所別：工業管理研究所碩士班 甲組 科目：統計學 乙組

Multiple-Choice Questions:
*Identify the letter of the choice that **best** completes the statement or answers the question. There are 40 multiple-choice questions. 2.5 points for each question. z-table and t-table are attached on the last page for your reference.*

1. The manager of a travel agency is considering a new promotion plan in order to increase sales. Currently, the mean sales rate per agent is 10 trips per month. The correct set of hypotheses for testing the effect of the promotion plan is
   a. $H_0: \mu = 10$ $H_a: \mu \neq 10$
   b. $H_0: \mu \leq 10$ $H_a: \mu > 10$
   c. $H_0: \mu > 10$ $H_a: \mu \leq 10$
   d. $H_0: \mu \geq 10$ $H_a: \mu < 10$
2. Suppose *p*-value is equal to 0.0626. The null hypothesis can be rejected
   a. if $\alpha = .01$
   b. if $\alpha = .05$
   c. if $\alpha = .10$
   d. Not enough information to make a conclusion.
3. Which of the following statements is not true about the level of significance for a hypothesis test?
   a. The level of significance is denoted by alpha (α).
   b. If the p-value is less than the level of significance, we reject the null hypothesis.
   c. The level of significance is the maximum allowable probability of making a Type I error.
   d. The level of significance is determined by the value of the test statistic.
4. Suppose we have a population that is normally distributed, and its standard deviation is unknown. We want to test the following hypotheses: $H_0: \mu=12$ vs $H_a: \mu\neq12$. If the value of the test statistic is -1.9 based on a sample of size 20, what type of test statistic is it and what is the corresponding p-value?
   a. z statistic; 0.0287
   b. z statistic; 0.0574
   c. t statistic; between 0.025 and 0.05
   d. t statistic; between 0.05 and 0.10
5. Which of the following does not need to be known in order to compute the p-value?
   a. The level of significance.
   b. Knowledge of whether the test is one-tailed or two-tailed.
   c. The value of the test statistic.
   d. The distribution that should be used.
6. The diameter of 3.5 inch diskettes is assumed to be normally distributed. The quality control inspector conducted a hypothesis test to examine the average diameter of diskettes. He used a sample of size 35 and the following null and alternative hypotheses: $H_0: \mu = 3.5$ vs $H_a: \mu \neq 3.5$. At $\alpha=0.05$, he did not reject the null hypothesis. Which one of the statements is true if his conclusion was right?
   a. The 95% confidence interval constructed by the sample contained 0.
   b. The 95% confidence interval constructed by the sample did not contain 0.
   c. The absolute value of the test statistic is less than 1.96.
   d. The p-value must be strictly less than 0.025 (i.e., p-value < 0.025).
7. It is known that the mean of a population is 35. A sample of size 55 was taken and the sample mean was 32. If $H_0: \mu\leq30$, and you decided to reject the null hypothesis, it means
   a. you have committed a Type I error
   b. you have committed a Type II error
   c. you have committed a Type III error
   d. you have committed neither Type I nor Type II error
8. Using the same data set, if the null hypothesis is not rejected at the 1% level of significance, it
   a. may be rejected or not rejected at the 5% level of significance
   b. will always be rejected at the 5% level of significance
   c. will never be rejected at the 5% level of significance
   d. should never be tested at the 5% level of significance

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9. We have a population that is normally distributed with an unknown variance. A two-tailed hypothesis test was conducted for the population mean. A random sample of size 22 was selected. At α level of significance, a student wrongly used $z_{\alpha/2}$ as the critical value and concluded to reject the null hypothesis. If the student did not make the mistake, what would be the correct conclusion?
   a. The conclusion stays the same, that is, the null hypothesis should be rejected.
   b. The conclusion is different, that is, the null hypothesis should not be rejected.
   c. There is insufficient information to make a conclusion. In other words, the null hypothesis may or may not be rejected.
   d. None of the above.
10. A random sample of 100 people was taken. Fifty-five of the people in the sample favored Candidate A. We are interested in determining whether the proportion of people in the population in favor of Candidate A is less than 60%. What is the value of the test statistic?
   a. -1.005
   b. -1.02
   c. 1.005
   d. 1.02
11. Based on the assumptions of an ANOVA procedure, which of the following cannot be determined?
   a. Whether all the population means are different.
   b. The distributions of the populations.
   c. Whether the samples are independent or not.
   d. The variance of the other populations if the variance of one population is known as 10.
12. You found that the null hypothesis $\mu_1 - \mu_2 \le 4$ could not be rejected at $\alpha = 0.05$. If the same sample is used, which of the following is correct?
   a. H_0: $\mu_1 - \mu_2 \le 3$ can never be rejected at $\alpha = 0.05$
   b. H_0: $\mu_1 - \mu_2 \le 5$ can never be rejected at $\alpha = 0.01$
   c. H_0: $\mu_1 - \mu_2 \ge 4$ can never be rejected at $\alpha = 0.05$
   d. Insufficient data to claim any of the above.

