Practice Exercises Lesson No. 1 to 5

Lesson No. 1

MCQs : Each MCQ carries 1 mark

1. A teacher practices the different teaching methods on different groups in her class to see which yields the best results. In this example, a treatment is

a) Teacher
b) Class
c) Different teaching methods
d) Different groups

2. A term referring to the amount of balancing, blocking and grouping of the experimental units is

a) Local control
b) Spurious effect
c) Systematic error
d) Extraneous factor

Question carry 2 marks

3. Define the term replication.

Question carry 3 marks

4. What is spurious effect? Also give an example.

Question carry 5 marks

5. Describe the experimental error and its various origins.

Lesson No. 2

MCQs : Each MCQ carries 1 mark

6. If the total degrees of freedom and between treatments in a completely randomized design are 15 and 4 respectively, the degrees of freedom for error will be
   a) 11
   b) 14
   c) 18
   d) 19

7. The null hypothesis in a completely randomized design is
   a) All treatment means are equal.
   b) Not all treatment means are equal.
   c) Addition of all treatment means is equal to 1.
   d) Subtraction of all treatment means is equal to 1.

Question carries 2 marks

8. Write the formula for finding the sum of square of treatments in Completely Randomized design.

Question carries 3 marks

9. Find the values of Sum of Squares for the given ANOVA table of Completely Randomized design.

SOV	*d.f*	Sum of Squares	Mean Square
Treatment	4		8
Error	7		5
Total	11		-

Question carries 5 marks

10. Complete the given ANOVA table of Completely Randomized design:

Source Of Variation	Degrees Of Freedom	Sum Of Squares	Mean Square	*F*
Between Treatments	2		27.25	
Within Error				-
Total	11	272.25	-	-

Lesson No. 3

MCQs : Each MCQ carries 1 mark

11. In a Randomized Complete Block design, the randomization is restricted in
    a) One direction
    b) Two directions
    c) Three directions
    d) No restriction

12. If there are 6 treatments with 3 blocks in a Randomized Complete Block Design (RCBD) then the degrees of freedom for error are
    a) 3
    b) 6
    c) 10
    d) 15

Question carries 2 marks

13. Give the main reason to divide the experimental units into subgroups or blocks.

Question carries 3 marks

14. Write any THREE disadvantages of Randomized Complete Block (RCB) design.

Question carries 5 marks

15. In a Randomized Complete Block Design (RCBD), there are 4 treatments and 5 blocks. By using the given values, Complete the ANOVA table.

ANOVA Table (RCBD)

Source of Variation	**Degree of Freedom**	**Sum of Squares**	**Mean Squares**	**F-test**
Treatment		147		
Blocks		35		
Error		43		---
Total			---	---

Lesson No. 4

MCQs : Each MCQ carries 1 mark

16. If there are 4 treatments and 4 blocks contain one missing observation in RCBD, then the error degrees of freedom is
    a) 2
    b) 4
    c) 6
    d) 8

17. The formula to find out the missing observation in Randomized Complete Block design is

    a) $x = \dfrac{rB + kT + G}{(k+1)(r-1)}$

    b) $x = \dfrac{rB - kT - G}{(k-1)(r-1)}$

    c) $x = \dfrac{rB - kT - G}{(k+1)(r+1)}$

    d) $x = \dfrac{rB + kT - G}{(k-1)(r-1)}$

Question carries 2 marks

18. If 4 treatments and 4 blocks contain one missing observation in RCBD, It is given that SSE = 7.3, then what would be the MSE?

Question carries 3 marks

19. There are four treatments A, B, C, D and five blocks I, II, III, IV and V in RCBD with one missing observation. Formulate the hypothesis for testing the block means.

Question carries 5 marks

20. Estimate the relative efficiency of RCB design to CR design by using the data given below:

Source of Variation	Degrees of freedom	Mean Square
Treatments	9	0.4074
Blocks	3	1.1986
Error	27	0.6247
Total	39	2.2309

Lesson No. 5

MCQs : Each MCQ carries 1 mark

21. For a 6x6 Latin Square design there will be observations
    a) 6
    b) 12
    c) 24
    d) 36

22. For a Latin Square design, the SSE can be obtained using the formula
    a) SSE=SST+SSTr+SSR+SSC
    b) SSE=SST-SSTr-SSR-SSC
    c) SSE=SST-SSTr+SSR+SSC
    d) SSE=SST+SSTr-SSR-SSC

