

國立台灣科技大學九十九學年度碩士班招生試題

系所組別：工業管理系碩士班甲組、乙組、丙組

科目：統計學

(總分為100分)

(Total 100 points.) There are 5 problems in this exam. Show intermediate steps and formulas for partial credit. You must explain how you compute your results or answers for full credit.

1. (20 points) 【單一選擇題】請將題號(與小題號)清楚標示在答案卷上，並選擇一個最適當之答案。

(a) (5 pts) Which one is **TRUE** for the probability density function $f(x)$ of continuous random variables:

(1) $f(\infty) = 1$; (2) $f(x) \geq 0$; (3) $0 \leq f(x) \leq 1$; (4) $f(-\infty) = 0$; (5) $-\infty \leq f(x) \leq \infty$.

(b) (5 pts) Which one is **FALSE** for the cumulative distribution function $F(x)$ of continuous random variables:

(1) $F(\infty) = 1$; (2) $F(-\infty) = 0$; (3) $0 \leq F(x) \leq 1$; (4) $F(0) = 1$; (5) $F(x)$ is a non-decreasing continuous function.

(c) (5 pts) Which one is **FALSE** for the means and variances of linear combinations of random variables X and Y , where a and b are constants:

(1) $E(aX + b) = aE(X) + b$; (2) $E[g(X) - h(X)] = E[g(X)] - E[h(X)]$; (3) $E(XY) = E(X)E(Y)$;

(4) $\sigma_{aX+b}^2 = a^2 \sigma_X^2$;

(5) If $f(x, y)$ is the joint probability distribution of X and Y , then

$$\sigma_{aX+bY}^2 = a^2 \sigma_X^2 + b^2 \sigma_Y^2 + 2ab \sigma_{XY}, \text{ where } \sigma_{XY} \text{ is the covariance of } X \text{ and } Y.$$

(d) (5 pts) Which one is **FALSE** for the following continuous probability distributions:

(1) The variance of the continuous uniform distribution $f(x; A, B) = \frac{1}{B-A}$ for $A \leq x \leq B$ is

$$\frac{(B-A)^3}{12};$$

(2) The curve of normal distribution is symmetric about a vertical axis through the mean μ ;

(3) The total area under the curve of normal distribution and above the horizontal axis is equal to 1;

(4) If a set of observations is normally distributed, 19.36% of these differ from the means by more than 1.3σ ;

(5) If a set of observations is normally distributed, 39.70% of these differ from the means by less than 0.52σ .

2. (20 points) A random variable X has the discrete uniform distribution:

$$f(x; N) = \begin{cases} \frac{1}{N}, & \text{for } x = 1, 2, \dots, N, \\ 0, & \text{elsewhere.} \end{cases}$$

(a) (5 pts) Find $E(X)$, the mean of the discrete uniform distribution.

(b) (5 pts) Find $Var(X)$, the variance of the discrete uniform distribution.

(c) (5 pts) Find $M_X(t)$, the moment-generating function of X .

(d) (5 pts) Find the second moment about the origin of the random variable X .



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3. (10 points) The hospital period, in days, for patients following treatment for a certain type of gastric hemorrhage is a random variable $Y = (X + 4)/2$, where X has the density function

$$f(x) = \begin{cases} \frac{18}{(x+3)^3}, & x > 0, \\ 0, & \text{elsewhere.} \end{cases}$$

- (a) (5 pts) Find the probability density function of the random variable Y .
- (b) (5 pts) Using the density function of Y , find the probability that the hospital period for a patient following this treatment will exceed 5 days.
4. (25 points) The output weight of a certain product is normally distributed with mean 12g and standard deviation 0.05g and the specifications for the weight are 12.05 ± 0.1 g.
- (a) (5 pts) What is the fraction of nonconforming in this process; that is, what is the fraction of the products that fail to meet the specifications?
- (b) (10 pts) Can shifting the mean reduce the number of nonconforming units produced? How? What is the resulting fraction of nonconforming?
- (c) (10 pts) After shifting the mean (if necessary), how much would the process variability need to be reduced in order to have a fraction of nonconforming less than 0.1%?

