KUMARAGURU
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Register Number:…………….

M.E DEGREE EXAMINATIONS: DEC 2022

(Regulation 2018)

First Semester

CONSTRUCTION MANAGEMENT

P18MAT1001: Statistical Methods for Management
(Statistical Tables Required)

COURSE OUTCOMES

CO1: Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.

CO2: Use statistical tests in testing hypotheses on data.

CO3: Concept of linear regression, correlation, and its applications.

CO4: List the guidelines for designing experiments and recognize the key historical figures in Design of Experiments.

CO5: Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The steps involved in testing of hypothesis is CO2 [K_1]
   (i) The test statistic is computed.
   (ii) Level of significance is fixed.
   (iii) Null hypothesis is defined.
   (iv) Based on the nature of the test alternative hypothesis is defined.

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

2. Choose the correct sequence in a Randomised Block Design CO4 [K_2]
   1. Calculate Residual
   2. Write H_o and H_1
   3. Correction Factor $= \frac{T^2}{N}$
   4. Finding Total Sum of Squares

   a) 1-2-3-4 b) 2-3-4-1
   c) 3-4-1-2 d) 3-4-2-1

3. Which of the following are true for a normal vector X having a multivariate normal distribution? CO5 [K_2]
   1. Linear combination of the components of X are normally distributed.
   2. All subsets of the components of X have a (multivariate) normal distribution.
   3. Zero covariance implies that the corresponding components are independently distributed.
   4. The conditional distributions of the components are normal.

   a) 1,2 b) 1,3,4

c) 1,2,3 d) 1.2.3.4

4. Match the following: CO2 [K_1]

List I	List II
A. Z-test	i. Variance $= \frac{\nu}{\nu - 2}$ if $\nu > 2$
B. χ^2 - test	ii. $n > 30$
C. t-test	iii. $\frac{Greater\ \text{var}iance}{smaller\ \text{var}iance}$
D. F-test	iv. $\sum \frac{(O-E)^2}{E}$

a) $A \to ii; B \to iv; C \to i; D \to iii$
b) $A \to ii; B \to i; C \to iv; D \to iii$
c) $A \to ii; B \to iii; C \to iv; D \to i$
d) $A \to iii; B \to iv; C \to i; D \to ii$

5. Two-way classification is also called CO4 [K_1]

a) Completely randomized design
b) Latin square design
c) Randomized block design
d) standard design

6. Regression equation of X_1 on X_2 and X_3 is given by CO3 [K_1]

a) $(X_1 + \bar{X}_1)\frac{\omega}{\sigma_1} + (X_2 + \bar{X}_2)\frac{\omega}{\sigma_2} + (X_3 + \bar{X}_3)\frac{\omega}{\sigma_3} = 0$
b) $(X_1 - \bar{X}_1)\frac{\omega}{\sigma_1} + (X_2 - \bar{X}_2)\frac{\omega}{\sigma_2} + (X_3 - \bar{X}_3)\frac{\omega}{\sigma_3} = 0$
c) $(X_1 + \bar{X}_1)\frac{\omega_{11}}{\sigma_1} + (X_2 + \bar{X}_2)\frac{\omega_{12}}{\sigma_2} + (X_3 + \bar{X}_3)\frac{\omega_{13}}{\sigma_3} = 0$
d) $(X_1 - \bar{X}_1)\frac{\omega_{11}}{\sigma_1} + (X_2 - \bar{X}_2)\frac{\omega_{12}}{\sigma_2} + (X_3 - \bar{X}_3)\frac{\omega_{13}}{\sigma_3} = 0$

7. Examine the two statements carefully and select the answer using the codes given below: CO3 [K_2]
Assertion (A): 2x + 3y = 4 and x – y =5 are regression lines of y on x and x on y respectively
Reason (R): Correlation coefficient lies between +1 and -1.

a) Both A and R are individually true and R is the correct explanation of A
b) Both A and R are individually true but R is not the correct explanation of A
c) A is not true , R is true and R is the correct explanation of A
d) A is false and R is also false

8. If T is the MLE of θ *and* $\psi(\theta)$ is one to one function of θ, then $\psi(T)$ is the MLE of $\psi(\theta)$, this is known as CO1 [K_2]

a) Unbiased
b) Invariant
c) Consistent
d) efficient

9. The equation of Maximum Likelihood Estimator (MLE) is given by CO1 [K_1]

a) $\frac{\partial logL}{\partial \theta} < 0$
b) $\frac{\partial logL}{\partial \theta} > 0$
c) $\frac{\partial logL}{\partial \theta} = 0$
d) $\frac{\partial L}{\partial \theta} < 0$

10. In principal component analysis, a smaller eigenvalue indicates that CO5 [K_1]

a) A given variable in the original data set, say Xj, is more important
b) A given variable in the original data set, say Xj, is less important
c) A given principal component, say Yj, is more important
d) A given principal component, say Yj, is less important

PART B (10 x 2 = 20 Marks)

