國立成功大學

111學年度碩士班招生考試試題

編　號：239

系　所：工業與資訊管理學系

科　目：統計學

日　期：0220

節　次：第 3 節

備　註：可使用計算機

國立成功大學 111 學年度碩士班招生考試試題

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※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

I-1 (10%) A machine operates from 8:00 to 16:00 every day and is equipped with a diagnostic test to assess whether the machine is in control (IC) or out of control (OC) at 12:00 on a daily basis. Because of the setup, the machine is always IC at 8:00 every day. The test is not 100% reliable: If the machine is OC, the test will report an OC status with probability 0.95. And, if the machine is IC, the test will report an OC status with probability 0.02. According to the historical maintenance records, the machine becomes OC in a morning with the probability 0.05.

(a) (6%) On a randomly chosen day, what is the conditional probability that the machine is indeed OC when the diagnostic test reports an OC status?

(b) (4%) When the test reports an OC status, an engineer immediately restores the machine to IC if necessary. What is the probability that the occurrence of an OC in the afternoon is due to the occurrence of an OC in the morning on the same day?

I-2 (10%) A maintenance service provided by a firm has uncertain service time X which is characterized as a continuous random variable with pdf $f(x)$, mean μ, and standard deviation σ.

(a) (5%) What is the expected service time of the average of 30 independent maintenance services?

(b) (5%) If a contract requires that the average of 50 independent maintenance services provided by the firm shall be less than T. Explain how the firm shall compute the probability of meeting this requirement.

I-3 (5%) College of Engineering at a national university conducted a salary survey for 100 alumni. The college is aware that the mean and the standard deviation of their salaries are \$30,000 and \$4,000, respectively, but does not know the underlying distribution. What percentage of these alumni would earn more than \$42,000?

I-4 (5%) The time between ambulance arrivals at an emergency room follows the exponential distribution with mean 30 minutes. What is the probability that no ambulance arrives at the emergency room within a one-hour period?

I-5 (8%) Suppose that a continuous random variable X has pdf $f(x)$, CDF $F(x)$, mean μ, and the support $[a,b]$, where $0 < a < b$. Verify whether each of the following statements is correct or incorrect.

(a) (2%) $F(a+b) = 1$.

(b) (2%) Define x_α to be the value of x such that $F(x_\alpha) = 1-\alpha$. Then, a smaller value of α indicates a larger value of x_α.

(c) (2%) μ can be obtained by evaluating $\int_a^b x f(x)\,dx$.

(d) (2%) The expression $\int_a^b (x-\mu) f(x)\,dx$ is evaluated to be zero.

I-6 (8%) Let $P(\cdot)$ denote the probability of an event occurring, and $A \cap B$ denote the intersection of two events A and B. Suppose that $P(A) = 0.3$, $P(B) = 0.8$, and $P(A \cap B) = 0.24$.

(a) (4%) Please verify whether A and B are mutually exclusive events or independent events.

(b) (2%) What is the joint probability of A and B?

(c) (2%) What is the probability of the union of A and B?

I-7 (4%) Consider a positively skewed (or right-skewed) mound-shaped distribution. Please order the mean, the median, and the mode for this distribution.

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II-1. **(15%)** An engineer would like to evaluate if the two machines produce products with the same mean and variance. The weights of the product produced from two machines are given. Use the data in the table and $\alpha = 0.05$ to answer the following questions.

Machine 1	32	36	37	37	39	35		
Machine 2	31	33	39	39	40	35	33	32

(1) **(5%)** Conduct a statistical test to determine whether there is a significant difference between the variances in the weights for two machines? Explicitly present your null hypothesis, test procedure and conclusion.

(2) **(10%)** Based on the previous conclusion from (1), formulate the hypotheses that can be used to determine if the sample data support the hypothesis that the average weights from these two machines are equal? Use $\alpha = 0.05$. Explicitly present your null hypothesis, test procedure and conclusion.

II-2. **(20%)** The following data are obtained from a completely randomized design. Use the data to answer the following questions.

	Treatment		
	A	B	C
1	20	17	21
2	22	18	23
3	24	19	24
4	21	22	26

(1) **(10%)** Set up the ANOVA table for this problem.

(2) **(5%)** Based on the ANOVA table in (1) (at the $\alpha = 0.05$ level of significance), what conclusion is implied in this problem?

(a) Not all means are equal.

(b) Not all variances are not equal.

(c) The three samples are not independent.

(d) The residuals are not normally distributed.

(3) **(5%)** Use Fisher's LSD procedure to test whether there is a significant difference between the means for Treatments A & B (at the $\alpha = 0.05$ level of significance).

II-3. (15%) A store manager would like to use the following multiple linear regression equation to predict sales (Y) with two independent variables and the model is: $Y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \varepsilon_i$. After collecting data, a Minitab computer solution output is given, use the output to answer the questions.

