Anova examples (Review for Test 3) **STA - 3123**

1. A researcher wants to determine whether the primary language spoken at home affects a child's reading level. She randomly selected 10 children from English, 10 from Spanish and 10 from Creole speaking homes. Children are given a reading achievement test. Do the data provide sufficient evidence to indicate that the mean reading scores differ for at least two of the three language groups? Identify what experimental design was used.

a. Independent samples z-test
b. Independent samples t-test
c. A randomized block design
d. A completely randomized design ANOVA
e. Matched pairs t-test

2. Three methods of treating beer cans are being compared by a panel of 5 people. Each person samples beer from each type of can in random order and scores the beer with a number between 0 and 6, 6 indicating a strong metallic taste and 0 meaning no metallic taste. Do the data provide sufficient evidence to indicate that the mean scores differ for at least two of the three beer cans?

a. Independent samples z-test
b. Independent samples t-test
c. A randomized block design
d. A completely randomized design ANOVA
e. Matched pairs t-test

3. Complete the ANOVA summary table:

SOURCE	df	SS	MS	F
Treatments	5	70		
Error	23			
Total		300		

a) _____ subjects were used for this experiment.

b) There are _____ treatment levels.

c) The estimate of the common variance is _____.

d) If $\alpha = .10$, RR: _____.

4. A study of depression and exercise was conducted. Four groups were used. A depression rating was given to members in each group. Small random samples from each groups provided the following data:

Cycle Group: 63 58 61
Sedentary Group: 71 64 68
Runners: 49 52 47
Walkers: 45 43 49

Use ANOVA to test if the mean depression ratings for the four groups are different. Use $\alpha = .05$.

SST = 24.00, SS total = 424, Define: H_0, H_a, RR, F_α, TS, Decision, Conclusion.
Fill in the ANOVA table.

SOURCE	DF	SS	MS	F
Treatment				
Error				
Total				

5. Four different leadership styles (A, B, C, and D) used by Big-Six accountants were investigated. As part of a designed study, 15 accountants were randomly selected from each of the four leadership style groups. Each accountant was asked to rate the performance of their subordinates. The objective is to compare the mean substandard work scales of the four leadership styles.

SOURCE	DF	SS	MS	F	P-value
Treatment		2100			0.000
Error					
Total		3810			

6. An industrial psychologist is investigating the effects of work environment on employee attitudes. A group of 20 recently hired sales trainees were randomly assigned to one of four different "home rooms" - five trainees per room. Each room is identical except for wall color. The psychologist wants to know whether room color has an effect on attitude, and, if so, wants to compare the mean attitudes of the trainees assigned to the four room colors. The attitude of each trainee was measured on a 60-pt. scale.

SOURCE	DF	SS	MS	F	P-value
Treatment			560		0.000
Error		160			
Total					

7. Science reported on the ability of 7-month-old infants to learn an unfamiliar language. In one experiment, 16 infants were trained in artificial language. Then, each infant was presented with two 3-word sentences that consisted entirely of new words. One sentence was consistent and one sentence was inconsistent. The time, that infant spent listening to the speaker, was measured in each trial, with the goal to compare the mean listening times of consistent and inconsistent sentences.

1) Identify what experimental design was used.

a. completely randomized design with 16 treatments
b. completely randomized design with 2 treatments
c. 2 x 16 factorial design
d. a randomized block design with 16 treatments and 2 blocks
e. a randomized block design with 2 treatments and 16 blocks

The dependent variable is _____.

a) The sentence is a _____.

b) An infant is a _____.

d) An inconsistent sentence is a _____.

8. Two independent random samples each of 10 released prisoners who had been in federal prisons were chosen. The time served in months was recorded for each. The released prisoners had either served time for fraud (A) or for firearm (B) offenses. Do the data provide enough evidence to indicate that the mean time served for fraud is less than the mean time served for firearm offenses?

a. Independent samples z-test
b. Independent samples t-test
c. Test for two proportions
d. A completely randomized design ANOVA
e. Matched pairs t-test

Suppose a 95% CI is **$-1.2 < \mu_A - \mu_B < -5.6$**. Hence, at α =5%, we can conclude that μ_A ____ μ_B.

9. Twenty cuttings of the same shrub were made. Each cutting weighed the same. Four cuttings were randomly assigned to each of 5 treatment groups. The cuttings in the first group were inoculated with 5 growth hormones (A,B,C,D,E). After the experimental period the increase in weight was recorded for each cutting . Do the data provide sufficient evidence at the 1% level to indicate that the mean increases in weight differ for at least 2 of the 5 inoculums?

