REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF MINERALS AND ENERGY
EXAMINATION FOR THE MINE SURVEYOR'S CERTIFICATE OF COMPETENCY

DATE: 11 October 2007 (Thursday) TOTAL MARKS: 100
TIME: 12:30 – 15:30 (3 Hours) TO PASS: 50

MINING ECONOMICS II

NOTE:

1. Any pocket calculator may be used and intermediate results need not be shown. The make and model number of the calculator used must be noted on the front cover of the answer book.
2. Tables that may be used are attached hereto.
3. Graph, Probability and Log paper will be supplied if required
4. Your examination number must be written on all graph paper and loose sheets that are handed in with your examination script.

Question 1

Explain the following terms:

a) Median.
b) Mode.
c) Geometric mean
d) Standard deviation
e) Geostatistics
f) Post plot
g) Maximum bandwidth
h) Lag distance
i) Anisotropy
j) Confidence limits

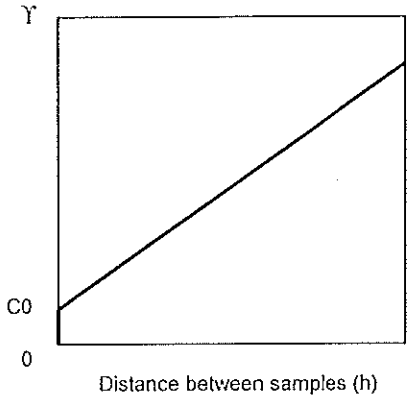
[18]

Question 2

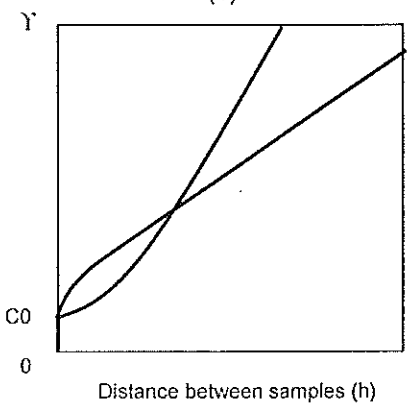
The eight sketches below show various shapes of semi-variograms. Using the list below, select the model, that best describes each shape.

Generalised Linear Model, Nested Spherical Model, Spherical Model, Gaussian Model, Hole Effect Model, Linear Model, Paddington Mix Model and Exponential Model.

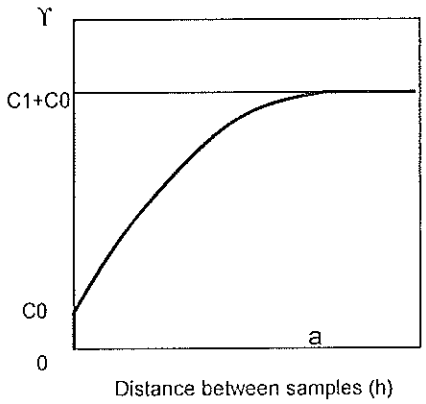
(a)



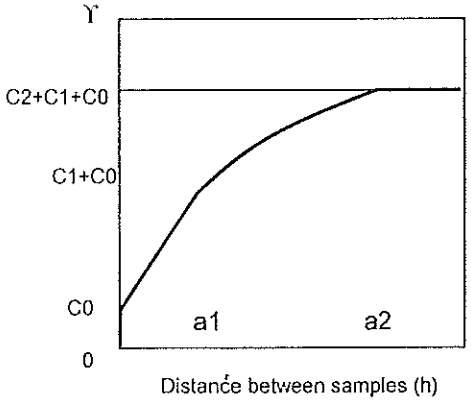
(b)



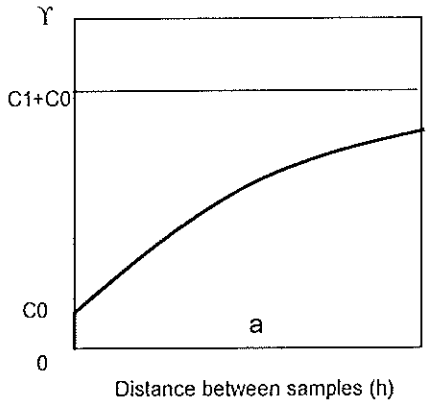
(c)



