SRM VALLIAMMAI ENGINEERING COLLEGE
(An Autonomous Institution)
S.R.M. Nagar, Kattankulathur - 603203

DEPARTMENT OF MATHEMATICS

QUESTION BANK

IV SEMESTER

B.E-Agriculture Engineering

MA3426- APPLIED MATHEMATICS FOR AGRICULTURAL ENGINEERING

Regulation – 2023

Academic Year – 2025 - 26

Prepared by

Dr.A.N.REVATHI / AP Mathematics

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603203.

DEPARTMENT OF MATHEMATICS

S.No	QUESTIONS	BT Level	Competence	COs
UNIT-I: ORDINARY DIFFERENTIAL EQUATIONS Higher order linear differential equations with constant coefficients – Method of variation of parameters.				
	Part - A (2 MARK QUESTIONS)			
1.	Solve $(D^2 + 3D + 2)y$=0	**BTL-2**	**Understanding**	**CO1**
2.	Find the general solution of $(D^3 - 1)y = 0$.	**BTL-2**	**Understanding**	**CO1**
3.	Solve$(D^2 + 5D + 10)y = 0$.	**BTL-2**	**Understanding**	**CO1**
4.	Solve$(D - 1)^2 y = 0$	**BTL-2**	**Understanding**	**CO1**
5.	Find the complementary function of $y'' - 4y' + 4y = 0$.	**BTL-1**	**Remembering**	**CO1**
6.	Find the solution $(D^2 + 2D + 1)y$=0	**BTL-2**	**Understanding**	**CO1**
7.	Solve$(D^2 + 9)y = 0$.	**BTL-2**	**Understanding**	**CO1**
8.	Solve $(D^2 + a^2)y = 0$	**BTL-2**	**Understanding**	**CO1**
9.	Solve $(D^4 + D^3 + D^2)y = 0$	**BTL-2**	**Understanding**	**CO1**
10.	Solve$(D^4 - 1)y = 0$.	**BTL-2**	**Understanding**	**CO1**
11.	Find the complementary function of$(D^2 + 4)y = sin2x$.	**BTL-1**	**Remembering**	**CO1**
12.	Estimate the P.I of $(D^3 + 3\ D^2 + 3D + 1)y = e^{-x}$.	**BTL-1**	**Remembering**	**CO1**
13.	Solve $(D^3 - 6D^2 + 11D - 6)y$	**BTL-1**	**Remembering**	**CO1**
14.	Find the particular Integral for$(D^2 - 2D + 1)y = 2e^x$.	**BTL-2**	**Understanding**	**CO1**
15.	Estimate the P.I of $(D^2 - 4D + 4)y = e^{2x}$	**BTL-1**	**Remembering**	**CO1**
16.	Find the P.I of $(D^2 + 4D + 5)y = e^{-2x}$	**BTL-1**	**Remembering**	**CO1**
17.	Estimate the P.I of$(D^2 + 5D + 4)y = sin2x$.	**BTL-2**	**Understanding**	**CO1**
18.	Find the P.I of$(D^2 + 1)y = cos2x$	**BTL-1**	**Remembering**	**CO1**
19.	Find the P.I of$(D^2 + 2)y = x^2$	**BTL-1**	**Remembering**	**CO1**
20.	Find the P.I. of $(D - a)^2 y = e^{ax}\ sinx$	**BTL-1**	**Remembering**	**CO1**
21.	Describe method of variation of parameter	**BTL-1**	**Remembering**	**CO1**
22.	Write the Wronskian in method of variation of parameter	**BTL-1**	**Remembering**	**CO1**
23.	Write the value of P in finding particular integral in solving ODE using method of variation of parameter	**BTL-1**	**Remembering**	**CO1**
24.	Write the value of Q in finding particular integral in solving ODE using method of variation of parameter	**BTL-1**	**Remembering**	**CO1**

25.	Write the formula for finding particular integral in solving ODE using method of variation of parameter	**BTL-1**	**Remembering**	**CO1**
	PART – B (16 MARK QUESTIONS)			
1.	Analyze the solution of $(D^3-1)y = e^{2x}$.	**BTL-4**	**Analyzing**	**CO1**
2.(a)	Analyze the solution of $(2D^3-D^2+4D-2)y = e^x$	**BTL-4**	**Analyzing**	**CO1**
2.(b)	Analyze the solution of $(4D^2+4D-3)y = e^{2x}$	**BTL-4**	**Analyzing**	**CO1**
3.	Analyze the solution of $(D^3-6D^2+11D-6)y = e^{-2x}+e^{-3x}$	**BTL-4**	**Analyzing**	**CO1**
4.	Analyze the solution of $(D^2+3D+2)y = sin3x$.	**BTL-4**	**Analyzing**	**CO1**
5.(a)	Analyze the solution of$(D^2+4)\ y\ = cos2x$+sin3x.	**BTL-4**	**Analyzing**	**CO1**
5.(b)	Analyze the solution of $(D^2+4)y = sin3x + \cos 2x$.	**BTL-4**	**Analyzing**	**CO1**
6.	Analyze the solution of $(D^2+1)y = sinx\ \sin 2x$.	**BTL-4**	**Analyzing**	**CO1**
7.	Analyze the solution of $(D^2+2D+2)y = e^{-2x}+cos2x$.	**BTL-4**	**Analyzing**	**CO1**
8.	Analyze the solution of $(D^2-4D+4)y = e^{-4x}+5cos3x$	**BTL-4**	**Analyzing**	**CO1**
9.(a)	Analyze the solution of $(D^2-6D+9)y = 2x^2-x+3$	**BTL-4**	**Analyzing**	**CO1**
9.(b)	Analyze the solution of $(D^2+5D+4)y = 4e^{-x}+x$	**BTL-4**	**Analyzing**	**CO1**
10.(a)	Analyze the solution of $(D^2+4D+3)y = e^{-x}sinx$	**BTL-4**	**Analyzing**	**CO1**
10.(b)	Analyze the solution of $(D^2-2D+5)y = e^x\ cos2x$	**BTL-4**	**Analyzing**	**CO1**
11.	Analyze the solution of $(D^2+2D+1)y = e^{-x}x^2$	**BTL-4**	**Analyzing**	**CO1**
12.(a)	Analyze the solution of $(D^2+4)y = x\cos 2x$.	**BTL-4**	**Analyzing**	**CO1**
12.(b)	Analyze the solution of $(D^2+4D-12)y = (x-1)e^{2x}$	**BTL-4**	**Analyzing**	**CO1**
13.	Analyze the solution of $(D^2-2D+1)y = xe^x sinx$	**BTL-4**	**Analyzing**	**CO1**
14.	(i) Apply method of variation of parameters to solve $y'' + y = \ tanx$	**BTL-3**	**Applying**	**CO1**
15.	Apply method of variation of parameters to solve $(D^2+a^2)y = tanax$	**BTL-3**	**Applying**	**CO1**
16.	Apply method of variation of parameters to solve $y'' + y = \ cotx$	**BTL-3**	**Applying**	**CO1**
17.	Apply method of variation of parameters to solve $(D^2+a^2)y = secax$	**BTL-3**	**Applying**	**CO1**
18.	Using the method of variation of parameter solve $(D^2-6D+9)\ y\ = \frac{e^{3x}}{x^2}$	**BTL-3**	**Applying**	**CO1**
UNIT II – Special Distributions Bernoulli,Binomial, Poisson, Uniform, Exponential and Normal distributions.				
	PART-A(2 MARK QUESTIONS)			
1.	Write the probability function of Binomial Distribution.	**BTL-1**	Remembering	CO2
2.	The mean and variance of binomial distribution are 5 and 4 Find the distribution of X.	**BTL-1**	Remembering	CO2
3.	If 3% of the electric bulbs manufactured by a company are defective, Find the probability that in a sample of 100 bulbs exactly 5 bulbs are defective.	**BTL-2**	Understanding	CO2
4.	For a Binomial distribution the mean is 6 and standard deviation is $\sqrt{2}$. Find parameters of the distribution	**BTL-1**	Remembering	CO2
5.	If the mean and variance of a binomial distribution are respectively 6 and 2.4, find P(x=2).	**BTL-1**	Remembering	CO2
6	A farmer plants 5 seeds, and the probability of a seed germinating is 0.8. What is the probability of exactly 4 seeds germinating?	**BTL-2**	Understanding	CO2
7.	In a pest infestation, the probability of a plant being infected is 0.1. Find the probability of no infection among 5 plants.	**BTL-2**	Understanding	CO2
8	Define Normal distribution	**BTL-1**	Remembering	CO2
9.	State any two properties of normal distribution.	**BTL-1**	Remembering	CO2

