PLSC 724 - PRACTICE EXAM 3

1. Assume you have ten wheat varieties and you plan a yield trial. List some of the points you should consider in choosing a design. Possible designs are CRD, RCBD, and Latin square.

2. Given that t=8 and r>1, which design (CRD, RCBD, LS) has the largest and which design the least number of degrees of freedom for experimental error?

3. Use the following data to calculate r, the y-intercept, the regression coefficient, and sums of squares due to regression.

X	Y
3	4
7	6
5	9
5	5

4. At what point on the X axis is a confidence interval for a predicted Y mean the smallest?

5. Given the following information, calculate the variance of the regression coefficient, and the variance of a predicted Y mean at (X - X bar)=5, n=10.

$\sum (\hat{Y}_i - \bar{Y})^2 = 180$ (Note, $\hat{Y}$ = Y hat)

$\sum (Y_i - \bar{Y})^2 = 420$

$\sum (Y_i - \hat{Y}_i)^2 = 240$

$\sum (X_i - \bar{X})^2 = 150$

6. Given the following data, compute:
   Sums of squares of X
   Sums of squares of Y
   Sums of squares of cross product

X	Y
50	78
60	86
70	103
80	110
90	132

7. Assume you conduct a regression analysis on some data in which the X values of 10, 20, 30, and 40 represent temperatures (celcius) and the Y values represent the circumference of mold colonies (in cm) on an agar medium after a specified

amount of time. If the regression coefficient was 0.8, tell precisely what this value means, other than slope of the line.

8. Given the following information:

   Summ. X=198
   Summ. Y=716
   Summ. X squared=4596
   Summ. Y squared=58,974
   Summ. XY=16,416
   Summ. N=9

   Compute the Y-intercept, the regression coefficient, the correlation coefficient, the coefficient of determination, the F-test to test the null hypothesis such that there is a linear relationship between X and Y, Y hat for X = 30, variance of the regression coeff., variance of a predicted Y mean when X=30, and 95% CI for the regression coefficient. Also, should you accept or reject the null hypothesis such that the regression coefficient equals zero. Why?

9. What three tests can be used to test the null hypothesis that there is not a linear relationship between the independent and dependent variable.

10. If the correlation coefficient, r, is significant, what hypothesis would you reject? H= ?

11. What are the upper and lower limits for the regression coefficient, r, and the coefficient of determination?

12. What source of variation in regression is symbolized by Summ. Of the quantity (Yi - Y hat i) squared?

13. Use the following data to compute 1) SS AWPT (A as whole plot), 2) SS AWPT (B as whole plot), and 3) SS ASPT (A as whole plot, B as subplot, and C as sub-subplot.

	rep 1	rep 2
a0 b0 c0	7	9
a0 b0 c1	12	11
a0 b1 c0	13	16
a0 b1 c1	18	20
a1 b0 c0	15	19
a1 b0 c1	22	20
a1 b1 c0	24	27
a1 b1 c1	33	29

14. Given the following information, calculate the statistics indicated. Show computations.

X	Y

30	53
40	69
50	72
60	94
70	98
80	76
330	462 summ. V (V stands for variable)
19900	36970 summ. V squared

Summ. Cross product = 26530
X bar = 55
Y bar = 77

Calculate: the Y-intercept, the regression coefficient, r, dev due to regn. SS, dev. from regression SS, Y hat for X = 75

15. In the regression problems you analyzed, there was one degree of freedom for the source of variation, due to regression. Why is there only one degree of freedom?

16. What is the difference, if any, between a 3 to the fourth power factorial and a 3 x 4 factorial?

17. Assume you have a 2 to the third power factorial, with treatments arranged in a latin square. What would be the size of the latin square?

18. Assume you have a 3 x 4 factorial in an RCBD with 4 reps. The experiment is repeated at 4 locations. In the combined analysis, how many degrees of freedom do you have for reps within locations and for error.

19. Refer to question 18. Assume that locations is a random variable and that factors A and B are fixed variables. When making F-tests of factor A and AxB, what are the appropriate denominators?

20. Assume you have a 3 x 4 factorial in an RCBD with 5 blocks. Factor A is fixed and B is random. Show how to compute the variance of a treatment mean for A, B, and AxB. Use actual numbers for the denominators.

21. Assume you have an RCBD with a 2 to the third power factorial arrangement.

    A) Write the expected mean square for B if A and B are fixed, and C is random.
    B) What mean square would be the appropriate denominator in making an F-test for B?

