THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

2021 FIRST SEMESTER EXAMINATION

THIRD YEAR MINING ENGINEERING

MN 325 – SURFACE MINING

DATE: *THURSDAY, 4ᵀᴴ NOVEMBER, 2021*

TIME: *8:20 PM*

TIME ALLOWED: 3 HOURS

<u>INFORMATION FOR CANDIDATES:</u>

1. You have 10 minutes to read this question paper you **SHOULD NOT** begin writing during this period.

2. There are **FOUR** questions altogether. Answer **ALL FOUR** questions. Marks to each question are shown on the paper.

3. **ALL** answers must be written on the answer book provided. No other written material will be accepted.

4. Write your **NAME** and **NUMBER** clearly on the **ANSWER BOOK**. Do this **NOW**.

QUESTION 1:

(a). The different type of placer deposits include; Alluvial, Elluvial, Colluvial, and Beach Sand deposits.

    (i). Describe with the help of a neat sketch so as to distinguish between the following common types of placer deposits frequently mined in PNG today; (1) Alluvial deposit, (2) Elluvial deposit, and (3) Colluvial deposits.

                                               (6marks)

    (ii). Explain briefly the mechanism involved in the formation and concentration of minerals in each of the placer deposits described in Qa(i); that is Alluvial deposits, Colluvial deposits, and Elluvial deposits.

                                             (6 marks)

(b). A sampling exercise conducted on an alluvial deposit using the pitting method is as shown by figure 1. The pit size is 4m x 4m x 4m depth. The stratigraphic profile of the deposit is that; 0.5m at the top is overburden or un-mineralized material, this is followed by a gold bearing layer of 1.5m thick gravel containing 5 grams of gold, and followed by 2m thick to the bedrock where a total of 35grams of gold were recovered. Assuming that the entire material is to be washed to recovered gold during mining;

    (i). Calculate the bank cubic grade of the sample.

    (ii). Calculate the loose grade if the swell factor (SF) is generally 1.25.
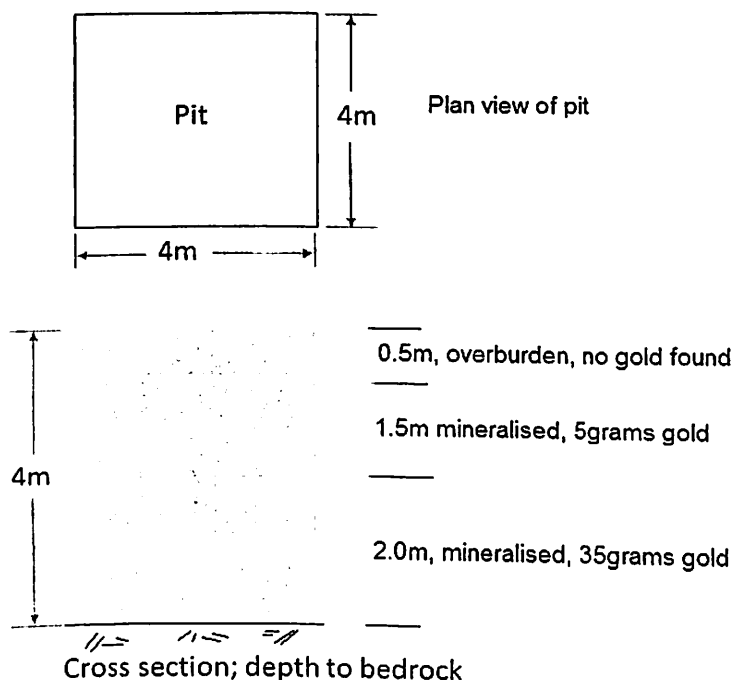
                                             (6marks)

Plan view of pit

0.5m, overburden, no gold found

1.5m mineralised, 5grams gold

4m

2.0m, mineralised, 35grams gold

Cross section; depth to bedrock

Figure 1: Plan and section view of pit sampling

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(c) A mechanized mining method is planned to be used to mine an alluvial deposit having an average grade of 900milligrams/m³ (bank m³), gold fineness is 80%, swell factor of gravel is 1.25, and plant recovery rate is 85%. The mining method selected has the following characteristics: production capacity is 50m³/hour; mining cost is K40.00/m³; processing cost is K45.00/m³, general & administration cost is K10.00/m³, depreciation cost is K7.00/m³. Given that the current market price of gold is K200.00/gram (fine gold price), and freight/smelting cost is K5.00/gram of refined gold, <u>determine</u> the following:

(i). <u>Net value</u> of the mine

(ii). <u>Quantity</u> (in kg) of fine gold produced at the mine per <u>month</u> if the mine operates on a, 9 production hours per day, and 5 production days per week schedule.

(iii). Break-even <u>cut-off grade</u> for this method of mining and <u>determine</u> if the selected mining method can be applied on this deposit (justify your answer).