11. Define consistent estimator. CO1 [K_1]

12. If $\hat{\theta}$ is an unbiased estimate of θ then show that $\hat{\theta}^2$ is also a biased estimate of θ^2. CO1 [K_2]

13. Define Type I and Type II error. CO2 [K_1]

14. A random sample of 500 pineapples was taken from a large consignment and 65 were found to be bad. Show that the percentage of bad pineapples in the consignment almost certainly lies between 8.5 and 17.5. CO2 [K_2]

15. If X and Y are random variables and a, b, c, d are any numbers provided only that $a \neq 0, c \neq 0$, then prove that $r(aX+b, cY+d) = \frac{ac}{|ac|} r(X,Y)$. CO3 [$K_2$]

16. In a partially destroyed laboratory, record of analysis of correlation data, the following results only are legible: CO3 [K_2]
Variance of X = 9. Regression equations: $8X - 10Y + 66 = 0, 40X - 18Y = 214$.
Find the mean values of X and Y.

17. State the basic principles in the design of experiment. CO4 [K_1]

18. Is 2×2 LSD is possible? Why? CO4 [K_1]

19. Find the expected value of a random vector $X = \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$ where X_1 and X_2 have CO5 [K_2]

X_1	-1	0	1
$P(X_1)$	0.3	0.3	0.4

and

X_2	0	1
$P(X_2)$	0.8	0.2

20. If the covariance matrix is $\Sigma = Cov\begin{pmatrix} X_1 \\ X_2 \end{pmatrix} = \begin{pmatrix} 1 & 4 \\ 4 & 100 \end{pmatrix}$, then find the population component matrix using standardized variables. CO5 [K_1]

PART C (6 x 5 = 30 Marks)

21. If X_1, X_2 and X_3 is a random sample of size 3 with mean μ and variance σ^2, T_1, T_2, T_3 are the estimators used to estimate mean value μ, where $T_1 = X_1 + X_2 - X_3$, $T_2 = 2X_1 + 3X_3 - 4X_2$, and $T_3 = \frac{1}{3}(\lambda X_1 + X_2 + X_3)/3$, then 5 CO1 [$K_3$]
    (i) Are T_1 and T_2 unbiased estimators?
    (ii) Find the value of λ such that T_3 is an unbiased estimator for μ.

22. A company keeps records of accidents. During a safety review, a random sample of 60 accidents was selected and classifieds by the day of the week on which they occurred. 5 CO2 [K_3]

Day:	Mon	Tue	Wed	Thur	Fri
No.of accidents	8	12	9	14	17

Test whether there is any evidence that accidents are more likely on some days than the others.

23. A Random sample of 900 members has a mean 3.4cm and standard deviation 2.61cm. Is the sample from a large population of mean 3.25cm and standard deviation 2.61cm? 5 CO2 [K_3]

24. If the regression equations of two variables x and y are x = 0.7y +5.2, 5 CO3 [K_3]

y = 0.3x+2.8 then find the mean of the variable and the coefficient of correlation between them.

25. A completely randomized design experiment with 10 plots and 3 treatments gave the following results: 5 CO4 [K3]

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 results for treatment effects:

26. Find the covariance matrix of the two random variables X_1 and X_2 given that their join probability mass function is 5 CO5 [K3]

$X_1 \setminus X_2$	**0**	**1**	$P(X_1)$
-1	0.24	0.06	0.3
0	0.16	0.14	0.3
1	0.40	0	0.4
$P(X_2)$	0.8	0.2	1

Answer any FOUR Questions

PART D (4 x 10 = 40 Marks)

27. (i) Find the Maximum Likelihood Estimator for the parameter λ of a Poisson distribution on the basis of a sample of size n. Also find its variance. 10 CO1 [K3]

(ii) Show that the sample mean $\bar{x}$, is sufficient for estimating the parameter λ of the Poisson distribution.

28. A random sample of 10 boys had the following I.Q.'s 70, 120, 110, 101, 88, 83, 95, 98, 107, 100. Do these data support the assumption of a population mean I.Q. of 100? Find a reasonable range in which most of the mean I.Q. values of samples of 10 boys lie. ($t_{0.05}$=2.26) 10 CO2 [K3]

29. The joint probability distribution of X and Y is given below, find the coefficient of correlation between X and Y. 10 CO3 [K3]

$Y \setminus X$	**-1**	**1**
0	1/8	3/8
1	2/8	2/8

30. A variable trial was conducted on wheat with 4 varities in a Latin square Design. The plan of the experiment and the per plot yield are given below: 10 CO4 [K3]

C25	B23	A20	D20
A19	D19	C21	B18
B19	A14	D17	C20
D17	C20	B21	A15

Analyze the experimental yield.

31. If the covariance matrix of $X = [X_1 \quad X_2]^T$ is $\Sigma = \begin{bmatrix} 1 & 2 \\ 2 & 16 \end{bmatrix}$ then find the principal components of X_1, X_2 using the standardized variables. 10 CO5 [K3]

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