10.	The weights of harvested tomatoes follow a normal distribution with mean 1.5 kg and standard deviation 0.3 kg. What proportion of tomatoes weigh more than 2 kg?	**BTL-2**	Understanding	CO2
11.	Define the Poisson distribution and mention one agricultural application.	**BTL-2**	Understanding	CO2
12.	Suppose that, on an average, in every three pages of a book there is one typographical error. If the number of typographical errors on a single page of the book is a Poisson random variable. What is the probability if at least one error on a specific page of the book?	**BTL-2**	Understanding	CO2
13.	Suppose that X has a Poisson distribution with parameter $\lambda = 2$. Compute $P[X \geq 1]$.	**BTL-2**	Understanding	CO2
14.	If X is a Poisson distribution such that $P(x = 1) = 4\,P(x = 2)$. Find its mean and variance.	**BTL-2**	Understanding	CO2
15.	State the conditions under which a random variable follows a Poisson distribution.	**BTL-1**	Remembering	CO2
16.	Define the exponential distribution and its relationship to the Poisson distribution.	**BTL-2**	Remembering	CO2
17.	A field has an average of 5 weeds per square meter. What is the probability of finding no weeds in a square meter?	**BTL-2**	Understanding	CO2
18.	Write the probability density function of an exponential distribution.	**BTL-1**	Remembering	CO2
19.	Define the exponential distribution and its relationship to the Poisson distribution.	**BTL-1**	Remembering	CO2
20.	If the time between irrigation system failures follows an exponential distribution with a mean of 10 days, what is the probability of a failure occurring within the first 5 days?	**BTL-2**	Understanding	CO2
21.	A machine in a crop processing plant has a failure rate of 0.1 failures per hour. What is the probability that the machine works for at least 8 hours without failure?	**BTL-2**	Understanding	CO2
22.	State the memory less property of the exponential distribution.	**BTL-1**	Remembering	CO2
23.	Define the uniform distribution and provide an example in agriculture.	**BTL-2**	Understanding	CO2
24.	A field is equally likely to have rainfall between 0 mm and 100 mm. What is the probability of rainfall being between 40 mm and 70 mm?	**BTL-2**	Understanding	CO2
25.	If the soil moisture content is uniformly distributed between 15% and 25%, what is the probability of it being below 18%?	**BTL-2**	Understanding	CO2
PART B (16 Mark Questions)				
1.(a)	Find the MGF of Binomial distribution and hence find its mean and variance.	**BTL-3**	Applying	CO2
1. (b)	Assume that 50% of all engineering students are good in mathematics. Determine the probabilities that among 18 engineering students (i) exactly 10, (ii) atleast 10 are good in mathematics.	**BTL-3**	Applying	CO2
2. (a)	A coin is biased so that a head is twice as likely to appear as a tail. If the coin is tossed 6 times, find the probabilities of getting (1) Exactly 2 heads, (2) at least 3 heads, (3) at most 4 heads.	**BTL-4**	Analyzing	CO2
2.(b)	In an agricultural experiment, the probability of a plant surviving after being transplanted is 0.75. If 15 plants are transplanted, find the probability that: (a) Exactly 10 plants survive. (b) At least 12 plants survive.	**BTL-4**	Analyzing	CO2