22. Assume you apply a herbicide (rates of 4, 8, and 12 ounces Per acre) to each of six wheat varietiess. The experiment

was randomized as a CRD with a factorial arrangement and four replicates. List all sources of variation and degrees of freedom.

23. Indicate the degees of freedom for all error terms given the following conditions (r=4, A=5, B=2, and C=3): RCBD

    A) factorial
    B) split-split-plot
    C) split-plot with whole plots a factorial of a and b
    D) split block of A and B, and C in suplots
    E) given part b, what is the formula for the standard error between two B means, assuming all factors are fixed. Use numbers where possible.

24. How many degrees of freedom would you have for error a and for error b if you have a split plot arrangement in which the main or whole plots are a 4x2 factorial in a latin square and sub-plots consist of three levels of C?

    A) Write the expected mean squares for C and for BC assuming A is fixed and B and C are random.
    B) The mean square from what source of variation would be used as the denominator in an F-test for C and for BC?

25. If you had a 3x4 factorial in an RCBD or a split plot in an RCBD with A=3 and B=4, in which arrangement would factor a be tested with greatest precision? Which arrangement for greatest B precision?

26. Assume you have three factors, A, B, and C. What arrangement would you use to:

    A) test A, B, and AxB with equal precision and other interactions with greater?
    B) test all with equal precision?
    C) test A and B with equal precision, AB, C, etc. with greater but not necessarily equal precision.

27. Write the expected mean square for C assuming A and C are fixed variables and B is a random variable.

28. What would be the appropriate denominator to make an F-test of C, given the conditions of question 27?

29. Write the expected mean square for B, if A is random and B and C are fixed.

30. Given 3 factors, A, B, and C, write the expected mean square for B if A and B are random and C is fixed.

31. Write the expected mean square for AD, assuming a four factor factorial with A and B fixed, and C and D random. What term would be the denominator of an F-test of the AD mean square?

32. Assume you have a split-split plot with whole plots in an RCBD, where A = 3, B = 4, C =2, and R = 4. How many degrees of freedom are there for each of the error terms? Show how to compute a standard error for the difference between two B means (use numbers when possible), when all factors are fixed.

33. If you have ten treatments, how many independent linear contrasts can be calculated (one set)? How many degrees of freedom are associated with each contrast?

34. What criteria regarding the coefficients must be met in order for two linear contrasts to be independent?

35. You are to determine the effect of air at different temperatures, forced through wheat samples, on germination percentage of dried samples. Air temperatures used are 90, 100, 110, 120, 130, and 140 degrees. Using the treatment totals shown below (totals of four reps), compute:

    1) ss trts (linear),
    2) ss trts (quadratic),
    3) ss deviations from linear regression, and
    4) the `b` value on a 1 degree per plot basis.

Temps	90	100	110	120	130	140
	326	349	365	396	359	284

36. Calculate the sum of squares for A quad. x B lin. from the following treatment totals (r=4, C=3).

	a1	a2	a3	a4
b1	91	86	105	120
b2	102	116	112	139
b3	106	118	132	127

37. From the following table of treatment totals, calculate the SS A and SS B. Illustrate, using numbers where possible, how to compute SS AxB (do not do calculations). Assume A=4, B=3, C=2, r=4, RCBD; factorial.

	a1	a2	a3	a4	
b1	25	30	32	39	126
b2	27	33	32	48	148
b3	37	42	51	60	190
	89	105	123	147	

38. Show the coefficients you would use to compute the SS A(linear) x B(linear) for a 2 x 3 factorial, RCBD.

a1b1	a1b2	a1b3	a2b1	a2b2	a2b3

39. Assume you have five treatments and are going to make a set of orthogonal contrasts. Write the first row of coefficients to compare the average of treatments 1 and 3 with the average of treatments 2, 4, and 5. Write the coefficients for the remaining comparisons.

	t1	t2	t3	t4	t5
Comp 1					

40. Assume you have 5 treatments and you make the following single degree of freedom comparisons. Are the two comparisons independent of one another? Compute SSQ, if r = 3.

	t1	t2	t3	t4	t5	Q	SS Q
Trt totals	40	50	60	70	75		
	-2	-2	-2	3	3		
	1	0	0	-1	0		

41. Assume you have six treatments in an RCBD. Write a linear contrast to compare the average of treatments one and two with the average of treatment 3, 4, 5, and 6. Complete a set of orthonogonal contrasts.