SOURCE	*DF*	*SS*	*MS*	*F*	*P*
Inoculums	**4**	**292.8**	**73.2**	**5.29**	**0.007**
ERROR	**15**	**207.8**	**13.9**		
TOTAL	**19**	**500.5**			

Since F = _____ with p-value = _____, there ____ sufficient evidence at the 1% level to indicate that the mean increases in weight differ for at least two of the five inoculums.

3) Given Tukey's confidence interval for $\mu_B - \mu_E$. **(-2.596,18.096)** Interpret this interval.

4) Given Tukey's confidence interval for $\mu_C - \mu_D$. **(3.346, 17.346)** Interpret this interval.

10. A fast food chain wants to compare daily sales during three types (A,B,C) of sales promotions. The sales promotions were employed in three different cities with two weeks for each promotion. The promotions were randomly assigned within each city, and the amount of sales (in thousands of dollars) for one outlet in each city was measured.

City	A	B	C
City 1	4.65	5.21	4.62
City 2	4.32	4.69	4.27
City 3	4.14	4.68	4.25

a. CRD for 3 treatments b. 3 x 3 Factorial Design

c. RBD with 3 treatments and 3 blocks d. CRD with 2 treatments

a. The response variable is _____ b. City 2 is a _____ c. Promotion C is a

11. The reporter wants to compare the average costs of groceries purchased at three different supermarkets, A, B, and C. Prices were recorded for a sample of 60 randomly selected grocery items at each of the three supermarkets. In order to reduce item-to-item variation, the prices were recorded for each item on the same day at each supermarket.

SOURCE	DF	SS	MS	F	P-value
Treatment	2	2.64	1.32	39.23	0.0001
Block	59	215.64	3.65	108.24	0.0001
Error	118	3.97	0.03		
Total	179	222.25			

The results of a **Bonferroni** analysis are summarized below.

Supermarket	A	B	C
Mean Price	1.67	1.93	1.95

Is there evidence to indicate a difference in the mean prices of the three supermarkets?

12. The lateral drift of a newly constructed skyscraper can be estimated with sophisticated computer software. The goal is to compare the mean drift estimates made by three different computer programs (A, B or C). Recognizing that lateral drift will depend on building level (floor), the drift (in inches) at each of five levels (Floors 1, 30, 70, 120, and 200) was estimated in random order by each of the three programs. Identify what experimental design was used.

a) The Response is: b) The Factor(s) and factor level(s) is (are):

c) The treatment(s) is (are): d) The Experimental units are:

13. A randomized block design used 5 blocks to compare the means of 4 treatments. Complete the ANOVA summary table for this experiment. Use $\alpha = .05$.

SOURCE	df	SS	MS	F	Rejection Region	Reject H_o?
Treatment			32		$F \geq$	
Block		28			$F \geq$	
Error			1.6			
TOTAL						

14. Three different advertising displays were developed to market a product. To determine whether the displays differ in effectiveness, the three displays are used for a month in each of four different stores in random order. The number of units of the product sold in a month is recorded. Do the data provide sufficient evidence to indicate that the mean number of units sold differ for at least 2 of the 3 displays?

1) Identify the experimental design the company plans to use.

a. 3x4 factorial design b. CRD with 3 treatments c. a RBD with 3 treatments and 4 blocks
d. a RBD with 4 treatments and 3 blocks d. none of the above

2) The dependent variable is _____. 3) A store is a _____.

15. A quality control supervisor measures the quality of a steel ingot on a scale from 0 to 10. He designs an experiment in which three different temperatures and four different pressures are utilized, with 5 ingots produced at each Temperature-Pressure combination.

1) Identify the experimental design the company plans to use.

a. CRD with 4 treatments b. 3x4 factorial design c. a RBD with 3 treatments and 4 blocks
d. a CRD with 3 treatments d. none of the above

2) The dependent variable is _____3) The treatments are: _____4) The experimental units are:

2) Complete the ANOVA summary table for this problem:

SOURCE	DF	SS	MS	F
Temperatu		60		
Pressure		90		
Interactio		120		
Error		240		
Total		510		

a) _____ experimental units used for this experiment. b) There are _____ treatments.

c) If you need to compare all treatment means, then there will be ___ pairs of means to compare.

16. The following results are from a statistics package in which all of the F values and P-values are given.

Sourse	DF	SS	MS	F	P-value
A	2	400	200	2.00	0.15
B	3	3000	1000	10	0.0000
Interaction	6	5400	900	9	0.0000
Error	46	4600	100		
Total	57	13400			

a) Is there a significant effect from the interaction? Should you test to see if there is a significant effect due to either A or B? If the answer is yes, is there a significant effect due to either A or B? Use $\alpha = .05$

b) Complete the following for the **first research hypothesis** (Test for equality of treatment means)

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$H_{o,}$ $H_{a,}$ **Test Statistic, RR, Decision, Conclusion.**

c) Since $F_{interact.}$ = _____ with p-value = _____, there **(is, is not)** enough evidence to indicate that factors **A** and **B** interact to affect the production output.

