2) a)

Circuit Type	Response Time					
1	9	12	10	8	15	$\bar{y}_{1.} = 10.8$
2	20	21	23	17	30	$\bar{y}_{2.} = 22.2$
3	6	5	8	16	7	$\bar{y}_{3.} = 8.4$

$\bar{y}_{..} = 13.8$

Test the hypothesis that the three circuit types have the same response time. Use $\alpha = 0.01$.

Source	SS	df	MSE	F	p-value
Between Trt	543.61	2	271.8	16.083	0.0004
Error (within Trt)	202.80	12	16.9		
Total	746.4	14			

$SS_{Trt} = \frac{1}{n}\sum_{1}^{a} y_{i.}^2 - \frac{y_{..}^2}{N}$

$= \frac{1}{5}(54^2 + 111^2 + 42^2) - \frac{207^2}{15}$

$= \frac{1}{5}(17001) - 2856.6$

$= 543.61$

$SS_{Tot} = \sum_{1}^{a}\sum_{1}^{n} y_{ij}^2 - \frac{(y_{..})^2}{N}$

$= 3{,}603 - \frac{207^2}{25}$

$= 3603 - 2856.6$

$= 746.4$

$P(F(16.083, 3, 12) = 0.0004$

With a p-value less than or equal to 0.01, there is evidence to suggest that one of the three means are different and we can reject the null hypothesis.

b) Use Tukey's test to compare pairs to treatment means. Note: With no stated α, I will use $\alpha = 0.05$.

$$T_{0.05} = q_{0.05}(3, 12)\sqrt{\frac{16.9}{5}} = (3.08)(1.838478) = 5.662512$$

$\bar{y}_1 - \bar{y}_2 = 10.8 - 22.2 = -11.4$ ✱

$\bar{y}_1 - \bar{y}_3 = 10.8 - 8.4 = 2.4$

$\bar{y}_2 - \bar{y}_3 = 22.2 - 8.4 = 13.8$ ✱

With a p-value less than 0.05, there is evidence to suggest we reject the null hypothesis. There is evidence to suggest that circuit type 2 is different than 1 or 3.