

UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 1988/89

IUK 207/3 -Kaedah dan Amalan Teknologis

Tarikh: 4 November 1988 Masa: 2.45 petang - 5.45 petang
(3 jam)

Jawab 5 (LIMA) soalan sahaja. Semua soalan mesti dijawab di dalam Bahasa Malaysia. Tiap-tiap soalan diperuntukkan markah yang sama.

Sila pastikan kertas soalan ini mengandungi 6 soalan dan 18 mukasurat bercetak.

1. Anda diminta menyediakan carta-carta kawalan bagi \bar{X} dan s bersabit dengan kekerasan Brinell alatan-alatan keluli dalam sebutan unit kg/mm^2 . Data-data untuk subgroup saiz 8 diberikan dalam jadual berikut. Tentukan garis tengah dan had-had kawalan cubaan bagi carta-carta \bar{X} dan s . Anggaphlah titik-titik yang tak terkawal berpunca dari "assignable causes". Kira semula garis tengah dan had-had kawalannya.

Nombor Subgroup	\bar{X}	s	Nombor Subgroup	\bar{X}	s
1	540	26	14	551	24
2	534	23	15	522	29
3	545	24	16	579	26
4	561	27	17	549	28
5	576	25	18	508	23
6	523	50	19	569	22
7	571	29	20	574	28
8	547	29	21	563	33
9	584	23	22	561	23
10	552	24	23	548	25
11	541	28	24	556	27
12	545	25	25	553	23
13	546	26			

2. Sebuah hospital baru sahaja selesai menjalankan suatu projek peningkatan mutu tentang masa yang diambil untuk menguruskan kemasukan pesakit ke dalam hospital, dengan menggunakan carta \bar{X} dan carta R. Sekarang pihak pengurusan hospital ingin mengawasi aktiviti ini dengan menggunakan carta median dan carta julat. Tentukan garis tengah dan had-had kawalan dengan menggunakan data-data terbaru (dalam minit) seperti berikut:

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Nombor		Pemerhatian		Nombor		Pemerhatian	
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Subgroup	X_1	X_2	X_3	Subgroup	X_1	X_2	X_3
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1	6.0	5.8	6.1	13	6.1	6.9	7.4
2	5.2	6.4	6.9	14	6.2	5.2	6.8
3	5.5	5.8	6.2	15	4.9	6.6	6.6
4	5.0	5.7	6.5	16	7.0	6.4	6.1
5	6.7	6.5	5.5	17	5.4	6.5	6.7
6	5.8	5.2	5.0	18	6.6	7.0	6.8
7	5.6	5.1	5.2	19	4.7	6.2	7.1
8	6.0	5.8	6.0	20	6.7	5.4	6.7
9	5.5	4.9	5.7	21	6.8	6.5	5.2
10	4.3	6.4	6.3	22	5.9	6.4	6.0
11	6.2	6.9	5.0	23	6.7	6.3	4.6
12	6.7	7.1	6.2	24	7.4	6.8	6.3
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3. Tentukan garis tengah dan had-had kawalan cubaan bagi satu carta p dengan menggunakan data-data dalam jadual berikut. Anggaplah sebarang titik tak terkawal berpunca dari "assignable cause" dan tentukan semula garis tengah dan had-had kawalannya.

Nombor Sub-group	Bilangan Diperiksa	Bilangan Kecacatan (Defective)	Nombor Sub-group	Bilangan Diperiksa	Bilangan Kecacatan (Defective)
1	300	3	14	300	6
2	300	6	15	300	7
3	300	4	16	300	4
4	300	6	17	300	5
5	300	20	18	300	7
6	300	2	19	300	5
7	300	6	20	300	0
8	300	7	21	300	2
9	300	3	22	300	3
10	300	0	23	300	6
11	300	6	24	300	1
12	300	9	25	300	8
13	300	5			

4. Ciri-ciri sebuah thermocouple chromel-constantan adalah hampir-hampir linear dalam julat suhu 300-800°C. Voltan output diukur pada suhu-suhu tertentu dan keputusannya dicatatkan dalam jadual berikut. Dengan menggunakan kaedah "least-squares regression", kira koefisien-koefisien a dan b bagi hubungan $T = aE + b$, yang mana paling sesuai dikenakan kepada ciri-ciri suhu melawan voltan bagi sistem thermocouple ini, di mana E mewakili voltan dan T mewakili suhu.