42. Assume you are testing different fertilizers on grass plots. You have two nitrogen levels, 50 and 100 pounds, and three phosphorous levels, 20, 40, and 60 pounds. Develop one complete set of meaningful orthogonal contrasts. Tell what each contrast is comparing.

43. Assume you are comparing four wheat varieties for grain yield in an RCBD with three replications. Two varieties are tall (t) and two are short (s). One of the tall varieties and one of the short varieties are early maturing (e) while the other two are late maturing (l). Using the following treatment totals, develop a meaningful set of orthogonal contrasts. Calculate Q values for each comparison and indicate the kr values.

	t,e	t,l	s,e	s,l	Q	kr
Trt total	122	140	135	164		

44. Given the following data, compute the simple effects of A and B for an RCBD.

	rep 1	rep 2	rep 3
a1b1	5	4	6
a1b2	7	6	8
a2b1	8	9	10

a2b2	12	11	13

45. Given the following table of treatment means, r=3, compute the main effect of A and the effect of AxB.

	a1	a2
b1	25	50
b2	40	80

46. From the following table of treatment totals, compute the simple effects of A, simple effects of B, main effect of A, main effect of B, and interaction effect. Label each answer.

	a1	a2
b1	60	75
b2	70	100

47. Can you have sampling within the experimental units of an RCBD with a split-split plot arrangement?

48. Show (diagram) and tell how to randomize a split-block; two replicates, three levels of A and four levels of B.

49. Assume you have a split-plot arrangement of an RCBD, and r=4, A=6, and B=3. The following table shows the treatment totals. Show how to compute the sums of squares for A linear and A quadratic (you don`t need to actually compute, but use numbers). How many other orthogonal comparisons could be made to complete the set for A?

	a1	a2	a3	a4	a5	a6	
b1 :	15	20	20	25	25	20 :	125
b2 :	20	25	25	35	30	30 :	165
b3 :	20	20	25	25	30	30 :	150
:	55	65	70	85	85	80	440

50. Use data from problem 49 and assume A represents levels of nitrogen fertilizer in equal increments from 0 to 100 and B represents levels of phosphorus fertilizer in equal increments from 0 to 100. Show how to set up the computations to compute a `regression coefficient which will show the average response to one pound of phosphorous fertilizer on an individual plot basis.

51. Use the data from problem 49 and show the numerical values for the components of the denominator when calculating the sums of squares for the A quad. x B lin. term?

52. Assume you have a split-split plot arrangement in which the whole plots are a CRD. The number of repetitions and levels

of each factor are as follows: r=4, A=3, B=2, and C=4. List the sources of variation and the degrees of freedom for each source.

53. How many sub-plot totals would be squared to compute the sums of squares of subplot totals in problem 53.

54. Using the situation of problem 53, show symbolically how to compute the SS AxC.

55. Given the situation in problem 53, show how to compute the variance of a difference between two C treatment means assuming all factors are fixed.

56. Show the sources of variation and degrees of freedom for a split-plot in time in which there were four complete sets of readings taken on the same experimental units. Readings were recorded every 24 hours over a four day period. Assume the basic design is five treatments and four replicates.

57. List the steps in randomizing a split-plot. You may choose whatever design you want for the whole plots. Draw a diagram of the experiment, showing the randomized arangement of treatment combinations on the experimental units. You choose the number of levels of the factors and reps.

58. Examine the following diagram. What type of design and/or arrangement is it? Designate one rep, one whole plot, one sub-plot, and one sub-subplot, if present.

a1b4c2	a1b2c2	a3b3c2	a3b2c2	a2b2c1	a2b1c2
a1b3c2	a1b3c1	a3b4c2	a3b2c1	a2b4c1	a2b3c1
a1b4c1	a1b1c2	a3b1c2	a3b3c1	a2b1c1	a2b2c2
a1b2c1	a1b1c1	a3b1c1	a3b4c1	a2b3c2	a2b4c2
a2b2c2	a2b3c1	a3b3c2	a3b4c1	a1b1c1	a1b3c2
a2b1c2	a2b3c2	a3b2c2	a3b4c2	a1b3c1	a1b4c2
a2b1c1	a2b4c2	a3b1c1	a3b2c1	a1b2c1	a1b2c2
a2b2c1	a2b4c1	a3b3c1	a3b1c2	a1b4c1	a1b1c2
a2b1c2	a2b2c1	a1b2c1	a1b1c2	a3b2c2	a3b4c1
a2b4c2	a2b3c1	a1b4c2	a1b1c1	a3b2c1	a3b1c1
a2b3c2	a2b1c1	a1b4c1	a1b2c2	a3b1c2	a3b3c2
a2b2c2	a2b4c1	a1b3c1	a1b3c2	a3b4c2	a3b3c1

