Question Paper Code : 12202

M.E./M.Tech. DEGREE EXAMINATIONS, JANUARY 2022.

First Semester

Construction Engineering and Management

MA 4159 — STATISTICAL METHODS FOR ENGINEERS

(Common to : M.E. Environmental Engineering/M.E. Industrial Engineering/
M.E. infrastructure Engineering and Management /
M.Tech. Remote Sensing and GIS.)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define unbiasedness of a estimator.

2. If T is unbiased estimator for θ, show that T^2 is a biased estimator for θ^2.

3. Define Type-I and Type-II errors.

4. State the conditions under which χ^2 test can be applied.

5. If $r_{12} = 0.80, r_{13} = -0.40, r_{23} = -0.56$, find the values of $r_{12.3}$, $r_{13.2}$.

6. What are the normal equations of linear least square method.

7. What are the basic principles in the design of experiment?

8. State the assumptions used in ANOVA.

9. State the general objectives of principal components analysis.

10. If $\Sigma = \begin{pmatrix} 4 & 1 & 2 \\ 1 & 9 & -3 \\ 2 & -3 & 25 \end{pmatrix}$ find ρ.

PART D — (5 × 13 = 65 marks)

11. (a) X_1, X_2 and X_3 is a random sample of size 3 from a population with mean value μ and variance σ^2 T_1, T_2, T_3 are the estimators used to estimate mean value μ, where $T_1 = X_1 + X_2 - X_3, T_2 = 2X_1 - 4X_2 + 3X_3$ and $T_3 = \frac{kX_1 + X_2 + X_3}{3}$.

(i) Are T_1 and T_2 unbiased estimators.

(ii) Find the value of k such that T_3 is unbiased estimation for μ.

(iii) With this value of k is T_3 a consistent estimator?

(iv) Which is the best estimator? (13)

Or

(b) (i) In random sampling from normal population $N(\mu, \sigma^2)$, find the maximum likelihood estimated for μ when σ^2 is known. (7)

(ii) Discuss the method of moments in Estimation. (6)

12. (a) (i) The mean produce of wheat from a sample of 100 fields comes to 200 kg per acre and another sample of 150 fields gives a mean of 220 kg per acre. Assuming the SD of the yield at 11 kg for the universe, test whether there is a significant difference between the samples. (7)

(ii) From the following data, test whether there is any association between intelligence and economic conditions?

Economic condition	Intelligence				
	Excellent	Good	Medium	Dull	Total
Good	48	200	150	80	478
Not good	52	180	190	100	522
Total	100	380	340	180	1000

(6)

Or

(b) Two horses A and B were tested according to the time to run a particular race with the following results: Test whether the horse A is running faster than B at 5% level. (13)

Horse A	28	30	32	33	33	29	34
Horse B	29	30	30	24	27	29	–

13. (a) Five hundred students were examined in three subjects I, II and III, each subject carrying 100 marks. A student getting 120 or more, but less than 150 marks was put in pass class, a student getting 150 or more, but less than 180 was put in second class and a student getting 180 or more marks was put in first class. The following results were obtained.

	I	II	III
Mean	35.8	52.4	48.8
S.D.	4.2	5.3	6.1
Corr. Coeff	$r_{12} = 0.6$	$r_{13} = 0.7$	$r_{23} = 0.8$

(i) Find the number of students in each of three classes.

(ii) Estimate the number of students with total marks lying between 180 and 190.

(iii) Calculate the proportion of students who failed.

(iv) If r_{23} is not known, obtain the limits with in which it may lie when r_{12} and r_{13} have the given values. (13)

Or

(b) Estimate Y for given $X_1 = 12$ and $X_2 = 10$ by fitting regression plane to the following data :

Y	412	226	292	323	233	368	239	382	218	222	214
X_1	28.7	13.4	14.6	18	12.1	23.4	12.6	30.2	11.6	12	12.4
X_2	21.5	11.7	12.9	14.8	11	19.2	11.4	22.6	10.8	10.2	10.1

(13)

14. (a) The following table gives the number of refrigerators sold by 4 salesman in three months :

Months	Salesman			
	A	B	C	D
I	45	40	38	37
II	43	41	45	38
III	39	39	41	41

(i) Is there a significant difference in the sales made by the four salesmen?

(ii) Is there a significant difference in the sales made during different month? (13)

Or

(b) A completely randomized design experiment with 10 plots and 3 treatments gave the following results

Treatments			
A	5	7	3
B	4	4	7
C	3	5	1

Analyze the results for treatment effects. (13)

15. (a) Let X follow $N(\mu,\Sigma)$ where $X=(X_1,X_2,X_3,X_4)$, $\mu=(0000)$ and $\Sigma=\begin{pmatrix}7&3&2\\3&4&1\\2&1&2\end{pmatrix}$. Obtain the distribution of $X_1+2X_2-3X_3$. (13)

Or

(b) Find the Covariance matrix of the data given below : (13)

X_2 \ X_1	0	1
−1	0.24	0.06
0	0.16	0.14
1	0.40	.00

PART C — (1 × 15 = 15 marks)

16. (a) Analyse the data below given as a Latin square design 5% level of significance and state your conclusion :

A(105)	B(95)	C(125)	D(115)
C(115)	D(125)	A(105)	B(105)
D(115)	C(95)	B(105)	A(115)
B(95)	A(135)	D(95)	C(115)

Or

(b) Let the Random variable X_1, X_2 and X_3 have the covariance matrix $\Sigma=\begin{pmatrix}1&-2&0\\-2&5&0\\0&0&2\end{pmatrix}$. Determine the principal components Y_1, Y_2 and Y_3.