Homework Assignment #4

1. B.

Type 3 Analysis of Variance								
Source	DF	Sum of Squares	Mean Square	Expected Mean Square	Error Term	Error DF	F Value	Pr > F
Chemicals	3	180.132750	60.044250	Var(Residual) + 2 Var(Location*Chemicals) + Q(Chemicals)	MS(Location*Chemicals)	12	44.59	<.0001
Location	4	3.811500	0.952875	Var(Residual) + 2 Var(Location*Chemicals) + 8 Var(Location)	MS(Location*Chemicals)	12	0.71	0.6020
Location*Chemicals	12	16.158500	1.346542	Var(Residual) + 2 Var(Location*Chemicals)	MS(Residual)	20	3.89	0.0037
Residual	20	6.925000	0.346250	Var(Residual)	.	.	.	.

D.

Covariance Parameter Estimates	
Cov Parm	Estimate
Location	-0.04921
Location*Chemicals	0.5001
Residual	0.3462

Homework #4

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1. a. This is a mixed Effect model with Chemicals as fixed terms and locations are Randomly randomly

$$y_{ijk} = \mu + \alpha_i + B_j + \alpha B_{ij} + \varepsilon_{ijk} \qquad \begin{matrix} i = 1,2,3,4 \\ j = 1,2,3,4,5 \end{matrix}$$

μ = Overall mean, y_{ijk} = k^{th} response of $A_i B_j$
α_i = fixed Effect due to ith Chemicals
B_j = random Effect due to j^{th} location, $N(0, \sigma_B^2)$
αB_{ij} = Interaction Effect of i & j, $\alpha B_{ij} \sim N(0, \sigma_{\alpha B}^2)$
ε_{ijk} = random Error due to exp Unit k

$$\varepsilon_{ijk} \sim N(0, \sigma_\varepsilon^2)$$

c. For $\alpha = 0.05$, from ANOVA table

$H_0 \Rightarrow \alpha_i = 0$

When P value is $P < 0.05$. Which is low for level of Chemicals. Therefore we Reject H_0.