	(c) At most 8 plants survive.			
3.	The probability of a man hitting a target is 1/4. If he fires 7 times, what is the probability of his hitting the target at least twice? And how many times must he fire so that the probability of his hitting the target at least once is greater than 2/3?	**BTL-3**	Applying	CO2
4.	Out of 2000 families with 4 children each, Find how many family would you expect to have i) at least 1 boy ii) 2 boys iii) 1 or 2 girls iv) no girls	**BTL-4**	Analyzing	CO2
5.	A farmer plants 20 seeds, and each seed has a 60% chance of germinating. Using the binomial distribution, calculate the following: (a) The probability that exactly 12 seeds will germinate. (b) The probability that at least 15 seeds will germinate. (c) The expected number of seeds that will germinate. (d) The standard deviation of the number of germinated seeds.	**BTL-4**	Analyzing	CO2
6. (a)	Derive the MGF of Poisson distribution and hence find its mean and variance.	BTL-3	Applying	CO2
6.(b)	Messages arrive at a switch board in a Poisson manner at an average rate of 6 per hour. Find the probability that exactly 2 messages arrive within one hour, no messages arrive within one hour and at least 3 messages arrive within one hour.	**BTL-3**	Applying	CO2
7.	The number of monthly breakdowns of a computer is a random variable having a Poisson distribution with mean equal to 1.8. Find the probability that this computer will function for a month (1) without breakdown (2) with only one breakdown and (3) with at least one breakdown.	**BTL-4**	Analyzing	CO2
8.	The life (in years) of a certain electrical switch has an exponential distribution with an average life of $\frac{1}{\lambda} = 2.$ If 100 of these switches are installed in different systems; find the probability that atmost 30 fail during the first year.	**BTL-4**	Analyzing	CO2
9.(a)	The average number of pests observed in a specific crop field per week is 5. Use the Poisson distribution to calculate: (a) The probability that no pests are observed in a given week. (b) The probability that exactly 3 pests are observed in a week. (c) The probability of observing more than 6 pests in a week.	**BTL-3**	Applying	CO2
9.(b)	The marks obtained by a number of students for a certain subject is assumed to be normally distributed with mean 65 and standard deviation 5. If 3 students are taken at random from this set. Find the probability that exactly 2 of them will have marks over 70?	**BTL-4**	Analyzing	CO2
10.	In a field of maize, pests appear according to a Poisson distribution with a mean of 4 pests per week. For a period of 2 weeks: (a) Calculate the probability of having exactly 5 pests in total over the 2 weeks. (b) What is the probability that there are more than 6 pests in the 2-week period? (c) Find the expected number of pests in the 2-week period and the standard deviation.	**BTL-4**	Analyzing	CO2
11.	In an Engineering examination, a student is considered to have failed, secured second class, first class and distinction, according as he scores	**BTL-4**	Analyzing	CO2

	less than 45%, between 45% and 60% between 60% and 75% and above 75%respectively. In a particular year 10% of the students failed in the examination and 5% of the students get distinction. Find the percentage of students who have got first class and second class. Assume normal distribution of marks.			
12.	A bank manager has learnt that the length of time the customers have to wait for being attended by the teller is normally distributed with mean time of 5 minutes and standard deviation of 0.8 minutes. Find the probability that a customer has to wait (i) For less than 6 minutes (ii) For more than 3.5 minutes and between 3.4 and 6.2 minutes.	**BTL-3**	Applying	CO2
13.	Derive MGF, Mean, Variance of Normal distribution.	**BTL-3**	Applying	CO2
14.	If X follows a normal distribution with mean 12 and variance 16 cm, find the probabilities for (i) $P(X \leq 20)$ (ii) $P(X \geq 20)$, and (iii) $P(0 \leq X \leq 12)$	**BTL-3**	Applying	CO2
15.(a)	X is a normal variable with mean 30 and standard deviation of 5. Find (i) $P[26 \leq X \leq 40]$ (ii) $P [X \geq 45]$ (iii) $P[X < 30]$	**BTL-3**	Applying	CO2
15.(b)	In a normal population with mean 15 and standard deviation 3.5, it is found that 647 observations exceed 16.25. What is the total number of observations in the population.	**BTL-3**	Applying	CO2
16.(a)	Find the MGF of Uniform distribution and hence find its mean and variance.	**BTL-3**	Applying	CO2
16.(b)	The growth rate of a certain variety of wheat is uniformly distributed between 4 and 6 cm per week. Calculate the probability that: (a) The growth rate is less than 5 cm per week. (b) The growth rate is between 4.5 and 5.5 cm per week.	**BTL-4**	Analyzing	CO2
17.(a)	Suppose that the life of a industrial lamp in 1,000 of hours is exponentially distributed with mean life of 3,000 hours. Find the probability that (i)The lamp last more than the mean life (ii) The lamp last between 2,000 and 3,000 hours (iii) The lamp last another 1,000 hours given that it has already lasted for 250 hours.	**BTL-3**	Applying	CO2
17.(b)	The time between the arrival of trucks at a grain storage facility follows an exponential distribution with a mean time of 30 minutes. Find the probability that: (a) The time between two trucks is less than 20 minutes. (b) The time between two trucks is more than 40 minutes.	**BTL-3**	Applying	CO2
18.	The lifetime of an agricultural irrigation pump follows an exponential distribution with an average lifetime of 2000 hours. For a sample of 10 pumps: (a) Find the probability that at least 5 pumps last more than 2500 hours. (b) Find the probability that exactly 3 pumps last between 1800 and 2200 hours.	**BTL-3**	Applying	CO2

	(c) What is the probability that a pump will last more than 3000 hours?			
UNIT III – ESTIMATION and SAMPLING DISTRIBUTION **Population, Sample, Parameters, Point, Estimation, Unbiasedness, Consistency, Comparing two estimators**				
PART-A(2 Mark Questions)				
1.	State the conditions under which a binomial distribution becomes a normal distribution.	BTL -2	Understanding	CO3
2.	Explain how do you calculate 95% confidence interval for the average of the population?	BTL -1	Remembering	CO3
3.	Find the maximum likelihood estimates for the population mean when the population variance is known for random sampling from a normal population.	BTL -1	Remembering	CO3
4.	Obtain the maximum likelihood estimator of $f(x,\theta)=(1+\theta)x^{\theta}, 0<x<1$ based on a random sample of size x.	BTL -1	Remembering	CO3
5.	Define population and sample.	BTL -1	Remembering	CO3
6	An automobile repair shop has taken a random sample of 40 services that the average service time on an automobile is 130 minutes with a standard deviation of 26 minutes. Compute the standard error of the mean.	BTL -2	Understanding	CO3
7.	What is a parameter? Give an example.	BTL -2	Understanding	CO3
8.	Define statistic with an example.	BTL -1	Remembering	CO3
9.	What is bias of an estimator?	BTL -2	Understanding	CO3
10	Random samples of size 225 are drawn from a population with mean 100 and standard deviation 25. Find the mean and standard deviation of the sample mean.	BTL -1	Remembering	CO3
11.	A population has mean 75 and standard deviation 12. Random samples of size121 are taken. Find the mean and standard deviation of the sample mean.	BTL -2	Understanding	CO3
12.	Define sampling distribution and standard error.	BTL -1	Remembering	CO3
13.	Define confidence coefficient.	BTL-1	Remembering	CO3
14.	What is the level of significance in testing of hypothesis?	BTL -1	Remembering	CO3
15.	Define confidence limits for a parameter.	BTL -2	Understanding	CO3
16.	Define estimator, estimate and estimation.	BTL-1	Remembering	CO3
17.	Distinguish between point estimation and interval estimation.	BTL-1	Remembering	CO3
18.	Mention the properties of a good estimator.	BTL-1	Remembering	CO3
19.	What is meant by maximum likelihood estimator?	BTL -2	Understanding	CO3
20.	What is the definition of an efficient estimator in estimation theory?	BTL -2	Understanding	CO3
21.	What is a sufficient statistic in estimation theory?	BTL -2	Understanding	CO3
22.	What is the definition of an efficient estimator in estimation theory?	BTL -2	Understanding	CO3
23.	Define unbiasedness of a good estimator.	BTL -2	Understanding	CO3
24.	How do you check if an estimator is consistent?	BTL -1	Remembering	CO3
25.	What does it mean for an estimator to be consistent?	BTL -1	Remembering	CO3
PART-B (16 Marks Questions)				
1.	For a random sampling from a normal population find the maximum likelihood estimators for i) The population mean, when the population variance is known. ii) The population variance, when the population mean is known. iii) The simultaneous estimation of both the population mean and variance.	BTL -3	Applying	CO3

