

ID# _____

Do not put your name on this exam.

1. Assume that several factors have been shown to be associated with depression, including gender, socioeconomic status, and time of year. Professor Mixed conducted a longitudinal study with 160 25- to 30-year-old participants to see if he could predict depressive symptoms. Men and women completed the Beck Depression Inventory (BDI) once a month for one year. Participants fell into one of four levels of socioeconomic status (lower class, working class, middle class, and upper class). Higher scores on the BDI indicate greater levels of depressive symptoms. Assume equal n.
 - a. (35 points) Fill in the source table for this experiment, including sources, degrees of freedom, SS, bracket terms, and error terms. The df and SS for the Mean have been done for you.

<u>Source</u>	<u>df</u>	<u>SS</u>	<u>Error term</u>
Mean	1	[T]	

- b. (5 points) The average BDI scores in each of the twelve months (starting with January) were: 6.5, 6.0, 5.5, 5.2, 5.0, 5.1, 4.9, 4.8, 4.6, 4.9, 5.3, and 5.5. The calculated F-value for the main effect of month was 2.0. What can Professor Mixed conclude based on this result?
- c. (15 points) Lay out a set of contrast coefficients to test the hypothesis that the months between the fall equinox and winter solstice (October to December, inclusive) show worsening mood (increasing scores) while the months between the spring equinox and summer solstice (April to June inclusive) show improving mood (decreasing scores). Also calculate the SS for the numerator for your contrast.

- d. (10 points) Test the contrast you did in part (c) against the error term for the effects of month from the overall ANOVA.
- e. (5 points) Describe a key statistical assumption embedded in the error term in part (d), and suggest the best remedy.

- f. (5 points) The average BDI scores for participants in each of the levels of socioeconomic status (starting with lower class) were: 5.4, 5.2, 5.3, and 5.2. The main effect of socioeconomic status was not significant. What can Professor Mixed conclude based on this result?
- g. (5 points) Professor Mixed did not analyze marital status in his design. Discuss how this omission might have influenced the results of his study (statistically speaking).

2. Below are data from a study of middle school students' performance on mathematics problems. The design is a 3 (operation: addition, subtraction, or multiplication) x 2 (problem type: equation or story problem) within-subject design with replications (R1 and R2). Number of errors (out of 10) is the dependent measure. Four middle school students participated in every condition of the experiment. The data are presented below. Operation is A, problem type is B, replication is R, and student is S.

	A1 (addition)				A2 (subtraction)				A3 (multiplication)			
	B1 (equation)		B2 (story)		B1 (equation)		B2 (story)		B1 (equation)		B2 (story)	
	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
S1	3	3	2	2	4	4	3	2	5	5	6	5
S2	1	3	1	1	2	4	2	3	3	5	4	4
S3	2	2	0	1	3	2	1	2	4	3	3	4
S4	2	1	1	0	2	2	1	1	2	3	4	3

- a. (15 points) Assume that the 4 students were not chosen randomly, but rather were chosen because they have special needs. Student 1 has Developmental dyscalculia, Student 2 has Dyslexia, Student 3 has Attention Deficit and Hyperactivity Disorder, and Student 4 has a learning disability (not otherwise specified). You want to calculate an F-value to test whether the effect of operation on problem-solving performance depends on the student being tested. Calculate the numerator and denominator degrees of freedom for that F-value, and give the names of the effects.

- b. (5 points) Now assume that the 4 students were chosen randomly. You want to construct an F-value to test whether the effect of problem type on problem-solving performance depends on replication. **Describe** (in terms of bracket expressions) how you would calculate the sum of squared deviations (SS) for the denominator of that F-value. You should **not** calculate the actual value (too time consuming for this exam). (For example, if I wanted to use bracket expressions to describe how to calculate the SS for the Mean, I would write $SS_{\text{Mean}} = [T]$.) Also, name the effect.

- c. (15 points) Now assume that the 4 students were chosen randomly and that you do **not** want to include replication as a factor. Instead, you want to use the average number of errors across the two replications as the dependent measure. **Calculate** the F-value to test whether operation influences problem-solving performance on story problems.

