

第一部分：單選題 (80%)，請使用2B鉛筆作答於答案卡，每題5分

Choose the most suitable answer and mark it on your answer sheet. Each question carries 5 points, accounting for 80% of the total score.

1. A company is assessing the effectiveness of four different training programs for its employees to identify which program yields the highest performance improvement. Each program is administered to fifty randomly selected employees, and their performance scores before and after the training are recorded. Which of the following tests is the most suitable for comparing the effectiveness of the training programs?  
  - A) An independent-sample t-test
  - B) A paired-sample t-test
  - C) A one-way ANOVA F-test
  - D) A repeated measures ANOVA test
  - E) A Chi-squared test
  
2. The table below displays the quarterly sales of a gifting store. What is the closest sales forecast for the 2<sup>nd</sup> quarter of year 4?  

Year	1				2				3			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4
Sales	103	204	110	114	116	218	122	126	124	224	133	134

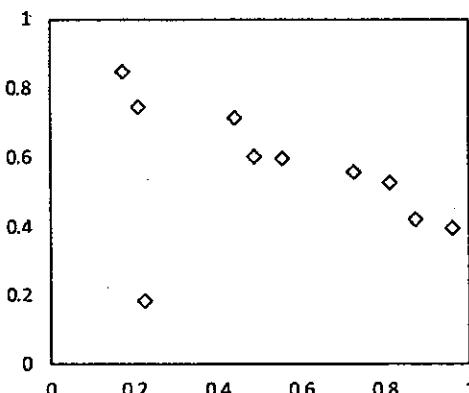
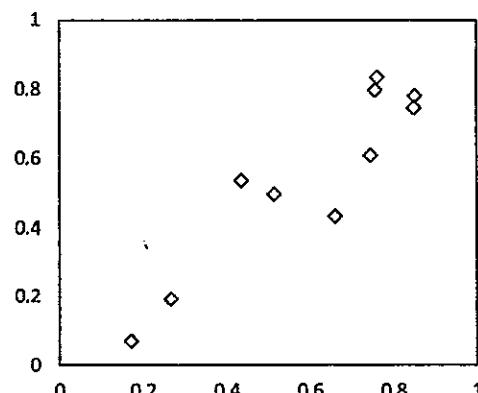
  
  - A) 132
  - B) 141
  - C) 150
  - D) 234
  - E) Cannot make the prediction based on the information provided.
  
3. A researcher wants to test whether the type of car owned (domestic or foreign) is independent of gender. He surveys 1000 car owners about their gender and the type of car they own. The result is summarized using cross-tabulation as below. Which of the following statements is incorrect?  

		Gender	
		Male	Female
Car Type	Domestic	100	400
	Foreign	300	200

- A) The null hypothesis can be written as males and females own similar proportions of foreign cars.
- B) At alpha = 0.05, we can conclude that the type of car owned is independent of gender.
- C) The researcher should use a chi-squared test to perform the analysis.
- D) The gender distribution of domestic car owners is different from that of foreign car owners.
- E) B and C

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4. For the following scatter plots, which estimate of the correlation coefficients is closest to the true values?



- A) Left: +0.8; Right: -1.0  
B) Left: +1.0; Right: -0.8  
C) Left: +0.7; Right: -0.2  
D) Left: +0.6; Right: -0.6  
E) Left: +0.9; Right: -0.4
5. Suppose we are examining the factors influencing the success of undergraduate programs, with the percentage of students going on to graduate schools as a measure of success. The faculty's union proposes a relationship between the average professors' monthly salary and the success of undergraduate programs. The resulting regression line is "% of students going on to graduate schools = 12 + 0.001(Average Professors' Monthly Salary)." Which of the following statements is true regarding the given scenario?
- A) If the percentage of students going on to graduate schools increases by 0.001, we would expect the average professors' monthly salary to approximately increase by one dollar.  
B) If the percentage of students going on to graduate schools increases by 1, we would expect the average professors' monthly salary to approximately increase by 0.001 dollar.  
C) If the average professors' monthly salary increases by 0.001 dollar, we would expect the percentage of students going on to graduate schools to increase approximately by one percent.  
D) If the average professors' monthly salary increases by one dollar, we would expect the percentage of students going on to graduate schools to increase approximately by 0.001 percent.  
E) None of the options above.

