Solutions for Exam 2 Review (Assume α=0.05 unless otherwise stated).

Submit a word document or pdf file to the Dropbox provided for the exam. For equations, you can use terms like mu\_level1 for to save time if using text editors like word.

**1)** A poultry experiment was run to investigate the effect of diet and antibiotic on egg production. They evaluated 2 diets of interest, and 2 specific antibiotics that are on the market. The feed and antibiotic were combined and used to fill the feeding trays in barns. They chose 3 poultry farms at random and used 4 barns on each farm to accommodate the combinations of diet and antibiotic. Total egg production by the chickens was recorded after 4 weeks.

a) (4pts) What is the treatment design? \_\_\_\_*2x2 factorial*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) (4pts) How many replications were there? \_\_\_\_\_*3*\_\_\_\_\_\_\_\_\_\_\_\_

c) (4pts) What was the experimental design? \_\_\_\_*RCBD*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) (4 pts) Identify which factors are fixed and which are random.

*Diet and Antibiotic: Fixed*

*Farms: Random*

e) (4 pts) Fill in the first two columns of the ANOVA table below:

Source df

*Farms 2*

*Diet 1*

*Antibiotic 1*

*DxA 1*

*Error 6*

*Total 11*

***Note that barns are simply the experimental units for the diet x antibiotic treatment*** *combinations. They don’t appear in the model. Partial credit was given if you had the main effects and interaction (Diet, Antibiotic, and D x A).*

**2)** Health awareness trainers use the same training program and researchers are interested in characterizing the variation among and within trainers. Five randomly selected trainers were selected for the study and for each trainer, 8 randomly selected participants are tested and given a score.

a) (4 pts) What would be the Null hypothesis for the effect of the trainers?

The Model II ANOVA output was in part::

Sum of

Source DF Squares Mean Square Expected Mean Square F Value Pr > F

trainer 4 5591.150 1397.787500 Var(Residual) + 8 Var(trainer) 3.01 0.0309

Residual 35 16233 463.792857 Var(Residual) .

b) (8pts) Estimate the variance components.

*To get use the method of moments:*

*Solving for gives: 116.7483*

c) (4pts) Find the intra-class correlation coefficient.

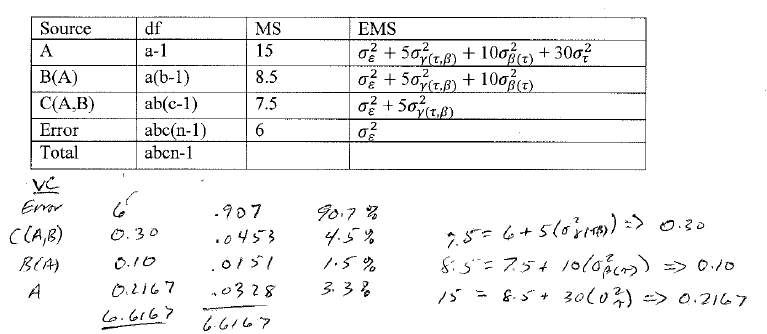
*ICC = 116.7483 / (116.7483 + 463.7929) =0.2011 or 20%*

d) (4pts) A large ICC would indicate \_\_*a*\_\_\_\_.

*a) trainers are ‘unreliable’(or inconsistent) as a group*

b) participants are so variable that trainer-to-trainer variability is relatively small

**3)** (10pts) Given the ANOVA table below for a fully nested random effects model, use the EMS and means squares to derive the variance components. Express these as percentages. Here, a=4 levels of factor A, b=3 levels of factor B, c=2 levels of factor C, and there were n=5 observations per cell.



**4)** Researchers are investigating the effect of storage temperature on bacterial growth for two types of seafood. They set up the experiment to evaluate 3 storage temperatures. There were 9 storage units that were available, and so they randomly selected 3 storage units to be used for each storage temperature, and both seafood types were stored in each unit. After 2 weeks, bacterial counts were made. After taking a logarithmic transformation of the counts, they produced the following ANOVA:

| **Type 3 Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **Expected Mean Square** |
| **temp** | 2 | 107.656588 | 53.828294 | Var(Residual) + 2 Var(unit(temp)) + Q(temp,temp\*seafood) |
| **seafood** | 1 | 3.713721 | 3.713721 | Var(Residual) + Q(seafood,temp\*seafood) |
| **temp\*seafood** | 2 | 2.647594 | 1.323797 | Var(Residual) + Q(temp\*seafood) |
| **unit(temp)** | 6 | 44.050650 | 7.341775 | Var(Residual) + 2 Var(unit(temp)) |
| **Residual** | 6 | 5.590873 | 0.931812 | Var(Residual) |

a) (5pts) For each factor, indicate whether it is a fixed or random effect.