2.	Obtain the maximum likelihood estimator of the population mean when a random sample is drawn from a normal population with known variance.	BTL -3	Applying	CO3
3.	Obtain the maximum likelihood estimator of the population variance when the population mean is known.	BTL -3	Applying	CO3
4.	For a random sample from a normal population, obtain simultaneously the maximum likelihood estimators of the population mean and variance.	BTL -3	Applying	CO3
5.	Find the maximum likelihood estimate for the parameter λ of a poisson distribution on the basis of a sample of size n. Also find its variance. Show that the sample mean x is sufficient for estimating the parameter λ of the poisson distribution.	BTL -3	Applying	CO3
6.	If $X_1, X_2, \dots, X_n$is a random sample from a population with mean μ, prove that the sample mean is an unbiased estimator of μ.	BTL -4	Understanding	CO3
7.(a)	A random sample (X1,X2,X3,X4,X5) of size 5 is drawn from a population with unknown mean μ. Consider the following estimators to estimate μ. $t_1 = \frac{X_1+X_2+X_3+X_4+X_5}{5}$ $t_2 = \frac{X_1+X_2}{2} + X_3, t_3 = \frac{2X_1+X_2+\lambda}{3}$, is such that t3 is an unbiased estimator of μ. Find λ. Are t1 and t2 unbiased ? State giving reason, the estimator which is best among t1,t2,and t3.	BTL -3	Applying	CO3
7.(b)	If $X_1, X_2, \dots, X_n$is a random sample from a population with finite variance, show that the sample mean is a consistent estimator of the population mean.	BTL -3	Applying	CO3
8.	Prove that the ML estimator of the parameter α of the population having pdf f(x,α) = 2/α2 (α – x). 0 < x < α for the sample of unit size is 2x, x being the sample value. Show also that the estimator is not unbiased.	BTL-4	Evaluating	CO3
9.	If $X_1, X_2, \dots, X_n$is a random sample from a normal population $N(\mu, 1)$, show that $\frac{1}{n}\sum_{i=1}^{n} X_i^2$ is an unbiased estimator of $\mu^2 + 1$.	BTL -4	Analyzing	CO3
10.	If $X$is a Bernoulli random variable taking values 1 and 0 with probabilities $\theta$and $1 - \theta$respectively, show that $\frac{(\sum X_i)(\sum X_i - 1)}{n(n-1)}$ is an unbiased estimator of θ^2.	BTL- 3	Creating	CO3
11.(a)	If $X_1, X_2, \dots, X_n$are Bernoulli observations with parameter p, show that $\frac{\sum X_i}{n}\left(1 - \frac{\sum X_i}{n}\right)$is a consistent estimator of $p(1-p)$.	BTL -4	Analyzing	CO3
11.(b)	If $X_1, X_2, \dots, X_n$is a random sample from a population with finite variance, show that the sample mean is a consistent estimator of the population mean.	BTL -4	Analyzing	CO3
12.	Let $X_1, X_2, \dots, X_n$be a random sample from a population with mean μ. Consider the estimator $$T = \frac{1}{n-1}\sum_{i=1}^{n} X_i$$ (i) Examine whether $T$is unbiased. (ii) If biased, obtain an unbiased estimator.	BTL-4	Analyzing	CO3

13.	If $X_1, X_2, \ldots, X_n$ is a random sample from a population with finite variance, show that the sample mean is a consistent estimator of the population mean.	BTL -3	Applying	CO3
14.	If T_1 and T_2 are two unbiased estimators of a parameter θ such that $\mathrm{Var}(T_1) < \mathrm{Var}(T_2)$, show that T_1 is more efficient than T_2.	BTL-3	Applying	CO3
15.	A random sample X_1, X_2, X_3 is drawn from a population with mean μ and variance σ^2. Consider the estimators: $$T_1 = X_1, T_2 = \frac{X_1 + X_2}{2}, T_3 = \frac{X_1 + X_2 + X_3}{3}$$ (i) Examine whether each estimator is unbiased for μ. (ii) Find the variance of each estimator. (iii) Which estimator is the most efficient? Justify.	BTL-4	Analyzing	CO3
16.	Let X1,X2,….Xn be a random sample of size n from a normal distribution with known variance. Obtain the maximum likelihood estimator of μ.	BTL -3	Applying	CO3
17.	Let X1,X2….Xn be a random sample size n from the Poisson distribution $f(x/\lambda) = \frac{\lambda^x e^{-\lambda}}{x!} \quad where \ \ 0 \le \lambda \le \infty$. Obtain the maximum likelihood estimator of λ	BTL-4	Analyzing	CO3
18.	If $X_1, X_2, \ldots, X_n$ is a random sample from a Poisson distribution with parameter λ, obtain the maximum likelihood estimator of λ and show that it is unbiased.	BTL -3	Applying	CO3

UNIT -IV CORRELATION AND REGRESSION

Simple linear regression, Curve fitting, Covariance, Correlation tests for slope and correlation, Analysis of variance, Regression analysis

PART-A(2 Mark Questions)				
1.	Define simple linear regression and state its equation.	**BTL 1**	Remembering	CO4
2.	What is the significance of the coefficient of determination (R²) in linear regression?	**BTL 2**	Understanding	CO4
3.	Differentiate between dependent and independent variables in regression analysis.	**BTL 2**	Understanding	CO4
4.	State the principle of least squares.	**BTL 1**	Remembering	CO4
5.	What is meant by the term "line of best fit"?	**BTL 2**	Understanding	CO4
6.	List the steps involved in fitting a parabola to a given set of data points.	**BTL 1**	Remembering	CO4
7.	Explain the difference between interpolation and curve fitting.	**BTL 2**	Understanding	CO4
8.	Define covariance and state its mathematical formula.	**BTL 1**	Remembering	CO4
9.	What does the sign of covariance indicate about the relationship between two variables?	**BTL 2**	Understanding	CO4
10.	How is covariance different from correlation?	**BTL 2**	Understanding	CO4