Question carries 2 marks

23. Write down the statistical model for Latin square design.

Question carries 3 marks

24. Construct a layout for the Latin Square design if five treatments A, B, C, D and E are involved in the experiment.

Question carries 5 marks

25. Calculate the row sum of squares and treatment sum of squares from the following Latin Square Design,

ROWS	COLUMNS		
	I	II	III
I	B 26	C 25	A 21.3
II	C 28.7	A 23.6	B 28.5
III	A25.3	B 28.4	C 30.1

Answer Key

1. Different teaching methods
2. Local control
3. Replication is basically a repetition of basic experiment. In other words, it is a complete run for all the treatments to be tested in the experiment.
4. When two variables have no direct relationship or not correlated to each other directly but they are related due to the presence of a third variable, hence the effect of a third variable on both variables is called spurious effect. An example of a spurious relationship can be illuminated by examining a city's ice cream sales. These sales are highest when the rate of drowning in city swimming pools is highest. To allege that ice cream sales cause drowning, or vice versa, would be to imply a spurious relationship between the two. In reality, a heat wave may have caused both. The heat wave is an example of a hidden or unseen variable.
5. It describes the variation among identically and independently treated experimental units.
   The various origins of experimental error include:
   The natural variation among the experimental units.
   Inability to reproduce the treatment conditions exactly from one unit to another.
   Interaction of treatments and experimental units.
   Any other extraneous factors that influence the measured characteristics.
6. 11
7. All treatment means are equal.
8. The TreatmentSS is equal to $\sum_{j=1}^{k} r_j(\bar{Y}_{.j}-\bar{Y}_{..})^2$.
9. TreatmentSS = MStreatment ×degrees of freedom=8×4=32
   ErrorSS = MS Error × degrees of freedom=7×5=35
   TotalSS = TreatmentSS+ErrorSS=32+35=67
10.

Source Of Variation	Degrees Of Freedom	Sum Of Squares	Mean Square	*F*
Between Treatments	2	2×27.25=54.5	27.25	27.25/24.19 =1.13
Within Error	11-2=9	272.25-54.5=217.75	217.75/9=24.19	
Total	11	272.25	-	-

11. One direction
12. 10
13. If the experimental units are not homogeneous, then we divide it into subgroups such that within each block data is homogeneous.
14. Disadvantages:
    It controls the variability only in one direction.
    It is not suitable design when the number of treatments is very large.
    It is not suitable design when the blocks are not homogeneous.

15.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-test
Treatment	4-1 = 3	147	147/3 = 49	49 / 3.58= 13.69
Blocks	5 – 1 = 4	35	35/4 = 8.75	8.75 / 3.58 = 2.44
Error	19 – 7 = 12	43	43/12 = 3.58	---
Total	(4×5) – 1 = 19	225	---	---

16. 8

17. $x = \dfrac{rB + kT - G}{(k-1)(r-1)}$

18. d.f = [(r-1) × (k-1)] – 1 = [(4-1) × (4-1)] – 1=8
MSE=SSE / d.f = 7.3 / 8=0.9125

19. $H_0 : \mu_{1.} = \mu_{2.} = \mu_{3.} = \mu_{4.} = \mu_{5.}$
H_1 : Not all block means are equal.

20. $RE(RCB, CR) = \dfrac{(r-1)s_b^2 + r(k-1)s_e^2}{(rk-1)s_e^2} = \dfrac{(9)(0.0453) + (10 \times 3 \times 0.0231)}{(39 \times 0.0231)} = 1.22 = 122\%$

21. 36

22. SSE=SST-SSTr-SSR-SSC

23. $Y_{ij(h)} = \mu + R_i + C_j + \tau_h + \varepsilon_{ij(h)}$

24.

A	B	C	D	E
B	C	D	E	A
C	D	E	A	B
D	E	A	B	C
E	A	B	C	D

25.

ROWS	COLUMNS			R_i	R_i^2
	I	**II**	**III**		
I	B 26	C 25	A 21.3	72.3	5227.29
II	C 28.7	A 23.6	B 28.5	80.8	6528.64
III	A25.3	B 28.4	C 30.1	83.8	7022.44
			Total	G=236.9	18778.37

	TREATMENTS			
	A	**B**	**C**	
	26	25	21.3	
	28.7	23.6	28.5	
	25.3	28.4	30.1	Total
T_h	70.2	82.9	83.8	236.9
T_h^2	4928.04	6872.41	7022.44	18822.89

$$C.\mathrm{F} = \frac{G^2}{k^2} = \frac{(236.9)^2}{(3)^2} = 6235.73$$

$$RSS = \frac{\sum R_i^2}{k} - C.F = \frac{18778.37}{3} - 6235.73 = 23.73$$

$$TrSS = \frac{\sum T_h^2}{k} - C.F = \frac{18822.89}{3} - 6235.73 = 38.57$$