Regression Equation

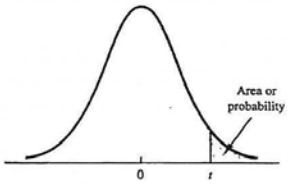
Y = 88.92 + 0.02135 X1 + 0.000780 X2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	21.504	10.7518	10.96	0.024
X1	1	20.210	20.2098	20.60	0.011
X2	1	2.436	2.4362	2.48	0.190
Error	4	3.925	0.9812		
Total	6	25.429			

(1) (5%) What is the value of coefficient of determination (r^2) in this problem?
(2) (5%) Predict the value of sales (Y) when X_1=300 and X_2=4,000.
(3) (5%) Can the multiple linear regression model above be applied to data with binary response ($Y = 1$ or 0)? Give an explanation to your answer.

t-distribution table



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					
	.20	.10	.05	.025	.01	.005
1	1.376	3.078	6.314	12.706	31.821	63.656
2	1.061	1.886	2.920	4.303	6.965	9.925
3	.978	1.638	2.353	3.182	4.541	5.841
4	.941	1.533	2.132	2.776	3.747	4.604
5	.920	1.476	2.015	2.571	3.365	4.032
6	.906	1.440	1.943	2.447	3.143	3.707
7	.896	1.415	1.895	2.365	2.998	3.499
8	.889	1.397	1.860	2.306	2.896	3.355
9	.883	1.383	1.833	2.262	2.821	3.250
10	.879	1.372	1.812	2.228	2.764	3.169
11	.876	1.363	1.796	2.201	2.718	3.106
12	.873	1.356	1.782	2.179	2.681	3.055
13	.870	1.350	1.771	2.160	2.650	3.012
14	.868	1.345	1.761	2.145	2.624	2.977
15	.866	1.341	1.753	2.131	2.602	2.947
16	.865	1.337	1.746	2.120	2.583	2.921
17	.863	1.333	1.740	2.110	2.567	2.898
18	.862	1.330	1.734	2.101	2.552	2.878
19	.861	1.328	1.729	2.093	2.539	2.861
20	.860	1.325	1.725	2.086	2.528	2.845
21	.859	1.323	1.721	2.080	2.518	2.831
22	.858	1.321	1.717	2.074	2.508	2.819
23	.858	1.319	1.714	2.069	2.500	2.807
24	.857	1.318	1.711	2.064	2.492	2.797
25	.856	1.316	1.708	2.060	2.485	2.787
26	.856	1.315	1.706	2.056	2.479	2.779
27	.855	1.314	1.703	2.052	2.473	2.771
28	.855	1.313	1.701	2.048	2.467	2.763
29	.854	1.311	1.699	2.045	2.462	2.756

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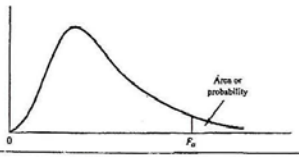
F-distribution table



Denominator Degrees of Freedom	Area in Upper Tail	Numerator Degrees of Freedom											
		1	2	3	4	5	6	7	8	9	10	15	20
1	.10	39.86	49.50	53.59	55.83	57.24	58.20	58.91	59.44	59.86	60.19	61.22	61.74
	.05	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	245.95	248.02
	.025	647.79	799.48	864.15	899.60	921.83	937.11	948.20	956.64	963.28	968.63	984.87	993.08
	.01	4052.18	4999.34	5403.53	5624.26	5763.96	5858.95	5928.33	5980.95	6022.40	6055.93	6156.97	6208.66
2	.10	8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38	9.39	9.42	9.44
	.05	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.43	19.45
	.025	38.51	39.00	39.17	39.25	39.30	39.33	39.36	39.37	39.39	39.40	39.43	39.45
	.01	98.50	99.00	99.16	99.25	99.30	99.33	99.36	99.38	99.39	99.40	99.43	99.45
3	.10	5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24	5.23	5.20	5.18
	.05	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.70	8.66
	.025	17.44	16.04	15.44	15.10	14.88	14.73	14.62	14.54	14.47	14.42	14.25	14.17
	.01	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.34	27.23	26.87	26.69
4	.10	4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.94	3.92	3.87	3.84
	.05	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.86	5.80
	.025	12.22	10.65	9.98	9.60	9.36	9.20	9.07	8.98	8.90	8.84	8.66	8.56
	.01	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.20	14.02
5	.10	4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32	3.30	3.324	3.21
	.05	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.62	4.56
	.025	10.01	8.43	7.76	7.39	7.15	6.98	6.85	6.76	6.68	6.62	6.43	6.33
	.01	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.72	9.55
6	.10	3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96	2.94	2.87	2.84
	.05	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	3.94	3.87
	.025	8.81	7.26	6.60	6.23	5.99	5.82	5.70	5.60	5.52	5.46	5.27	5.17
	.01	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.56	7.40
7	.10	3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72	2.70	2.63	2.59
	.05	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.51	3.44
	.025	8.07	6.54	5.89	5.52	5.29	5.12	4.99	4.90	4.82	4.76	4.57	4.47
	.01	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.31	6.16
8	.10	3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56	2.54	2.46	2.42
	.05	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.22	3.15
	.025	7.57	6.06	5.42	5.05	4.82	4.65	4.53	4.43	4.36	4.30	4 10	4.00
	.01	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.52	5.36
9	.10	3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44	2.42	2.34	2.30
	.05	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.01	2.94
	.025	7.21	5.71	5.08	4.72	4.48	4.32	4.20	4.10	4.03	3.96	3.77	3.67
	.01	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	4.96	4.81
10	.10	3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35	2.32	2.24	2.20
	.05	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.85	2.77
	.025	6.94	5.46	4.83	4.47	4.24	4.07	3.95	3.85	3.78	3.72	3.52	3.42
	.01	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.56	4.41
11	.10	3.23	2.86	2.66	2.54	2.45	2.39	2.34	2.30	2.27	2.25	2.17	2.12
	.05	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.72	2.65
	.025	6.72	5.26	4.63	4.28	4.04	3.88	3.76	3.66	3.59	3.53	3.33	3.23
	.01	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.25	4.10
12	.10	3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21	2.19	2.10	2.06
	.05	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.62	2.54
	.025	6.55	5.10	4.47	4.12	3.89	3.73	3.61	3.51	3.44	3.37	3.18	3.07
	.01	9.33	6.93	5 95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.01	3.86