<table>
<tr><td>11.</td><td>Define the term "correlation" and its significance in data analysis.</td><td>BTL 1</td><td>Remembering</td><td>CO4</td></tr>
<tr><td>12.</td><td>What does a correlation coefficient of +1 or -1 indicate?</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td>13.</td><td>State the null hypothesis in a test for the significance of a correlation coefficient.</td><td>BTL 1</td><td>Remembering</td><td>CO4</td></tr>
<tr><td>14.</td><td>Write the formula to calculate the t-statistic for testing the slope of a regression line.</td><td>BTL 1</td><td>Remembering</td><td>CO4</td></tr>
<tr><td>15.</td><td>What is the significance of testing the slope in regression analysis?</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td>16.</td><td>What is the purpose of analysis of variance (ANOVA)?</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td>17.</td><td>Define the terms "factor" and "levels" in ANOVA.</td><td>BTL 1</td><td>Remembering</td><td>CO4</td></tr>
<tr><td>18.</td><td>State the null hypothesis for a one-way ANOVA.</td><td>BTL 1</td><td>Remembering</td><td>CO4</td></tr>
<tr><td>19.</td><td>What is the F-statistic in ANOVA, and how is it calculated?</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td>20.</td><td>Mention any two assumptions required for performing ANOVA.</td><td>BTL 1</td><td>Remembering</td><td>CO4</td></tr>
<tr><td>21.</td><td>Define regression analysis</td><td>BTL 1</td><td>Remembering</td><td>CO4</td></tr>
<tr><td>22.</td><td>What is the least square method in regression analysis?</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td>23.</td><td>What does the coefficient of determination (R^2) indicate in a regression analysis?</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td>24.</td><td>Explain the assumptions of linear regression.</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td>25.</td><td>What is the significance of the slope and intercept in a simple linear regression model?</td><td>BTL 2</td><td>Understanding</td><td>CO4</td></tr>
<tr><td colspan="4">PART-B (16 Mark Questions)</td><td></td></tr>
<tr><td>1.</td><td>A company collects data on the advertising expenditure (in thousand rupees) and the corresponding sales (in thousand units) over a period of 6 months:
<table>
<tr><td>Advertising (X):</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td></tr>
<tr><td>Sales (Y):</td><td>15</td><td>25</td><td>35</td><td>45</td><td>50</td><td>65</td></tr>
</table>
Perform a linear regression analysis to determine the relationship between advertising expenditure and sales. Evaluate the slope, intercept, and R^2 value, and interpret the results.</td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>2. (a)</td><td>In an engineering study, data on material strength (Y, in MPa) is collected as a function of the percentage of alloy (X, in %). Given the following data:
<table>
<tr><td>Alloy percentage (X):</td><td>5</td><td>10</td><td>15</td><td>20</td><td>25</td></tr>
<tr><td>Material strength (Y):</td><td>50</td><td>55</td><td>65</td><td>70</td><td>80</td></tr>
</table></td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
</table>

<table>
<tr><td></td><td>Fit a linear regression model, find the regression coefficients, and use the model to predict material strength when the alloy percentage is 18%. Evaluate the model's performance using residual analysis.</td><td></td><td></td><td></td></tr>
<tr><td>3. (a)</td><td>By the method of least square, find the straight lines that best fits the following data
<table>
<tr><td>X</td><td>5</td><td>10</td><td>15</td><td>20</td><td>25</td></tr>
<tr><td>Y</td><td>16</td><td>19</td><td>23</td><td>26</td><td>30</td></tr>
</table></td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>3.(b)</td><td>Find the second degree parabola of the form $y = ax^2 + bx + c$ to the following data
<table>
<tr><td>X</td><td>-3</td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>Y</td><td>4.63</td><td>2.11</td><td>0.67</td><td>0.09</td><td>0.63</td><td>2.15</td><td>4.58</td></tr>
</table></td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>4. (a)</td><td>Explain the method of fitting a power curve y=axb using logarithmic transformation. Use the method of least squares and apply it to the following data:
<table>
<tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Y</td><td>2</td><td>5</td><td>9</td><td>15</td><td>25</td></tr>
</table></td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>4.(b)</td><td>Fit a 2 nd degree parabola for the following data:
<table>
<tr><td>X</td><td>19291</td><td>1930</td><td>19311</td><td>1932</td><td>1933</td><td>1934</td><td>1935</td><td>1936</td><td>1937</td></tr>
<tr><td>Y</td><td>352</td><td>356</td><td>357</td><td>358</td><td>360</td><td>361</td><td>361</td><td>360</td><td>359</td></tr>
</table></td><td>BTL 3</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>5.</td><td>Given the following data on two variables X and Y:
X={1,2,3,4}
Y={2,4,6,8}

Compute the covariance between X and Y and interpret the result.</td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>6.</td><td>Given the joint probability distribution of two random variables X and Y, compute the covariance between them:
<table>
<tr><td>X</td><td>Y</td><td>P(X,Y)</td></tr>
<tr><td>1</td><td>1</td><td>0.1</td></tr>
<tr><td>1</td><td>2</td><td>0.2</td></tr>
<tr><td>2</td><td>1</td><td>0.3</td></tr>
<tr><td>2</td><td>2</td><td>0.4</td></tr>
</table>
Also, interpret the result of covariance and its implication on the relationship between X and Y.</td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
</table>