(5 + 5 + 5 marks)

QUESTION 2:

(a) Appropriate selection of bench height to be used at a mine is essential for effective and safe production and ore recovery.

(i). <u>State</u> at least 3 main factors that affect the selection of bench heights and briefly <u>explain</u> each.

(ii). <u>State</u> and <u>explain</u> the relationship between bench height, bench face angle, and berm width.

(iii). A mine is planned for production using 12m bench height. The final pit wall can either be formed by a 12 m bench height having a 75⁰ face angle and a 4 m berm-width <u>OR</u> by a 24m bench height having a 65⁰ face angle and a 7m berm-width. <u>Comment</u> on the two designs (Justify your comments by showing appropriate calculations).

(6 + 3 + 5marks)

(b) Stripping ratio is an important index used for setting pit limits during mine design and also used for ore-waste production planning during mining in open pit mines.

(i). <u>Define</u> Break-Even Stripping Ratio (BESR) (use symbols with explanation of each parameter).

(iv) <u>Determine</u> the BESR of a gold mine if the following information about the mine are true: Mining cost is K40.00/tonne ore; Milling cost is K55.00 per tonne ore; Freight-Smelting- Refining (FSR) Cost is K5.00 per gram of recovered Au; average gold grade is 1.0g/t Au; Overall Mill Recovery is 85%; gold price is K150 per gram of fine gold, fineness of gold is 90%; and stripping cost per tonne waste is K5.00.

(5 + 5 marks)

(c) An open pit mine having 15m bench height must have an average of 10 benches stripped back to add a haul road having a width of 30m wide.

(i). <u>How much</u> additional striping tonnage must be handled due to the inclusion of the haul road if the haul road grade is 10%? The rock S.G is 2.5t/m³.

(ii). <u>State</u> the factors that influence the selection of haul road grade.

(iii). <u>State</u> the factors that influence haul road width.

(5 + 2.5 + 2.5) marks)

QUESTION 3:

(a) <u>Express</u> the formula for calculating the Block Economic Value (BEV) and <u>explain</u> each parameter.

(b) Assume that figure 2 below shows the Block Economic Values (BEV) of a section of an ore deposit.

(i). Using the Floating/ moving cone Technique <u>determine</u> the optimum pit limit. *(Consider a 2-dimensional problem, and show your working by indicating at least 2 other possible options, and give your reason(s) for your selection/ design)*

-1	-1	-1	-1	-1	-1	-1	-1
-3	3	3	-3	4	4	-3	-3
-5	-5	20	-5	5	6	-5	-5

Figure 2: Cross-section of a deposit showing block economic values (BEV)

(ii) For the same problem in Q3b(i) <u>define/ determine</u> the pit limit using Learch-Grossman (2-D dynamic programing) Technique *(show all workings, consider a 2-dimensional problem)*.

(7marks)

(iii) <u>What</u> is the pit optimization <u>criteria</u> used in the above Q3b (i) & (ii)?

(2 marks)

(c) For the same problem in Q2b(ii) using the pit limit defined Learch-Grossman technique, assume that 4 blocks of ore are to be mined at a time (i.e. per year) and income earned for

each year is to be discounted at a rate of 20% based on perceived interest rates, and project risks. Furthermore, assume that the slope constraint is 1block:1block, ie. an overall pit slope angle of 45°.

Based on these data;

(i). <u>determine</u> at least 3 competitive mining sequence/ options and their appropriate mine values.

(ii). <u>select</u> the best option or mining sequence and give your reason(s).

(6 + 2 marks)

QUESTION 4:

(a). (i). <u>Explain</u> briefly in a short paragraph the concept used in shovel - truck selection and <u>state</u> their selection criteria.

(ii). <u>State</u> the mine <u>operating</u> factors that affect the cycle time of haul trucks.

(5 + 5 marks)

(b). A mine is planned to handle or produce 20 million tonnes of material per year using a combination of $15m^3$ shovel and a $45m^3$ capacity (box-size) truck. The mine is scheduled to operate 260 working days per year, on a 2 shift per day roster having an effective 10 hours productive time per shift. The broken material has an average bulk density of 2.6 t/m^3. Consider the following additional data to be true for the shovel and truck respectively:

Shovel data:		
Scheduled availability	-	85%
Utilisation	-	90%
Productive working time	-	55 minutes/hour
Shovel swing time	-	1.0 minute
Truck spotting time	-	2.0 minutes

Truck data:		
Scheduled availability	-	80%
Utilisation	-	85%
Truck productive time	-	54 minutes/hour
Truck cycle time based on the selected route	-	18minutes/ cycle

Based on the above information, <u>determine</u>:

(i). <u>Productivity</u> and <u>fleet size</u> of $15m^3$ shovels.

(ii). <u>Productivity</u> and <u>fleet size</u> of $45m^3$ trucks

(5 + 5 marks)

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