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Suhu (°C)	300	325	350	375	400	425	450	475	500	525	550
Voltan (mV)	21.0	23.2	25.0	26.9	28.6	31.3	32.8	35.0	37.2	38.5	40.7
Suhu (°C)	575	600	625	650	675	700	725	750	775	800	
Voltan (mV)	43.0	45.2	47.6	49.5	51.1	53.0	55.5	57.2	59.0	61.0	

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5. Anda diminta merancangkan satu ujikaji untuk menentukan kadar pemindahan haba, \dot{Q} , dari permukaan sebuah plat tegak (vertical plate) melalui proses natural convection, kepada gas yang mengelilingi plat tersebut. Anda dimaklumkan bahawa pembolehubah-pembolehubah tak bersandar yang terlibat adalah seperti berikut:-

- (a) g , pecutan graviti, dan β , koefisien isipadu bagi pengembangan gas, dalam gabungan $g\beta$;
- (b) C_v , koefisien haba tentu (specific heat) bagi gas;
- (c) k_o , kekonduksian thermal, dan ρ_o , ketumpatan gas, dalam gabungan k_o/ρ_o ;
- (d) μ_o , kelikatan gas dalam gabungan μ_o/ρ_o ;
- (e) l , dimensi saiz plat;
- (f) ΔT , perbezaan suhu di antara plat dan gas;

sementara pembolehubah bersandar ialah gabungan \dot{Q}/k_o .

Seterusnya analisis berdimensi (dimensional analysis) menunjukkan bahawa pembolehubah-pembolehubah ini boleh dikurangkan kepada tiga kumpulan tak berdimensi yang boleh disusun sebagai:-

$$\frac{\dot{Q}}{k_o l \Delta T} = f \left[\frac{g \beta \rho_o^2 C_v^2 l^3 \Delta T}{k_o^2} ; \frac{g \beta \rho_o^2 l^2 \dot{Q}}{k_o \mu_o^2} \right]$$

Dari maklumat-maklumat di atas, jawab soalan-soalan berikut:-

- (i) Secara ujikaji, apakah pembolehubah-pembolehubah yang boleh diubah dengan senang, dan apakah kuantiti yang perlu diukur?
- (ii) Susulan dari (i), apakah kuantiti yang perlu ditetapkan pada nilai malar, dan mengapa?
- (iii) Susulan dari (ii), apakah kuantiti-kuantiti yang boleh ditentukan, dan apakah kesimpulan anda?
- (iv) Huraikan dengan ringkas mengapa operasi-operasi (i)-(iii) di atas tidak dapat menyelesaikan masalah ini dengan lengkap. Apakah cadangan anda untuk menentukan kadar pemindahan haba \dot{Q} diperolehi dengan sempurna dan cepat?

6. (a) Alatan ujian untuk mengukur beban kejutan maksimum (maximum shock load) dalam tali keledar sebuah motor car terdiri dari satu pengukur daya jenis piezoelektrik, sebuah penguat cas (charge amplifier), dan sebuah perakam (recorder). Dalam satu ujian tertentu yang dijalankan pada halaju 50 km/j, pesongan maksimum 90 mm dicatatkan oleh perakam. Tentukan nilai maksimum beban kejutan jika alatan ini mempunyai kepekaan seperti berikut:-

Pengukur daya piezoelektrik	4 pC/N
Penguat cas	10 mV/pC
Perakam	1 mm/V

- (b) Satu termometer platinum mempunyai rintangan 138.5Ω pada 100°C . Jika rintangannya meningkat kepada 281Ω apabila bersentuhan dengan satu gas panas, tentukan suhu gas ini. Rintangan termometer bernilai 100Ω pada 0°C . Nilai α (koefisien suhu bagi rintangan) untuk platinum ialah $0.0039/^{\circ}\text{C}$.

