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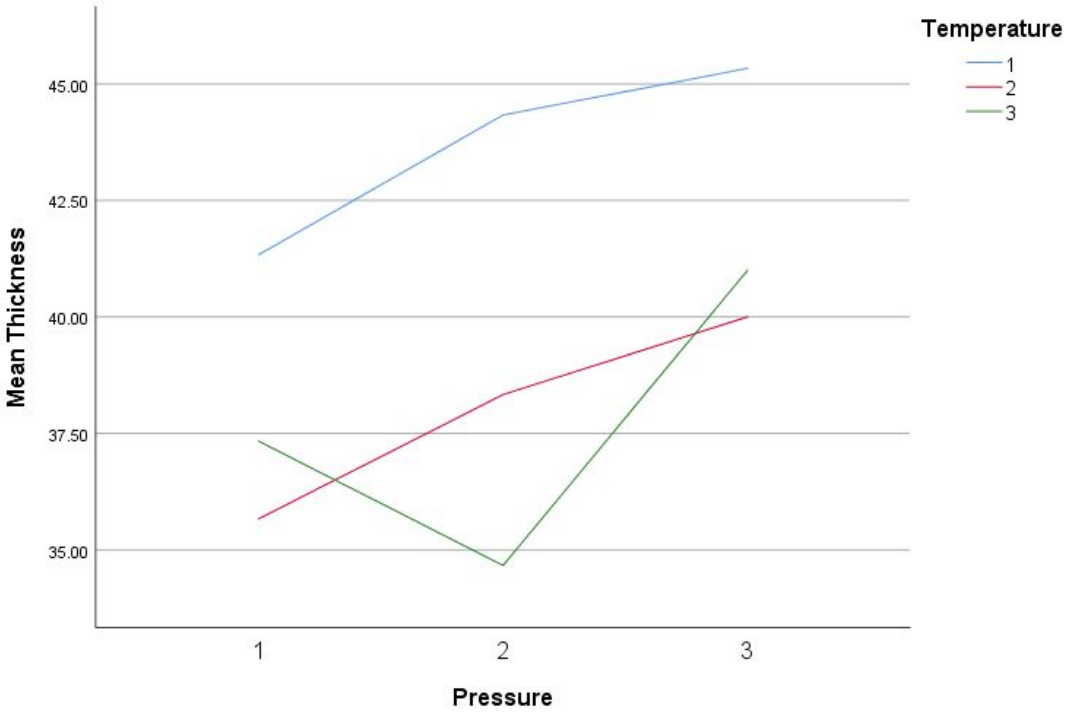
STATS 252

1.(a)Experimental unit is the film coatings. Response is thickness. It is measured by a process called infrared interference and the unit is angstroms. The levels of factors are temperature and pressure.

(b) Factors are selected to conduct experiment so it's an experimental study. So casual inference can be made. But random selection is not satisfied so we can not have population inference.

2.(a)



There is a positive approximately linear relationship between pressure and graph.
For temperature, lowest temperature produces highest thickness but for temperature 2 and 3, they have similar thicknesses. We can not tell one of the two factors has greater effect. Temp 3 and pressure 2 produces the thinnest thickness.

(b) Report

Thickness

Pressure	Temperature	Mean	N	Std. Deviation
1	1	41.3333	3	2.08167
	2	35.6667	3	1.52753
	3	37.3333	3	.57735
	Total	38.1111	9	2.84800
2	1	44.3333	3	1.15470
	2	38.3333	3	1.15470
	3	34.6667	3	1.52753
	Total	39.1111	9	4.37163
3	1	45.3333	3	1.52753
	2	40.0000	3	2.00000
	3	41.0000	3	1.00000
	Total	42.1111	9	2.80377
Total	1	43.6667	9	2.29129
	2	38.0000	9	2.34521
	3	37.6667	9	2.91548
	Total	39.7778	27	3.71414

Higher pressure leads to greater marginal mean of thickness so there is positive relation between pressure and thickness.

Higher temperature leads to lower marginal mean of thickness so there is a negative relation between temperature and thickness.

3.(a)

Tests of Between-Subjects Effects

Dependent Variable: Thickness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	320.000a	8	40.000	18.621	.000
Intercept	42721.333	1	42721.333	19887.517	.000
pressure	78.000	2	39.000	18.155	.000
temp	204.667	2	102.333	47.638	.000
pressure * temp	37.333	4	9.333	4.345	.012
Error	38.667	18	2.148		
Total	43080.000	27			
Corrected Total	358.667	26			

a R Squared = .892 (Adjusted R Squared = .844)

The two main effects are pressure and temperature and the the interaction is between pressure and temperature.

Temperature: H0: there is no effect of temperature on thickness. P-value = 0.000 reject H0 So there is an effect of temperature on thickness.

Pressure: H0: there is no effect of pressure on thickness. P-value = 0.000 reject H0 So there is an effect of pressure on thickness.
Interaction: H0: there is no interaction between pressure and temperature. P-value = 0.012 reject H0. So there is an interaction between pressure and temperature.

(b)
Multiple Comparisons
Dependent Variable: Thickness
Tukey HSD

(I) Temperature	(J) Temperature	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	5.6667*	.69092	.000	3.9033	7.4300
	3	6.0000*	.69092	.000	4.2367	7.7633
2	1	-5.6667*	.69092	.000	-7.4300	-3.9033
	3	.3333	.69092	.880	-1.4300	2.0967
3	1	-6.0000*	.69092	.000	-7.7633	-4.2367
	2	-.3333	.69092	.880	-2.0967	1.4300

Based on observed means.
The error term is Mean Square(Error) = 2.148.
* The mean difference is significant at the 0.05 level.