*Temp=fixed, seafood=fixed, storage unit=random*

b) (5pts) Identify the treatments and describe (in words) the treatment design.

*Temperture and Seafood, factorial design*. *Each seafood type is combined with each temperature level in the experiment.*

c) (5pts) Describe (in words) the randomization used.

*Split-plot in a CRD. Units were assigned (randomly) a temperature level. Then the storage unit set a t a temperature is split to accommodate each of the two seafood types.*

d) (5pts) Compute the F statistic for each effect in the ANOVA, and determine significance for each effect (use the closest Fcritical value in Table B4 of the Text).

*Temperature Reject Ho.*

**5)** A study is conducted to evaluate college students at different levels of class standing (First year, Sophomores, Juniors and Seniors) (groups) and the effectiveness of 3 technology integration methods. Four different colleges were choosen from all possible colleges in the United States. The 3 technology integration levels were randomly assigned to students within each of 4 groups in each of 4 colleges (blocks) chosen at random from all 4-year colleges in a particular geographic region.

| **Type 3 Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **Expected Mean Square** |
| **group** | 3 | 6429.388333 | 2143.129444 | Var(Residual) + 3 Var(block\*group) + Q(group,group\*tech\_int) |
| **tech\_int** | 2 | 881.408750 | 440.704375 | Var(Residual) + Q(tech\_int,group\*tech\_int) |
| **group\*tech\_int** | 6 | 207.507917 | 34.584653 | Var(Residual) + Q(group\*tech\_int) |
| **block** | 3 | 408.985000 | 136.328333 | Var(Residual) + 3 Var(block\*group) + 12 Var(block) |
| **block\*group** | 9 | 466.543333 | 51.838148 | Var(Residual) + 3 Var(block\*group) |
| **Residual** | 24 | 595.696667 | 24.820694 | Var(Residual) |

a) (5pts) For each factor, indicate whether it is a fixed or random effect.

*Group = fixed, tech\_int = fixed, college = random*

b) (5pts) Identify the treatments and describe (in words) the treatment design.

*Group and tech\_int, crossed for a factorial treatment design*

c) (5pts) Describe (in words) the randomization used.

*Split plot in a RCBD. Each college (block) has all combinations of group x tech\_int levels represented (RCBD). However, the groups are established in each college, and then the students within each group are split into 3 subgroups that subsequently receive a tech\_int method, forming a split plot design within the RCBD structure.*

d) (5pts) Compute the F statistic for each effect in the ANOVA, and determine significance (i.e., compare Fcalculated to Fcritical) for each effect (use the closest Fcritical value in Table B4 of the Text).

*Group F=* 2143.129444 / 51.838148 =41.3427 Fcritical = F(.05, 3, 9) = 3.86 Reject Ho.

*Tech\_int F=* 440.704375/ 24.820694 = 17.7555 Fcritical = F(.05, 2, 24) = 3.40 Reject Ho.

*Group x tech\_int F=* 34.584653 / 24.820694 = 1.3934 Fcritical = 2.51 Do not Reject Ho.

*Block F = 136.3283 / 51.8381 = 2.6299 Fcritical= 3.86 Do Not Reject Ho.*

*Block\*Group = 51.8381 / 24.8207 = 2.0885 Fcritical= 2.30 Do Not Reject Ho*

**6)** (10pts) An investigator wants to run an experiment in a Latin square design evaluating 5 levels of a treatment (labelled A,B,C,D, and E) and included the layout in a research proposal that you are reviewing.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | B | C | D | E |  |  |  |  |  |
| B | C | D | **B** | A |
| C | D | E | A | B |
| D | E | A | B | C |
| E | A | B | C | D |

(5pts) Identify any problems you see and suggest how to revise the design.

*Column 4, row 2,* ***B*** *should be* ***E*** *to form complete blocks.*

*In addition, the rows and columns need to be independently randomized to produce the actual layout of the Latin square for the experimental plan.*