Answer questions 6 and 7 using the provided information as follows:

The researcher is interested in comparing the performance of two franchisees. She takes two samples of daily sales values, each of size 25, from the two franchisees, assumed to be normally distributed with equal variances. The first sample has a mean sales value of \$5500 with a standard deviation of \$460, while the second sample has a mean sales value of \$4800 with a standard deviation of \$340. The researcher aims to test if there is a difference between the population means at the 0.05 significance level.

6. What conclusion can the researcher draw?
  - A) There is insufficient evidence to reject the null hypothesis.
  - B) The researcher can reject the null hypothesis and conclude that the two population means are equal.
  - C) There is sufficient evidence to reject the null hypothesis and conclude that the two population means are different.
  - D) The answer cannot be determined without calculating the p-value and comparing it to the significance level.
  - E) None of the options above.
7. The researcher calculated the p-value for the F test of equal variances and found it to be 0.171. Based on this p-value, what conclusion can the researcher draw?
  - A) The assumption of equal variances is correct.
  - B) The assumption of equal variances is incorrect.
  - C) The answer cannot be determined based on this p-value.
  - D) The variance of the first sample is greater than that of the second one.
  - E) None of the options above.
8. In analyzing the factors influencing job satisfaction, data were collected on the characteristics of 50 employees, and the regression model is expressed as  $S = \beta_0 + \beta_1A + \beta_2E + \beta_3G + \epsilon$ , where S represents job satisfaction, A denotes the number of years of experience, E stands for his/her years of education, and G is a dummy variable for gender (G=1 if the employee is female). Suppose the regression outcome is  $S = 78.2 + 2.5A + 3.8E - 6.2G$ . How would you interpret the coefficient on gender (G)?
  - A) A female employee's satisfaction is 6.2 less than a male employee, on average.
  - B) A female employee's satisfaction is 6.2 higher than a male employee, on average.
  - C) For any female employees, her satisfaction must be lower than any male employee with a similar number of years of experience and years of education.
  - D) A and C
  - E) None of the options above is correct.

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國立臺灣大學 113 學年度碩士班招生考試試題

科目： 統計學(K)

節次： 7

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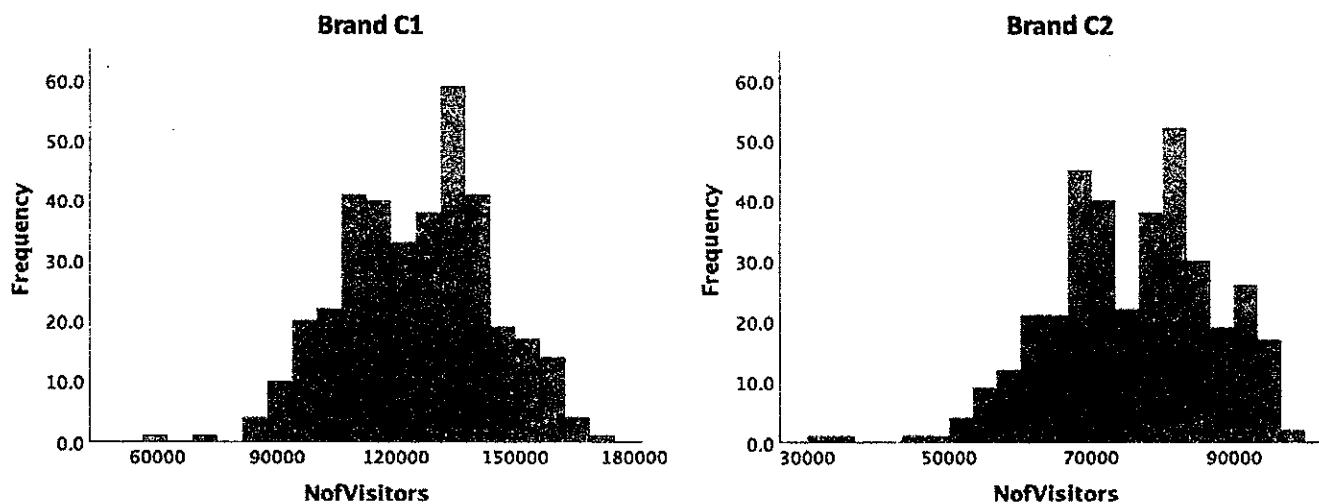
Questions 9-16 are based on the dataset described as follows.