<table>
<tr><td>7.</td><td>Explain the role of covariance in multivariate data analysis. Derive the covariance matrix for the following dataset:
X={2,4,6};
Y={1,3,5};
Z={7,9,11}.
Discuss the significance of the covariance matrix in real-world applications.</td><td>BTL 4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>8.</td><td>In an engineering context, the stress and strain of a material are measured during a tensile test. The data is as follows:
Stress (X) in MPa: {10,20,30,40,50}
Strain (Y) in %: {1,2,3,4,5}
Calculate the covariance, interpret the result, and discuss how this analysis helps in understanding material properties.</td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>9. (a)</td><td>Given the following data, test whether the correlation between X and Y is significant at a 5% level:
X={1,2,3,4,5}
Y={2,4,6,8,10}
Compute the correlation coefficient and verify its significance.</td><td>BTL 4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>9.(b)</td><td>Discuss the procedure for testing the slope of a regression line and its importance in practical applications.</td><td>BTL 4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>10.</td><td>The following data represents the relationship between pressure (X) and temperature (Y) in an engineering system:
<table>
<tr><td>X</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td></tr>
<tr><td>Y</td><td>12</td><td>24</td><td>30</td><td>40</td><td>50</td></tr>
</table>
(a). Compute the correlation coefficient.
(b). Test its significance at a 5% level.
(c). Discuss how this information can be used in engineering design.</td><td>BTL 4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>11.</td><td>The slope of a regression line fitted to the relationship between load (X) and deflection (Y) is estimated to be 0.8. Test whether this slope is significantly different from zero at a 5% level of significance, using the following data:
Sum of squares for X (SSX) = 50
Sum of squares for Y (SSY) = 80
Sum of products (SPXY) = 40
Number of observations (n) = 10
Explain the implications for structural analysis.</td><td>BTL 4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>12.</td><td>Explain the methodology to test the significance of both slope and correlation in a regression model. Using the following data, test the slope and correlation significance and interpret the results:
X={2,4,6,8,10}; Y={3,6,9,12,15}.
Discuss its relevance to engineering quality control.</td><td>BTL 4</td><td>Analyzing</td><td>CO4</td></tr>
<tr><td>13.</td><td>The following data shows the monthly salaries of employees selected at random from 4 companies A, B, C and D.
<table>
<tr><td></td><td>Salaries in Rs.(Employees)</td></tr>
</table></td><td>BTL 4</td><td>Analyzing</td><td></td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>A</td><td>560</td><td>590</td><td>530</td><td>600</td><td>510</td><td>570</td></tr>
<tr><td>B</td><td>490</td><td>510</td><td>500</td><td>480</td><td>470</td><td></td></tr>
<tr><td>C</td><td>610</td><td>580</td><td>590</td><td>620</td><td></td><td></td></tr>
<tr><td>D</td><td>580</td><td>590</td><td>620</td><td>640</td><td>550</td><td></td></tr>
</table>
Test whether the salaries differ from company to company.
</td>
<td></td>
<td></td>
<td>CO4</td>
</tr>
<tr>
<td>14.</td>
<td>A researcher conducted an experiment to evaluate the yield of a specific crop under three different fertilizer treatments. The data obtained (in quintals per acre) is as follows:
<table>
<tr><td>Fertilizer Type</td><td colspan="5">Yield (Quintals per Acre)</td></tr>
<tr><td>A</td><td>15</td><td>16</td><td>14</td><td>17</td><td>16</td></tr>
<tr><td>B</td><td>18</td><td>17</td><td>19</td><td>20</td><td>18</td></tr>
<tr><td>C</td><td>13</td><td>14</td><td>15</td><td>13</td><td>14</td></tr>
</table>
Perform a One-Way ANOVA at a 5% level of significance to test if there is a significant difference in the mean yield across the three fertilizer treatments.
</td>
<td>BTL 3</td>
<td>Applying</td>
<td>CO4</td>
</tr>
<tr>
<td>15.</td>
<td>To compare three varieties of wheat and 4 Blocks of three plots of land each were used. The following table shows the yield of the 12 plots in Kg. Analyze the data.
<table>
<tr><td rowspan="2">Varieties</td><td colspan="4">Blocks</td></tr>
<tr><td>B1</td><td>B2</td><td>B3</td><td>B4</td></tr>
<tr><td>V1</td><td>3</td><td>4</td><td>6</td><td>4</td></tr>
<tr><td>V2</td><td>4</td><td>6</td><td>5</td><td>3</td></tr>
<tr><td>V3</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
</table>
</td>
<td>BTL 4</td>
<td>Analyzing</td>
<td>CO4</td>
</tr>
<tr>
<td>16.(a)</td>
<td>Given the following data, perform a simple linear regression analysis to find the equation of the best-fit line:
<table>
<tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Y</td><td>1.</td><td>4</td><td>8</td><td>2.</td><td>10</td></tr>
</table>
(a). Find the regression equation Y=a+bX , where a is the intercept and b is the slope.
(b). Interpret the coefficients.
</td>
<td>BTL 3</td>
<td>Applying</td>
<td>CO4</td>
</tr>
<tr>
<td>16.(b)</td>
<td>Given the following data on the number of hours studied (X) and marks obtained (Y), perform regression analysis to estimate the marks for a student who studies for 8 hours:</td>
<td>BTL 3</td>
<td>Applying</td>
<td></td>
</tr>
</table>

<table>
<tr><td></td><td><table><tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Y</td><td>35</td><td>45</td><td>50</td><td>60</td><td>70</td></tr></table>(1). Find the equation of the regression line Y=a+bX
(2). Estimate the marks for a student who studies for 8 hours.</td><td></td><td></td><td>CO4</td></tr>
<tr><td>17.</td><td>Given the following data, perform multiple regression analysis to find the equation of the regression plane that predicts Y using X1and X2:<table><tr><td>X_1</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>X_2</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Y</td><td>3</td><td>5</td><td>7</td><td>9</td><td>11</td></tr></table>(i) Calculate the regression coefficients for $Y=a+b_1X_1+b_2X_2$.
(ii). Interpret the results and draw conclusions.</td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td>18.</td><td>A researcher wants to predict the crop yield based on the amount of rainfall and fertilizer used. The following data is given:<table><tr><td>Rainfall(X1)</td><td>10</td><td>12</td><td>14</td><td>16</td><td>18</td></tr><tr><td>Fertilizer (X_2)</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>Yield (Y)</td><td>50</td><td>55</td><td>60</td><td>65</td><td>70</td></tr></table>(i). Perform a multiple linear regression analysis to find the equation that predicts crop yield Y based on rainfall X1 and fertilizer X2.
(ii). Calculate the regression coefficients and interpret the results.</td><td>BTL 3</td><td>Applying</td><td>CO4</td></tr>
<tr><td colspan="5">UNIT –V: STATISTICAL QUALITY CONTROL
Control charts for measurements (X and R charts) – Control charts for attributes (p,c and np charts) – Tolerance limits – Acceptance sampling</td></tr>
<tr><td colspan="4">PART-A (2 Mark Questions)</td><td></td></tr>
<tr><td>1.</td><td>What is Statistical quality control?</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>2.</td><td>Write down advantage of SQC.</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>3.</td><td>What is meant by chance variation?</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>4.</td><td>What is meant by Assignable variation?</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>5.</td><td>Name the types of Control Chart.</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>6</td><td>Define product control</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>7.</td><td>Define process control</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>8</td><td>What is control Chart?</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>9.</td><td>Write down uses of Mean Chart.</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>10</td><td>Write down types of Acceptance sampling plan</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>11.</td><td>Define OC Curve</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>12.</td><td>Write down types of Causes variation.</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>13.</td><td>Write the formula for np chart.</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>14.</td><td>What is meant by AQL and LTPD</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>15.</td><td>What is the formula for c chart and p chart</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>16.</td><td>Define Acceptance Sampling.</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
</table>