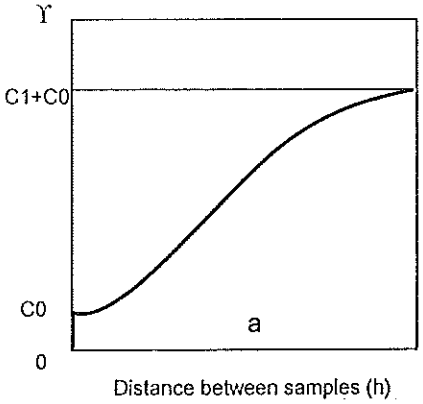
(d)



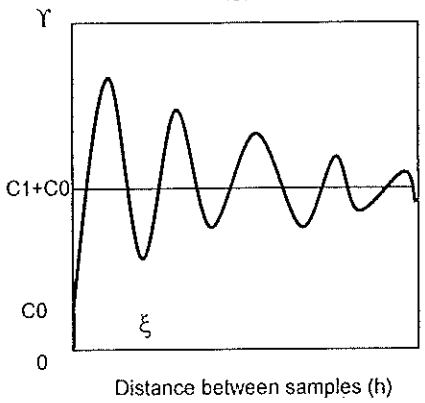
(e)



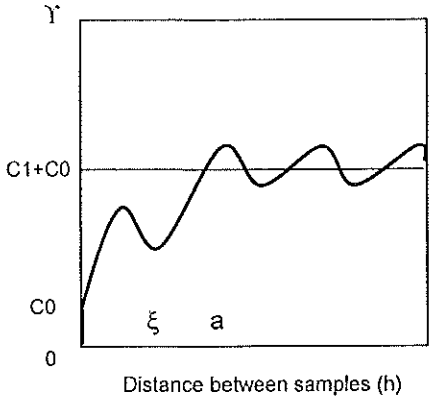
(f)



(g)



(h)



[8]

Question 3

It is required to obtain an estimate of the mean porosity of a clay body within accuracy of 1%. If a sample of size 55 shows a standard deviation of 4%, determine the sample size which would give the required accuracy of estimate with a confidence of 95%.

[10]

Question 4

A reef drive, advancing in a North/South direction, was sampled at 5 metre intervals and the following values (in g/t) were obtained. Calculate and plot an experimental semi-variogram of these values on the graph paper provided.

34	Missing	30	32	30	39	27	36	21	32	24

[20]

Question 5

A variogram for a 5m x 5m unit is spherical with a range of 19m and a sill of 24% MgO^2. Regularise the range and sill values into 30m x 30m units by making use of the F(L;B) tables provided.

[12]

Question 6

The results of an exploration programme, based on 240 samples of approximately three tons each, show that the ore values are normally and randomly distributed with a mean value of 33% MgO and a standard deviation of 10,6% MgO. Based on these figures it was estimated that 30 million tons would be payable with a mining pay limit of 26,8% MgO. The minimum quantity that can be allocated to either the mill or the waste dump is a truck load of 30 tons.

a) Calculate the total tons in the deposit
b) Determine the payable tons and the pay value for the given mining conditions
c) Determine the 90% confidence limits for the mean value.

[12]

Question 7

An investment of R10 000 now produces a cash flow of R4 000 per year for five years. Calculate the following:

a) The NPV at a discount rate of 10%
b) The IRR
c) The pay back period

[10]

Question 8

It is expected that a sum of R1 000 000 will be required in five years time for the purchase of new equipment.

a) Calculate the once-off amount that is required to be invested now, at an interest rate of 12% per annum compounded monthly, to provide the required money.

(5)

b) What would the investment be if the interest rate accrued is on a yearly basis?