A research team collected samples of the number of daily visitors for different brands over the course of a year. The data is organized as follows: Date denotes the date of the record, Weekday is a dummy variable that equals 1 for Monday to Friday and 0 for Saturday and Sunday, Brand represents the name of the brand, and NofVisitors indicates the number of customers who visited the brand's stores on the specific day.

Date	Weekday	Brand	NofVisitors
1-Jan	1	X1	2 673
2-Jan	0	X1	2 524
3-Jan	0	X1	2 710
4-Jan	1	X1	2 537
5-Jan	1	X1	34 65
		...	
29-Dec	1	X1	7 44
30-Dec	1	X1	7 840
31-Dec	1	X1	7 448
1-Jan	1	X2	5175
		...	
30-Dec	1	X2	6080
31-Dec	1	X2	8 45
1-Jan	1	X3	4 948
2-Jan	0	X3	4 932
		...	
31-Dec	1	X3	8244
		...	

Answer questions 9-11 using the provided information as follows:

After collecting the dataset, the research team initially selected two competing brands and generated histograms of the number of daily visitors as follows:



9. Which of the following statements is correct for Brand C2?
- A) The distribution of the number of daily visitors is unimodal.
  - B) The total number of observations is 365.
  - C) The mean is approximately 86,000.
  - D) The median is approximately 70,000.
  - E) None of the above options is correct.
10. Suppose the research team discovered that one data point was falsely recorded for Brand C2. The true number of visitors was 41,100 instead of 31,100 on this date. What is correct regarding the influence of this change on the descriptive statistics?
- A) The median increased.
  - B) The mean increased.
  - C) The standard deviation decreased.
  - D) Options B and C.
  - E) Cannot conclude.
11. What conclusion can the research team make for the comparison between the number of daily visitors of Brand C1 and Brand C2?
- A) The median is larger for Brand C1 than Brand C2.
  - B) The mean is larger for Brand C1 than Brand C2.
  - C) The standard deviation is larger for Brand C1 than Brand C2.
  - D) All of the above options are correct.
  - E) None of the above options is correct.

The research team conducted various analyses, including tests to determine whether the daily number of visitors differs for different brands or between weekdays and weekends. For questions 12-16, choose the appropriate SPSS output (A, B, C, D, or E) that corresponds to each descriptive result. Note that questions 12-16 share the same answer options.

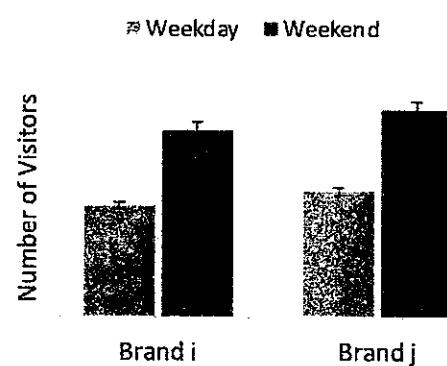
12. What is the SPSS output for this data table? Each cell displays the mean and standard deviation (in parentheses) of the number of daily visitors.

	Weekday	Weekend
Brand 1	4050.0	3917.1
	(1608.8)	(1514.2)
Brand 2	3175.7	5216.6
	(1479.8)	(2396.6)

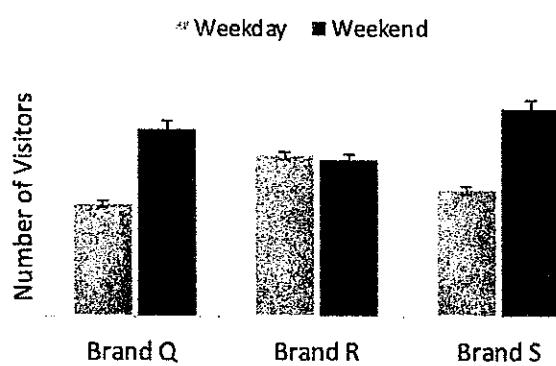
13. What is the SPSS output for this data table? The dependent variable is the number of daily visitors.