<table>
<tr><td>17.</td><td>Explain producers Risk and Consumer Risk.</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>18.</td><td>Define Tolerance limits.</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>19.</td><td>Define one-sided Tolerance limits.</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>20.</td><td>Define Two-Sided Tolerance limits.</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>21.</td><td>What is an $\overline{X}$ chart used for in Statistical Quality Control?</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>22.</td><td>How do you interpret an $\overline{X}$ chart?</td><td>BTL -1</td><td>Remembering</td><td>CO5</td></tr>
<tr><td>23.</td><td>What is the purpose of an R chart in Statistical Quality Control?</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>24.</td><td>How are control limits for an R chart determined?</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td>25.</td><td>What are the main differences between an $\overline{X}$ chart and an R chart?</td><td>BTL -2</td><td>Understanding</td><td>CO5</td></tr>
<tr><td colspan="4">PART-B (16 Mark Questions)</td><td></td></tr>
<tr><td>1.</td><td>You are given the value of sample means ($\overline{X}$) and Range for 10 samples of size 5 each. Draw mean chart and comment on the state of control of the process.
<table>
<tr><td>Sample No</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>($\overline{X}$)</td><td>43</td><td>49</td><td>37</td><td>44</td><td>45</td><td>37</td><td>51</td><td>46</td><td>43</td><td>47</td></tr>
<tr><td>R</td><td>5</td><td>6</td><td>5</td><td>7</td><td>7</td><td>4</td><td>8</td><td>6</td><td>4</td><td>6</td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>2.(a)</td><td>What do you understand by SQC. Discuss its utility and limitations?</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>2.(b)</td><td>The following data give the weight of an automobile part. Five samples of four items each were taken on a random sample basis (at an interval of 1 hour each).Draw the mean Control Chart and find out if the production process is in control.
<table>
<tr><td>Sample</td><td colspan="4">Weight of the parts in ounces</td></tr>
<tr><td>1</td><td>10</td><td>12</td><td>10</td><td>12</td></tr>
<tr><td>2</td><td>10</td><td>12</td><td>13</td><td>13</td></tr>
<tr><td>3</td><td>10</td><td>10</td><td>9</td><td>11</td></tr>
<tr><td>4</td><td>11</td><td>10</td><td>9</td><td>14</td></tr>
<tr><td>5</td><td>12</td><td>12</td><td>12</td><td>12</td></tr>
</table></td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>3.</td><td>For a sampling plan N = 1,200, n = 64 and c = 1, determine the probability of acceptance of the following lots; (i) 0.5%defective (ii) 0.8%defective (iii) 1%defective (iv) 2%defective (v) 4% defective (vi) 10% defective Also draw and OC curve</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>4.(a)</td><td>A machine is set to deliver packets of a given weight, 10 samples of size 5 each were recorded. Below are given the relevant data:
<table>
<tr><td>Sample No</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>($\overline{X}$)</td><td>15</td><td>17</td><td>15</td><td>18</td><td>17</td><td>14</td><td>18</td><td>15</td><td>17</td><td>16</td></tr>
<tr><td>R</td><td>7</td><td>7</td><td>4</td><td>9</td><td>8</td><td>7</td><td>12</td><td>4</td><td>11</td><td>5</td></tr>
</table>
Calculate the values of the Central Line and the control limits for the mean chart and the range chart and then comment on the state of control. (Conversion factors for $n = 5$ are $A_2 = 0.58\ D_3 = 0, D_4 = 2.115$)
</td><td></td><td></td><td></td></tr>
<tr><td>4.(b)</td><td>Explain in detail the R-Chart clearly?</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>5.</td><td>10 samples each of size 50 were inspected and the number of defectives in the inspection were: 2,1,1,2,3,5,5,1,2,3. Draw the appropriate control chart for defectives.</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>6.</td><td>The following data show the values of sample mean $\overline{X}$ and the range. R for the samples of size 5 each. Calculate the values for central line and control limits for mean-chart and range chart and determine whether the process is in control.
<table>
<tr><td>Sample No</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>($\overline{X}$)</td><td>11.2</td><td>11.8</td><td>10.8</td><td>11.6</td><td>11</td><td>9.6</td><td>10.4</td><td>9.6</td><td>10.6</td><td>10</td></tr>
<tr><td>R</td><td>7</td><td>4</td><td>8</td><td>5</td><td>7</td><td>4</td><td>8</td><td>4</td><td>7</td><td>9</td></tr>
</table>
(Conversion factors for $n = 5$ are $A_2 = 0.577\ D_3 = 0, D_4 = 2.115$)
</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>7.</td><td>15 tape-recorders were examined for quality control test. The number of defects in each tape-recorder is recorded below. Draw the appropriate control chart and comment on the state of control.
<table>
<tr><td>Unit No (i)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>No of defects (c)</td><td>2</td><td>4</td><td>3</td><td>1</td><td>1</td><td>2</td><td>5</td><td>3</td><td>6</td><td>7</td><td>3</td><td>1</td><td>4</td><td>2</td><td>1</td></tr>
</table>
</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>8.</td><td>Construct $\overline{X}$ chart for following data
<table>
<tr><td>Sample No</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td rowspan="3">Observation</td><td>32</td><td>28</td><td>39</td><td>50</td><td>42</td><td>50</td><td>44</td><td>22</td></tr>
<tr><td>36</td><td>32</td><td>52</td><td>42</td><td>45</td><td>29</td><td>52</td><td>35</td></tr>
<tr><td>42</td><td>40</td><td>28</td><td>31</td><td>34</td><td>21</td><td>35</td><td>44</td></tr>
</table>
Also determine whether the process is in control.
</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>9.</td><td>From the information given below construct an appropriate control chart
<table>
<tr><td>Sample No.(each of 100)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td>No. of defectives</td><td>12</td><td>7</td><td>9</td><td>8</td><td>10</td><td>6</td><td>7</td><td>11</td><td>8</td></tr>
