

臺灣綜合大學系統 109 學年度學士班轉學生聯合招生考試試題

科目名稱	統計學	類組代碼	D38
		科目碼	D3891

※本項考試依簡章規定所有考科均「不可」使用計算機。 本科試題共計 5 頁

Part I (60%, 4% for each question) Multiple choice (單選題). [本大題請於答案卡作答]

- What is the expected value of the sum of the faces when two fair dies are tossed?  
(A) 6, (B) 7, (C) 5, (D) 4, (E) 12.
- COVID-19 has an 85% pass-through rate if one stays close to a COVID-19 patient for 1 hour within 1 meter range. Suppose twenty people had contact with a COVID-19 patient for 1 hour within 1 meter range. What is the probability that exactly eighteen are infected?  
(A)  $(.85)^{18}$ , (B) 0, (C)  $(.15)^2$ , (D)  $(.85)^{18} (.15)^2$ , (E) none of the above.
- Suppose in a football team the weights of the football players follow a normal distribution, with mean at 75 kg and standard deviation of 15. If there are 39 players in this team, approximately how many players are with weights between 75 and 90 kg?  
(A) 5, (B) 21, (C) 8, (D) 13, (E) none of the above.
- In a large company, an experienced applicant has an 80% probability of getting a particular job. An inexperienced applicant has a 50% chance of getting the same job. In the past few years, 60% of the applicants are inexperienced. If the job was offered to an applicant, what is the closest probability that the applicant was inexperienced?  
(A) 0.4, (B) 0.7, (C) 0.3, (D) 0.6, (E) 0.5.
- Suppose the price of stock S1 is normally distributed over time with mean of 25 and a standard deviation of 3. If Tom buys stock S1 at \$25 and sells it on a randomly chosen day in the future, what is the approximate probability that Tom will make at least \$3 on S1?  
(A) 0.50, (B) 0.32, (C) 0.16, (D) 0.05, (E) none of the above.
- The width of a 95% confidence interval for the population mean is 40 units. The sample size is large (over 100). What would be the approximate width of a 90% confidence interval for the population mean, everything else (sample size, sample variance) are the same?  
(A) 20, (B) 24, (C) 28, (D) 32, (E) 36.
- In a regular statistical test, an increase in alpha, the level of significance, causes:  
(A) An increase in the probability of the type I error to occur.  
(B) A decrease in the probability of type I error to occur.  
(C) No change in any of the type I or type II error.  
(D) An increase in the probability of type II to occur.  
(E) None of the above.

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8. A statistician would like to test the null hypothesis that the population mean is 50 versus the alternative that it is not 50. A random sample was collected with sample size 4. The sample mean is 38 with a sample standard deviation of 16. At  $\alpha = 0.05$ , the statistician should:

- (A) strongly reject the null hypothesis
- (B) mildly reject the null hypothesis
- (C) fail to reject the null hypothesis
- (D) accept the alternative hypothesis
- (E) there is insufficient information to determine

9. A 90% confidence interval can be interpreted as:

- (A) In 90% of the samples, the mean of the samples will be outside the interval.
- (B) There is a 10% chance that the true parameter value is outside the interval.
- (C) 90% of all population values are within the interval.
- (D) Both A) and B).
- (E) None of the above.

10. The telephone company CHT wants to estimate the mean number of minutes people in a city spend talking long distance, to within 5 minutes with 95% confidence. From past records, an estimate of the standard deviation is 16 minutes. What is the minimum sample size of a random sample?

- (A) 30, (B) 16, (C) 23, (D) 5, (E) None of the above.

11. When testing for the equality of two population proportions based on two independent random samples, the F distribution is:

- (A) sometimes appropriate.
- (B) never appropriate.
- (C) only appropriate if both sample sizes are less than 30.
- (D) only appropriate if at least one sample is at least 30.
- (E) used when the two variances are not equal.

12. Two population means are compared to determine if a difference exists by observing two independent random samples. The number in the first sample is 15 and the number in the second sample is 12. How many degrees of freedom are associated with the critical t-value?

- (A) 12, (B) 15, (C) 25, (D) 27, (E) None of the above.

背面有題，請繼續作答。

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13. How many degrees of freedom are there in the test statistic comparing five population means with each sample containing 50 observations using an ANOVA?

- (A) 250, (B) 4, (C) 245, (D) 50, (E) None of the above.

14. Consider a multiple regression problem with 4 independent variables. When the null hypothesis,  $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$  is rejected, the interpretation should be:

- (A) there is no linear relationship between y and any of the three independent variables.  
 (B) all three independent variables have a slope of zero.  
 (C) there is a regression relationship between y and at least one of the 3 variables.  
 (D) all three independent variables have equal slopes.  
 (E) there is a regression relationship between y and all three independent variables.

