

**National Exams December 2013**

**09-Mmp-A4, Mine Valuation and Mineral Resource Estimation**

**3 hours duration**

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. One only reference sheet, 8.5 x 11 inch, hand written both sides is allowed in the exam. This is not an open book exam, therefore only the approved Sharp or Casio type calculators are permitted.
3. Compulsory Question 1 and FOUR (4) other questions constitute a complete exam paper.  
  
Only question 1 and the first four optional questions as they appear in the answer book will be marked. You must select four questions from the "optional" Questions 2 to 7. Be sure you understand that two of Questions 2 to 7 must not be answered.
4. Compulsory Question 1 is worth 40 marks. Each optional question is of equal value (15 marks). Four optional questions plus Question 1 constitute a complete exam paper.
5. Many questions require an answer in essay format. Clarity and organization of the answer are important. Use neat sketches and drawings to illustrate your answers whenever possible.

**Question 1** (40 marks) You must answer **all** of this question, parts 1.1 to 1.7 inclusive

**Question 1.1** (6 marks)

In the context of mine development, what do you understand by "Taylor's Rule". Is there any scientific basis for this rule. (6 marks)

**Question 1.2** (6 marks)

What are the effects of improper handling of inflation on the valuation of a mining operation? (6 marks)

**Question 1.3** (5 marks)

What data is typically used to build a semi-variogram, how are the calculations made and what information is provided by the experimental model. (5 marks)

Note that in this question and for the rest of this exam paper, and in your answer book, the term "variogram" is taken to mean "semi-variogram".

**Question 1.4** (7 marks)

There are several methods of providing the means to start a mine from a mineral deposit which you have discovered and own. Explain how each of the following can be used, including a description of the circumstances under which each could be used to the financial advantage of you, the deposit owner. Describe any disadvantages to you, the deposit owner. (7 marks)

1.4.1. Equity

1.4.2. Loan

1.4.3. Contract

1.4.4. Joint Venture

1.4.5. Lease

**Question 1.5** (5 marks)

An exploration project is drilling and assaying consecutive 1 meter cores from a series of steeply dipping diamond drill holes. An open pit working with 15 meter bench heights is indicated.

Discuss the “compositing” of the diamond drill hole assay data from the individual exploration holes assayed in 1 meter units along the hole. (5 marks)

**Question 1.6** (6 marks)

How is the cost of capital for mining projects impacted by

1.6.1 geographic location. (3 marks)

1.6.2 the record of political stability. (3 marks)

**Question 1.7** (5 marks)

Assuming that an NSR calculation provides a suitable result for cash flow when concentrate leaves the mill.

1.7.1 How can the NSR be modified to give the mining engineer/geologist the cash flow of broken rock ready for extraction from the mine. (3 marks)

Such a modification would be invaluable in aiding the decision to send material to the mill or stockpiles and waste dumps.

1.7.2 Comment on the value of the modification you have suggested. (2 marks)

**Question 2** (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

- 2.1 What financial statements are prepared by a mining company to illustrate its financial performances and its financial condition, and what does each include.
- 2.2 Briefly explain the concept of capital costs as applied to investment decisions in a mining project.
- 2.3 What are the differences between capital cost and cost of capital?

(5 marks each for 2.1, 2.2 and 2.3)

**Question 3** (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

3.1 With regard to variograms, describe the following terms and their significance with the aid of a graph. (3 marks)

- 3.1.1 Spherical Model
- 3.1.2 Nugget
- 3.1.3 Sill
- 3.1.4 Range
- 3.1.5 Step or Lag
- 3.1.6 "Gamma" and the units it is expressed in

3.2 A spherical variogram has a nugget of 0.2, a sill of 1.0 and a range of 200 m. What is the variogram value at the following distances, (4 marks)

- 3.2.1 0.0m
- 3.2.2 100m
- 3.2.3 300m

3.3 What do you understand by the terms "nested spherical model", "anisotropy", "tolerance" and "band width". (4 marks)

3.4 With the aid of neat sketches, describe/explain the following, Why the variogram at "azimuth 90, dip 45" is not necessarily the same as "azimuth 270, dip 45". (4 marks)

**Question 4** (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

It is claimed that the cost per day of a component of mining activity equals  $KT^x$  where T represents the tonnes of material mined per day, K is a constant and x a power, with K and x depending on the cost component being estimated. Further the cost per tonne can be derived as;

$$K/T^{(1-x)}$$

4.1 Comment on these claims. (5 marks)

An open pit mine moves 50,000 tonnes per day of rock (ore plus waste). The component costs per day of mining are;

Drilling	$1.90 T^{0.7}$
Blasting	$3.17 T^{0.7}$
Loading	$2.67 T^{0.7}$
Haulage	$18.07 T^{0.6}$
General	$6.65 T^{0.7}$

What are the individual component and total costs per day and per tonne based on the formulae given as claimed. (10 marks)

**Question 5** (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

5.1) Describe and compare the "ordinary" and "simple" kriging methods of obtaining block grade estimates from dispersed assay data. (5 marks)

5.2) In "simple" kriging, the sum of weights is seldom 1 (100%). How is the problem of systematically underestimating or overestimating block grades resolved. (4 marks)

5.3) In recent years "indicator" kriging has become a more mainstream method of estimating block grades. Describe how the method can be used to estimate the volume and average grade of both the ore and the waste contained in a block given a cut-off grade. (6 marks)

**Question 6** (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

A junior mining company has the opportunity to purchase certain non-core assets from another company. The cash cost of purchasing the assets is \$0.7 million, and the salvage value (scrap minus environmental liabilities) is \$0.1 million.

The following table lists the revenues, operating costs and anticipated taxes.

Year	1	2	3	4	5
Revenues (\$ millions)	1.1	0.9	1.0	1.2	0.8
Operating Costs (\$ millions)	0.41	0.39	0.4	0.42	0.2
Taxes (\$ thousands)	159	162	166	168	92

6.1 Using an 8% cost of capital, what are the after tax cash flows and what is the net present value (NPV) of the asset. (10 marks)

6.2 Discuss the use of NPV and the rate of 8% cost of capital in the investment decision making process. Explain and compare rate of return (ROR) and discounted cash flow ROR (DCF-ROR) with NPV in the decision making process. (5 marks)

*You are expected to calculate the discounting factors required.*

**Question 7** (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

Find the NSR for each of the four metals tabulated (copper, zinc, silver, gold) (10 marks)

*Given Metal Prices*

Cu	\$7500/t
Zn	\$1875/t
Ag	\$28/troz
Au	\$1600/troz

*The symbol "t" refers to metric tonne and "troz" troy ounce*

**Question 7 continued**

**Smelting/Transportation Costs**

Copper concentrate	(containing 20%Cu)	\$185
Zinc concentrate	(containing 52%Zn)	\$350
Silver and Gold	no charge, recovered in concentrator	

**Smelter Recoveries**

Cu	60%
Zn	80%
Ag	14%
Au	55%

Use your NSR's to find individual metal and total NSR of a stope sample with the following assay 0.2% Cu, 0.8% Zn, 0.30 g/t Ag and 0.02 g/t Au

(5 marks)

**End of Exam**

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