APPENDIX

TABLE A Areas Under the Normal Curve*

$\frac{X_i - \mu}{\sigma}$	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00
-3.5	0.00017	0.00017	0.00018	0.00019	0.00019	0.00020	0.00021	0.00022	0.00022	0.00023
-3.4	0.00024	0.00025	0.00026	0.00027	0.00028	0.00029	0.00030	0.00031	0.00033	0.00034
-3.3	0.00035	0.00036	0.00038	0.00039	0.00040	0.00042	0.00043	0.00045	0.00047	0.00048
-3.2	0.00050	0.00052	0.00054	0.00056	0.00058	0.00060	0.00062	0.00064	0.00066	0.00069
-3.1	0.00071	0.00074	0.00076	0.00079	0.00082	0.00085	0.00087	0.00090	0.00094	0.00097
-3.0	0.00100	0.00104	0.00107	0.00111	0.00114	0.00118	0.00122	0.00126	0.00131	0.00135
-2.9	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0017	0.0018	0.0019
-2.8	0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026
-2.7	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035
-2.6	0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047
-2.5	0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062
-2.4	0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082
-2.3	0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107
-2.2	0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139
-2.1	0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179
-2.0	0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228
-1.9	0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287
-1.8	0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359
-1.7	0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446
-1.6	0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548
-1.5	0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668
-1.4	0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808
-1.3	0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968
-1.2	0.0895	0.1003	0.1020	0.1038	0.1057	0.1075	0.1093	0.1112	0.1131	0.1151
-1.1	0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357
-1.0	0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587
-0.9	0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841
-0.8	0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119
-0.7	0.2148	0.2177	0.2207	0.2236	0.2266	0.2297	0.2327	0.2358	0.2389	0.2420
-0.6	0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743
-0.5	0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085
-0.4	0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446
-0.3	0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821
-0.2	0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207
-0.1	0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602
-0.0	0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000

*Proportion of total area under the curve that is under the portion of the curve from $-\infty$ to $(X_i - \mu)/\sigma$ (X_i represents any desired value of the variable X).

TABLE A (continued)

X, μ σ	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
+0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
+0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
+0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
+0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
+0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
+0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
+0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
+0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
+0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8079	0.8106	0.8133
+0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
+1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
+1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
+1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
+1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
+1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
+1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
+1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
+1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
+1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
+1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
+2.0	0.9773	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
+2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
+2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
+2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
+2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
+2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
+2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
+2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
+2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
+2.9	0.9981	0.9982	0.9983	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
+3.0	0.99865	0.99869	0.99874	0.99878	0.99882	0.99886	0.99889	0.99893	0.99896	0.99900
+3.1	0.99903	0.99906	0.99910	0.99913	0.99915	0.99918	0.99921	0.99924	0.99926	0.99929
+3.2	0.99931	0.99934	0.99936	0.99938	0.99940	0.99942	0.99944	0.99946	0.99948	0.99950
+3.3	0.99952	0.99953	0.99955	0.99957	0.99958	0.99960	0.99961	0.99962	0.99964	0.99965
+3.4	0.99966	0.99967	0.99969	0.99970	0.99971	0.99972	0.99973	0.99974	0.99975	0.99976
+3.5	0.99977	0.99978	0.99978	0.99979	0.99980	0.99981	0.99981	0.99982	0.99983	0.99983

TABLE B Factors for Computing Central Lines and 3 σ Control Limits for \bar{X} , s, and R, Charts

Observations in Sample, n	Chart for Averages			Chart for Standard Deviations						Chart for Ranges						
	Factors for Control Limits			Factors for Central Line		Factors for Control Limits				Factors for Central Line		Factors for Control Limits				
	A	A ₂	A ₃	c ₄	1 c ₄	B ₃	B ₄	B ₅	B ₆	d ₂	1 d ₂	d ₁	D ₁	D ₂	D ₃	D ₄
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.0423	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9846	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	1.0140	0.497	1.503	0.490	1.483	3.689	0.2711	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	1.0133	0.510	1.490	0.504	1.470	3.735	0.2677	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	1.0126	0.523	1.477	0.516	1.459	3.778	0.2647	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	1.0119	0.534	1.466	0.528	1.448	3.819	0.2618	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	1.0114	0.545	1.455	0.539	1.438	3.858	0.2592	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	1.0109	0.555	1.445	0.549	1.429	3.895	0.2567	0.712	1.759	6.031	0.451	1.548
25	0.600	0.155	0.606	0.9896	1.0105	0.565	1.435	0.559	1.420	3.931	0.2544	0.708	1.806	6.056	0.459	1.541