Therefore, There is a Significant Effect due to chemicals Used

> For Location at $H_0: \sigma_B^2 = 0$

Hence F Value is 0.71, $P > 0.05$ & $P = 0.602$

∴ We fail to Reject H_0

∴ There is no significant effect of level of location

⇒ location * Chemicals ⇒ $H_0: \sigma_{\alpha B}^2 = 0$

Hence, P Value is Very low $P = 0.0037$ then $P < 0.05$

Hence, There is Significant Interaction

∴ F Value = 3.89

2. Code:

```
ODS listing;
DM 'log; clear; output; clear;';
Options pageno=1 nodate ls=100;
DATA Weight;
INPUT Center program Gender$ Subject Wtloss @@;
DATALINES;
1 1 F 1 17.2299
1 1 F 2 15.7648
1 2 F 1 19.2342
1 2 F 2 18.0468
1 3 F 1 9.1973
1 3 F 2 8.6906
1 1 M 1 17.4656
1 1 M 2 15.9233
1 2 M 1 24.2613
1 2 M 2 25.3422
1 3 M 1 19.6999
1 3 M 2 18.3468
2 1 F 1 14.9102
2 1 F 2 15.5265
2 2 F 1 24.5785
2 2 F 2 22.9297
2 3 F 1 21.4465
2 3 F 2 19.4496
2 1 M 1 17.7488
2 1 M 2 18.6772
2 2 M 1 18.6206
2 2 M 2 19.6741
2 3 M 1 16.2433
2 3 M 2 16.958
3 1 F 1 9.4561
3 1 F 2 10.0818
3 2 F 1 19.9627
3 2 F 2 21.6687
3 3 F 1 20.5674
3 3 F 2 20.1926
3 1 M 1 14.5206
3 1 M 2 15.4205
3 2 M 1 16.1217
3 2 M 2 16.7883
3 3 M 1 11.7393
3 3 M 2 11.8407
4 1 F 1 18.468
4 1 F 2 17.854
4 2 F 1 25.7911
4 2 F 2 24.0275
4 3 F 1 15.1685
4 3 F 2 16.4565
4 1 M 1 15.0173
4 1 M 2 15.0015
4 2 M 1 23.053
4 2 M 2 23.3327
4 3 M 1 20.8105
4 3 M 2 20.9137
5 1 F 1 11.6695
```

```
5 1 F 2 12.1876
5 2 F 1 11.6978
5 2 F 2 10.0957
5 3 F 1 7.4432
5 3 F 2 5.9384
5 1 M 1 10.9597
5 1 M 2 11.2989
5 2 M 1 18.3452
5 2 M 2 18.1953
5 3 M 1 17.3051
5 3 M 2 17.2238
6 1 F 1 16.439
6 1 F 2 16.9725
6 2 F 1 26.3404
6 2 F 2 25.6193
6 3 F 1 23.5122
6 3 F 2 20.7551
6 1 M 1 19.4338
6 1 M 2 16.2848
6 2 M 1 19.9519
6 2 M 2 22.5633
6 3 M 1 17.4446
6 3 M 2 19.0843
7 1 F 1 10.1201
7 1 F 2 10.9801
7 2 F 1 15.4252
7 2 F 2 14.9049
7 3 F 1 16.3866
7 3 F 2 17.3304
7 1 M 1 13.9226
7 1 M 2 14.7064
7 2 M 1 25.6431
7 2 M 2 25.9734
7 3 M 1 20.9447
7 3 M 2 21.4765
8 1 F 1 11.4767
8 1 F 2 12.4374
8 2 F 1 34.4723
8 2 F 2 34.6249
8 3 F 1 20.801
8 3 F 2 20.3882
8 1 M 1 25.4748
8 1 M 2 25.3372
8 2 M 1 25.1632
8 2 M 2 25.9337
8 3 M 1 19.9659
8 3 M 2 20.9266
;
PROC GLM DATA=Weight alpha=0.01;
CLASS Center program Gender subject;
MODEL Wtloss=program|Gender|Center;
Random Center subject Center*program Center*Gender Center*Subject Center*program*Gender
Center*program*Subject Center*Gender*Subject;
*Test h=reagent e=reagent*catalyst;
Lsmeans program Gender  program*Gender/PDIFF;
MEANS program / LSD linestable;
```

```
MEANS Gender / LSD linestable;
RUN;
Proc Mixed data=Weight alpha=0.01;
class Center program Gender Subject;
Model Wtloss=program|Gender / ddfm=satterth;
Random Center subject Center*program Center*Gender Center*Subject Center*program*Gender
Center*program*Subject Center*Gender*Subject;
Lsmeans program Gender  program*Gender/PDIFF;
Title 'STAT 5023: Mixed Model SAS Example';
title2 'REML Estimates of the Variance Components';
Run;
Proc Mixed data=Weight alpha=0.01 method=type3;
class Center program Gender Subject;
Model Wtloss=program|Gender / ddfm=satterth;
Random Center subject Center*program Center*Gender Center*Subject Center*program*Gender
Center*program*Subject Center*Gender*Subject;
Title 'STAT 5023: Mixed Model SAS Example';
title2 'REML Estimates of the Variance Components';
run;
```

2.i

Source	Type III Expected Mean Square
program	Var(Error) + 2 Var(Center*progra*Subjec) + 2 Var(Center*progra*Gender) + 4 Var(Center*program) + Q(program,program*Gender,program*Subject,progra*Gender*Subjec)
Gender	Var(Error) + 3 Var(Center*Gender*Subjec) + 2 Var(Center*progra*Gender) + 6 Var(Center*Gender) + Q(Gender,program*Gender,Gender*Subject,progra*Gender*Subjec)
program*Gender	Var(Error) + 2 Var(Center*progra*Gender) + Q(program*Gender,progra*Gender*Subjec)
Center	Var(Error) + 3 Var(Center*Gender*Subjec) + 2 Var(Center*progra*Subjec) + 6 Var(Center*Subject) + 2 Var(Center*progra*Gender) + 6 Var(Center*Gender) + 4 Var (Center*program) + 12 Var(Center)
Center*program	Var(Error) + 2 Var(Center*progra*Subjec) + 2 Var(Center*progra*Gender) + 4 Var(Center*program)
Center*Gender	Var(Error) + 3 Var(Center*Gender*Subjec) + 2 Var(Center*progra*Gender) + 6 Var(Center*Gender)
Center*progra*Gender	Var(Error) + 2 Var(Center*progra*Gender)
Subject	Var(Error) + 3 Var(Center*Gender*Subjec) + 2 Var(Center*progra*Subjec) + 6 Var(Center*Subject) + 48 Var(Subject) + Q (program*Subject,Gender*Subject,progra*Gender*Subjec)
program*Subject	Var(Error) + 2 Var(Center*progra*Subjec) + Q(program*Subject,progra*Gender*Subjec)
Gender*Subject	Var(Error) + 3 Var(Center*Gender*Subjec) + Q(Gender*Subject,progra*Gender*Subjec)
progra*Gender*Subjec	Var(Error) + Q(progra*Gender*Subjec)
Center*Subject	Var(Error) + 3 Var(Center*Gender*Subjec) + 2 Var(Center*progra*Subjec) + 6 Var(Center*Subject)
Center*progra*Subjec	Var(Error) + 2 Var(Center*progra*Subjec)
Center*Gender*Subjec	Var(Error) + 3 Var(Center*Gender*Subjec)

