Charles Liu
304804942
Stats 101B
Disc. 3A
4-18-20

①

Source	DF	SS	MS	F	P
Factor	?= 4	?= 987.71	246.93	?= 33.10	?= P<0.00001
Error	25	186.53	?=7.46		
Total	29	1174.24			

$SST = SSR + SSE$

$MS = \frac{SS}{DF}$

$F = \frac{MSR}{MSE}$

② ⓐ

Dosage	Observations				Total($Y_{i.}$)	n	$\bar{Y}_{i.}$
20g	24	28	37	30	119	4	29.75
30g	37	44	31	35	147	4	36.75
40g	42	47	52	38	179	4	44.75
					445	12	37.08

ANOVA Table

Source	DF	SS	MS	F	P
Dosage	2	453.63	226.82	7.16	P<0.05 ✱
Error	9	285.29	31.70		
Total	11	738.92			

$(24-37.08)^2 + (28-37.08)^2 + (37-37.08)^2 + (30-37.08)^2 = 303.6656$ SST

$(37-37.08)^2 + (44-37.08)^2 + (31-37.08)^2 + (35-37.08)^2 = 89.1856$

$(42-37.08)^2 + (47-37.08)^2 + (52-37.08)^2 + (38-37.08)^2 = 346.0656$

738.9168

Answers off slightly from RStudio since I rounded up

$SSE = SST - SSR = 285.29$

(4) $\sum_i (29.75)^2 + (36.75)^2 + (44.75)^2 - (12)(37.08)^2 = (16952.75) - (16499.1168) =$

$SSR = 453.6332$

$F_0 > F_{0.05,2,9}$

$7.16 > (4.26)$ Reject!

(b) "done in RStudio"

(c) Since the $F_0 > F_{0.05,2,99}$ we Reject the Null Hypothesis and say that there is Significant difference between Dosage & Bioactivity. (Dosage affects bioactivity)

(d) Yes, it would be appropiate to compare between pairs of means because we need to check our Power test (β) to see if we might've made a Type II Error. The F-test had the Null Rejected, too.

(e) $H_0: \mu_i = \mu_j$ for
$H_a: \mu_i \neq \mu_j$ if at least one (i)

$$T_{ij} = \frac{\bar{Y}_i - \bar{Y}_j}{\sqrt{\frac{MSE}{n_i} + \frac{MSE}{n_j}}} \longrightarrow |T_{ij}| > \underbrace{\frac{1}{\sqrt{2}} q_\alpha(a, N-a)}_{2.79}$$

"Work done in RStudio"

$$T_{20g,30g} = \left| \frac{(29.75 - 36.75)}{\sqrt{\frac{32.028}{4 \cdot 2} \cdot \left(\frac{2}{1}\right)}} \right| = 1.75 > 2.79 \; \otimes$$

$$T_{20g,40g} = \left| \frac{(29.75 - 44.75)}{\sqrt{\frac{32.028}{2 \cdot 2} \cdot \left(\frac{2}{1}\right)}} \right| = 3.75 > 2.79 \; ✓$$

$$T_{30g,40g} = \left| \frac{(36.75 - 44.75)}{\sqrt{\frac{32.028}{4 \cdot 2} \cdot \left(\frac{2}{1}\right)}} \right| = 1.999 > 2.79 \; \otimes$$

We fail to Reject the Null, and we can say they are NOT significantly different for the means

(f) "Plots done in RStudio"

We can see that the Normal Plot & Residuals Plot have their assumptions satisfied

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(3) (a)

Coating Type	Conductivity				$Y_{i.}$	n	$\bar{Y}_{i.}$
1	143	141	150	146	580	4	145
2	152	149	137	143	581	4	145.25
3	134	136	132	127	529	4	132.25
4	129	127	132	129	517	4	129.25
Total					2207	16	137.9375

$$SST = \sum_i \sum_j Y_{ij}^2 - N \cdot \bar{Y}_{..}^2 \rightarrow (143^2 + 141^2 + \cdots + 129^2) - (16)\cdot(137.9375^2) \Rightarrow$$

$$(305509) - (304428.0625) = 1080.9375 = SST$$

$$SSR = n \sum_i \bar{Y}_{i.}^2 - N \cdot \bar{Y}_{..}^2 = (145^2 + \cdots + 129.25^2)(4) - (16)(137.9375^2) \Rightarrow$$

$$(305272.75) - (304428.0625) = 844.6875 = SSR$$

$$SSE = SST - SSR \rightarrow (1080.9375) - (844.6875) = 236.25 = SSE$$

ANOVA table

Source	DF	SS	MS	F	P
Coating Type	3	844.6875	281.5625	14.302	$P < 0.05$ ***
Error	12	236.25	19.6875		
Total	15	1080.9375			

$F_0 > F_{\alpha, a-1, N-a}$ Reject!
$14.302 > 3.49$

(b) "done in RStudio"

(c) $F_0 > F_{0.05,3,12}$ [$14.302 > 3.49$] Therefore, we Reject the Null Hypothesis and say there is a significant difference between Coating Type & Conductivity.

(d) $$(\mu_1 - \mu_4) \pm t_{\frac{\alpha}{2}, N-a} \cdot \sqrt{\frac{MSE \cdot (2)}{n}} \rightarrow (145 - 129.25) \pm (3.055) \cdot \sqrt{\frac{(19.6875)(2)}{4}}$$

$$= [6.17, 25.33]$$ Confidence Interval for 99%

(e) "Work in RStudio" We fail to Reject the Null Hypothesis, and we say there is No significant difference between means.

(f) "Plots in RStudio" We can see both Normal & Residual Plots have their assumptions satisfied.

(4) $\mu_1 = 50$ $\quad \alpha = 0.05$ $\quad \mu_i = \mu + \tau_i$ for $i = 1, \ldots, 4$

$\mu_2 = 60$ $\quad \sigma^2 = 25$

$\mu_3 = 50$ $\quad \mu = \frac{\Sigma \mu_i}{a} = \left(\frac{220}{4}\right) = 55$

$\mu_4 = 60$ $\quad \tau_i = (\mu_i - \mu)$

$\tau_1 = -5$

$\tau_2 = 5$ $\quad \sum_{i=1}^{a=4} \tau_i^2 = 100$ $\quad \Phi^2 = \frac{n \Sigma \tau_i^2}{a \cdot \sigma^2} = \frac{\cancel{(100)}(n)}{\cancel{(4)(25)}} = n$

$\tau_3 = -5$ $\quad \Phi = \sqrt{n}$

$\tau_4 = 5$

$v_1 = 3$

$v_2 = 4(n-1)$

n	Φ	v_1	v_2	β	$(1-\beta)$ (Power)
4	2	3	12	0.18	0.82
5	2.24	3	16	0.08	0.92

We would choose $n = 5$ since the Power Test is 0.92 (at least 0.90).