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TABLE C The Poisson Distribution $P(c) = (np_0/c!)e^{-np_0}$
(Cumulative Values Are in Parentheses)

np_0 c	0.1	0.2	0.3	0.4	0.5
0	0.905 (0.905)	0.819 (0.819)	0.741 (0.741)	0.670 (0.670)	0.607 (0.607)
1	0.091 (0.996)	0.164 (0.983)	0.222 (0.963)	0.268 (0.938)	0.303 (0.910)
2	0.004 (1.000)	0.016 (0.999)	0.033 (0.996)	0.054 (0.992)	0.076 (0.986)
3		0.010 (1.000)	0.004 (1.000)	0.007 (0.999)	0.013 (0.999)
4				0.001 (1.000)	0.001 (1.000)

np_0 c	0.6	0.7	0.8	0.9	1.0
0	0.549 (0.549)	0.497 (0.497)	0.449 (0.449)	0.406 (0.406)	0.368 (0.368)
1	0.329 (0.878)	0.349 (0.845)	0.359 (0.808)	0.366 (0.772)	0.368 (0.736)
2	0.099 (0.977)	0.122 (0.967)	0.144 (0.952)	0.166 (0.938)	0.184 (0.920)
3	0.020 (0.997)	0.028 (0.995)	0.039 (0.991)	0.049 (0.987)	0.061 (0.981)
4	0.003 (1.000)	0.005 (1.000)	0.008 (0.999)	0.011 (0.998)	0.016 (0.997)
5			0.001 (1.000)	0.002 (1.000)	0.003 (1.000)

np_0 c	1.1	1.2	1.3	1.4	1.5
0	0.333 (0.333)	0.301 (0.301)	0.273 (0.273)	0.247 (0.247)	0.223 (0.223)
1	0.366 (0.699)	0.361 (0.662)	0.354 (0.627)	0.345 (0.592)	0.335 (0.558)
2	0.201 (0.900)	0.217 (0.879)	0.230 (0.857)	0.242 (0.834)	0.251 (0.809)
3	0.074 (0.974)	0.087 (0.966)	0.100 (0.957)	0.113 (0.947)	0.126 (0.935)
4	0.021 (0.995)	0.026 (0.992)	0.032 (0.989)	0.039 (0.986)	0.047 (0.982)
5	0.004 (0.999)	0.007 (0.999)	0.009 (0.998)	0.011 (0.997)	0.014 (0.996)
6	0.001 (1.000)	0.001 (1.000)	0.002 (1.000)	0.003 (1.000)	0.004 (1.000)

np_0 c	1.6	1.7	1.8	1.9	2.0
0	0.202 (0.202)	0.183 (0.183)	0.165 (0.165)	0.150 (0.150)	0.135 (0.135)
1	0.323 (0.525)	0.311 (0.494)	0.298 (0.463)	0.284 (0.434)	0.271 (0.406)
2	0.258 (0.783)	0.264 (0.758)	0.268 (0.731)	0.270 (0.704)	0.271 (0.677)
3	0.138 (0.921)	0.149 (0.907)	0.161 (0.892)	0.171 (0.875)	0.180 (0.857)
4	0.055 (0.976)	0.064 (0.971)	0.072 (0.964)	0.081 (0.956)	0.090 (0.947)
5	0.018 (0.994)	0.022 (0.993)	0.026 (0.990)	0.031 (0.987)	0.036 (0.983)
6	0.005 (0.999)	0.006 (0.999)	0.008 (0.998)	0.010 (0.997)	0.012 (0.995)
7	0.001 (1.000)	0.001 (1.000)	0.002 (1.000)	0.003 (1.000)	0.004 (0.999)
8					0.001 (1.000)

TABLE C (continued)

np_0		2.1		2.2		2.3		2.4		2.5	
c											
0	0.123	(0.123)	0.111	(0.111)	0.100	(0.100)	0.091	(0.091)	0.082	(0.082)	
1	0.257	(0.380)	0.244	(0.355)	0.231	(0.331)	0.218	(0.309)	0.205	(0.287)	
2	0.270	(0.650)	0.268	(0.623)	0.265	(0.596)	0.261	(0.570)	0.256	(0.543)	
3	0.189	(0.839)	0.197	(0.820)	0.203	(0.799)	0.209	(0.779)	0.214	(0.757)	
4	0.099	(0.938)	0.108	(0.928)	0.117	(0.916)	0.125	(0.904)	0.134	(0.891)	
5	0.042	(0.980)	0.048	(0.976)	0.054	(0.970)	0.060	(0.964)	0.067	(0.958)	
6	0.015	(0.995)	0.017	(0.993)	0.021	(0.991)	0.024	(0.988)	0.028	(0.986)	
7	0.004	(0.999)	0.005	(0.998)	0.007	(0.998)	0.008	(0.996)	0.010	(0.996)	
8	0.001	(1.000)	0.002	(1.000)	0.002	(1.000)	0.003	(0.999)	0.003	(0.999)	
9							0.001	(1.000)	0.001	(1.000)	