(5)

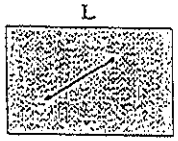
[10]

Total Marks [100]

TABLE FOR THE COMPUTATION OF TONNAGE AND GRADE CUT-OFF FOR THE NORMAL DISTRIBUTION				
Cut-off below the mean		Reduced cut-off = z PV = MV+ws	Cut-off above the mean	
Tonnage proportion	w factor		w factor	Tonnage proportion
50.00%	0.798	0.00	0.798	50.00%
51.99%	0.766	0.05	0.830	48.01%
53.98%	0.735	0.10	0.863	46.02%
55.96%	0.705	0.15	0.896	44.04%
57.93%	0.675	0.20	0.929	42.07%
59.87%	0.646	0.25	0.964	40.13%
61.79%	0.617	0.30	0.998	38.21%
63.68%	0.589	0.35	1.033	36.32%
65.54%	0.562	0.40	1.069	34.46%
67.36%	0.535	0.45	1.105	32.64%
69.15%	0.509	0.50	1.141	30.85%
70.88%	0.484	0.55	1.178	29.12%
72.57%	0.459	0.60	1.215	27.43%
74.22%	0.435	0.65	1.253	25.78%
75.80%	0.412	0.70	1.290	24.20%
77.34%	0.389	0.75	1.329	22.66%
78.81%	0.368	0.80	1.367	21.19%
80.23%	0.346	0.85	1.406	19.77%
81.59%	0.326	0.90	1.446	18.41%
82.89%	0.306	0.95	1.485	17.11%
84.13%	0.288	1.00	1.525	15.87%
85.31%	0.269	1.05	1.565	14.69%
86.43%	0.252	1.10	1.606	13.57%
87.49%	0.235	1.15	1.647	12.51%
88.49%	0.219	1.20	1.688	11.51%
89.44%	0.204	1.25	1.729	10.56%
90.32%	0.190	1.30	1.770	9.68%
91.15%	0.176	1.35	1.812	8.85%
91.92%	0.163	1.40	1.854	8.08%
92.65%	0.150	1.45	1.896	7.35%
93.32%	0.139	1.50	1.939	6.68%
93.94%	0.128	1.55	1.981	6.06%
94.52%	0.117	1.60	2.024	5.48%
95.05%	0.108	1.65	2.067	4.95%
95.54%	0.098	1.70	2.110	4.46%
95.99%	0.090	1.75	2.154	4.01%
96.41%	0.082	1.80	2.197	3.59%
96.78%	0.074	1.85	2.241	3.22%
97.13%	0.068	1.90	2.285	2.87%
97.44%	0.061	1.95	2.329	2.56%
97.72%	0.055	2.00	2.373	2.28%
97.98%	0.050	2.05	2.418	2.02%
98.21%	0.045	2.10	2.462	1.79%
98.42%	0.040	2.15	2.507	1.58%
98.61%	0.036	2.20	2.551	1.39%
98.78%	0.032	2.25	2.596	1.22%

