queuing systems are classified by using the standard notations (A/B/C) : (D/E)

Where,

A- Specifies the probability distribution of arrival process

B- Specifies the probability distribution of service process

C- Specifies the number of channels

D- Capacity of the queue

E- Specifies the maximum number of customers in the total.

6. Define a queue.

Ans:- Queuing is an activity in which every individual may experience in their daily lives.

7. What are the characteristics of a Queuing System.

Ans:- (i) Expected number of customers in the system denoted by E(n) is the average number of

Customers in the system, both waiting and in service. Here, n stands for the number of customers in the queuing system.
(ii) Expected number of customers in the queue denoted by E(m) is the average number of customers Waitingin the queue. Here m = n − 1. i.e., excluding the customer being served.

8. Write a short note on (M/M/1) : (∞ / FIFO) Model.

Ans:- On (M/M/1) : (∞ / FIFO) Model, the first M denotes that the arrivals are Poisson. The second M denotes that the departures are Poisson. '1' denotes that there is a single service channel attending to the service of the customers. '∞' Denotes that the arrivals are from an Infinite population and there is no limit or upper bound for the number of people that are admitted into the system. FIFO describes the queue discipline. It indicates that the queue discipline is ".First In, First Out ".

9. Write a short note on (M/M/1) : (N / FCFS) Model.

Ans:- On (M/M/1) : (N / FCFS) Model, the first M denotes that the arrivals are Poisson. The second M denotes that the departures are Poisson. '1' denotes that there is a single service channel attending to the service of the customers. Let the maximum capacity in the system be N. FCFS describes the queue discipline. It indicates that the queuediscipline is " First Come, First Served ".

10. Write the formula for traffic intensity.

Ans:- We have

$$\text{traffic intensity}, \rho = \frac{\lambda}{\mu}$$

where μ is a service rate and λ is a arrival rate.

11. Define the following terms ,(i) pure birth process (ii) pure death process (iii) pure birth and death process.

Ans:- <u>(i) pure birth process</u>:- A queuing system which keeps the track of only arrivals of the customers and not their departures is known as pure birth process or pure birth model.

<u>(ii) pure death process</u> :-A queuing system which only records departures of the customers once after they are served is known as pure death process.

<u>(iii) pure birth and death process</u>:- The queuing system which comprises of both arrivals and departures is known as pure birth and death process.

12. Discuss queuing theory.

Ans:- A mathematical study of waiting in lines (i.e., queues) is called queuing theory. Queuing is an activity in which every individual may experience in their daily lives.

13. Write a short note on queue discipline in queuing system.

Ans:- It is a rule according to which customers are selected for service when a queue has been formed. The most common queue discipline is the " First Come, First Served "(FCFS), or the " First In, First Out "(FIFO) rule under which the customers are serviced in the strict order of their arrivals. Other queue discipline include: " Last In, First Out "(LIFO) rule according to which the last arrival in the system is serviced first.

14. Write a short note on service mechanism in queuing system.

Ans:- The service mechanism is concerned with service time and service facilities. The service system in this case is termed as bulk service system.

Service facilities can be of the following types:

(i) Single queue – one server

(ii) Single queue – several servers

(iii) Several queues – one server

(iv) Several servers

15. What is queuing problem?

Ans:- In a typical queuing problem we study the following:

(i) From time to time the number of customers in a queue varies.

(ii) It is also of interest to estimate on average, how much time a new customer entering the system will spend in the system including the time of waiting plus the service time. We shall try to estimate also the time spent in the queue before the customer reaches the service counter.

16. Write any two characteristics of (M/M/1) : (∞ / FIFO) Model.

Ans:- (i) Average number of customers in the system $= E(n) = L_s = \frac{\rho}{1-\rho} = \frac{\lambda}{\mu-\lambda}$

(ii) Average number of customers in the queue $= E(m) = L_q = \frac{\rho^2}{1-\rho} = \frac{\lambda^2}{\mu(\mu-\lambda)}$

17. Write the characteristics of (M/M/1) : (N / FCFS) Model.

Ans:- (i) Average number of customers in the system $= E(n) = L_s = \sum_{n=1}^{N} nP_n$

(ii) Average number of customers in the queue $= E(m) = L_q = \sum_{n=1}^{N} (n-1)P_n$

18. Arrival rate is 15 per hour; service rate is 10per hour. Then traffic intensity is ____________

Ans:- Given that,

service rate, $\mu = 10$

arrival rate, $\lambda = 15$

$\therefore$ traffic intensity, $\rho = \frac{\lambda}{\mu} = \frac{15}{10} = \frac{3}{2}$

19. Arrival rate is 3per hour; service rate is 5per hour. Then traffic intensity is ____________

Ans:- Given that,

service rate, $\mu = 5$

arrival rate, $\lambda = 3$

$\therefore$ traffic intensity, $\rho = \frac{\lambda}{\mu} = \frac{3}{5}$

20. Write the formula for effective arrival rate in (M/M/1) : (N / FCFS) Model.

Ans:- Effective arrival rate = $\mu(1 - P_0)$.

UNIT-III (IMP 20)

t-test

① Find (i) $t_{0.05}$ when $\nu = 16$.
*
(ii) $t_{-0.01}$ when $\nu = 10$.

(iii) $t_{0.995}$ when $\nu = 7$.

Sol: (i) when d.f = 16, $\alpha = 0.05$

From table,

$t_{0.05}(16) = 1.745884$

(ii) when d.f = 10, $\alpha = -0.01$.

From table,

$t_{-0.01}(10) = -2.76377$.

(iii) when d.f = 7, $\alpha = 1 - 0.995$
$= 0.005$

$t_{0.005}(7) = 3.49948$.

②. Find (i) $P(t < 2.365)$ when $\nu = 7$.
*
(ii) $P(t > 1.318)$ when $\nu = 24$.

(iii) $P(-1.356 < t < 2.179)$ when $\nu = 12$.

(iv) $P(t > -2.567)$ when $\nu = 17$.

Sol: (i) when $t < 2.365$

$t = 2.365$, d.f = 7.

$\alpha = 0.05$. (To the left of $t = 2.365$)

From table $t_{\alpha}(7) = t_{0.05}(7) = 2.365$.

But, $\frac{\alpha}{2} = \frac{0.05}{2} = 0.025$.

$\therefore P(t < 2.365) = 1 - 0.025 = 0.975$.

(iii) When $t < 2.179$ with d.f = 12.

Area to the right of 2.179 is 0.025.

When $t > -1.356$ with d.f = 12.

Area to the left of 1.356 is 0.10.

when $-1.356 < t < 2.179$, the

area is $1 - 0.10 - 0.025$.

$= 0.875$.

$\therefore P(-1.356 < t < 2.179) = 0.875$.

(ii) when $t > 1.318$.

d.f = 24.

To the right of $t = 1.318$.

From table $t_{\alpha}(24) = 1.318$.

$\alpha = 0.10$.

(iv) when $t > -2.567$.

d.f = 17.

area to the right of $t = -2.567$.

From table.

$t_{-\alpha}(17) = -2.567$.

$\alpha = 0.01$.

Then $1 - \alpha = 1 - 0.01 = 0.99$

$\therefore P(t > -2.567) = 0.99$.