STAT 514 Homework#8 (Due Thursday 11/05/15 BEFORE CLASS)

- **0.** Problem 3 from Homework#7.
- An experiment was performed to investigate the capability of a measurement system. Ten parts were randomly selected, and two operators measured each part three times. The tests were made in random order, and the data below resulted. Assume that the operators are a fixed factor.

	Operator 1			Operator 2		
Parts	1	2	3	1	2	3
1	50	49	50	50	48	51
2	52	52	51	51	51	51
3	53	50	50	54	52	51
4	49	51	50	48	50	51
5	48	49	48	48	49	48
6	52	50	50	52	50	50
7	51	51	51	51	50	50
8	52	50	49	53	48	50
9	50	51	50	51	48	49
10	47	46	49	46	47	48

- (a) Describe a restricted mixed model for this experiment.
- (b) Work out the ANOVA table with the expected mean squares.
- (c) Estimate the fixed effects and variance components (using ANOVA method).
- (d) Propose an appropriate F-test for each set of effects.
- (e) Find 95% confidence intervals on the variance components (the Satterthwaite method may be used for some components).
- 2. Redo Problem 1 using the unrestricted mixed model.
- 3. You are interested in studying two factors (operator and machine) that may influence the breaking strength of a synthetic fiber. Four production machines and three operators are investigated using a factorial design with two replicates at each combination of factors. Using $\alpha = .05$ and the SAS results below,

Dependent Variable: Y

		Sum of	Mean
Source	DF	Squares	Square
Model	11	526.70812314	47.88255665

Error		12	1.86216148	0.15518012	
Corrected Total		23	528.57028462		
Source		DF	Type I SS	Mean Square	
МАСН		3 75.42655320		25.14218440	
OPER		2 296.83487270		148.41743635	
OPER*MACH		6	154.44669724	25.74111621	
Level of	Level of		YY		
OPER	MACH	Ν	Mean	SD	
1	1	2	30.1896300	0.62791082	
1	2	2	36.5580300	0.09107535	
1	3	2	34.3030900	0.27660603	
1	4	2	30.3998150	0.39434638	
2	1	2	28.7647400	0.13184713	
2	2	2	35.7989300	0.70048826	
2	3	2	34.1403100	0.24439025	
2	4	2	29.7922450	0.03714432	
3	1	2	22.4060100	0.04992174	
3	2	2	20.9867700	0.25635449	
3	3	2	26.7772800	0.59825476	
3	4	2	30.0718950	0.48195691	

- (a) Perform the proper F-tests assuming both factors are **random**.
- (b) Give variance component estimates using the ANOVA method.
- (c) What is the estimate of the grand mean μ ?
- (d) What is the variance of the estimate μ (HINT: Use approach similar to slide 10-6. It will involve a linear combination of mean squares.)?
- 4. (Refer to Problem 3) Suppose the three operators are of specific interest (fixed) but the machines are chosen at random.
 - (a) Perform the proper F-tests using the restricted model.
 - (b) Give variance component estimates using the ANOVA method.
 - (c) Compare the three operators using Tukey's method.