np_0		2.6		2.7		2.8		2.9		3.0	
c											
0	0.074	(0.074)	0.067	(0.067)	0.061	(0.061)	0.055	(0.055)	0.050	(0.050)	
1	0.193	(0.267)	0.182	(0.249)	0.170	(0.231)	0.160	(0.215)	0.149	(0.199)	
2	0.251	(0.518)	0.245	(0.494)	0.238	(0.469)	0.231	(0.446)	0.224	(0.423)	
3	0.218	(0.736)	0.221	(0.715)	0.223	(0.692)	0.224	(0.670)	0.224	(0.647)	
4	0.141	(0.877)	0.149	(0.864)	0.156	(0.848)	0.162	(0.832)	0.168	(0.815)	
5	0.074	(0.951)	0.080	(0.944)	0.087	(0.935)	0.094	(0.926)	0.101	(0.916)	
6	0.032	(0.983)	0.036	(0.980)	0.041	(0.976)	0.045	(0.971)	0.050	(0.966)	
7	0.012	(0.995)	0.014	(0.994)	0.016	(0.992)	0.019	(0.990)	0.022	(0.988)	
8	0.004	(0.999)	0.005	(0.999)	0.006	(0.998)	0.007	(0.997)	0.008	(0.996)	
9	0.001	(1.000)	0.001	(1.000)	0.002	(1.000)	0.002	(0.999)	0.003	(0.999)	
10							0.001	(1.000)	0.001	(1.000)	

np_0		3.1		3.2		3.3		3.4		3.5	
c											
0	0.045	(0.045)	0.041	(0.041)	0.037	(0.037)	0.033	(0.033)	0.030	(0.030)	
1	0.140	(0.185)	0.130	(0.171)	0.122	(0.159)	0.113	(0.146)	0.106	(0.136)	
2	0.216	(0.401)	0.209	(0.380)	0.201	(0.360)	0.193	(0.339)	0.185	(0.321)	
3	0.224	(0.625)	0.223	(0.603)	0.222	(0.582)	0.219	(0.558)	0.216	(0.537)	
4	0.173	(0.798)	0.178	(0.781)	0.182	(0.764)	0.186	(0.744)	0.189	(0.726)	
5	0.107	(0.905)	0.114	(0.895)	0.120	(0.884)	0.126	(0.870)	0.132	(0.858)	
6	0.056	(0.961)	0.061	(0.956)	0.066	(0.950)	0.071	(0.941)	0.077	(0.935)	
7	0.025	(0.986)	0.028	(0.984)	0.031	(0.981)	0.035	(0.976)	0.038	(0.973)	
8	0.010	(0.996)	0.011	(0.995)	0.012	(0.993)	0.015	(0.991)	0.017	(0.990)	
9	0.003	(0.999)	0.004	(0.999)	0.005	(0.998)	0.006	(0.997)	0.007	(0.997)	
10	0.001	(1.000)	0.001	(1.000)	0.002	(1.000)	0.002	(0.999)	0.002	(0.999)	
11							0.001	(1.000)	0.001	(1.000)	

TABLE C (continued)

$c \backslash np_0$	3.6	3.7	3.8	3.9	4.0
0	0.027 (0.027)	0.025 (0.025)	0.022 (0.022)	0.020 (0.020)	0.018 (0.018)
1	0.098 (0.125)	0.091 (0.116)	0.085 (0.107)	0.079 (0.099)	0.073 (0.091)
2	0.177 (0.302)	0.169 (0.285)	0.161 (0.268)	0.154 (0.253)	0.147 (0.238)
3	0.213 (0.515)	0.209 (0.494)	0.205 (0.473)	0.200 (0.453)	0.195 (0.433)
4	0.191 (0.706)	0.193 (0.687)	0.194 (0.667)	0.195 (0.648)	0.195 (0.628)
5	0.138 (0.844)	0.143 (0.830)	0.148 (0.815)	0.152 (0.800)	0.157 (0.785)
6	0.083 (0.927)	0.088 (0.918)	0.094 (0.909)	0.099 (0.899)	0.104 (0.889)
7	0.042 (0.969)	0.047 (0.965)	0.051 (0.960)	0.055 (0.954)	0.060 (0.949)
8	0.019 (0.988)	0.022 (0.987)	0.024 (0.984)	0.027 (0.981)	0.030 (0.979)
9	0.008 (0.996)	0.009 (0.996)	0.010 (0.994)	0.012 (0.993)	0.013 (0.992)
10	0.003 (0.999)	0.003 (0.999)	0.004 (0.998)	0.004 (0.997)	0.005 (0.997)
11	0.001 (1.000)	0.001 (1.000)	0.001 (0.999)	0.002 (0.999)	0.002 (0.999)
12			0.001 (1.000)	0.001 (1.000)	0.001 (1.000)

