STAT 244BU Hw 5 Answer Key

7. a.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	p-value
Treatments	4560	2	2280	9.87	.0006
Error	6240	27	231.11		
Total	10800	29			

b. Using F table (2 degrees of freedom numerator and 27 denominator), p-value is less than .01

Using Excel or Minitab, the p-value corresponding to F = 9.87 is .0006.

Because p-value $\leq \alpha$ = .05, we reject the null hypothesis that the means of the three assembly methods are equal.

9.

	50°	60°	70°
Sample Mean	33	29	28
Sample Variance	32	17.5	9.5

$\bar{\bar{x}}$ = (33 + 29 + 28)/3 = 30

$\text{SSTR} = \sum_{j=1}^{k} n_j \left(\bar{x}_j - \bar{\bar{x}}\right)^2 = 5(33 - 30)^2 + 5(29 - 30)^2 + 5(28 - 30)^2 = 70$

MSTR = SSTR /(k - 1) = 70 /2 = 35

$\text{SSE} = \sum_{j=1}^{k} (n_j - 1)s_j^2$ = 4(32) + 4(17.5) + 4(9.5) = 236

MSE = SSE /(n_T - k) = 236 /(15 - 3) = 19.67

F = MSTR /MSE = 35 /19.67 = 1.78

Using F table (2 degrees of freedom numerator and 12 denominator), p-value is greater than .10

Using Excel or Minitab the p-value corresponding to F = 1.78 is .2104.

Because p-value $> \alpha$ = .05, we cannot reject the null hypothesis that the mean yields for the three temperatures are equal.

17. a.

	Marketing Managers	Marketing Research	Advertising
Sample Mean	5	4.5	6
Sample Variance	.8	.3	.4

$\bar{\bar{x}}$ = (5 + 4.5 + 6)/3 = 5.17

$\text{SSTR} = \sum_{j=1}^{k} n_j \left(\bar{x}_j - \bar{\bar{x}}\right)^2 = 6(5 - 5.17)^2 + 6(4.5 - 5.17)^2 + 6(6 - 5.17)^2 = 7.00$

MSTR = SSTR /(k - 1) = 7.00/2 = 3.5

$\text{SSE} = \sum_{j=1}^{k} (n_j - 1)s_j^2 = 5(.8) + 5(.3) + 5(.4) = 7.50$

MSE = SSE /(n_T - k) = 7.50/(18 - 3) = .5

F = MSTR /MSE = 3.5/.50 = 7.00

Using F table (2 degrees of freedom numerator and 15 denominator), p-value is less than .01

Using Excel or Minitab, the p-value corresponding to F = 7.00 is .0071

Because p-value $\leq \alpha$ = .05, we reject the null hypothesis that the mean perception score is the same for the three groups of specialists.

b. Since there are only 3 possible pairwise comparisons we will use the Bonferroni adjustment.

= .05/3 = .017

$t_{.017/2} = t_{.0085}$ which is approximately $t_{.01}$ = 2.602

$$\text{BSD} = 2.602\sqrt{\text{MSE}\left(\frac{1}{n_i} + \frac{1}{n_j}\right)} = 2.602\sqrt{.5\left(\frac{1}{6} + \frac{1}{6}\right)} = 1.06$$

$|\bar{x}_1 - \bar{x}_2| = |5 - 4.5| = .5 <$ 1.06; no significant difference

$|\bar{x}_1 - \bar{x}_3| = |5 - 6| = 1 <$ 1.06; no significant difference

$|\bar{x}_2 - \bar{x}_3| = |4.5 - 6| = 1.5 >$ 1.06; significant difference

25. The prices were entered into column 1 of the Minitab worksheet. Coding the treatments as 1 for CVS, 2 for Kmart, 3 for Rite-Aid, and 4 for Wegmans, the coded values were entered into column 2. Finally, the corresponding number of each item was entered into column 3. The Minitab output is shown below:

Two-way ANOVA: Price versus Block, Treatment

Source	DF	SS	MS	F	P
Block	12	323.790	26.9825	63.17	0.000
Treatment	3	9.802	3.2672	7.65	0.000
Error	36	15.376	0.4271		
Total	51	348.968			

S = 0.6535   R-Sq = 95.59%   R-Sq(adj) = 93.76%

The *p*-value corresponding to Treatment is 0.000; because the *p*-value < α = .05, there is a significant difference in the mean price for the four retail outlets.