AREAS under the
STANDARD
NORMAL CURVE
from 0 to z

Z	0	1	2	3	4	5	6	7	8	9
0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000



AUXILIARY FUNCTION F(L,B) for SPHERICAL MODEL with RANGE 1.0 and SILL 1.0

L/a \ B/a	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	3.5	4.0	5.0
.10	.078	.120	.165	.211	.256	.300	.342	.383	.422	.457	.520	.572	.614	.650	.679	.735	.775	.804	.827	.860
.20	.120	.155	.196	.237	.280	.321	.362	.401	.438	.473	.534	.584	.625	.659	.688	.743	.781	.810	.832	.864
.30	.165	.196	.231	.270	.309	.349	.387	.424	.460	.493	.551	.600	.639	.672	.700	.752	.789	.817	.838	.869
.40	.211	.237	.270	.305	.342	.379	.415	.451	.484	.516	.572	.618	.655	.687	.713	.763	.799	.825	.845	.874
.50	.256	.280	.309	.342	.376	.411	.445	.479	.511	.541	.593	.637	.673	.703	.728	.775	.809	.834	.853	.881
.60	.300	.321	.349	.379	.411	.443	.476	.507	.538	.566	.616	.657	.691	.719	.743	.788	.820	.843	.861	.887
.70	.342	.362	.387	.415	.445	.476	.506	.536	.565	.591	.638	.677	.709	.736	.758	.800	.830	.852	.870	.894
.80	.383	.401	.424	.451	.479	.507	.536	.564	.591	.616	.660	.697	.727	.752	.773	.813	.841	.861	.878	.901
.90	.422	.438	.460	.484	.511	.538	.565	.591	.616	.640	.682	.716	.744	.767	.787	.824	.851	.870	.885	.907
1.00	.457	.473	.493	.516	.541	.566	.591	.616	.640	.662	.701	.733	.760	.782	.800	.835	.860	.878	.892	.913
1.20	.520	.534	.551	.572	.593	.616	.638	.660	.682	.701	.736	.764	.788	.807	.823	.854	.876	.892	.905	.923
1.40	.572	.584	.600	.618	.637	.657	.677	.697	.716	.733	.764	.790	.811	.828	.842	.870	.890	.904	.915	.931
1.60	.614	.625	.639	.655	.673	.691	.709	.727	.744	.760	.788	.811	.829	.845	.858	.883	.901	.914	.924	.938
1.80	.650	.659	.672	.687	.703	.719	.736	.752	.767	.782	.807	.828	.845	.859	.871	.894	.910	.921	.931	.944
2.00	.679	.688	.700	.713	.728	.743	.758	.773	.787	.800	.823	.842	.858	.871	.882	.903	.917	.928	.936	.948
2.50	.735	.743	.752	.763	.775	.788	.800	.813	.824	.835	.854	.870	.883	.894	.903	.920	.932	.941	.948	.957
3.00	.775	.781	.789	.799	.809	.820	.830	.841	.851	.860	.876	.890	.901	.910	.917	.932	.942	.950	.955	.964
3.50	.804	.810	.817	.825	.834	.843	.852	.861	.870	.878	.892	.904	.914	.921	.928	.941	.950	.956	.961	.969
4.00	.827	.832	.838	.845	.853	.861	.870	.878	.885	.892	.905	.915	.924	.931	.936	.948	.955	.961	.966	.972
5.00	.860	.864	.869	.874	.881	.887	.894	.910	.907	.913	.923	.931	.938	.944	.948	.957	.964	.969	.972	.977