5. (25 points) Two samples were selected from two normal populations with means and variances

μ_1, μ_2 and σ_1^2, σ_2^2 , respectively. The following information was obtained.

$$\begin{cases} n_1 = 25, \bar{X}_1 = 100, S_1^2 = 196. \\ n_2 = 250, \bar{X}_2 = 90, S_2^2 = 169. \end{cases}$$

- (a) (5 pts) What is the 95% confidence interval for μ_1 ?
- (b) (5 pts) What is the 95% confidence interval for $\mu_1 - \mu_2$ if we assume $\sigma_1^2 = \sigma_2^2$?
- (c) (5 pts) What is the 95% confidence interval for σ_1^2 ?
- (d) (5 pts) Suppose that we want to test whether μ_1 is greater than or equal to 105. What are the hypothesis and the conclusion? ($\alpha = 0.1$)
- (e) (5 pts) If the true mean $\mu_1 = 94.332$, what is the power of your test in (d)?



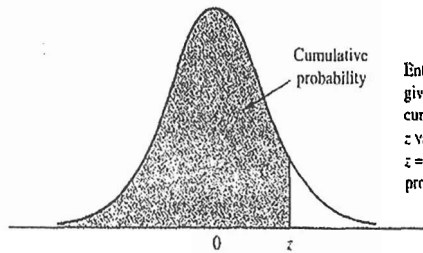
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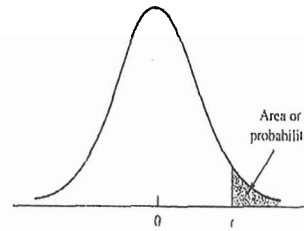
TABLE 1 CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL DISTRIBUTION



Entries in the table give the area under the curve to the left of the z value. For example, for $z = 1.25$ the cumulative probability is .8944.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9915
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9986	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990

TABLE 2 t DISTRIBUTION



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



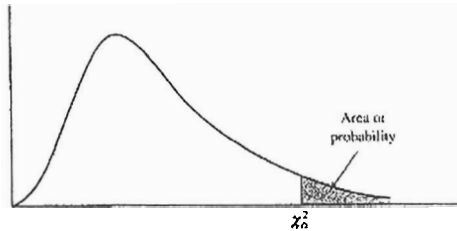
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TABLE 3 CHI-SQUARE DISTRIBUTION



Entries in the table give χ^2_{α} values, where α is the area or probability in the upper tail of the chi-square distribution. For example, with 10 degrees of freedom and a .01 area in the upper tail, $\chi^2_{.01} = 23.2093$.

