```
/* Montgomery 13.7 */
proc import datafile="/home/u63048916/STAT571B/Homework/Homework 7/Q13-2.xlsx"
    dbms=xlsx
    out=randr
    replace;
    getnames=yes;
run;

/* 2.2: mixed effect (1 fixed: operator + 1 random: part) model */


/* restricted */
/* for the fixed factor "operator", specify its' denominator for the others just use the usual ANOVA table output*/
/* need to do hand calculation for the "part" or just use the result from the first table for "part" */
proc glm data=randr;
class Inspector Part;
model Impedance=Inspector|Part;
random Part Inspector*Part/test;
lsmeans Inspector / adjust=tukey E=Inspector*Part tdiff stderr;
run;


/* unrestriced*/
/* (by glm) */
/* no need to do any hand calculation */
proc glm data=randr;
class Inspector Part;
model Impedance=Inspector|Part;
random  Part Inspector*Part/test;
lsmeans Inspector / adjust=tukey E=Inspector*Part tdiff stderr;
run;


/* unrestriced*/
/* (by mixed) */
proc mixed data=randr alpha=.05 cl covtest;
class Inspector Part;
model Impedance=Inspector / ddfm=kr;
random Part Inspector*Part;
lsmeans Inspector / alpha=.05 cl diff adjust=tukey;
run;
```

13.7. Reanalyze the measurement system experiment in Problem 13.2, assuming that operators are a fixed factor. Estimate the appropriate model components using the ANOVA method.

13.2. An article by Hoof and Berman ("Statistical Analysis of Power Module Thermal Test Equipment Performance," *IEEE Transactions on Components, Hybrids, and Manufacturing Technology* Vol. 11, pp. 516–520, 1988) describes an experiment conducted to investigate the capability of measurements in thermal impedance (C°/w × 100) on a power module for an induction motor starter. There are 10 parts, three operators, and three replicates. The data are shown in Table P13.2.

TABLE P13.2
Power Module Thermal Test Equipment Data for Problem 13.2

	Inspector 1			Inspector 2			Inspector 3		
	Test			Test			Test		
Part No.	1	2	3	1	2	3	1	2	3
1	37	38	37	41	41	40	41	42	41
2	42	41	43	42	42	42	43	42	43
3	30	31	31	31	31	31	29	30	28
4	42	43	42	43	43	43	42	42	42
5	28	30	29	29	30	29	31	29	29
6	42	42	43	45	45	45	44	46	45
7	25	26	27	28	28	30	29	27	27
8	40	40	40	43	42	42	43	43	41
9	25	25	25	27	29	28	26	26	26
10	35	34	34	35	35	34	35	34	35

(**a**) Analyze the data from this experiment, assuming that both parts and operators are random effects.

(**b**) Estimate the variance components using the analysis of variance method.

(**c**) Estimate the variance components using the REML method. Use the confidence intervals on the variance components to assist in drawing conclusions.

Need to check assumptions

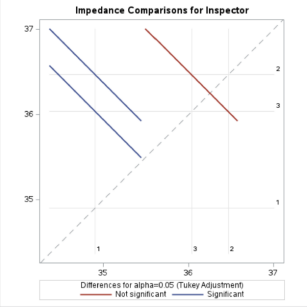

Figure 13.7.3

See Figure 13.7.3, pairwise comparisons indicate that Inspector 1 is different from 2 and 3, but 2 and 3 are not different. Figure 13.7.2 show the Part factor and the Inspector*Part interaction factor are individually significant at an $\alpha = 0.05$ level.

$$\hat{\sigma}^2 = MS_{Error} = 0.511$$

$$\hat{\sigma}^2_{\beta} = \frac{MS_{Part} - MS_{Error}}{n} = \frac{437.33 - 0.511}{3*3} = 48.535$$

$$\hat{\sigma}^2_{\tau\beta} = \frac{MS_{Inspector*Part} - MS_{Error}}{n} = \frac{2.695 - 0.511}{3} = 0.728$$