AFRICA UNIVERSITY
(A United Methodist-Related Institution)

"Investing in Africa's Future"

FACULTY OF AGRICULTURE AND NATURAL RESOURCES

2016 END OF FIRST SEMESTER EXAMINATIONS

COURSE CODE:	ACP 501
COURSE TITLE:	BIOSTATISTICS
DATE:	NOVEMBER-DECEMBER 2016
TIME:	3 HOURS

INSTRUCTIONS

Answer **ALL** Questions in **SECTION A** and **ANY TWO (2)** Questions from **SECTION B**

The mark allocation for each question is indicated at the end of the question

Credit will be given for logical, systematic and neat presentations.

Section A.

Answer all questions

QUESTION 1

What are the underlying assumptions of the analysis of variance and how do you check for these assumptions. [8]

QUESTION 2

The response of soybeans to four seed treatments was measured in a Randomized Complete Block Design. Copy and complete the ANOVA table. [12]

Source	*DF*	*SS*	*MS*	*F*
Total	23	5195		
Blocks		2345		
			695	
Error	15			

a) Do the results indicate that there were differences among the treatments? Support your statement with a significance test using the tables provided at the end of this exam. [6]

b) The mean grain yield is 46 bu/acre. What is the Coefficient of Variation (CV%) for this experiment? show your work. [4]

c) What is the relative efficiency of this design compared to a CRD? [4]

d) Was blocking effective? What is your evidence? [6]

SECTION B

ANSWER ANY TWO QUESTIONS

QUESTION 3

The following data are given for the development rate of apple maggot pupae for different rearing temperatures.

X = rearing temperature in Celsius
Y = mean development per day

X	10.0	13.5	19.5	26.0	29.0
Y	0.10	0.322	1.10	2.15	2.25

$\Sigma X = 98,\ \Sigma X^2 = 2179.5$

$\Sigma Y = 5.92,\ \Sigma Y^2 = 11.0087$

$\Sigma XY = 147.92$

Pupae were placed individually in vials and assigned randomly to the five temperature treatments (X) in physically separated Schmitt insect storage boxes. Percent development per day was recorded for each pupa and the mean percent developed per day calculated (Y).

a. Plot the data. Does a linear relationship seem reasonable? [5]

b. Estimate the regression line for mean percent development per day and superimpose this line on your plot. [10]

c. Calculate the coefficient of determination and check for significance of the correlation coefficient at 5% confidence. [15]

QUESTION 4

You have been asked to study the effect of three depth of planting (S1=1 inch, S2=2 inches, S3=3 inches) and three methods of cultivation (C1=no till, C2=stubble mulch, C3=offset disk/harrow) on the yield of dryland wheat. You suspect that the effect of the depths of seeding may depend on the method of cultivation.

The width of the offset disk is 30 feet which is the same for the harrow. Your project owns a planter that can adjust the depth of seeding and row spacings to match the accepted practice in the dryland area. The maximum width of one pass of this planter is 10 feet. At your experimental site, soil texture is slightly heavier (higher clay content) at one end of the field than at the other.

It is inconvenient (but not impossible) to change the depth of planting on the planter. You are weighing the pros and cons of using a split-plot design vs a strip-plot design.

a) Give the field plan diagram for a single block of this experiment using:
1) a split-plot and
2) a strip plot arrangement of treatments. Include an example of randomization for each of the designs. [15]

b) Discuss the relative merits of each design in terms of :
1) the power to detect differences among treatments,
2) control of experimental error,
3) ease of statistical analysis and interpretation, and
4) logistic considerations in the field. Indicate which design you would choose and support your decision. [15]

QUESTION 5

i). Two plant breeders have collaborated to test their best varieties at ten locations representing the area where the varieties are likely to be produced. At the end of the season, they consult their resident biometricians to determine how best to analyze the data. One is told to consider locations to be a random effect, and the other is advised that the environments are fixed effects. You are called in to settle the dispute.

a) Would you consider the environments to be fixed or random? Support your answer. [5]

b) Would you consider the varieties to be fixed or random? Support your answer. [5]

c) Why does it matter whether environments and varieties are considered to be fixed or random? [5]

ii). You have a colleague who wishes to compare 100 experimental varieties of wheat. He is not sure whether to use an RBD, an augmented design, or a lattice design.

a) List three questions that you would ask to help him make a decision. Indicate how the answers to those questions would affect the choice of design. [8]

b) What is meant by an 'adjusted mean' in a lattice experiment? How do you decide whether to report adjusted means or arithmetic means for your treatments? [7]

End

List of formulae

$$SSTreat = \frac{\sum_{i=1}^{t} Y_i^2}{r_i} - \frac{G^2}{N}$$

$$SSTot = \frac{\sum_{i=1}^{n} Y_i^2}{} - \frac{G^2}{N}$$

$$SSColumns = \frac{\sum_{i=1}^{t} C_i^2}{t} - \frac{G^2}{N}$$

$$SSRows = \frac{\sum_{i=1}^{t} R_i^2}{t} - \frac{G^2}{N}$$

$$RepSS = \frac{\sum_{i=1}^{t} R_i^2}{ab} \quad \frac{G^2}{N}$$

$$ASS = \frac{\sum_{i=1}^{t} A_i^2}{rb} - \frac{G^2}{N}$$

$$BSS = \frac{\sum_{i=1}^{t} B_i^2}{ra} - \frac{G^2}{N}$$

$$LSD = \sqrt{\frac{2MSE}{r}}$$

$$CV = \frac{\sqrt{MSE}}{\bar{y}} * 100$$

$$L(\mu_i) = \bar{Y}_i \pm t_\alpha \sqrt{\frac{MSE}{r_i}}$$

$$r \geq 2\frac{CV^2}{D^2}(t_1 + t_2)^2$$

$$\beta_1 = \frac{n\sum XY - \sum X \sum Y}{n\sum X^2 - (\sum X)^2}$$

$$\bar{y} - \beta_1 \bar{x} = \beta_0$$

$$r = \frac{n\sum XY - \sum X \sum Y}{\sqrt{(n\sum X^2 - (\sum X)^2)(n\sum Y^2 - (\sum Y)^2}}$$

