THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

2020 FIRST SEMESTER EXAMINATION

THIRD YEAR MINING ENGINEERING

MN 315 – SURFACE MINING

DATE: ***FRIDAY, 26TH JUNE, 2020***

TIME: ***12:50 PM***

TIME ALLOWED: **3 HOURS**

INFORMATION FOR CANDIDATES:

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. Placer mining is one of the simplest forms of surfaces mining producing a variety of precious metals. In PNG the most common metal being mined is gold which occurs in many types of deposits and the most common forms being in; alluvials. colluvial, and elluvial deposits.

Describe so as differentiate between these 3 deposits with the help of a neat sketch and explain briefly how they are formed.

(5 marks)

b. State and describe the different scales/ categories of placer mining used as a mining classification system in Papua New Guinea.

(5 marks)

c. An alluvial gold deposit is to be mined using mechanized mining method where a combination of a hydraulic excavator and a shaker as a wash-plant is planned to be used whose overall gold recovery is estimated will be 85% (15% lost mostly as fines). The productivity of the excavator is approximately 55m^3 per hour, the wash plant has the capacity to match the production output of the excavator. The deposit is a wide-river gravel deposit averaging 800mg/m^3 grade (bank m^3), and gold purity is about 75% Au, and 25% Ag. The swell factor of the gravel is 1.15. The purchase price of the 1.8m^3 bucket hydraulic excavator is K950, 000.00 and the wash plant and concentration equipment is K200,000.00. The investor wants the capital equipment cost to be fully depreciated and recovered in 4 years.

The mine plan is such that; operating hours per day will be 10 hours, actual production hours is estimated will be 8 hours, the mine is expected to operate 6 days per week, however actual production days will be 5 (average of 1day is allocated for maintenance and service), and it is expected the mine will operate for 48 weeks per year. The following are mine operating costs typically associated with the planned mining method;

- Mining Costs K20.00/m^3
- Processing Cost K25.00/m^3
- Sales Marketing Cost K2.00/m^3 (includes; security, transport)
- Smelting cost K2.00/gram
- Administration cost K2.00/m^3
- Other costs K4.00/m^3

* The current market price of gold is K120/gram. Silver has a market value of K20/ gram.

Given the above scenario determine:

i. The depreciation cost as a unit cost (K/ m^3).

ii. Whether the deposit is viable or not (Justify your answer by showing your working)

iii. The minimum deposit grade that this mining method can be applied? (express as bank m^3 grade).

(5 + 5 + 5 marks)

d. For the following gravity separation techniques, describe any ONE of them with the help of a neat sketch, and state the underlying concept or principles behind it and explain how valuable minerals of interest such as gold ores from placer mining are concentrated and separated. Choose any ONE of the following:

- Shaking Table
- Spiral concentrator
- Knelson Concentrator
- Jig Concentrator

(5 marks)

QUESTION 2:

a. With the help of a neat sketch explain briefly the following open pit design parameters; Bench Height, Bench Face Angle, Berm Width, Pit Slope Angle, and Inter-ramp Angle.

(6 marks)

b. Consider that a joint structure that exists in a mining project that is likely to impact the bench design as depicted in figure 1 below. The design issue at hand is that the wedge formed as a result of constructing the bench has the potential to fail and cause safety and stability issues during the mining operation.

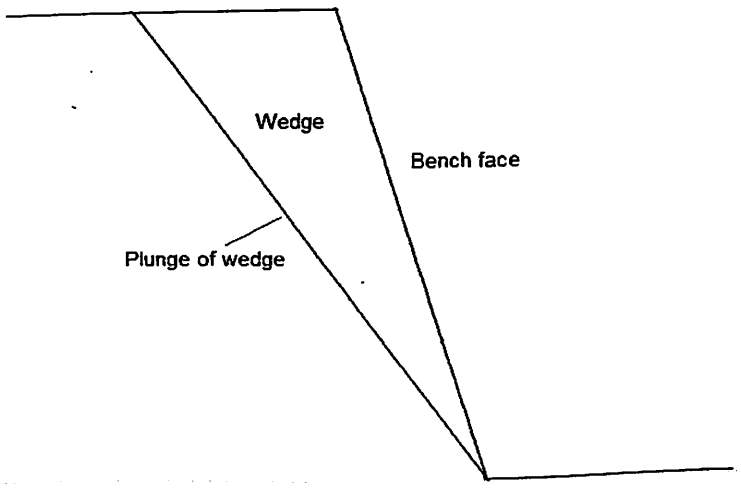

Figure 1: A potential failure wedge formed on a bench

i. State and briefly explain the likely design actions one would take to alleviate the potential failure or reduce the impact of the wedge should it fail during mining operation.