</table>
State your conclusions. Write all the steps in the construction of the above chart including formula for UCL and LCL.
</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>10.</td><td>Construct a Control Chart for fraction defectives (p-Chart) for following data.
<table>
<tr><td>Sample No.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>Sample Size</td><td>90</td><td>65</td><td>85</td><td>70</td><td>80</td><td>80</td><td>70</td><td>95</td><td>90</td><td>75</td></tr>
</table>
</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td>No of defectives</td><td>9</td><td>7</td><td>3</td><td>2</td><td>9</td><td>5</td><td>3</td><td>9</td><td>6</td><td>7</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>11.</td><td>Explain Control Limits for the sample mean $\bar{X}$ and sample range R.</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>12.</td><td>An inspection of 10 samples of size 400 each from 10 lots reveled the following number of defective units17,15,14,26,9,4,19,12,9,6</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>13.</td><td>Construct R chart for following data
<table>
<tr><th>Sample No.</th><th colspan="4">Observation</th></tr>
<tr><td>1</td><td>1.7</td><td>2.2</td><td>1.9</td><td>1.2</td></tr>
<tr><td>2</td><td>0.8</td><td>1.5</td><td>2.1</td><td>0.9</td></tr>
<tr><td>3</td><td>1</td><td>1.4</td><td>1</td><td>1.3</td></tr>
<tr><td>4</td><td>0.4</td><td>0.6</td><td>0.7</td><td>0.2</td></tr>
<tr><td>5</td><td>1.4</td><td>2.3</td><td>2.8</td><td>2.7</td></tr>
<tr><td>6</td><td>1.8</td><td>2</td><td>1.1</td><td>0.1</td></tr>
<tr><td>7</td><td>1.6</td><td>1.</td><td>1.5</td><td>2</td></tr>
<tr><td>8</td><td>2.5</td><td>1.6</td><td>1.8</td><td>1.2</td></tr>
<tr><td>9</td><td>2.9</td><td>2</td><td>0.5</td><td>2.2</td></tr>
</table>
Comment on State of Control.</td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
<tr><td>14</td><td>The following data gives the number of defectives in 10 samples each of size 100.Constuct a np chart for these data and also determine whether the process is in control
<table>
<tr><td>Sample No.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>No. of defectives</td><td>24</td><td>38</td><td>62</td><td>34</td><td>26</td><td>36</td><td>38</td><td>52</td><td>33</td><td>44</td></tr>
</table></td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>15)</td><td>The following data relate to the number of defects in each of 15 units drawn randomly from a production process. Draw the control chart or the number of defects and comment on the state of control. The Units are
6, 4, 9, 10, 11, 12, 20, 10, 9, 10, 15, 10, 20, 15, 10.</td><td>BTL -3</td><td>Applying</td><td>CO5</td></tr>
<tr><td>16.</td><td>A machine fills boxes with dry cereal. 15 samples of 4 boxes are drawn randomly. The weights of the sampled boxes are shown as follows. Draw the control charts for the sample mean and sample range and determine whether the process is in a state of control.
<table>
<tr><td>Sample No.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td></td><td>10</td><td>10.3</td><td>11.5</td><td>11</td><td>11.3</td><td>10.7</td><td>11.3</td><td>12.3</td><td>11</td><td>11.3</td><td>12.5</td><td>11.9</td><td>12.1</td><td>11.9</td><td>10.6</td></tr>
</table></td><td>BTL -4</td><td>Analyzing</td><td>CO5</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td rowspan="3">Weight of Boxes (X)</td><td>10.2</td><td>10.9</td><td>10.7</td><td>11.1</td><td>11.6</td><td>11.4</td><td>11.4</td><td>12.1</td><td>13.1</td><td>12.1</td><td>11.9</td><td>12.1</td><td>11.1</td><td>12.1</td><td>11.9</td></tr>
<tr><td>11.3</td><td>10.7</td><td>11.4</td><td>10.7</td><td>11.9</td><td>10.7</td><td>11.1</td><td>12.7</td><td>13.1</td><td>10.7</td><td>11.8</td><td>11.6</td><td>12.1</td><td>13.1</td><td>11.7</td></tr>
<tr><td>12.4</td><td>11.7</td><td>12.4</td><td>11.4</td><td>12.1</td><td>11</td><td>10.3</td><td>10.7</td><td>12.4</td><td>11.5</td><td>11.3</td><td>11.4</td><td>11.7</td><td>12</td><td>12.1</td></tr>
</table>
</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>
The following are the $\overline{\mathrm{X}}$ and R values for 20 samples of readings. Draw $\overline{\mathrm{X}}$ chart and R chart and write your conclusion.
<table>
<tr><td>Samples</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>$\overline{\mathrm{X}}$</td><td>34</td><td>31.6</td><td>30.8</td><td>33</td><td>35</td><td>33.2</td><td>33</td><td>32.6</td><td>33.8</td><td>37.8</td></tr>
<tr><td>R</td><td>4</td><td>4</td><td>2</td><td>3</td><td>5</td><td>2</td><td>5</td><td>13</td><td>19</td><td>6</td></tr>
<tr><td>Samples</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td></tr>
<tr><td>$\overline{\mathrm{X}}$</td><td>35.8</td><td>38.4</td><td>34</td><td>35</td><td>38.8</td><td>31.6</td><td>33</td><td>28.2</td><td>31.8</td><td>35.6</td></tr>
<tr><td>R</td><td>4</td><td>4</td><td>14</td><td>4</td><td>7</td><td>5</td><td>5</td><td>3</td><td>9</td><td>6</td></tr>
</table>
$(\text{Given for } n = 5 \text{ are } A_2 = 0.58\ \ D_3 = 0, D_4 = 2.12)$
</td>
<td>BTL -3</td>
<td>Applying</td>
<td>CO5</td>
</tr>
<tr>
<td>18.</td>
<td>
The following table gives the inspection data relating to 10 samples of 100 items each, concerning the production of bottle corks.
<table>
<tr><td>Sample Number</td><td>Size of Sample</td><td>Number of Defectives</td><td>Fraction Defective</td></tr>
<tr><td>1</td><td>100</td><td>5</td><td>.05</td></tr>
<tr><td>2</td><td>100</td><td>3</td><td>.03</td></tr>
<tr><td>3</td><td>100</td><td>3</td><td>.03</td></tr>
<tr><td>4</td><td>100</td><td>6</td><td>.06</td></tr>
<tr><td>5</td><td>100</td><td>5</td><td>.05</td></tr>
<tr><td>6</td><td>100</td><td>6</td><td>.06</td></tr>
<tr><td>7</td><td>100</td><td>8</td><td>.08</td></tr>
<tr><td>8</td><td>100</td><td>10</td><td>.10</td></tr>
<tr><td>9</td><td>100</td><td>10</td><td>.10</td></tr>
<tr><td>10</td><td>100</td><td>4</td><td>.04</td></tr>
</table>
Construct a p- chart.
</td>
<td>BTL -3</td>
<td>Applying</td>
<td>CO5</td>
</tr>
</table>

****