Brand	Mean	Std. Deviation	95% Confidence Interval	
			Lower Bound	Upper Bound
Brand A	4012.1	1581.5	3826.3	4197.9
Brand B	3757.2	2010.1	3571.4	3943.1

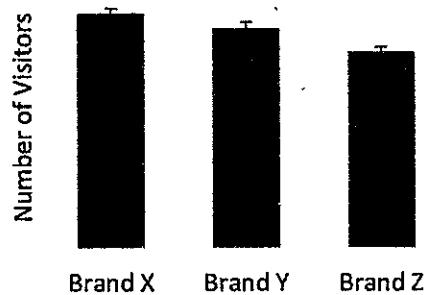
14. What is the SPSS output for this bar chart? Error bars represent the standard error of the mean.



15. What is the SPSS output for this bar chart? Error bars represent the standard error of the mean.



16. What is the SPSS output for this bar chart? Error bars represent the standard error of the mean.



The answer options for questions 12-16 are as follows:

A) Output A

Tests of Between-Subjects Effects					
Dependent Variable: NofVisitors					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	658213096 <sup>a</sup>	5	131642619	49.135	<.001
Intercept	1.412E+10	1	1.412E+10	5271.798	<.001
Brand	28909322.1	2	14454661.1	5.395	.005
Weekday	357464328	1	357464328	133.421	<.001
Brand*Weekday	219078483	2	109539241	40.885	<.001
Error	2917668105	1089	2679217.727		
Total	1.862E+10	1095			
Corrected Total	3575881201	1094			

a. R Squared = .184 (Adjusted R Squared = .180)

B) Output B

Tests of Between-Subjects Effects					
Dependent Variable: NofVisitors					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	605638122 <sup>a</sup>	3	201879374	72.969	<.001
Intercept	9403942644	1	9403942644	3399.034	<.001
Brand	28897354.9	1	28897354.9	10.445	.001
Weekday	574376060	1	574376060	207.607	<.001
Brand*Weekday	853815.439	1	853815.439	.309	.579
Error	2008588954	726	2766651.452		
Total	1.183E+10	730			
Corrected Total	2614227076	729			

a. R Squared = .232 (Adjusted R Squared = .228)

C) Output C

Tests of Between-Subjects Effects					
Dependent Variable: NofVisitors					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	322929712 <sup>a</sup>	3	107643237	37.753	<.001
Intercept	9951355171	1	9951355171	3490.155	<.001
Brand	6724034.360	1	6724034.360	2.358	.125
Weekday	135369866	1	135369866	47.477	<.001
Brand*Weekday	175703236	1	175703236	61.623	<.001
Error	2070017971	726	2851264.423		
Total	1.341E+10	730			
Corrected Total	2392947683	729			

a. R Squared = .135 (Adjusted R Squared = .131)

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D) Output D

Tests of Between-Subjects Effects					
Dependent Variable: NofVisitors					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11856609.8 <sup>a</sup>	1	11856609.8	3.625	.057
Intercept	1.102E+10	1	1.102E+10	3368.085	<.001
Grand Total	11856609.8	1	11856609.8	3.625	.057
Error	2381091073	728	3270729.496		
Total	1.341E+10	730			
Corrected Total	2392947683	729			

a. R Squared = .005 (Adjusted R Squared = .004)

E) Output E

Tests of Between-Subjects Effects					
Dependent Variable: NofVisitors					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	81670284.8 <sup>a</sup>	2	40835142.4	12.762	<.001
Intercept	1.504E+10	1	1.504E+10	4700.285	<.001
Grand Total	81670284.8	2	40835142.4	12.762	<.001
Error	3494210916	1092	3199826.846		
Total	1.862E+10	1095			
Corrected Total	3575881201	1094			

a. R Squared = .023 (Adjusted R Squared = .021)

第二部分：計算題 (20%)，本大題請於試卷內之「非選擇題作答區」標明題號依序作答。

- ◆ Please show the detailed calculation process for the questions whenever necessary.
- ◆ If the "final" answers are with decimal numbers, please round to the fourth decimal place, e.g., 99.3745 or 0.0243 = 2.43%.

17. (10%) Find the slope of the tangent line to the curve of intersection of the surface  $z = \frac{1}{2}\sqrt{24 - x^2 - 2y^2}$  with the plane  $y = 2$  at the point  $(2, 2, \sqrt{3})$ .

18. (10%) Find  $\frac{\partial^3}{\partial x \partial z \partial y} f(x, y, z)$  if  $f(x, y, z) = \sin(xy + 2z)$ .