



M.E DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

First Semester

ENVIRONMENTAL ENGINEERING

P18MAT0001: Statistical Methods For Environmental Engineers

COURSE OUTCOMES

- CO1:** Discriminate theory of Statistical estimation
- CO2:** Test hypothesis using various tests for small and large samples.
- CO3:** Gain knowledge in Multiple and partial correlation and regression.
- CO4:** Analyse experiments based on one-way, two – way and Latin square classifications
- CO5:** Analyse multivariate data.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. **Assertion (A):** Let X_1, \dots, X_n be a random sample from a normal distribution with parameters μ and σ . CO1 [K₂]
Reason (R): Then the estimator $\hat{\mu} = \bar{X}$ is the Minimum Variance Unbiased Estimator for μ .
a) Both assertion and reason are true and reason is the correct explanation of assertion. b) Both assertion and reason are true but reason is not the correct explanation of assertion.
c) Assertion is false but reason is true. d) Assertion is true but reason is false.
2. A statistician calculates a 95% confidence interval for μ when σ is known. The confidence interval is Rs. 18000 to Rs. 22000, the amount of the sample mean \bar{X} is: CO1 [K₃]
a) Rs.18000 b) Rs.20000
c) Rs.22000 d) Rs.40000
3. The degrees of freedom for a chi square test statistic, when testing for independence in a contingency table with 5 rows and 5 columns would be CO2 [K₂]
a) 24 b) 10
c) 25 d) 16

4. Match the following

CO3 [K₁]

List I		List II	
A. Correlation coefficient		i. Scatter diagram	
B. Method of finding correlation		ii. $\beta_{x y}$	
C. Multiple correlation		iii. $-1 < r < 1$	
D. Regression coefficient		iv. $R_{1.23}$	

A B C D

- a) ii i iv iii
 b) ii iv i iii
 c) iii i iv ii
 d) iii iv i ii

5. **Assertion (A):** If the securities with less than perfect negative correlation between their price movements are combined, portfolio risk can be reduced significantly

CO3 [K₂]

Reason (R): The term with negative correlation has the effect of reducing the computed value of total portfolio risk, given other terms that are positive

- a) Both assertion and reason are true but reason is not the correct explanation of assertion. b) Both assertion and reason are true and reason is the correct explanation of assertion.
 c) Assertion is false but reason is true. d) Assertion is true but reason is false.

6. In Latin square design, the number of rows, columns and treatments are

CO4 [K₁]

- a) Always different b) Not necessarily equal
 c) Always equal d) None of them

7. The assumption used in ANOVA is

CO4 [K₂]

- (i) The population from which the samples were obtained must be normally distributed
 (ii) The samples must be independent
 (iii) The variances of the population must be different
 (iv) The dependent variable must be a continuous level of measurement

- a) i,ii,iii b) i,iii,iv
 c) ii,iii,iv d) i,ii,iv

8. **Assertion (A):** If X_i and X_k are dependent, $\text{Cov}(X_i, X_k)$ is not equal to zero.

CO5 [K₃]

Reason (R): The Continuous random variable $X_1, X_2, X_3 \dots X_p$ are mutually statistical independent if their joint density $f_{12\dots p}(x_1, x_2, \dots, x_p) = f_1(x_1)f_2(x_2)\dots f_p(x_p)$

- a) Both assertion and reason are true but reason is not the correct explanation of assertion. b) Both assertion and reason are true and reason is the correct explanation of assertion.
 c) Assertion is false but reason is true. d) Assertion is true but reason is false.

9. The multivariate normal density is a generalization of the univariate normal density of the dimension

CO5 [K₁]

- a) $p=1$ b) $p > 1$

24. In an experiment on immunization of cattle from tuberculosis the following research were obtained CO2 [K₃]

	affected	Not affected
Inoculated	12	26
Not inoculated	16	6

Apply Chi-square test and discuss the effect of vaccine in controlling susceptibility to tuberculosis.

25. Calculate $R_{1,23}$ and $R_{3,12}$ for the following data CO3 [K₃]

$$\begin{aligned} \bar{X}_1 &= 6.8 & \bar{X}_2 &= 7.0 & \bar{X}_3 &= 74 \\ S_1 &= 1.0 & S_2 &= 0.8 & S_3 &= 9.0 \\ r_{12} &= 0.6 & r_{13} &= 0.7 & r_{23} &= 0.65 \end{aligned}$$

26. The following constants are obtained from measurements on length in mm. (X_1), volume in cc (X_2) and weight in gm. (X_3) of 300 eggs. CO3 [K₃]

$$\begin{aligned} \bar{X}_1 &= 55.95 & \bar{X}_2 &= 51.48 & \bar{X}_3 &= 56.03 \\ S_1 &= 2.26 & S_2 &= 4.39 & S_3 &= 4.41 \\ r_{12} &= 0.578 & r_{13} &= 0.581 & r_{23} &= 0.974 \end{aligned}$$

Obtain the linear regression equation of egg weight on egg length and egg volume.

27. The three samples below have been obtained from normal populations with equal variances. Test the hypothesis that the sample means are equal. CO4 [K₃]

Sample 1: 8,10,7,14,11

Sample 2: 7,5,10,9,9

Sample 3: 12,9,13,12,14

The table value of F at 5% level of significance for $v_1=2$ and $v_2=12$ is 3.88.

28. Construct the analysis of variance table in two way classification model. CO4 [K₂]

29. CO5 [K₃]

	x_1/x_2	0	1
Computing covariance matrix of the joint probability function	-1	.24	.06
	0	.16	.14
	1	.40	.00

30. CO5 [K₃]

Calculating the principal components of the covariance matrix	$\begin{pmatrix} 1 & -2 & 0 \\ -2 & 5 & 0 \\ 0 & 0 & 2 \end{pmatrix}$
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Answer any TWO Questions

PART D (2 x 10 = 20 Marks)

31. Two types of drugs were used on 5 and 7 patients for reducing their weight. Drug A was imported and drug B indigenous. The decrease in the weight after using the drugs for six months was as follows: 10 CO2 [K₃]

Drug A 10 12 13 11 14
 Drug B 8 9 12 14 15 10 9

32. From the following data find the coefficient of correlation between the marks in 10 CO3 [K₃]
 economics and statistics.

Marks in eco X	25	30	28	29	32	24	36	28	27	21
Marks in stat Y	18	20	21	16	14	13	22	15	19	12

33. A completely randomized design experiment with 10 plots and 3 treatments gave 10 CO4 [K₃]
 the following result.

Plot no	1	2	3	4	5	6	7	8	9	10
Treatment	A	B	C	A	C	C	A	B	A	B
yield	5	4	3	7	5	1	3	4	1	7

Analyse the result for treatment effects