Statistical Tables

F Distribution 5% Points

Distribution

Denominator Numerator

df	1	2	3	4	5	6	7
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33

Student's t

(2-tailed probability)

df	0.4	0.2	0.05
1	1.376	3.078	12.706
2	1.061	1.886	4.303
3	0.978	1.638	3.182
4	0.941	1.533	2.776
5	0.920	1.476	2.571
6	0.906	1.440	2.447
7	0.896	1.415	2.365
8	0.889	1.397	2.306
9	0.883	1.383	2.262
10	0.879	1.372	2.228
11	0.876	1.363	2.201
12	0.873	1.356	2.179
13	0.870	1.350	2.160
14	0.868	1.345	2.145
15	0.866	1.341	2.131
16	0.865	1.337	2.120
17	0.863	1.333	2.110
18	0.862	1.330	2.101
19	0.861	1.328	2.093
20	0.860	1.325	2.086
21	0.859	1.323	2.080
22	0.858	1.321	2.074
23	0.858	1.319	2.069
24	0.857	1.318	2.064
25	0.856	1.316	2.060
26	0.856	1.315	2.056
27	0.855	1.314	2.052
28	0.855	1.313	2.048
29	0.854	1.311	2.045
30	0.854	1.310	2.042

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.9	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00004	.00003	.00003
-3.8	.00007	.00007	.00007	.00006	.00006	.00006	.00006	.00005	.00005	.00005
-3.7	.00011	.00010	.00010	.00010	.00009	.00009	.00008	.00008	.00008	.00008
-3.6	.00016	.00015	.00015	.00014	.00014	.00013	.00013	.00012	.00012	.00011
-3.5	.00023	.00022	.00022	.00021	.00020	.00019	.00019	.00018	.00017	.00017
-3.4	.00034	.00032	.00031	.00030	.00029	.00028	.00027	.00026	.00025	.00024
-3.3	.00048	.00047	.00045	.00043	.00042	.00040	.00039	.00038	.00036	.00035
-3.2	.00069	.00066	.00064	.00062	.00060	.00058	.00056	.00054	.00052	.00050
-3.1	.00097	.00094	.00090	.00087	.00084	.00082	.00079	.00076	.00074	.00071
-3.0	.00135	.00131	.00126	.00122	.00118	.00114	.00111	.00107	.00104	.00100
-2.9	.00187	.00181	.00175	.00169	.00164	.00159	.00154	.00149	.00144	.00139
-2.8	.00256	.00248	.00240	.00233	.00226	.00219	.00212	.00205	.00199	.00193
-2.7	.00347	.00336	.00326	.00317	.00307	.00298	.00289	.00280	.00272	.00264
-2.6	.00466	.00453	.00440	.00427	.00415	.00402	.00391	.00379	.00368	.00357
-2.5	.00621	.00604	.00587	.00570	.00554	.00539	.00523	.00508	.00494	.00480
-2.4	.00820	.00798	.00776	.00755	.00734	.00714	.00695	.00676	.00657	.00639
-2.3	.01072	.01044	.01017	.00990	.00964	.00939	.00914	.00889	.00866	.00842
-2.2	.01390	.01355	.01321	.01287	.01255	.01222	.01191	.01160	.01130	.01101
-2.1	.01786	.01743	.01700	.01659	.01618	.01578	.01539	.01500	.01463	.01426
-2.0	.02275	.02222	.02169	.02118	.02068	.02018	.01970	.01923	.01876	.01831
-1.9	.02872	.02807	.02743	.02680	.02619	.02559	.02500	.02442	.02385	.02330
-1.8	.03593	.03515	.03438	.03362	.03288	.03216	.03144	.03074	.03005	.02938
-1.7	.04457	.04363	.04272	.04182	.04093	.04006	.03920	.03836	.03754	.03673
-1.6	.05480	.05370	.05262	.05155	.05050	.04947	.04846	.04746	.04648	.04551
-1.5	.06681	.06552	.06426	.06301	.06178	.06057	.05938	.05821	.05705	.05592
-1.4	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
-1.3	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08226
-1.2	.11507	.11314	.11123	.10935	.10749	.10565	.10383	.10204	.10027	.09853
-1.1	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11702
-1.0	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13786
-0.9	.18406	.18141	.17879	.17619	.17361	.17106	.16853	.16602	.16354	.16109
-0.8	.21186	.20897	.20611	.20327	.20045	.19766	.19489	.19215	.18943	.18673
-0.7	.24196	.23885	.23576	.23270	.22965	.22663	.22363	.22065	.21770	.21476
-0.6	.27425	.27093	.26763	.26435	.26109	.25785	.25463	.25143	.24825	.24510
-0.5	.30854	.30503	.30153	.29806	.29460	.29116	.28774	.28434	.28096	.27760
-0.4	.34458	.34090	.33724	.33360	.32997	.32636	.32276	.31918	.31561	.31207
-0.3	.38209	.37828	.37448	.37070	.36693	.36317	.35942	.35569	.35197	.34827
-0.2	.42074	.41683	.41294	.40905	.40517	.40129	.39743	.39358	.38974	.38591
-0.1	.46017	.45620	.45224	.44828	.44433	.44038	.43644	.43251	.42858	.42465
-0.0	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46414