Answer questions 13-14 based on the information given in Exhibit 1.

Exhibit 1:

Salary information for random samples of male and female employees in a large company is shown below.

	Male	**Female**
Sample Size	64	36
Sample Mean Salary (in $1,000)	44	41
Sample Variance	128	72

13. Refer to Exhibit 1. The 95% confidence interval for the difference between the average salaries of male and female employees in this company is (in $1,000)
   a. 0 to 6.92
   b. -2 to 2
   c. -1.96 to 1.96
   d. -0.92 to 6.92
14. Refer to Exhibit 1. We would like to test whether the average salary of male employees is different from that of female employees in this company. The value of the test statistic is
   a. 2.0
   b. 1.5
   c. 1.96
   d. 1.645

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Answer questions 15-17 based on the information given in Exhibit 2.

Exhibit 2:

The daily production rates for a sample of factory workers before and after a training program are shown below.

Worker	Before	After
1	6	9
2	10	12
3	9	10

Define the following:

μ_1 is the mean of the daily production rates of factory workers before the training program,

μ_2 is the mean of the daily production rates of factory workers after the training program,

μ_d is the mean of the differences of the daily production rates between after-training and before-training program.

15. Refer to Exhibit 2. What are the appropriate null and alternative hypotheses if we want to test to determine whether the training program increases the daily production rates?
    a. $H_0: \mu_1 - \mu_2 \geq 0, H_a: \mu_1 - \mu_2 < 0$
    b. $H_0: \mu_1 - \mu_2 \leq 0, H_a: \mu_1 - \mu_2 > 0$
    c. $H_0: \mu_d = 0, H_a: \mu_d \neq 0$
    d. $H_0: \mu_d \leq 0, H_a: \mu_d > 0$
16. In Refer to Exhibit 2. What is the value of the test statistic?
    a. 1.342
    b. 2
    c. 3.464
    d. 1.414
17. Refer to Exhibit 2. At 5% level of significance, we
    a. reject the null hypothesis
    b. do not reject the null hypothesis
    c. may or may not reject the null hypothesis
    d. conclude none of the above

Answer questions 18-20 based on the information given in Exhibit 3.

Exhibit 3:

The following is part of an ANOVA table. It is known that there are five populations (treatments) and the total number of observations is 65.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Treatments	64			
Error			2	
Total				

18. Refer to Exhibit 3. The total sum of squares (SST) is
    a. 64
    b. 120
    c. 184
    d. Cannot be determined.
19. Refer to Exhibit 3. At 5% level of significance, if we want to determine whether or not the means of all the populations are equal, the critical value of F is
    a. 5.69
    b. 2.53
    c. 8
    d. 1

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20. Refer to Exhibit 3. The conclusion of the test is:
    a. Not all the population means are equal.
    b. All the population means all equal.
    c. At least two population means are equal.
    d. Cannot be determined whether the population means are equal or not.

21. Suppose the flights of SimAir airlines depart on time with a probability of 0.85 according to the previous record. The airlines want to predict the delays among 8 flights that will depart tomorrow. Let X be the number of on-time flights, and Y be the number of delayed flights. Compare P_1 and P_2 that are defined as follows. (Hint: X and Y are binomially distributed.)
    $P_1=P(x>5)$
    $P_2=P(y\leq 3)$
    What is the relationship between P_1 and P_2?
    a. $P_1 < P_2$
    b. $P_1 = P_2$
    c. $P_1 > P_2$
    d. $P_1 + P_2 = 1$

22. X is a normal random variable with mean μ and standard deviation σ. k is a constant number. As the sample size increases, which one of the following statement is true about the probability $P(-k < \overline{X} < k)$, where $\overline{X}$ is the sample mean?
    a. $P(-k < \overline{X} < k)$ increases.
    b. $P(-k < \overline{X} < k)$ decreases.
    c. $P(-k < \overline{X} < k)$ remains the same.
    d. Cannot be determined.