15. What is the difference between  $R^2$  and the adjusted  $R^2$ ?

- (A) the adjusted  $R^2$  always increases as more independent variables are added  
 (B) the adjusted  $R^2$  is smaller in this case because the constant term is negative.  
 (C) the adjusted  $R^2$  is always smaller than  $R^2$ .  
 (D) the adjusted  $R^2$  adjusts explanatory power by the degrees of freedom.  
 (E) the adjusted  $R^2$  adjusts explanatory power by the standard error.

**Part II (40%)** [本大題請於答案卷作答]

(Show the formulas and the hand calculation of values. 必須列出手算過程和數值結果)

1. (20%) Given the following ANOVA table, with sample size 10 for each factor level combination of a two factor completely randomized experiments.  
 Factor A has 4 levels and Factor B has 7 levels:

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square
Factor A	90	3	
Factor B	60	6	
Interaction	100		
Error	400		

- (A) (5%) What is the sample size of the experiment?  
 (B) (5%) Calculate the F statistic and test the effect of Factor A at  $\alpha=0.05$ .  
 (C) (5%) Calculate the F statistic and test the interaction effect of Factor A and B at  $\alpha=0.05$ .  
 (D) (5%) What are the assumptions needed for using a F test?

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2. (20 %) A factory had collected production data in a machine. The output voltage  $V$  was affected by the pressure  $P$  and temperature  $T$ . Two linear regression models are considered.

The computer output of Model 1  $M1: V \sim P+T$

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	0.679439	0.143532	4.734	3.20e-05 ***
P	1.407331	0.196925	7.147	1.81e-08 ***
T	-0.015629	0.001428	-10.948	3.67e-13 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2593 on 37 degrees of freedom

Multiple R-squared: 0.822, Adjusted R-squared: 0.8124

F-statistic: 85.46 on 2 and 37 DF, p-value: 1.351e-14

The computer output of Model 2  $M2: V \sim T$

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	1.595295	0.098404	16.212	< 2e-16 ***
T	-0.015629	0.002173	-7.191	1.36e-08 ***

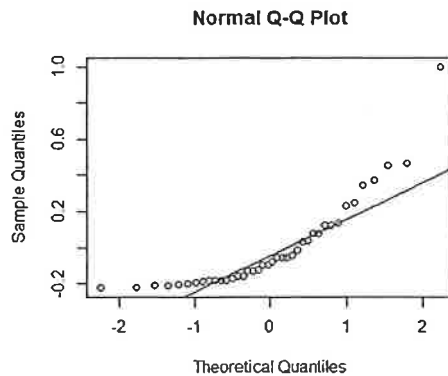
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3948 on 38 degrees of freedom

Multiple R-squared: 0.5764, Adjusted R-squared: 0.5653

F-statistic: 51.71 on 1 and 38 DF, p-value: 1.358e-08

The following figure is the normal Q-Q plot of residuals for  $M1$ .model.



- (A) (5%) From the residual plots, explain what could be the problem for the  $M1$  model?
- (B) (5%) What will be the problem when we use the t-test to assess the significance of the regression coefficients?
- (C) (5%) Did  $P$  and  $T$  have effects on the output voltage? Why?
- (D) (5%) Compare model  $M1$  and  $M2$  by looking at  $R^2$ . Which one is better and why?

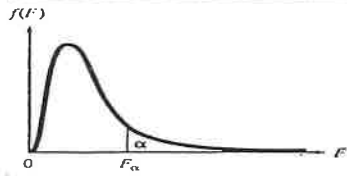
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TABLE IX Percentage Points of the  $F$ -distribution,  $\alpha = .05$



		NUMERATOR DEGREES OF FREEDOM								
		1	2	3	4	5	6	7	8	9
DENOMINATOR DEGREES OF FREEDOM	1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5
	2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
	3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
	4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
	5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
	6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
	7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
	8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
	9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
	10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
	11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
	12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
	13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
	14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
	15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
	16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
	17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
	18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
	19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42
	20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
	21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
	22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
	23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
	24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
	25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28
	26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27
	27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25
	28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24
	29	4.18	3.33	2.93	2.70	2.55	2.44	2.35	2.28	2.22
	30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	
$\infty$	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	

Source: From M. Merrington and C. M. Thompson, "Tables of Percentage Points of the Inverted Beta ( $F$ )-Distribution," *Biometrika*, 1943, 33, 73-81. Reproduced by permission of the *Biometrika* Trustees.

(continued)

TABLE IX Continued

		NUMERATOR DEGREES OF FREEDOM									
		10	12	15	20	24	30	40	60	120	$\infty$
DENOMINATOR DEGREES OF FREEDOM	1	241.9	243.9	245.9	248.0	249.1	250.1	251.1	252.2	253.3	254.3
	2	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
	3	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
	4	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
	5	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.36
	6	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
	7	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
	8	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
	9	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
	10	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
	11	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
	12	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
	13	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
	14	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
	15	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
	16	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
	17	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
	18	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
	19	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
	20	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
	21	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
	22	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
	23	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
	24	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
	25	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
	26	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
	27	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
	28	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
	29	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
	30	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51	
60	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39	
120	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25	
$\infty$	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00	