59. Examine the following diagram. What type of design and/or arrangement is it? Assume A is fixed, and B and C are random. Show how to calculate the variance of an AxC mean (use numbers when possible).

a3b2c1	a1b1c2	a3b2c1	a2b2c3	a2b2c2	a1b1c3
a3b2c3	a1b1c1	a3b2c2	a2b2c1	a2b2c1	a1b1c1
a3b2c2	a1b1c3	a3b2c3	a2b2c2	a2b2c3	a1b1c2

a3b1c3 a1b2c3 a3b1c2 a2b1c1 a2b1c2 a1b2c1
a3b1c1 a1b2c2 a3b1c3 a2b1c3 a2b1c1 a1b2c3
a3b1c2 a1b2c1 a3b1c1 a2b1c2 a2b1c3 a1b2c2

PLSC 724 PRACTICE EXAM 3 ANSWERS

1. Soil uniformity- if exp units are uniform, a CRD probably is best. If exp units are not uniform overall but blocks of uniform exp units can be used, an RCBD is best. if there are gradients in two directions, consider a Latin square, but a 10x10 is quite large for a Latin square and you may lose as much as you might gain.

2. Highest- CRD
   Lowest- Latin square

3. r = 0.378
   Y-intercept = 3.5
   Regression coefficient = 0.5
   SS due to regression = 2

4. At X bar (the mean of the X`s)

5. Variance of the regression coefficient =0.2
   Variance of a predicted y mean =8.0

6. SS X = 1000
   SS Y = 1796.8
   SS cross product = 1320.0

7. That for every degree rise in temperature, there was an 0.8 cm increase in circumference of colonies.

8. Y-intercept=18.62
   Regression coefficient= 2.77
   r = 0.955
   F-value for test= 74.46
   Variance of regression= 0.1029
   Y hat for X=30 = 101.72
   Variance of a predicted Y mean at X=30 = 9.33
   CI for the regression coefficient; LCI = 2.01 UCI= 3.53
   The null hypothesis would be rejected since the CI does not include zero.

9. 1) F-test
   2) t-test
   3) confidence interval

10. The null hypothesis such that rho= 0

11. Regression coefficient: upper limit=infinity
    lower limit= negative infinity
    r: upper limit =1 lower limit = -1

r squared lower limit = 0.0 upper limit = 1.0

12. SS of deviation from regression = SS residual

13. SS AWPT (A as whole plot) = 435.187
SS AWPT (B as whole plot) = 267.187
SS ASPT (A as whole plot, B as subplot, C as sub-sub plot
= 707.437

14. Regression coefficient = 0.64
Y-intercept = 41.8
r = 0.717
Dev due to reg. SS = 716.8
Dev from regression SS = 679.2
Y hat for x=75 = 89.8

15. Because we are checking 1 independent variable
with one dependent variable.

16. A 3 to the fourth power factorial has four
factors each having 3 levels. A 3 x 4 factorial
has factor A with 3 levels and factor B with
4 levels.

17. 8 x 8

18. Reps within locations = 12
error = 132

19. For A, use Loc x A; for AxB, use Loc x A x B

20. Variance of a treatment mean for A =
AxB MS/4x5
Variance of a treatment mean for B =
Error MS/3x5
Variance of a treatment mean for AxB =
Error MS/5

21. a) B = sigma square + ra sigma square BC +
rac sigma square B
b) Use estimated mean square for BxC. BC =
sigma square + ra sigma square BC

22.

sov	df
Variety	5
Rate	2
Rate lin	1
Rate quad	1
V x R	10
Error	54
Total	71

23. a) Error = 87

b) Err(a) = 12, Err(b) = 15, Err(c) = 60
c) Err(a) = 27, Err(b) = 60
d) Err(a) = 12, Err(b) = 3, Err(c) = 12, Err(d) = 60
e) The square root of the quantity
   2 x Err b MS/(4 x 5 x 3)

