REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF MINERAL RESOURCES
EXAMINATION FOR THE MINE SURVEYOR'S CERTIFICATE OF COMPETENCY

DATE: 30th April 2010
TIME: (3 Hours)

TOTAL MARKS: 100
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:

a) Explain what is meant by the following terms:

i) Ordinary Kriging
ii) Point Kriging
iii) Simple Kriging
iv) Skewness
v) Kurtosis
vi) Coefficient of Variation
vii) Anisotropy
viii) Negative linear correlation

b) Draw an annotated sketch of a Spherical Semi-variogram illustrating your understanding of the function of the following components:

i) Nugget
ii) Sill
iii) Range

c) Name 4 essential assumptions made when attempting to describe a population's statistics from its sampled data.

[26 Marks]

Question 2:

The results of an exploration program based on 240 samples of approximately 3 tons each, show that the values are normally and randomly distributed with a mean value of 33% MgO and a standard deviation of 10.6% MgO. It is estimated that 30 000 000 tons would be payable with a pay value of 37.9% MgO for a mining pay limit of 26.8% MgO. However, the minimum quantity that can be allocated to either the mill or waste dump is a truck load of 30 tons.

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

[20 Marks]

Question 3:

The area of a working mine amounts to 1 400 claims of which 12% has already been stoped out. Of the remaining area 8% is barren due to faults, 12% of the monthly tonnage hoisted is obtained from reclamation in old areas, surface sorting amounts to 7% and 5% of ore broken in stopes is sorted and packed underground. The average stoping width is 145 cm and the average dip is 21º. Ignoring development tonnages, determine the life of mine, assuming:

i) 95 000 metric tons are milled per month
ii) The percentage payability is 55%
iii) The density of rock is 2.75 t/m^3
iv) 1 claim is 5 948m^2

[15 Marks]

Question 4:

The following values, in grams per ton, were obtained from an underground reef raise which was recently sampled.

19, 19, 32, 20, 35, 24, 23, 24, 28, 25.

Calculate:

i) The mean.
ii) The mode.
iii) The median.
iv) The standard deviation for a sample.
v) The standard deviation for the population.
vi) The sample variance.
vii) The population variance.
viii) The population standard deviation mean.
ix) The population standard deviation mean if samples have a mass of 5kg and 30kg of ore is sent to the plant.

[12 Marks]

Question 5:

A mining company wants to undertake a project whereby they will be processing an old waste rock dump. During the expected duration of the project the following cash flow streams is expected to be generated;

Year	Cash Flow (R`000)
0	(R1 500)
1	R1 000
2	R750
3	R550

i) Calculate the IRR of this project.
ii) If the company has a hurdle rate of 24%, is the project an acceptable proposition?

[13 Marks]

Question 6:

In the mining industry there are a variety of different types of costs falling under the heading of "Operating Costs". Name and describe at least seven of these costs.

[14 Marks]

Total Marks [100]

SOME USEFUL FORMULAE

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

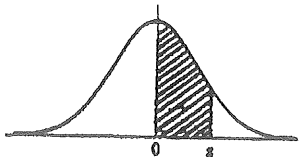
$$\sigma^e = \hat{s}_y\sqrt{1-r^2}$$

$$\text{additive constant (a)} = \frac{m^2 - f1 * f2}{f1 + f2 - 2m}$$

$$\gamma(h) = C_0 + C_1\left[\frac{3h}{2a} - \frac{h^3}{2a^3}\right]$$

TABLE 1

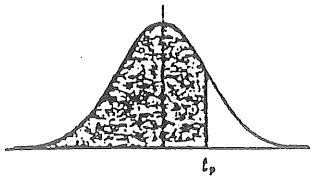
AREAS under the STANDARD NORMAL CURVE from 0 to z



z	0	1	2	3	4	5	6	7	8	9
0·0	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	0·0754
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	0·2258	0·2291	0·2324	0·2357	0·2389	0·2422	0·2454	0·2486	0·2518	0·2549
0·7	0·2580	0·2612	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	0·2996	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	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	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	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

TABLE 2

PERCENTILE VALUES (t_p)
for
STUDENT'S t DISTRIBUTION
with ν degrees of freedom
(shaded area = p)