$c \backslash np_0$	4.1	4.2	4.3	4.4	4.5
0	0.017 (0.017)	0.015 (0.015)	0.014 (0.014)	0.012 (0.012)	0.011 (0.011)
1	0.068 (0.085)	0.063 (0.078)	0.058 (0.072)	0.054 (0.066)	0.050 (0.061)
2	0.139 (0.224)	0.132 (0.210)	0.126 (0.198)	0.119 (0.185)	0.113 (0.174)
3	0.190 (0.414)	0.185 (0.395)	0.180 (0.378)	0.174 (0.359)	0.169 (0.343)
4	0.195 (0.609)	0.195 (0.590)	0.193 (0.571)	0.192 (0.551)	0.190 (0.533)
5	0.160 (0.769)	0.163 (0.753)	0.166 (0.737)	0.169 (0.720)	0.171 (0.704)
6	0.110 (0.879)	0.114 (0.867)	0.119 (0.856)	0.124 (0.844)	0.128 (0.832)
7	0.064 (0.943)	0.069 (0.936)	0.073 (0.929)	0.078 (0.922)	0.082 (0.914)
8	0.033 (0.976)	0.036 (0.972)	0.040 (0.969)	0.043 (0.965)	0.046 (0.960)
9	0.015 (0.991)	0.017 (0.989)	0.019 (0.988)	0.021 (0.986)	0.023 (0.983)
10	0.006 (0.997)	0.007 (0.996)	0.008 (0.996)	0.009 (0.995)	0.011 (0.994)
11	0.002 (0.999)	0.003 (0.999)	0.003 (0.999)	0.004 (0.999)	0.004 (0.998)
12	0.001 (1.000)	0.001 (1.000)	0.001 (1.000)	0.001 (1.000)	0.001 (0.999)
13					0.001 (1.000)

TABLE C (continued)

c	np ₀		4.6		4.7		4.8		4.9		5.0	
0	0.010	(0.010)	0.009	(0.009)	0.008	(0.008)	0.008	(0.008)	0.007	(0.007)		
1	0.046	(0.056)	0.043	(0.052)	0.039	(0.047)	0.037	(0.045)	0.034	(0.041)		
2	0.106	(0.162)	0.101	(0.153)	0.095	(0.142)	0.090	(0.135)	0.084	(0.125)		
3	0.163	(0.325)	0.157	(0.310)	0.152	(0.294)	0.146	(0.281)	0.140	(0.265)		
4	0.188	(0.513)	0.185	(0.495)	0.182	(0.476)	0.179	(0.460)	0.176	(0.441)		
5	0.172	(0.685)	0.174	(0.669)	0.175	(0.651)	0.175	(0.635)	0.176	(0.617)		
6	0.132	(0.817)	0.136	(0.805)	0.140	(0.791)	0.143	(0.778)	0.146	(0.763)		
7	0.087	(0.904)	0.091	(0.896)	0.096	(0.887)	0.100	(0.878)	0.105	(0.868)		
8	0.050	(0.954)	0.054	(0.950)	0.058	(0.945)	0.061	(0.939)	0.065	(0.933)		
9	0.026	(0.980)	0.028	(0.978)	0.031	(0.976)	0.034	(0.973)	0.036	(0.969)		
10	0.012	(0.992)	0.013	(0.991)	0.015	(0.991)	0.016	(0.989)	0.018	(0.987)		
11	0.005	(0.997)	0.006	(0.997)	0.006	(0.997)	0.007	(0.996)	0.008	(0.995)		
12	0.002	(0.999)	0.002	(0.999)	0.002	(0.999)	0.003	(0.999)	0.003	(0.998)		
13	0.001	(1.000)	0.001	(1.000)	0.001	(1.000)	0.001	(1.000)	0.001	(0.999)		
14									0.001	(1.000)		