Hence, Bonferroni pairwise comparisons for treatment means **(should, should not)** be done.

17. A manufacturer of shock absorbers would like to advertise that their shock absorbers last longer than those produced by its biggest competitor. To see if there is support for such a claim, six of the manufacturer's shocks and six of the competitor's shocks were randomly selected, and one of each brand was installed on the rear wheels of each of six cars. After the cars had been driven 20,000 miles, the strength of each shock absorber was measured.

a. Independent samples z-test b. Independent samples t-test c. Test for two proportions

d. A completely randomized design ANOVA e. Matched pairs t-test

18. The strength of concrete depends upon the formula used to prepare it and on number of cycles of freezing and thawing. An experiment compares four different mixtures. Six specimens of concrete are poured from each mixture. Two of these specimens are subjected to 0 cycles of freezing and thawing, two are subjected to 100 cycles, and two specimens are subjected to 500 cycles. The strength of each specimen is then measured.

a) Response: b) The Factor(s) and factor level(s) is (are):

c) The treatment(s) is (are): d)Experimental units

e) For this experiment r =

19. The HMO believes that certain types of doctors are more cost-effective than others. To investigate this, the president obtained independent random samples of 40 HMO physicians, half foreign graduates and half USA graduates, from each of four primary specialties-- General Practice, Internal Medicine , Pediatrics , and Family Physician -- and recorded the total charges for each. Thus, information on charges were obtained for a total of n = 160 doctors.

1. What type of design was used for this experiment?

a) 2 x 4 factorial design with 160 replications b) CRD with eight treatments

c) RBD with two treatments and four blocks c) 4 x 2 factorial design with 20 replications

2) Family Physician is a _____ **3)** Primary Specialty is a _____

4) USA graduate is a _____ 5) Response_____ 6) The experimental units are:

7) The Factor(s) and Factor level(s) is (are): 8) The treatment(s) is (are):

9) For this experiment r =

2. Complete the ANOVA summary table for this problem:

1)

SOURCE	DF	SS	MS	F
Specialty		**90**		
Graduate		**20**		
		300		
Error		**304**		
Total		**714**		

2) _____ experimental units used for this experiment. 3) There are _____ treatments.

4) To compare all treatment means they have to compare _____ pairs of means

20. Suppose you want to determine whether the brand of laundry detergent used and the temperature affects the amount of dirt removed from your laundry. You buy two different Brand of Detergent (Tide and Cheer) and choose three different Temperature (cold, warm and hot). Four laundry loads were washed for each combination of detergent and temperature. The amount of dirt removed from each load was recorded.

a. Completely Randomized Design for 3 treatments
b. 2 x 3 Factorial Design
c. Randomized Block Design with 2 treatments and 3 blocks
d. Completely Randomized Design with 2 treatments

Identify the following elements of the experiment:

Response, Factors, Factor Levels, Treatments, Experimental Units.

For the experiment, r = _____

21. A manager of a manufacturing plant wants to investigate the effect of "foreman" and "shift" on the output of production. Therefore, he conducts three replications of a 2 x 3 factorial experiment.

SOURCE	DF	SS	MS	F	P-value
Foreman	1	19012	19012	26.43	0.0002
Shift	2	80908	40454	56.23	0.0001
Foreman*Shift	2	258	129	0.18	0.8380
ERROR	12	8633	719		
TOTAL	17	1018813			

a) Is there a significant effect from the interaction? Explain.

b) Should you test to see if there is a significant effect due to either A or B?_____

c) If the answer on item A is **yes**, is there a significant effect due to either A or B?

22. The following is the Turkey 95% CI for all pairwise comparison for three treatment means:

$$\mu_A - \mu_B \ : \ (-0.87,\ 4.07)$$
$$\mu_A - \mu_C \ : \ (1.03,\ 5.97)$$
$$\mu_B - \mu_C \ : \ (0.57,\ 4.37)$$

a. Which of the following is the rank of the means from smallest to largest?

a. $\overline{\text{B A}}$ **C** **b. C** $\overline{\text{B A}}$ **c.** $\overline{\text{C A}}$ **B** **d. C** $\overline{\text{A B}}$ **e. A** $\overline{\text{C B}}$

b. What is the experimentwise error rate for the Turkey multiple comparison?

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