(5marks)

ii. An important parameter that one must take into account to assist bench design is to calculate the volume of the failure wedge. State the factors influencing the volume of failure material.

(5 marks)

c. A mine is planned for production and the final pit wall can either be formed by a 15m bench height having a 65^0 face angle and a 4m berm-width OR by a 10m bench height having a 80^0 face angle and 2m berm-width.

Evaluate the two design options and comment on them comparatively in relation to the two important design issues often considered in such circumstances. (Justify your answer by showing appropriate calculations).

(5 marks)

d. Haul roads are important mining infrastructure during mining operation for effective transportation of ore and waste rock from within the pit to the surface.

i. State the different layout of haul roads and briefly explain the main advantage and disadvantage of each.

ii. Haul road width can have a great influence on the additional amount of waste to be stripped. State the factors that influence selection of haul road widths.

(5 + 5 marks)

QUESTION 3:

a. Consider a copper mine having an average deposit grade of 1.0%Cu is planned to be mined by open pit mining methods. Based on the mine design the following data are said to be true:

- Mining cost is K5.00/ t_{ore}
- Processing cost is K15.00/t_{ore}
- General and Admin. cost is K2.5/t_{ore}
- Depreciation cost is K5.00/t_{ore}
- Freight smelting & Refining (FSR) is K2.50/kg
- Process/mill recovery rate is 85%

i. Given these data and given that the market price of copper is K7.50/kg, what will be the cut-off grade for this mine.

ii. Calculate the stripping ratio of the mine if the stripping cost is K3.00 per tonne of waste.

(5 + 3 marks)

b. State and briefly describe the steps involved in setting pit limits using manual techniques of mine design.

(5 marks)

c. A block model having Block Economic Values (BEV) as shown in figure-2 below forms the basis for computerized method of open pit mine design and pit Optimization.

Assuming that the slope constraint is 1block:1block (45^0 angle), locate the pit limit on this section by;

i. Floating/ Moving Cone technique. *(Show all workings).*

ii. Learch-Grossman 2D Dynamic Programming technique. *(Show your working).*

(5 + 5 marks)

-3	-3	-3	-3	-3	-3	-3
-6	3	7	4	8	5	-6
-9	-9	19	-9	17	-9	-9

Figure 2: A cross section through an ore body

d. For the same problem in Q3(c) part(ii), based on the optimal pit outline set, select the best mining sequence that should be used to completely mine out the ore body, if only 4 blocks are to be mined at a time, and a discount rate of 20% to account for interest rates and risk of future income. (Show your working, including at least 2 best mining sequences).

(6 marks)

QUESTION 4:

a. The general objective of mine planning is to extract the mineral deposit in a safe, efficient and economically feasible manner. There are generally 3 different recognized levels of mine planning practiced in most mines.

State the 3 different levels of mine planning and briefly explain the main objective of each level.

(6 marks)

b. Shovel-Truck evaluation and selection is an important aspect of open pit mine planning and design, as it determines the mine production output and the mine value.

i. Explain briefly the Shovel-Truck selection criteria used in mines.

ii. State the mine operating factors that affect cycle time of haul trucks.

(2 + 5 marks)

c. A mine is planned to handle or produce 25 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 240 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 3.0 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	-	0.9 minute
Truck data:	Scheduled availability	-	80%
	Utilisation	-	85%
	Truck productive time	-	55 minutes/hour
	Truck dump time	-	1.2 minute
	Truck spot time (loader & dump)	-	2.0 minute
	Delay time per cycle	-	2.0 minutes
	Average hauling distance	-	3000m (or 3.0km)
	Average Loaded truck speed	-	40 km/hr
	Average Empty truck speed	-	50 km/hr

Based on the above information, determine:

i. Productivity of the $15m^3$ shovel and $45m^3$ truck

ii. Fleet sizes of both the shovel and truck

(Show your working)

(8 + 5 marks)