c	np ₀		6.0		7.0		8.0		9.0		10.0		
0	0.002	(0.002)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	
1	0.015	(0.017)	0.006	(0.007)	0.003	(0.003)	0.001	(0.001)	0.001	(0.001)	0.000	(0.000)	
2	0.045	(0.062)	0.022	(0.029)	0.011	(0.014)	0.005	(0.006)	0.002	(0.002)	0.002	(0.002)	
3	0.089	(0.151)	0.052	(0.081)	0.029	(0.043)	0.015	(0.021)	0.007	(0.009)	0.007	(0.009)	
4	0.134	(0.285)	0.091	(0.172)	0.057	(0.100)	0.034	(0.055)	0.019	(0.028)	0.019	(0.028)	
5	0.161	(0.446)	0.128	(0.300)	0.092	(0.192)	0.061	(0.116)	0.038	(0.066)	0.038	(0.066)	
6	0.161	(0.607)	0.149	(0.449)	0.122	(0.314)	0.091	(0.207)	0.063	(0.129)	0.063	(0.129)	
7	0.138	(0.745)	0.149	(0.598)	0.140	(0.454)	0.117	(0.324)	0.090	(0.219)	0.090	(0.219)	
8	0.103	(0.848)	0.131	(0.729)	0.140	(0.594)	0.132	(0.456)	0.113	(0.332)	0.113	(0.332)	
9	0.069	(0.917)	0.102	(0.831)	0.124	(0.718)	0.132	(0.588)	0.125	(0.457)	0.125	(0.457)	
10	0.041	(0.958)	0.071	(0.902)	0.099	(0.817)	0.119	(0.707)	0.125	(0.582)	0.125	(0.582)	
11	0.023	(0.981)	0.045	(0.947)	0.072	(0.889)	0.097	(0.804)	0.114	(0.696)	0.114	(0.696)	
12	0.011	(0.992)	0.026	(0.973)	0.048	(0.937)	0.073	(0.877)	0.095	(0.791)	0.095	(0.791)	
13	0.005	(0.997)	0.014	(0.987)	0.030	(0.967)	0.050	(0.927)	0.073	(0.864)	0.073	(0.864)	
14	0.002	(0.999)	0.007	(0.994)	0.017	(0.984)	0.032	(0.959)	0.052	(0.915)	0.052	(0.915)	
15	0.001	(1.000)	0.003	(0.997)	0.009	(0.993)	0.019	(0.978)	0.035	(0.951)	0.035	(0.951)	
16			0.002	(0.999)	0.004	(0.997)	0.011	(0.989)	0.022	(0.973)	0.022	(0.973)	
17			0.001	(1.000)	0.002	(0.999)	0.006	(0.995)	0.013	(0.986)	0.013	(0.986)	
18					0.001	(1.000)	0.003	(0.998)	0.007	(0.993)	0.007	(0.993)	
19							0.001	(0.999)	0.004	(0.997)	0.004	(0.997)	
20								0.001	(1.000)	0.002	(0.999)	0.002	(0.999)
21										0.001	(1.000)	0.001	(1.000)

TABLE C (continued)