23. Let $A = P(-1 < X < 1)$, $B = P(-1 < Y < 1)$, and $C = P(-1 < Z < 1)$, where $X \sim$ Normal(-1,1), $Y \sim$ Normal(0,2), and $Z \sim$ Normal(0,1). Choose the right inequality below:
    a. $A > B > C$
    b. $C > A > B$
    c. $B > C > A$
    d. $A > C > B$

24. X is a normal random variable with mean μ and standard deviation σ. Regarding the sample mean ($\overline{X}$), which one of the following statements is *not* true?
    a. As the sample size increases, the standard deviation of $\overline{X}$ decreases.
    b. As the sample size increases, the expected value of the sample mean remains the same.
    c. As the sample size increases, the $100(1-\alpha)\%$ confidence interval becomes narrower.
    d. As the sample size increases, $P(\overline{X} > \mu)$ increases.

25. From a population that is not normally distributed and whose standard deviation is unknown, a sample of 15 items is selected to develop an interval estimate for the population mean μ. Which of the following is true?
    a. The sample size must be increased.
    b. The normal distribution may be used.
    c. The t distribution with 14 degrees of freedom can be used.
    d. The t distribution with 15 degrees of freedom can be used.

26. In estimating the population mean, it is known that the necessary sample size is 150 in order to provide a particular margin of error at **98%** confidence level. With a **95%** confidence level, what is the minimum sample size that needs to be taken if the desired margin of error is **halved**?
    a. 213
    b. 253
    c. 425
    d. 505

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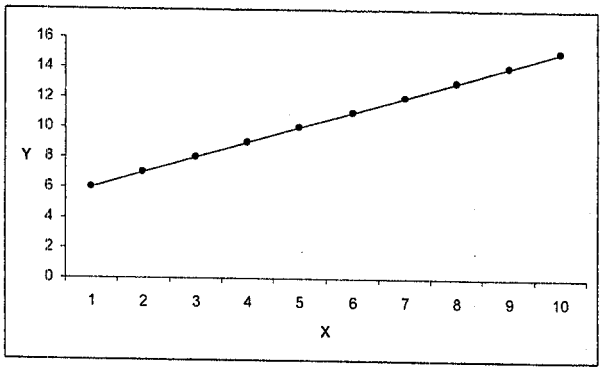
27. Comparing the multiple coefficient of determination (R^2) and adjusted multiple coefficient of determination (R_a^2) for the same regression model, which of the following statements is correct?
    a. When an additional independent variable is added to the model, R^2 will always increase.
    b. When an additional independent variable is added to the model, R_a^2 will always increase.
    c. R_a^2 can be greater than R^2.
    d. Both (a) and (b) are right.
28. Using the least squares method, the regression line is obtained by minimizing
    a. SST : Total sum of squares
    b. SSR : Sum of squares due to the regression
    c. SSE : Sum of squares due to the errors
    d. none of the above.
29. According to a model regressing a firm's monthly sales (in thousands) of a product on the price of that product, the 90% confidence interval on the average monthly sales is [5.3, 7.7] if the price is $6. Which of the following could be the 90% prediction interval for a single month sales if the price is $6?
    a. [4.4, 8.2]
    b. [4.4, 8.6]
    c. [5.9, 7.1]
    d. [6.2, 8.4]
30. If all the points of a scatter diagram lie on the least squares regression line (see the figure below), then the coefficient of determination for these variables based on this data is



    a. 0
    b. 1
    c. either 1 or -1, depending upon whether the relationship is positive or negative
    d. could be any value between -1 and 1
31. Which of the following is incorrect for the linear regression model $y = \beta_0 + \beta_1 x + \varepsilon$ and its estimation by the equation $\hat{y} = b_0 + b_1 x$?
    a. b_0 and b_1 are random variables
    b. β_0 and β_1 are random variables
    c. y and ε are random variables
    d. $\hat{y}$ is a random variable

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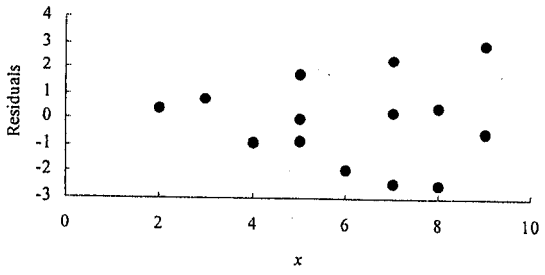
32. In simple linear regression estimation, the following plot of the residuals is obtained. Based on this residual plot, which of the following statements is true regarding the assumptions on the error ε?



a. The value of ε is zero.
b. The values of ε are dependent.
c. The variance of ε varies depending on the values of the independent variable.
d. None of the above.