SOME USEFUL FORMULAE

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - u)^2$$

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}x_i^2 - u^2$$

$$s^2 = \frac{1}{n-1}\sum(x-\bar{x})^2$$

$$\gamma(h) = C(\frac{3h}{2a} - \frac{h^3}{2a^3})$$

$$s^2 = \frac{1}{n-1}[\sum x^2 - n\bar{x}^2]$$

$$\gamma(h) = C(1-\exp(\frac{-h}{a}))$$

$$T = \frac{\bar{x}-\mu}{s\sqrt{n}}$$

$$T = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

$$P = PV\frac{i}{1-(1+i)^n}$$

$$PV = A/(1+r)^n$$

$$PV = P(1-(1+i)^n)/i$$

$$PV = \frac{P[(1+r)^n - 1]}{r(1+r)^n}$$

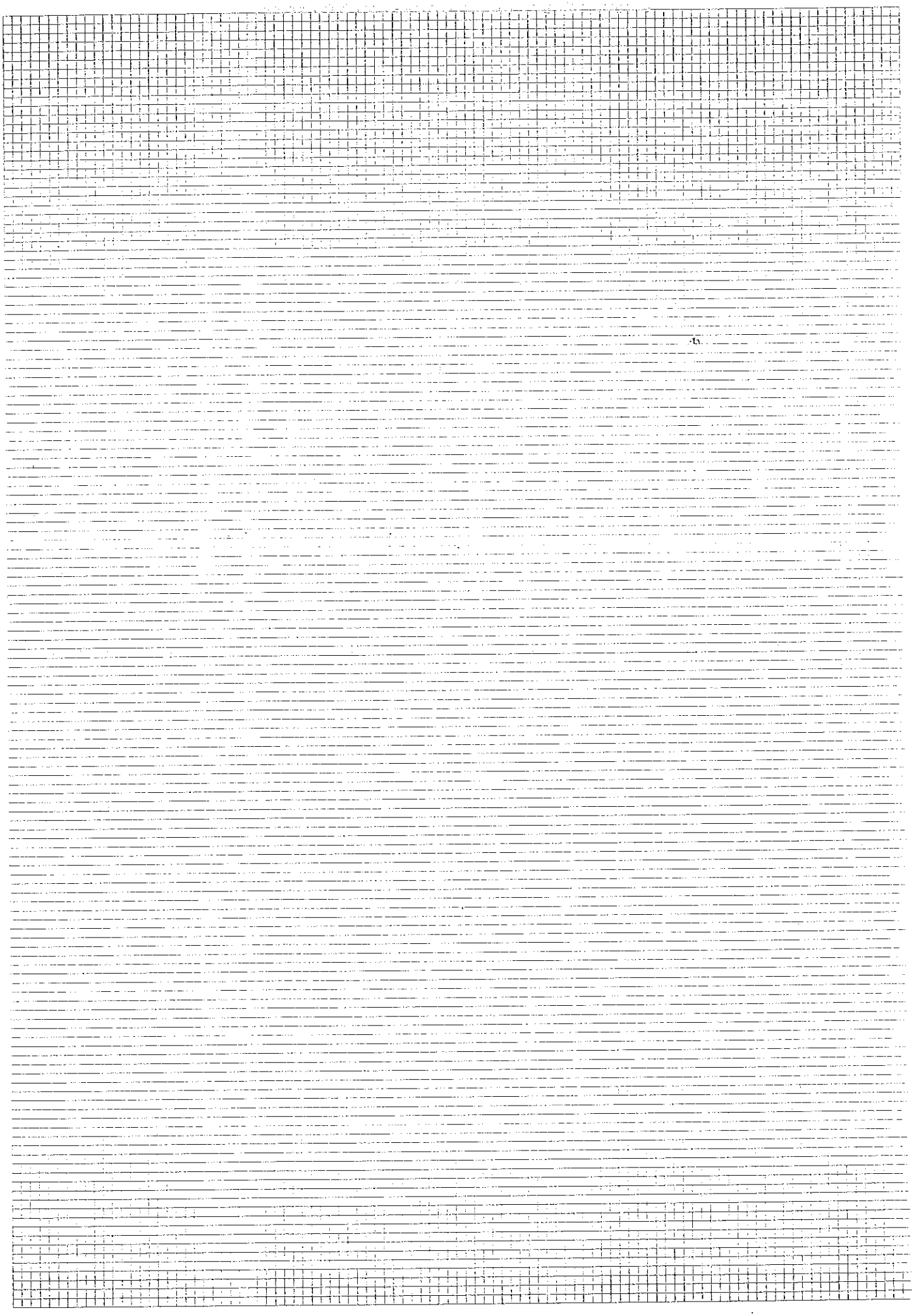
$$0 = \frac{Mx^2 - x_p x_{1-p}}{x_p + x_{1-p} - 2Mx}$$

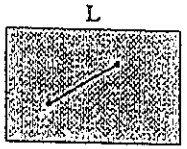
$$b = \frac{n\sum xy - \sum x\sum y}{n\sum x^2 - (\sum x)^2}$$

$$2\gamma(h) = \frac{1}{n}\sum[g(x) - g(x+h)]$$

$$r = \frac{\sum xy - \sum x\sum y/n}{[\sum x^2 - (\sum x)^2/n][\sum y^2 - (\sum y)^2/n]}$$

