

**National Exams December 2009**

**98-MMP-A2, Mining Methods and Design**

**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. This is an OPEN BOOK EXAM.  
Any non-communicating calculator is permitted.
3. FIVE (5) questions constitute a complete exam paper.  
Only the first five questions as they appear in the answer book will be marked.
4. Each question is of equal value (20 points).
5. Most questions require an answer in essay format. Clarity and organization of the answer are important. Use drawings to illustrate your answers.

**Question 1** (Dealing with Sublevel Caving) 20 points

Having reached the economic limit of open pit mining, a mine is planning to go underground and use sublevel caving as the mining method for the ore deposit.

- a) Outline the typical geology to be expected in such a deposit with special reference to relative dimensions and dip of the ore, and the quality of the rock masses in the ore, hanging and foot walls. (6 points)
- b) Describe the mining method and mining sequence. (7 points)
- c) Assume that the underground mine has been operating for ten years. Explain the steps which must be taken to maximize recovery and minimize dilution, and how the stope design has been affected over time. (7 points)

**Question 2** (Dealing with Mine Hoisting) 20 points

- a) When designing a head-frame, what is the critical design parameter. (3 points)
- b) What do you understand by the term "fleet angle". (3 points)
- c) What criteria are used to determine the sheave wheel diameter. (3 points)
- d) What is the basis for determining the rope diameter. (3 points)
  
- e) Briefly name and describe three types of mine hoist rope. Under what conditions would you recommend using the types of ropes you have described. (4 points)
  
- f) Discuss the testing and safety of hoist ropes. (4 points)

**Question 3** (Dealing with Ore Handling and Grade Control) 20 points

An extensive underground ore-body has variable grades and ore thicknesses. Ore blending and stope sequencing are required to provide continuous production of relatively constant grade ore from various parts of the ore-body.

Using sound mine sequencing principles and materials handling techniques, describe a general stoping plan and stope-to-shaft materials handling system which would provide a secure supply of well graded ore in the following situations, a and b immediately below.

Provide your reasons for using the approach selected. A vertical shaft access must be assumed.

- a) A steeply dipping narrow gold vein, 3-4 meters thick, with a strike length and dip extension of approximately 500 meters. The ore is locally quite variable due to the presence of high grade stringers, but has a similar overall grade in all parts of the ore-body. (10 points)

- b) A 30 meter thick flat dipping ore-body with discontinuous mineralization creating individual mineralized zones distributed over an area of five square kilometers and at a depth of 700 meters below surface. The grades vary from zone to zone. (10 points)

**Question 4** (Dealing with the Re-Opening of Old Underground Mines as Open Pits) 20 points

In recent years several old underground mines have been re-opened as open pits. Examples include the Dome Mine (Timmins, ON) and Nickel Plate (Hedley, BC).

Describe the steps you would take to bring a typical underground mine that has been closed for many decades back into production as an open pit. Suitable topics would include, but not be limited to; safety, economics, surveys, grade and production control, waste and tailings disposal, equipment selection, haulage routes, etc., etc. (20 points)

**Question 5** (Dealing with Draglines) 20 points

A dragline is operating in a simple side casting mode. It has an operating radius of 100 meters, tub diameter of 18 meters, a "positioning factor" of 0.75 and a dumping height of 37 meters.

The overburden material being mined has an angle of repose of 63 degrees, and the depth to the top of the 2 meter thick coal seam is 30 meters. The width of cut is 40 meters and the spoil pile has an angle of repose of 34 degrees and a swell factor of 24 percent.

- a) Calculate the important distances and volumes (areas) of the range diagram (6 points) and draw a neat range diagram to scale (4 points).
- b) Will the dragline be capable of using simple side casting to mine the overburden and why/why not. (4 points)
- c) If another smaller dragline could not complete the removal of the overburden using simple side casting, briefly describe other operating techniques which would allow the coal to be mined which include the use of the smaller dragline. (6 points)

**Question 6** (Dealing with Open Pit Limits) 20 points

Describe the progression of open pit limit optimization from simple section analysis of scale drawings through computerized moving (walking) cone to computer intensive operations research based methods. (10 points)

In 1964, Lerchs and Grossmann introduced the first true open pit limit optimizer.

- a) Why did it take so long for the mining industry to adopt the method. (2 points)
- b) Describe any computer software you are familiar with which uses variants of the L-G algorithm to define optimum pit limits. (2 points)
- c) Realistically and practically, is such a limit truly optimal and why/why not. (3 points)
- d) How can the 'time value of money' be incorporated into L-G method. (3 points)

**Question 7** (Dealing with Open Pit Truck Loading and Haulage) 20 points

- a) How is the "match factor" determined and give an example calculation which shows the number of trucks required for optimal truck/shovel operations. (4 points)
- b) Explain why "double back up" is the preferred loading configuration and how it has been further modified to increase truck/shovel productivity. (4 points)

In 1980, truck dispatch was developed at the Tyrone NM mine.

- c) Describe a typical installation of that era, and the technological changes that have been made leading to a modern application. (4 points)
- d) How have mine productivity, maintenance of stripping ratios, grade control and other parameters benefited from this technology. (4 points)
- e) Discuss the interaction of Best Path, Linear Programming and Dynamic Programming in determining which truck goes where in a large mine with 10 loaders and 60 trucks. (4 points)

**End of Exam**