33. Four numbers selected from the whole numbers 0 to 10 (with repeats allowed) that have the largest possible standard deviation are
a. 0, 5, 5, 10
b. 0, 0, 10, 10
c. 0, 5, 10, 10
d. 0, 0, 5, 10

34. Since the population size is always larger than the sample size, the sample mean
a. can never be larger than the population mean
b. can never be equal to the population mean
c. can never be smaller than the population mean
d. can be smaller, larger, or equal to the population mean

35. In a binomial experiment, which one(s) of the following is (are) true?
(i) The probability of success in the second trial does not depend on the outcome of the first trial.
(ii) Only two outcomes are possible in each trial.
(iii) The expected value is always greater than the variance.
(iv) The probability of success in each trial is always larger than the probability of failure.
a. (i) only.
b. (i) and (ii).
c. (i), (ii) and (iii).
d. (i), (ii), (iii) and (iv).

36. The assembly times for products in a factory are normally distributed with a mean of 15 minutes and a standard deviation of 6 minutes. What is the probability that the assembly time of a randomly selected product will be exactly 15 minutes?
a. 1
b. 0.5
c. 0.4
d. 0

37. X is normally distributed with mean μ and standard deviation σ. If $P(X<x_0) > 0.65$, which one describes the correct relation between μ and x_0?
a. $\mu > x_0$
b. $\mu = x_0$
c. $\mu < x_0$
d. Cannot be determined.

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38. A population is normally distributed with mean μ and a standard deviation of 5. If a sample of size 25 is selected from this population, what is the probability that the sample mean will be within ±1.5 of the population mean?
    a. 0.4332
    b. 0.8664
    c. 0.9544
    d. Since μ is not given, the probability cannot be determined.

39. Suppose the population standard deviation is known. Which one of the following is *incorrect*?
    a. The wider the margin of error is, the wider the confidence interval is.
    b. The width of a confidence interval depends on the confidence coefficient.
    c. The larger the sample mean is, the wider the confidence interval is.
    d. When a sample is used to construct confidence intervals, the 98% confidence interval is always wider than the 95% confidence interval.

40. Regarding t-distribution, which one of the following is *incorrect*?
    a. The mean can be negative.
    b. When the degrees of freedom gets larger, the t-distribution approximates normal distribution.
    c. t-distribution is symmetric.
    d. When the degrees of freedom $n_1 > n_2$, the value of $t_{\alpha/2,n_1}$ is always smaller than the value of $t_{\alpha/2,n_2}$

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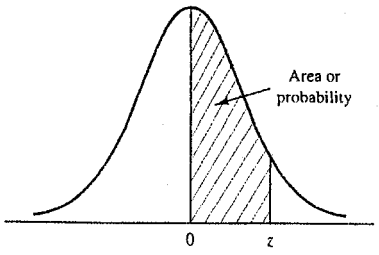

Entries in the table give the area under the curve between the mean and z standard deviations above the mean. For example, for $z = 1.25$ the area under the curve between the mean and z is .3944.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
.7	.2580	.2612	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4986	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

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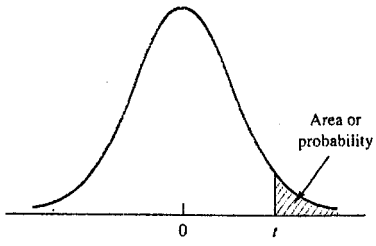

Entries in the table give *t* values for an area or probability in the upper tail of the *t* distribution. For example, with 10 degrees of freedom and a .05 area in the upper tail, $t_{.05} = 1.812$.

Degrees of Freedom	Area in Upper Tail .10	.05	.025	.01	.005
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
60	1.296	1.671	2.000	2.390	2.660
120	1.289	1.658	1.980	2.358	2.617
∞	1.282	1.645	1.960	2.326	2.576