$$\sigma^c = \hat{s}_y\sqrt{1-r^2}$$





AUXILIARY FUNCTION F(L,B) for SPHERICAL MODEL with RANGE 1.0 and SILL 1.0

L/a or B/a	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	3.5	4.0	5.0
.10	.078	.120	.165	.211	.256	.300	.342	.383	.422	.457	.520	.572	.614	.650	.679	.735	.775	.804	.827	.860
.20	.120	.155	.196	.237	.280	.321	.362	.401	.438	.473	.534	.584	.625	.659	.688	.743	.781	.810	.832	.864
.30	.165	.196	.231	.270	.309	.349	.387	.424	.460	.493	.551	.600	.639	.672	.700	.752	.789	.817	.838	.869
.40	.211	.237	.270	.305	.342	.379	.415	.451	.484	.516	.572	.618	.655	.687	.713	.763	.799	.825	.845	.874
.50	.256	.280	.309	.342	.376	.411	.445	.479	.511	.541	.593	.637	.673	.703	.728	.775	.809	.834	.853	.881
.60	.300	.321	.349	.379	.411	.443	.476	.507	.538	.566	.616	.657	.691	.719	.743	.788	.820	.843	.861	.887
.70	.342	.362	.387	.415	.445	.476	.506	.536	.565	.591	.638	.677	.709	.736	.758	.800	.830	.852	.870	.894
.80	.383	.401	.424	.451	.479	.507	.536	.564	.591	.616	.660	.697	.727	.752	.773	.813	.841	.861	.878	.901
.90	.422	.438	.460	.484	.511	.538	.565	.591	.616	.640	.682	.716	.744	.767	.787	.824	.851	.870	.885	.907
1.00	.457	.473	.493	.516	.541	.566	.591	.616	.640	.662	.701	.733	.760	.782	.800	.835	.860	.878	.892	.913
1.20	.520	.534	.551	.572	.593	.616	.638	.660	.682	.701	.736	.764	.788	.807	.823	.854	.876	.892	.905	.923
1.40	.572	.584	.600	.618	.637	.657	.677	.697	.716	.733	.764	.790	.811	.828	.842	.870	.890	.904	.915	.931
1.60	.614	.625	.639	.655	.673	.691	.709	.727	.744	.760	.788	.811	.829	.845	.858	.883	.901	.914	.924	.938
1.80	.650	.659	.672	.687	.703	.719	.736	.752	.767	.782	.807	.828	.845	.859	.871	.894	.910	.921	.931	.944
2.00	.679	.688	.700	.713	.728	.743	.758	.773	.787	.800	.823	.842	.858	.871	.882	.903	.917	.928	.936	.948
2.50	.735	.743	.752	.763	.775	.788	.800	.813	.824	.835	.854	.870	.883	.894	.903	.920	.932	.941	.948	.957
3.00	.775	.781	.789	.799	.809	.820	.830	.841	.851	.860	.876	.890	.901	.910	.917	.932	.942	.950	.955	.964
3.50	.804	.810	.817	.825	.834	.843	.852	.861	.870	.878	.892	.904	.914	.921	.928	.941	.950	.956	.961	.969
4.00	.827	.832	.838	.845	.853	.861	.870	.878	.885	.892	.905	.915	.924	.931	.936	.948	.955	.961	.966	.972
5.00	.860	.864	.869	.874	.881	.887	.894	.900	.907	.913	.923	.931	.938	.944	.948	.957	.964	.969	.972	.977

SOME USEFUL FORMULAE

$$s^2 = \frac{1}{n-1}\sum (x-\bar{x})^2$$

$$s^2 = \frac{1}{n-1}\sum x^2 - n\bar{x}^2$$

$$T = \frac{\bar{x}-\mu}{s\sqrt{n}}$$

$$P = PV'\frac{i}{1-(1+i)^{n}}$$

$$PV' = P(1-(1+i)^{n})/i$$

$$b = \frac{n\sum xy - \sum x\sum y}{n\sum x^2 - (\sum x)^2}$$

$$r = \frac{\sum xy - \sum x\sum y/n}{[\sum x^2 - (\sum x)^2/n][\sum y^2 - (\sum y)^2/n]}$$

$$\gamma(h) = C(\frac{3h}{2a} - \frac{h^3}{2a^3})$$

$$\gamma(h) = C(1-\exp(\frac{-h}{a}))$$

$$T = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

$$PV' = A/(1+r)^{n}$$

$$\theta = \frac{Mx^2 - x_p x_{1-p}}{x_p + x_{1-p} - 2Mx}$$

$$2\gamma(h) = \frac{1}{n}\sum [g(x) - g(x+h)]$$

$$\sigma^{c} = \hat{s}_y\sqrt{1-r^2}$$