24. Error a = 42
Error b = 112
a) C = sigma square + ra sigma square BC + rab sigma square C
   BC= sigma square + ra sigma square BC
b) C = bc
   BC= error b

25. A with greatest precision- factorial
B with greatest precision- split-plot

26. a) split-plot, whole plots a factorial arrangement of A and B
b) factorial
c) split-block of A and B, C as subplots

27. C MS = sigma square + ra sigma square BC + rab sigma square C

28. BC MS

29. B MS = sigma square + rc sigma square AB + rac sigma square B

30. B MS = sigma square + rc sigma square AB + rac sigma square B

31. AD MS = sigma square+ rb sigma square ACD + rbc sigma square AD
denominator would be the ACD ems

32.

Error term	df
Error a	6
Error b	27
Error c	36

Standard error = the square root of the quantity
Err (b) MS x 2/(4x3x2)

33. 9 independent linear contrasts
1 df each

34. Summ ci = 0; summ cicj = 0.

35. 1) SS TRTS (linear) = 79.3
2) SS TRTS (quadratic) = 1466.68
3) SS Deviations = 1741.1

4) b = -0.05

36. 14.26

37. SS A = 77.5
SS B = 64.0

$$SS\ AxB = \frac{(25^2 + \ldots + 60^2)}{4 \times 2} - cf - 77.5 - ssb$$

38.

	a1b1	a1b2	a1b3	a2b1	a2b2	a2b3
al	-1	-1	-1	1	1	1
bl	-1	0	1	-1	0	1
albl	1	0	-1	-1	0	1

39.

	t1	t2	t3	t4	t5
comp 1	-3	2	-3	2	2
	1	0	-1	0	0
	0	-2	0	1	1
	0	0	0	-1	1

40. No, the comparisons are not independent .
SS Q = 202.5 for first comparison
SS Q = 150.0 for second comparison

41.

t1	t2	t3	t4	t5	t6
-4	-4	2	2	2	2
-1	1	0	0	0	0
0	0	-3	1	1	1
0	0	0	-2	1	1
0	0	0	0	-1	1

42.

n		p		
50	100	20	40	60	
-3	-3	2	2	2	n vs p
-1	1	0	0	0	n1 vs n2
0	0	-1	0	1	p lin
0	0	1	-2	1	p quad

43.

		t,e	t,l	s,e	s,l		
trt	total	122	140	135	164	q	kr
		-1	-1	1	1	37	12
		-1	1	0	0	18	6
		0	0	-1	1	29	6

44. Simple effects of A at b1 = 4
Simple effects of A at b2 = 5
Simple effects of B at a1 = 2
Simple effects of B at a2 = 3

45. Main effect of A = 32.5
    Effect of AxB = 7.5

46. Simple effect A = 3, 6
    Main effect A = 4.5
    Simple effect B = 2, 5
    Main effect B = 3.5
    Effect AxB = 1.5

47. Yes

48. rep 1 a2 a3 a1 a4 rep 2 a4 a2 a1 a3
    b1 b2
    b3 b1
    b2 b3

    levels of A were randomized separately for each rep
    levels of B were randomized separately for each rep

49. SS Al=$\frac{(55x-5)+(65x-3)+(70x-1)+(85x1)+(85x3)+(80x5)!}{70x4x3}$

    SS Aq=$\frac{(55x5)+(65x-1)+(70x-4)+(85x-4)+(85x-1)+(80x5)!^2}{84x4x3}$

    3 more orthogonal contrasts could be made

50. $\frac{(150 - 125)}{(6x2x4x50)}$

51. k x r = 168 x 4

52.

SOV	df
A	2
Err(a)	9
A	1
AxB	2
Err(b)	9
C	3
AxC	6
BxC	3
AxBxC	6
Err(c)	54

53. 24

54. SS AxC= Summ. $X.j.l^2$ /rb - cf - SS A - SS C

55. = 2 x Err c MS/rab

56.

SOV	df
Reps	3
Treatments	4
Err(a)	12
Dates	3
Err(b)	9
Date x trts	12
Err(c)	36
Total	79

57. Steps for randomization
    1) randomize A within reps
    2) randomize B within A

58. RCBD A whole plot B x C factorial

59. CRD; split-split plot arrangement,
    variance of an AxC mean = ABC MS/2x2