For temperature, level 1 and level 3 are different, level 1 and level 2 are different.

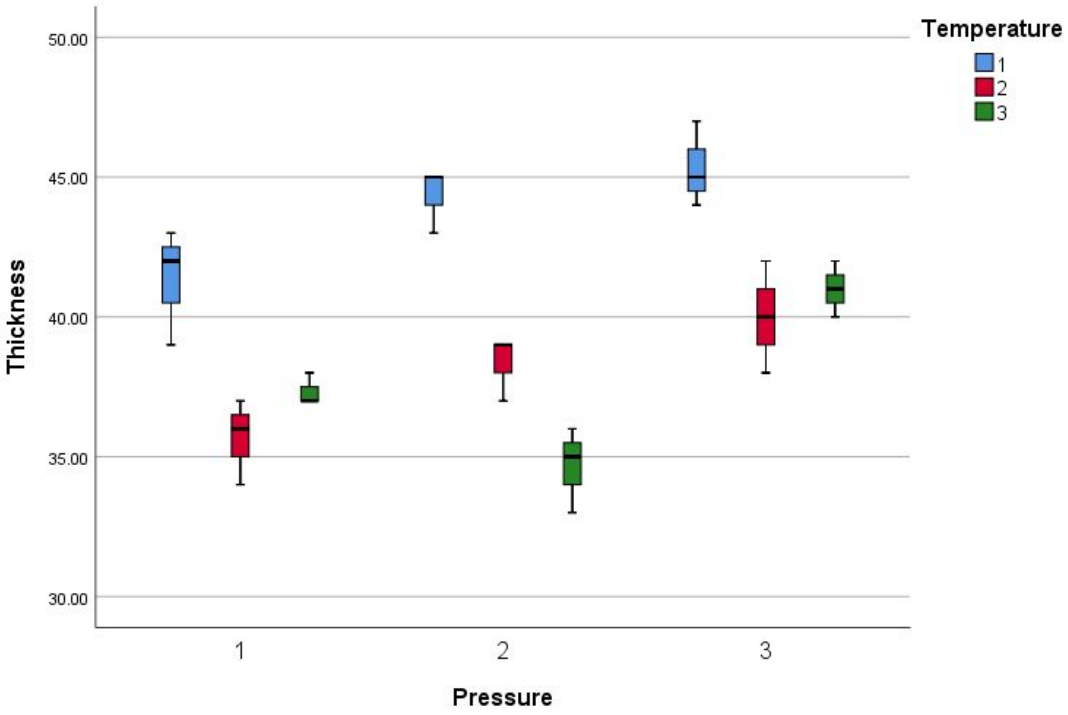
Multiple Comparisons
Dependent Variable: Thickness
Tukey HSD

(I) Pressure	(J) Pressure	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-1.0000	.69092	.339	-2.7633	.7633
	3	-4.0000*	.69092	.000	-5.7633	-2.2367
2	1	1.0000	.69092	.339	-.7633	2.7633
	3	-3.0000*	.69092	.001	-4.7633	-1.2367
3	1	4.0000*	.69092	.000	2.2367	5.7633
	2	3.0000*	.69092	.001	1.2367	4.7633

Based on observed means.
The error term is Mean Square(Error) = 2.148.
* The mean difference is significant at the 0.05 level.

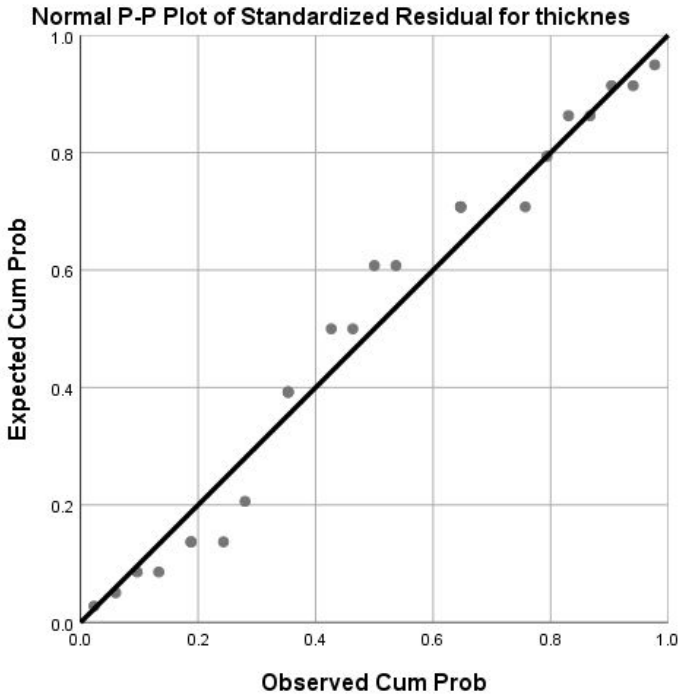
For pressure, level 1 and level 3 are different, level 3 and level 2 are different.

4.(a)



Since every box only contains 3 elements, so the boxplot is not reliable.For levene' test p-value = 0.633 which is large enough , so do not reject H0 and equal variance can be assumed.

(b)



Normality assumption can be assumed.