Dept. of Mathematics and Statistics

King Fahd University of Petroleum & Minerals

STAT 511: APPLIED REGRESSION AND EXPERIMENTAL DESIGN
Dr. Ridwan A. Sanusi

Mid-Term Exam T242

Saturday, April 12, 2025

7:00 PM – 9:00. PM

Name……..…ID#:_____ Section #:___

Instructions.

1. Please turn off your cell phones and place them under your chair. Any student caught with mobile phones on during the exam will be considered under the cheating rules of the University.

2. If you need to leave the room, please do so quietly so not to disturb others taking the test. No two person can leave the room at the same time. No extra exam time will be provided for the time spent outside the room.

3. Only materials provided by the instructor can be present on the table during the exam.

4. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.

5. Use the blank portions of each page for your work. Extra blank pages can be provided if necessary. If you use an extra page, indicate clearly what problem you are working on.

6. Only answers supported by work will be considered. Unsupported guesses will not be graded.

7. While every attempt is made to avoid defective questions, sometimes they do occur. In the rare event that you believe a question is defective, the instructor cannot give you any guidance beyond these instructions.

8. Mobile calculators, I-pad, or communicable devices are disallowed. Use regular scientific calculators, financial calculators, or SOA-approved calculators only. ***Write important steps to arrive at the solution of the exam problems.***

The test is 120 minutes, GOOD LUCK, and you may begin now!

Question	Total Mark	Mark Obtained	Comments
PART A: 1-15	1*15		
PART B: 1	2		
2	2		
3	3		
4	3		
Total	25		

PART A

1. The value of F will _____ when chance-related variability reduces.
   A. remains constant.
   B. reduces
   C. increases
   D. none of the above

2. **If the true means of the k populations are equal, then MST/MSE should be**
   A. close to 1.00
   B. close to -1.00
   C. a negative value between 0 and – 1
   D. more than 1.00.
   E. very high.

3. The number of covariates in the dataset frequently causes an increase in the error degrees of freedom.
   A. TRUE B. FALSE

4. Two factors are said to interact when the simple main effects of one factor are not homogeneous across all levels of the other.
   A. TRUE B. FALSE

5. If in a randomized block design having five treatments and 4 replications, a treatment is added, the increase in error degrees of freedom will be:
   A. 1 B. 2 C. 3 D. 4

6. When the k population means are truly different from each other, it is likely that the average error deviation:
   A. is relatively large compared to the average treatment deviations
   B. is about equal to the average treatment deviation
   C. is relatively small compared to the average treatment deviations
   D. none of the above

7. When conducting an ANOVA, F value will always fall within what range?
   A. between negative one and infinity
   B. between zero and one
   C. between negative infinity and zero
   D. between zero and infinity

8. In order to adjust the effect of uncontrollable nuisance factors we use ----------
   A. ANCOVA
   B. Randomization
   C. Replication
   D. Blocking

9. A covariate is a nuisance factor that can be easily controlled by the experimenter.
A. TRUE B. FALSE

10. What will be the degrees of freedom of treatment when there are 5 blocks and 24 error degrees of freedom.
A. 4 B. 5 C. 6 D. 7

11. The mean square error in the ANOVA provides an estimate of
A. The variance of the random error.
B. The variance of an individual treatment average
C. The standard deviation of an individual observation
D. None of the above

12. In a single-factor ANOVA, if the F-statistic is insignificant, it means that the means being compared are all different.
A. TRUE B. FALSE

13. In a Latin square design, If degrees of freedom for MST are 5 and MSE are *v*, then v=?
A. 30 B. 20 C. 25 D. 10

14. In a completely randomized design for ANOVA, the number of degrees of freedom for the numerator and denominator are 4 and 25, respectively. The total number of observations must equal ---------
A. 29
B. 31
C. 26
D. 30

15. In order to eliminate the effect of controllable nuisance factors we use ----------
A. blocking
B. randomization
C. ANOVA
D. Replication

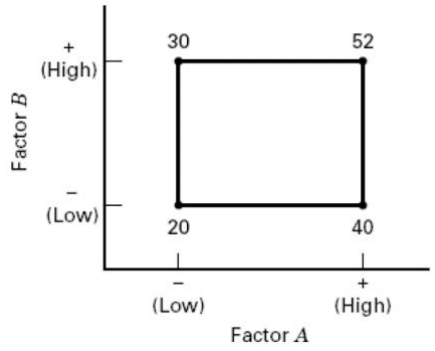
16. The number of blocks in the RCBD must always equal the number of treatments of factor levels.
A. TRUE B. FALSE

PART B

1.A computer ANOVA output is shown below. Fill in the blanks [4*0.5 = 2 MARKS].

One-way ANOVA					
Source	DF	SS	MS	F	P
Factor	?	?	246.93	?	< 0.0001
Error	25	186.53	?		
Total	29	1174.24			

2a. In the figure below, calculate the main effects of A and B, and the interaction effect [4*0.5 = 2 MARKS].



2b. In the general arrangement for a two-factor factorial design shown below, give an expression for the degree of freedom of the sum of square error

Factor A	Factor B: 1	2	. . .	b
1	$y_{111}, y_{112}, \ldots, y_{11n}$	$y_{121}, y_{122}, \ldots, y_{12n}$		$y_{1b1}, y_{1b2}, \ldots, y_{1bn}$
2	$y_{211}, y_{212}, \ldots, y_{21n}$	$y_{221}, y_{222}, \ldots, y_{22n}$		$y_{2b1}, y_{2b2}, \ldots, y_{2bn}$
⋮				
a	$y_{a11}, y_{a12}, \ldots, y_{a1n}$	$y_{a21}, y_{a22}, \ldots, y_{a2n}$		$y_{ab1}, y_{ab2}, \ldots, y_{abn}$

3. A chemist wants to see how four different synthetics will react on a certain kind of fabric. The researcher believes there is variations from one bolt to the next. Five bolts were chosen, each with all four chemicals in a different order. Tensile strengths are what follow.

Bolts					
Synthetic	I	II	III	IV	V
A	73	68	74	71	67
B	73	67	75	72	70
C	75	68	78	73	68
D	73	71	75	75	69

Use 0.05 to analyze the experiment's results, assuming **normality** and come to the necessary conclusions together with the following reports [6*0.5 = 3 MARKS]:

Clear Hypotheses:

Name of the Design:

Name of the test used:

Test statistic: **F (Synthetic) = 0.059**

p-value: **0.980 (Synthetic).**

Does the decision really favor the null hypothesis? YES or NO

If YES, state the decision and conclusion

Decision:

Conclusion:

If NO, state the next step and specify the appropriate test needed:

4. A computer program has produced the following output for the hypothesis testing problem [3*1 = 3 MARKS]:

Difference in sample means: -11.5
Degrees of freedom: 24
Standard error of the difference in the sample means: ?
Test statistic: t_o = -1.88
P-Value = 0.0723

(a) What is the missing value for the standard error?

(b) If *alpha* = 0.05, what are your decision and conclusion?

(c) Find a 90% two-sided CI on the difference in the means.

FORMULAR SHEET

$$\bar{y}_1 - \bar{y}_2 - t_{\alpha/2,n_1+n_2-2} S_p \sqrt{\frac{1}{n_1}+\frac{1}{n_2}} \le \mu_1 - \mu_1 \le \bar{y}_1 - \bar{y}_2 + t_{\alpha/2,n_1+n_2-2} S_p \sqrt{\frac{1}{n_1}+\frac{1}{n_2}}$$

$$t_0 = \frac{\bar{y}_1 - \bar{y}_2}{S_p \sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$$