Degrees of Freedom	Area in Upper Tail									
	.995	.99	.975	.95	.90	.10	.05	.025	.01	.005
1	392.704×10^{-10}	157.088×10^{-9}	982.069×10^{-9}	393.214×10^{-1}	.0157908	2.70554	3.84146	5.02389	6.63490	7.87944
2	.0100251	.0201007	.0506356	.102587	.210720	4.60517	5.99147	7.37776	9.21034	10.5966
3	.0717212	.114832	.215795	.351846	.584375	6.25139	7.81473	9.34840	11.3449	12.8381
4	.206990	.297110	.484419	.710721	1.063623	7.77944	9.48773	11.1433	13.2767	14.8602
5	.411740	.554300	.851211	1.145476	1.61031	9.23635	11.0705	12.8325	15.0863	16.7496
6	.675727	.872085	1.237347	1.63539	2.20413	10.6446	12.5916	14.4494	16.8119	18.5476
7	.989265	1.239043	1.68987	2.16735	2.83341	12.0170	14.0671	16.0128	18.4753	20.2777
8	1.344419	1.646482	2.17973	2.73264	3.48954	13.3616	15.5073	17.5346	20.0902	21.9550
9	1.734926	2.087912	2.70039	3.32511	4.16816	14.6817	16.9190	19.0228	21.6660	23.5893
10	2.15585	2.55821	3.24697	3.94030	4.86518	15.9871	18.3070	20.4831	23.2093	25.1882
11	2.60321	3.05347	3.81575	4.57481	5.57779	17.2750	19.6751	21.9200	24.7250	26.7569
12	3.07382	3.57056	4.40379	5.22603	6.30380	18.5494	21.0261	23.3367	26.2170	28.2995
13	3.56503	4.10691	5.00874	5.89186	7.04150	19.8119	22.3621	24.7356	27.6883	29.8194
14	4.07468	4.66043	5.62872	6.57063	7.78953	21.0642	23.6848	26.1190	29.1413	31.3193
15	4.60094	5.22935	6.26214	7.26094	8.54675	22.3072	24.9958	27.4884	30.5779	32.8013
16	5.14224	5.81221	6.90766	7.96164	9.31223	23.5418	26.2962	28.8454	31.9999	34.2672
17	5.69724	6.40776	7.56418	8.67176	10.0832	24.7690	27.5871	30.1910	33.4087	35.7185
18	6.26481	7.01491	8.23075	9.39046	10.8649	25.9894	28.8693	31.5264	34.8053	37.1564
19	6.84398	7.63273	8.90655	10.1170	11.6509	27.2036	30.1435	32.8523	36.1908	38.5822
20	7.43386	8.26040	9.59083	10.8508	12.4426	28.4120	31.4104	34.1696	37.5662	39.9968
21	8.03366	8.89720	10.28293	11.5913	13.2396	29.6151	32.6705	35.4789	38.9321	41.4010
22	8.64272	9.54249	10.9823	12.3380	14.0415	30.8133	33.9244	36.7807	40.2894	42.7958
23	9.26042	10.19567	11.6885	13.0905	14.8479	32.0069	35.1725	38.0757	41.6384	44.1813
24	9.88623	10.8564	12.4011	13.8484	15.6587	33.1963	36.4151	39.3641	42.9798	45.5585
25	10.5197	11.5240	13.1197	14.6114	16.4734	34.3816	37.6525	40.6465	44.3141	46.9278
26	11.1603	12.1981	13.8439	15.3791	17.2919	35.5631	38.8852	41.9232	45.6417	48.2899
27	11.8076	12.8786	14.5733	16.1513	18.1138	36.7412	40.1133	43.1944	46.9630	49.6449
28	12.4613	13.5648	15.3079	16.9279	18.9392	37.9159	41.3372	44.4607	48.2782	50.9933
29	13.1211	14.2565	16.0471	17.7083	19.7677	39.0875	42.5569	45.7222	49.5879	52.3356
30	13.7867	14.9535	16.7908	18.4926	20.5992	40.2560	43.7729	46.9792	50.8922	53.6720
40	20.7065	22.1643	24.4331	26.5093	29.0505	51.8050	55.7585	59.3417	63.6907	66.7659
50	27.9907	29.7067	32.3574	34.7642	37.6886	63.1671	67.5048	71.4202	76.1539	79.4900
60	35.5346	37.4848	40.4817	43.1879	46.4589	74.3970	79.0819	83.2976	88.3794	91.9517
70	43.2752	45.4418	48.7576	51.7393	55.3290	85.5271	90.5312	95.0231	100.425	104.215
80	51.1720	53.5400	57.1532	60.3915	64.2778	96.5782	101.879	106.629	112.329	116.321
90	59.1963	61.7341	65.6466	69.1260	73.2912	107.565	113.145	118.136	124.116	128.299
100	67.3276	70.0648	74.2219	77.9295	82.3581	118.498	124.342	129.561	135.807	140.169

