MSc DEGREE EXAMINATION MAY 2026

(Second Semester)

Branch - **STATISTICS**

LINEAR MODELS AND DESIGN OF EXPERIMENTS

Time: Three Hours Maximum: 75 Marks

SECTION-A (10 Marks)

Answer **ALL** questions

ALL questions carry **EQUAL** marks $(10 \times 1 = 10)$

Module No.	Question No.	Question	K Level	CO
1	1	What is the defining characteristic of the Best Linear Unbiased Estimator (BLUE)? (i) It has the minimum variance among all linear unbiased estimators. (ii) It is the estimator with the minimum variance among all possible unbiased estimators. (iii) It is the linear estimator that is most robust to outliers in the dataset. (iv) It minimizes the bias for any given linear combination of parameters.	K1	CO1
	2	In the general linear model $Y=X\beta+\varepsilon$, the error vector ε is assumed to have (i) Mean β (ii) Mean 1 (iii) Mean 0 (iv) Mean $X\beta$	K2	CO1
2	3	Confounding occurs when (i) Treatments are replicated (ii) Treatments are randomized (iii) Treatment effects are mixed with block effects (iv) Blocks are eliminated	K1	CO2
	4	Which of the following best describes an asymmetrical (or mixed-level) factorial design? (i) A design where the number of replicates is unequal across treatment groups. (ii) An experiment where the factors involved do not all have the same number of levels. (iii) A design where only a fraction of the full treatment combinations are run. (iv) An experiment where blocks have varying sizes.	K2	CO2
3	5	In Resolution III designs, main effects are aliased with (i) Main effects (ii)Two-factor interactions (iii) Three-factor interactions only (iv) Error	K1	CO3
	6	Recall the purpose of ANCOVA _____ (i) Increase bias (ii) Eliminate treatments (iii) Adjust treatment means using covariates (iv) Remove replication	K2	CO3
4	7	Identify the fundamental relation in BIBD (i) $\lambda(v-1) = r(k-1)$ (ii) $\lambda v = rk$ (iii) $r = v$ (iv) $b = k$	K1	CO4
	8	In PBIBD, treatment pairs are (i) Occurring together equal number of times (ii) Not occurring together (iii) Occurring together in different frequencies (iv) Always independent	K2	CO4
5	9	Mention the use of Response surface methodology (i) Optimization problems (ii) Eliminating error (iii) Avoiding interactions (iv) Complete randomization only	K1	CO5
	10	Bio-assay is mainly used to (i) Estimate variance (ii) Measure potency of a substance (iii) Reduce error (iv) Increase replication	K2	CO5

Cont...

SECTION - B (35 Marks)

Answer **ALL** questions

ALL questions carry **EQUAL** Marks (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	What is a general linear model? State the Gauss–Markov assumptions.	K3	CO1
		(OR)		
	11.b.	Define BLUE. Show that the least squares estimator is linear and unbiased.		
2	12.a.	Derive the model for a 2^3 factorial experiment and describe the estimation of main and interaction effects.	K4	CO2
		(OR)		
	12.b.	What is confounding in factorial experiments? Explain complete and partial confounding with suitable examples.		
3	13.a.	Explain the construction and analysis of a half replicate in a 2^3 factorial experiment.	K4	CO3
		(OR)		
	13.b.	Describe the analysis of Split – plot design. Illustrate.		
4	14.a.	Write a note on Youden Square & Lattice Designs.	K5	CO4
		(OR)		
	14.b.	Define a Partially Balanced Incomplete Block Design (PBIBD). Explain the properties of its parameters.		
5	15.a.	Define bio-assay. Distinguish between direct and indirect bio-assay methods.	K5	CO5
		(OR)		
	15.b.	Explain the concept of cross-over design. Illustrate		

SECTION -C (30 Marks)

Answer **ANY THREE** questions

ALL questions carry **EQUAL** Marks (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	Describe the general linear model. Derive the least squares estimator and prove that it is the Best Linear Unbiased Estimator (BLUE) under Gauss–Markov assumptions.	K4	CO1
2	17	Construct 2^4 factorial experiment by confounding higher order interaction and Test its significance with Anova table.	K5	CO2
3	18	Define nested design. Derive the statistical model for a two-way nested design and explain the F-tests used in analysis.	K5	CO3
4	19	Define a Balanced Incomplete Block Design (BIBD). Derive the relationships among its parameters and explain its properties.	K5	CO4
5	20	Delineate about response surface design and derive the design.	K5	CO5

Z-Z-Z END