3. Multiple choice (2 points each):

1. Compound symmetry is a stricter version of _____, an important assumption required for within-subject ANOVA.
 - a. homogeneity of variance
 - b. sphericity of the variance-covariance matrix
 - c. normality of the variance-covariance matrix
 - d. homogeneity of covariance
 - e. normal distribution of errors

2. The SS_{error} from a within-subject ANOVA will normally be _____ the SS_{error} from the same data analyzed as if it were a between-subjects ANOVA.
 - a. larger than
 - b. smaller than
 - c. equal to

3. Professor Happy conducted a 3(A) x 4(B) between-subjects ANOVA, with number correct as the dependent measure. Results revealed a significant AxB interaction. To follow-up the significant interaction, Professor Happy performed an $A_{(-1, 2, -1)} \times B_{(1, -1, 0, 0)}$ interaction contrast. The F-ratio for Professor Happy's interaction contrast should have _____ numerator degree(s) of freedom.
 - a. one
 - b. two
 - c. six
 - d. twelve

4. If you increase your alpha level (for example, use .10 instead of .05) you also increase
 - a. Type II error.
 - b. power.
 - c. error variance.
 - d. all of the above.

5. The post-hoc method below that is appropriate for testing all possible pairwise comparisons that would also have the most power is the _____ method.
 - a. Tukey
 - b. Scheffe
 - c. Fisher-Hayter
 - d. Dunnett

6. Ima Student conducted a 3 (A) x 3 (B) mixed ANOVA, with A as the between-subjects factor, B as the within-subject factor, and scores on a self-report questionnaire as the dependent measure. The Levine test indicated that homogeneity of variance was not violated for factor A ($p > .20$). Results revealed a significant AxB interaction. To follow-up the significant interaction, Ima analyzed the simple effects of A at each level of B. The error term that Ima should have used to test all three of these simple effects is _____.
- $MS_{S/A}$
 - $MS_{S/A \times B}$
 - $(SS_{S/A} + SS_{S/A \times B}) / (df_{S/A} + df_{S/A \times B})$
 - $MS_{S/A} + MS_{S/A \times B}$
7. In a 2 (A) x 2 (B) factorial design with 30 participants, the main effects and interaction will **not** be orthogonal to one another if the number of subjects in each of the four cells (A1B1, A1B2, A2B1, and A2B2) is _____ respectively.
- 5, 10, 5, and 10
 - 6, 9, 7, and 8
 - both a and b
 - neither a nor b
8. Stat Student conducted a 3 (A) x 2 (B) x 4 (C) between-subjects design, with factor C random and nested in factor B and number of errors as the dependent measure. Results revealed a marginal main effect of factor B ($p = .07$). Stat plans to run the study again. In the second study, she could increase the power for detecting an effect of B by
- increasing the number of subjects.
 - increasing the number of levels of factor A.
 - increasing the number of levels of factor B.
 - increasing the number of levels of factor C.
 - all of the above
9. Thirty newborns were tested in a habituation procedure. First, newborns were habituated to their mother's voice. Then, they were presented with one of three voices: (1) their mother's voice, (2) their grandmother's voice, or (3) the voice of a female stranger. Five newborns dropped out of the experiment because they were too fussy. The final sample consisted of 10 newborns in the mother-mother group, 9 newborns in the mother-grandmother group, and 6 newborns in the mother-stranger group. Results revealed a significant effect of condition. As a reviewer, the most important concern you have about this study would be the
- violation of independence.
 - nonorthogonality of the effects.
 - violation of normality.
 - small sample size.
 - diaper supply.

10. Professor Dictum studies whether your name influences how other people perceive you. In a recent study, he presented participants with photos of five women and asked them to guess the average IQ of each woman. Each photo was paired with one of five names: Hannah, Hazel, Hope, Harriet, or Holly. Each of the five names was randomly assigned to each of the photos using a Latin Square, and participants were randomly assigned to rows of the Latin Square. The F-ratio that tests the effect of name on perceived IQ should have _____ denominator degrees of freedom.
- four
 - twelve
 - sixteen
 - one hundred
11. Professor Moore has used the phrase “look in the mirror” to imply that
- grad students aren’t such great looking folks.
 - university professors are downright ugly.
 - scientific honesty should be the primary consideration.
 - beauty is as beauty does.