ν	$t_{0.995}$	$t_{0.99}$	$t_{0.975}$	$t_{0.95}$	$t_{0.90}$	$t_{0.80}$	$t_{0.75}$	$t_{0.70}$	$t_{0.60}$	$t_{0.55}$
1	63·66	31·82	12·71	6·31	3·08	1·376	1·000	0·727	0·325	0·158
2	9·92	6·96	4·30	2·92	1·89	1·061	0·816	0·617	0·289	0·142
3	5·84	4·54	3·18	2·35	1·64	0·978	0·765	0·584	0·277	0·137
4	4·60	3·75	2·78	2·13	1·53	0·941	0·741	0·569	0·271	0·134
5	4·03	3·36	2·57	2·02	1·48	0·920	0·727	0·559	0·267	0·132
6	3·71	3·14	2·45	1·94	1·44	0·906	0·718	0·553	0·265	0·131
7	3·50	3·00	2·36	1·90	1·42	0·896	0·711	0·549	0·263	0·130
8	3·36	2·90	2·31	1·86	1·40	0·889	0·706	0·546	0·262	0·130
9	3·25	2·82	2·26	1·83	1·38	0·883	0·703	0·543	0·261	0·129
10	3·17	2·76	2·23	1·81	1·37	0·879	0·700	0·542	0·260	0·129
11	3·11	2·72	2·20	1·80	1·36	0·876	0·697	0·540	0·260	0·129
12	3·06	2·68	2·18	1·78	1·36	0·873	0·695	0·539	0·259	0·128
13	3·01	2·65	2·16	1·77	1·35	0·870	0·694	0·538	0·259	0·128
14	2·98	2·62	2·14	1·76	1·34	0·868	0·692	0·537	0·258	0·128
15	2·95	2·60	2·13	1·75	1·34	0·866	0·691	0·536	0·258	0·128
16	2·92	2·58	2·12	1·75	1·34	0·865	0·690	0·535	0·258	0·128
17	2·90	2·57	2·11	1·74	1·33	0·863	0·689	0·534	0·257	0·128
18	2·88	2·55	2·10	1·73	1·33	0·862	0·688	0·534	0·257	0·127
19	2·86	2·54	2·09	1·73	1·33	0·861	0·688	0·533	0·257	0·127
20	2·84	2·53	2·09	1·72	1·32	0·860	0·687	0·533	0·257	0·127
21	2·83	2·52	2·08	1·72	1·32	0·859	0·686	0·532	0·257	0·127
22	2·82	2·51	2·07	1·72	1·32	0·858	0·686	0·532	0·256	0·127
23	2·81	2·50	2·07	1·71	1·32	0·858	0·865	0·532	0·256	0·127
24	2·80	2·49	2·06	1·71	1·32	0·857	0·685	0·531	0·256	0·127
25	2·79	2·48	2·06	1·71	1·32	0·856	0·684	0·531	0·256	0·127
26	2·78	2·48	2·06	1·71	1·32	0·856	0·684	0·531	0·256	0·127
27	2·77	2·47	2·05	1·70	1·31	0·855	0·684	0·531	0·256	0·127
28	2·76	2·47	2·05	1·70	1·31	0·855	0·683	0·530	0·256	0·127
29	2·76	2·46	2·04	1·70	1·31	0·854	0·683	0·530	0·256	0·127
30	2·75	2·46	2·04	1·70	1·31	0·854	0·683	0·530	0·256	0·127
40	2·70	2·42	2·02	1·68	1·30	0·851	0·681	0·529	0·255	0·126
60	2·66	2·39	2·00	1·67	1·30	0·848	0·679	0·527	0·254	0·126
120	2·62	2·36	1·98	1·66	1·29	0·845	0·677	0·526	0·254	0·126
∞	2·58	2·33	1·96	1·645	1·28	0·842	0·674	0·524	0·253	0·126

TABLE 5

TABLE FOR THE COMPUTATION OF TONNAGE AND GRADE ABOVE CUTT-OFF FOR THE NORMAL DISTRIBUTION

Cut-off below the mean		Reduced cut-off = Z PV = MV + $\omega\sigma$	Cut-off above the mean	
Tonnage proportion	ω-factor		ω-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	1.034	36.32
65.54	0.562	0.40	1.069	34.45
67.36	0.535	0.45	1.106	32.64
69.15	0.509	0.50	1.142	30.85
70.88	0.484	0.55	1.180	29.12
72.57	0.459	0.60	1.217	27.43
74.22	0.435	0.65	1.256	25.78
75.80	0.411	0.70	1.295	24.20
77.34	0.389	0.75	1.334	22.66
78.81	0.367	0.80	1.375	21.19
80.23	0.346	0.85	1.415	19.77
81.59	0.326	0.90	1.457	18.41
82.89	0.306	0.95	1.499	17.11
84.13	0.287	1.00	1.542	15.87
85.31	0.269	1.05	1.586	14.69
86.43	0.251	1.10	1.631	13.57
87.49	0.235	1.15	1.677	12.51
88.49	0.219	1.20	1.724	11.51
89.44	0.204	1.25	1.772	10.56
90.32	0.189	1.30	1.821	9.68
91.15	0.175	1.35	1.872	8.85
91.92	0.162	1.40	1.923	8.08
92.65	0.150	1.45	1.977	7.35
93.32	0.138	1.50	2.033	6.68
93.94	0.127	1.55	2.098	6.06
94.52	0.117	1.60	2.147	5.48
95.05	0.107	1.65	2.208	4.95
95.54	0.098	1.70	2.270	4.46
95.99	0.090	1.75	2.335	4.01
96.41	0.082	1.80	2.403	3.59
96.78	0.074	1.85	2.473	3.22
97.13	0.067	1.90	2.546	2.87
97.44	0.061	1.95	2.622	2.56
97.72	0.055	2.00	2.701	2.28
97.98	0.050	2.05	2.784	2.02
98.21	0.045	2.10	2.870	1.79
98.42	0.040	2.15	2.961	1.58
98.61	0.036	2.20	3.055	1.39
98.78	0.032	2.25	3.155	1.22