Covariance Parameter Estimates

Cov Parm	Estimate	Alpha	Lower	Upper
Center	6.2298	0.01	1.3135	516.55
Subject	0	.	.	.
Center*program	0	.	.	.
Center*Gender	2.7250	0.01	0.3241	216291
Center*Subject	0	.	.	.
Center*progra*Gender	13.2800	0.01	7.1915	30.6090
Center*progra*Subjec	0	.	.	.
Center*Gender*Subjec	0	.	.	.
Residual	0.7014	0.01	0.4374	1.2700

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
program	2	28	13.17	<.0001
Gender	1	7.01	1.25	0.3003
program*Gender	2	28	0.62	0.5470

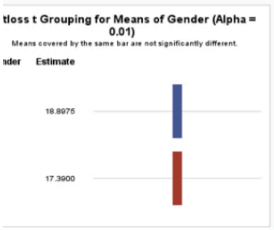
2 ii.

Differences of Least Squares Means									
Effect	Gender	program	_Gender	_program	Estimate	Standard Error	DF	t Value	Pr > |t|
program		1		2	-6.5505	1.3053	28	-5.02	<.0001
program		1		3	-2.0588	1.3053	28	-1.58	0.1260
program		2		3	4.4917	1.3053	28	3.44	0.0018
Gender	F		M		-1.5075	1.3480	7.01	-1.12	0.3003
program*Gender	F	1	M	1	-2.8512	2.0221	25.5	-1.41	0.1706
program*Gender	F	1	F	2	-7.9903	1.8460	28	-4.33	0.0002
program*Gender	F	1	M	2	-7.9618	2.0221	25.5	-3.94	0.0006
program*Gender	F	1	F	3	-2.6344	1.8460	28	-1.43	0.1646
program*Gender	F	1	M	3	-4.3343	2.0221	25.5	-2.14	0.0418
program*Gender	M	1	F	2	-5.1392	2.0221	25.5	-2.54	0.0175
program*Gender	M	1	M	2	-5.1106	1.8460	28	-2.77	0.0099
program*Gender	M	1	F	3	0.2168	2.0221	25.5	0.11	0.9155
program*Gender	M	1	M	3	-1.4832	1.8460	28	-0.80	0.4285
program*Gender	F	2	M	2	0.02854	2.0221	25.5	0.01	0.9888
program*Gender	F	2	F	3	5.3560	1.8460	28	2.90	0.0072
program*Gender	F	2	M	3	3.6560	2.0221	25.5	1.81	0.0824
program*Gender	M	2	F	3	5.3274	2.0221	25.5	2.63	0.0141
program*Gender	M	2	M	3	3.6275	1.8460	28	1.97	0.0594
program*Gender	F	3	M	3	-1.7000	2.0221	25.5	-0.84	0.4083

Alpha	0.01
Error Degrees of Freedom	48
Error Mean Square	0.701412
Critical Value of t	2.68220
Least Significant Difference	0.4585

Means with the same letter are not significantly different.

t Grouping	Mean	N	Gender
A	18.8975	48	M
B	17.3900	48	F



Alpha	0.01
Error Degrees of Freedom	48
Error Mean Square	0.701412
Critical Value of t	2.68220
Least Significant Difference	0.5616

Means with the same letter are not significantly different.

t Grouping	Mean	N	program
A	21.8245	32	2
B	17.3327	32	3
C	15.2740	32	1

For gender level, using fisher LSD, BOTH are significantly different and has significance difference = 0.4585
For program level all are significantly different by LSD =0.5616