c	np_0		11.0		12.0		13.0		14.0		15.0	
0	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
1	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
2	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
3	0.004	(0.005)	0.002	(0.002)	0.001	(0.001)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
4	0.010	(0.015)	0.005	(0.007)	0.003	(0.004)	0.003	(0.004)	0.001	(0.001)	0.001	(0.001)
5	0.022	(0.037)	0.013	(0.020)	0.007	(0.011)	0.007	(0.011)	0.004	(0.005)	0.002	(0.003)
6	0.041	(0.078)	0.025	(0.045)	0.015	(0.026)	0.015	(0.026)	0.009	(0.014)	0.005	(0.008)
7	0.065	(0.143)	0.044	(0.089)	0.028	(0.054)	0.028	(0.054)	0.017	(0.031)	0.010	(0.018)
8	0.089	(0.232)	0.066	(0.155)	0.046	(0.100)	0.046	(0.100)	0.031	(0.062)	0.019	(0.037)
9	0.109	(0.341)	0.087	(0.242)	0.066	(0.166)	0.066	(0.166)	0.047	(0.109)	0.032	(0.069)
10	0.119	(0.460)	0.105	(0.347)	0.086	(0.252)	0.086	(0.252)	0.066	(0.175)	0.049	(0.118)
11	0.119	(0.579)	0.114	(0.461)	0.101	(0.353)	0.101	(0.353)	0.084	(0.259)	0.066	(0.184)
12	0.109	(0.688)	0.114	(0.575)	0.110	(0.463)	0.110	(0.463)	0.099	(0.358)	0.083	(0.267)
13	0.093	(0.781)	0.106	(0.681)	0.110	(0.573)	0.110	(0.573)	0.106	(0.464)	0.096	(0.363)
14	0.073	(0.854)	0.091	(0.772)	0.102	(0.675)	0.102	(0.675)	0.106	(0.570)	0.102	(0.465)
15	0.053	(0.907)	0.072	(0.844)	0.088	(0.763)	0.088	(0.763)	0.099	(0.669)	0.102	(0.567)
16	0.037	(0.944)	0.054	(0.898)	0.072	(0.835)	0.072	(0.835)	0.087	(0.756)	0.096	(0.663)
17	0.024	(0.968)	0.038	(0.936)	0.055	(0.890)	0.055	(0.890)	0.071	(0.827)	0.085	(0.748)
18	0.015	(0.983)	0.026	(0.962)	0.040	(0.930)	0.040	(0.930)	0.056	(0.883)	0.071	(0.819)
19	0.008	(0.991)	0.016	(0.978)	0.027	(0.957)	0.027	(0.957)	0.041	(0.924)	0.056	(0.875)
20	0.005	(0.996)	0.010	(0.988)	0.018	(0.975)	0.018	(0.975)	0.029	(0.953)	0.042	(0.917)
21	0.002	(0.998)	0.006	(0.994)	0.011	(0.986)	0.011	(0.986)	0.019	(0.972)	0.030	(0.947)
22	0.001	(0.999)	0.003	(0.997)	0.006	(0.992)	0.006	(0.992)	0.012	(0.984)	0.020	(0.967)
23	0.001	(1.000)	0.002	(0.999)	0.004	(0.996)	0.004	(0.996)	0.007	(0.991)	0.013	(0.980)
24			0.001	(1.000)	0.002	(0.998)	0.002	(0.998)	0.004	(0.995)	0.008	(0.988)
25					0.001	(0.999)	0.001	(0.999)	0.003	(0.998)	0.005	(0.993)
26					0.001	(1.000)	0.001	(1.000)	0.001	(0.999)	0.003	(0.996)
27									0.001	(1.000)	0.002	(0.998)
28											0.001	(0.999)
29											0.001	(1.000)

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TABLE D Random Numbers (Generated by an Electronic Hand Calculator)

9069	7629	5756	2237	3069	6004	3792	2530
4321	5890	0822	5994	9996	8961	1262	5870
4195	5124	9161	6899	6857	6455	7662	7035
8589	4484	0905	8676	4514	8790	7186	4591
1007	3877	2592	8860	5753	8661	7694	5013
7047	2263	8242	9363	0458	5459	2369	3815
6974	5289	7527	6283	3635	1209	3791	1709
6203	5675	0586	8541	7337	3896	3060	1726
3888	0533	6091	6066	2169	4146	1047	3999
9860	9589	0814	1976	8775	8710	0231	8630
3845	7559	3167	1845	5491	4805	7966	9334
5732	0238	6134	5642	7306	2351	3150	2848
9534	6145	1823	0269	6577	4545	2181	9347
3574	9563	8359	4776	0111	9110	6160	8471
6574	1550	9890	5275	3005	3922	7048	1569
3756	6594	6634	9824	1318	6586	4075	5091
5569	2958	8823	3073	2471	1512	1015	9361
9109	2166	2146	9374	9483	2111	7095	8421
1165	2712	2021	6154	5522	9017	0354	0754
8078	2347	6410	2480	7247	1283	1307	6651
0179	4334	7117	2530	2504	4703	1756	0688
1125	2677	9553	7596	1407	3062	4701	9624
9936	2780	0687	7901	4265	5741	3310	2535
2827	1781	7272	4947	8892	7557	3134	8504
5389	9850	5081	5267	5164	1340	0605	5451
2166	6647	7554	4773	9682	3348	8503	8358
3760	1243	7458	6177	8038	2223	2679	4284
7522	6494	8298	7868	0822	8806	9255	3581
3111	6280	3705	0257	0298	6587	8677	8291
6589	0555	8479	4523	0150	4309	2756	9037
3879	9015	1218	3420	1552	8760	2758	3897
4607	5549	8957	1643	7731	6421	4639	0839
6202	0118	0479	4969	5067	3423	2718	1440
6226	1693	7411	0887	8890	0987	6252	8683
8490	3667	9016	6370	3826	4061	4548	6521
0267	5886	8597	3128	1833	7218	2997	4017
4977	9118	3327	7049	0913	0947	9262	8071
3846	7549	8036	7688	4659	9984	4752	7859
4786	4360	7316	7631	4046	0174	8035	4080
1680	4395	6313	9927	0274	1499	7072	4169