31. Factor A is method of loading and unloading; Factor B is type of ride.

		Factor B Roller Coaster	Factor B Screaming Demon	Factor B Log Flume	Factor A Means
Factor A	Method 1	$\bar{x}_{11}$ = 42	$\bar{x}_{12}$ = 48	$\bar{x}_{13}$ = 48	$\bar{x}_{1\cdot}$ = 46
	Method 2	$\bar{x}_{21}$ = 50	$\bar{x}_{22}$ = 48	$\bar{x}_{23}$ = 46	$\bar{x}_{2\cdot}$ = 48
Factor B	Means	$\bar{x}_{\cdot 1}$ = 46	$\bar{x}_{\cdot 2}$ = 48	$\bar{x}_{\cdot 3}$ = 47	$\bar{\bar{x}}$ = 47

<u>Step 1</u>

$$\text{SST} = \sum_i \sum_j \sum_k \left(x_{ijk} - \bar{\bar{x}}\right)^2 = (41 - 47)^2 + (43 - 47)^2 + \cdots + (44 - 47)^2 = 136$$

Step 2

$\text{SSA} = br\sum_i \left(\bar{x}_{i\cdot} - \bar{\bar{x}}\right)^2$ = 3 (2) [(46 - 47) ^{2} + (48 - 47) ^{2}] = 12

Step 3

$\text{SSB} = ar\sum_j \left(\bar{x}_{\cdot j} - \bar{\bar{x}}\right)^2$ = 2 (2) [(46 - 47) ^{2} + (48 - 47) ^{2} + (47 - 47) ^{2}] = 8

Step 4

$\text{SSAB} = r\sum_i \sum_j \left(\bar{x}_{ij} - \bar{x}_{i\cdot} - \bar{x}_{\cdot j} + \bar{\bar{x}}\right)^2$ = 2 [(41 - 46 - 46 + 47) ^{2} + · · · + (44 - 48 - 47 + 47) ^{2}] =

56

Step 5

SSE = SST - SSA - SSB - SSAB = 136 - 12 - 8 - 56 = 60

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	*F*	*p*-value
Factor A	12	1	12	12/10 = 1.2	.3153
Factor B	8	2	4	4/10 = .4	.6870
Interaction	56	2	28	28/10 = 2.8	.1384
Error	60	6	10		
Total	136	11			

Using *F* table for Factor A (1 degree of freedom numerator and 6 denominator), *p*-value is greater than .10

Using Excel or Minitab, the *p*-value corresponding to *F* = 1.2 is .3153.

Because *p*-value > α = .05, Factor A is not significant

Using *F* table for Factor B (2 degrees of freedom numerator and 6 denominator), *p*-value is greater than .10

Using Excel or Minitab, the *p*-value corresponding to F = .4 is .6870.

Because *p*-value > α = .05, Factor B is not significant

Using F table for Interaction (2 degrees of freedom numerator and 6 denominator), *p*-value is greater than .10

Using Excel or Minitab, the *p*-value corresponding to F = 2.8 is .1384.

Because *p*-value > α = .05, Interaction is not significant

33. Factor A is time pressure (low and moderate); Factor B is level of knowledge (naïve, declarative and procedural).

$\bar{x}_{1\cdot}$ = (1.13 + 1.56 + 2.00)/3 = 1.563

$\bar{x}_{2\cdot}$ = (0.48 + 1.68 + 2.86)/3 = 1.673

$\bar{x}_{\cdot 1}$ = (1.13 + 0.48)/2 = 0.805

$\bar{x}_{\cdot 2}$ = (1.56 + 1.68)/2 = 1.620

$\bar{x}_{\cdot 3}$ = (2.00 + 2.86)/2 = 2.43

$\bar{\bar{x}}$ = (1.13 + 1.56 + 2.00 + 0.48 + 1.68 + 2.86)/6 = 1.618

<u>Step 1</u>

SST = 327.50 (given in problem statement)

<u>Step 2</u>

$\text{SSA} = br\sum_i \left(\bar{x}_{i\cdot} - \bar{\bar{x}}\right)^2$ = 3(25)[(1.563 - 1.618)^2 + (1.673 - 1.618)^2] = 0.4538

<u>Step 3</u>

$\text{SSB} = ar\sum_j \left(\bar{x}_{\cdot j} - \bar{\bar{x}}\right)^2$ = 2(25)[(0.805 - 1.618)^2 + (1.62 - 1.618)^2 + (2.43 - 1.618)^2] = 66.0159

<u>Step 4</u>

$\text{SSAB} = r\sum_i \sum_j \left(\bar{x}_{ij} - \bar{x}_{i\cdot} - \bar{x}_{\cdot j} + \bar{\bar{x}}\right)^2$ = 25[(1.13 - 1.563 - 0.805 + 1.618)^2 + (1.56 - 1.563 - 1.62 + 1.618)^2 + · · · + (2.86 - 1.673 - 2.43 + 1.618)^2] = 14.2525

<u>Step 5</u>

SSE = SST - SSA - SSB - SSAB = 327.50 - 0.4538 - 66.0159 - 14.2525

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	*F*	*p*-value
Factor A	0.4538	1	0.4538	0.2648	.6076
Factor B	66.1059	2	33.0080	19.2608	.0000
Interaction	14.2525	2	7.1263	4.1583	.0176
Error	246.7778	144	1.7137		
Total	327.5000	149			

Factor A: Using Excel or Minitab, the *p*-value corresponding to *F* = .2648 is .6076. Because *p*-value $> \alpha$ = .05, Factor A is not significant.

Factor B: Using Excel or Minitab, the *p*-value corresponding to *F* = 19.2608 is .0000. Because *p*-value $\leq \alpha$ = .05, Factor B is significant.

Interaction: Using Excel or Minitab, the *p*-value corresponding to *F* = 4.1583 is .0176. Because *p*-value $\leq \alpha$ = .05, Interaction is significant.