UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

DEPARTMENT OF GEOLOGY

POST GRADUATE

2017-2018 ACADEMIC YEAR

GGY 5139 ENGINEERING GEOLOGY AND ROCK MECHANICS

GGY 5149 EXPLORATION GEOPHYSICS

GGY 5159 ECONOMIC GEOLOGY OF METTALLIFEROUS MINERAL DEPOSITS

GGY 5179 ECONOMIC GEOLOGY OF ENERGY AND INDUSTRIAL MINERAL DEPOSITS

MET 5139 SPECIAL TOPICS IN MINERAL PROCESSING

MET 5259 SPECIAL TOPICS IN EXTRACTIVE METALLURGY

MET 5349 FOUNDRY TECHNOLOGY

MIN 5019 GEOTECHNICAL ENGINEERING

MIN 5029 COAL MINING METHODS

MIN 5049 APPLICATION OF SOFTWARES IN MINING

MIN 5059 MINE MANAGEMENT

MIN 5069 SAFETY, HEALTH AND ENVIRONMENT

MIN 5079 ROCK MECHANICS II

MIN 5089 MINE PLANNING AND DESIGN

MIN 5099 MINERAL ECONOMICS AND MANAGEMENT

UNIVERSITY OF ZAMBIA

UNIVERSITY OF ZAMBIA EXAMINATIONS: NOVEMBER – DECEMBER, 2018

GGY 5139 – ENGINEERING GEOLOGYAND ROCK MECHANICS

INSTRUCTIONS: Answer any five questions. All questions carry equal marks

Time: Three (3) Hours
Full marks: 100

Q.1. You were contracted by an Engineering Consulting Firm to determine parameters of a soil for purposes of establishing its permeability for foundation design at the East Park Mall Extension. A soil sample, 415 g, was collected from the site and gave the following results:

Grain size (mm)	50.0	35.5	20	14	10	6.3	3.35	1.18	0.6	0.15	0.063
Mass retained (g)	0	25.5	27	20	21	43	124.5	73.6	28.2	22	15.5

For this soil, determine the:

a) Uniformity coefficient, CU.
b) Type of soil, and Justify your answer.
c) Percentages of each major soil fraction contained in the soil based on the British Standards Institution (BSI), shown in the Table below.
d) In terms of its permeability, would this soil provide suitable ground to underlie a foundation? Justify your answer.

Major Soil Fraction	Clay	Silt	Sand	Gravel	Cobble
Particle Size (mm)	< 0.002	0.002 – 0.06	0.06 – 2	2 – 60	> 60

(20 marks)

Q.2. New Students' hostels are planned for construction near the Goma Fields. Each hostel has been designed to be founded on rectangular footings, 2m x 2.5m, and at a depth of 1.2 m. If unit weight of the underlying soil was 15 kN m^{-3}, and triaxial cell tests performed on a specimen of this soil sample gave the following results:

σ_2 (kN m^{-2})	1	5	9.5	15
σ_1 (k Nm^{-2})	9.2	28	48.7	74

BEARING CAPACITY FACTORS

ϕ (Degrees)	N_c	N_q	$N\gamma$
0	5.14	1.00	0.00
5	6.49	1.57	0.45
10	8.35	2.47	1.22
15	10.98	3.94	2.65
20	14.83	6.40	5.39
25	20.72	10.66	10.88
30	30.14	18.40	22.40
35	46.12	33.30	48.03
40	75.31	64.20	109.41
45	138.88	134.88	271.76
50	266.89	319.07	762.89

i) Calculate the ultimate bearing capacity of the soil under each footing.
ii) What effect would modifying the footings to a square shape, 2 m wide, have on the ultimate bearing capacity under each footing?

(20 marks)

Q.3. In the execution of its Link-8000 programme, the Road Development Agency (RDA) constructed the Bottom Road, which links Livingstone directly to Siavonga. After its construction, a slope cut into one of the hills, at an angle of 60°, exposed a discontinuity with a dip of 45° into the cut slope, and striking parallel to it. Samples collected from across this discontinuity plane were subjected to shear box testing in the lab and gave the following results:

Normal stress (kNm^{-2})	100	200	300	400
Shear stress (kNm^{-2})	98	139	180	222

If the potential failure plane was supporting a block weighing 200kN with a contact area of 100 m^2, and if you were asked to write report from your analysis of these results, what would be your recommendation to the RDA regarding:

a) The state of this slope's stability?
b) Any remedial measures to be taken, if at all? Justify your answer.

(20 marks)

Q.4. (a). To determine the average depth to suitable foundation ground under the UNZA Shopping Mall, a seismic refraction survey was undertaken, which gave the following results:

Geophone distance (m)	10	15	20	25	30	35	40	45	50	55
Arrival times (ms)	3	4.5	6	7	7.8	8.5	9	10	10.6	11.5

If layers in the prospective site are considered to be horizontal, calculate the:
i) Wave velocities in each layer
ii) Depth to the first refractor, which would be assumed to represent competent rock-head.
iii) Poisson's ration of the groundmass

(b) Core samples collected from the same site as in (a) were subjected to a refraction seismic survey in the laboratory, and gave the following results:

Compressional waves = 1,000 m s^{-1}
Transverse waves = 600 m s^{-1}

i) Determine, for this sample, its Poisson's ratio (μ)
ii) Give one possible reason for the difference in the Poisson's value, if at all, with that obtained in (a).

(20 marks)

Q.5. A 20 – metre borehole was drilled at East Park Mall, near the Canada Court Staff compound, to ascertain ground conditions for foundation design of new structures to extend the Mall. The drill hole intersected nine metres of soil, while the remainder intersected rock. The logged section that intersected rock gave the following drill core lengths (in cms):

11.8	23	7	5.3	17	9	9.2	9	75.8	10.7	8	8.9	5.3
9.9	56	10.8	9	7.6	17.9	19.4	8.3	8.8	7.3	33.9	7.8	10.5
11	8.9	8.2	9	10.7	11	8.4	9.8	6.5	7.5	9.9	6.5	8.9
20	12.3	9.7	5.8	56	9.1	87.9	10.8	16	7.3	65	7.9	12.3
8.5	17	9.7	44.1	8.8	9.8	20	9	25	9	45	11.4	39.1

a) Determine, for this groundmass, its:
   i) Rock Quality Designation (RQD)
   ii) Total Core Recovery (TCR)
   iii) Core Loss

b) How would you describe the quality of the rock intersected by the drill hole? Qualify your answer.

(20 marks)

Q.6. A soil sample was collected from new students' hostels site, in the Kalingalinga Dambo, and tested it for Atterberg Limits. The sample gave the following results:

i) Liquid Limit (Casagrande Apparatus)

Test Number	Mass of Tin	Tin + Wet Soil (g)	Tin + Dry Soil (g)	Number of Blows
1	23.68	40.86	34.68	13
2	22.93	42.62	35.78	20
3	26.27	38.02	34.27	47

(ii) Plastic Limit

1	25.34	32.17	31.01
2	24.83	30.48	29.51

In their reporting, what would;

a) be the one reason for undertaking this test?

b) you determine as the plasticity index of the soil?

(20 marks)

Q.7. (a) In hydrogeology, the unit m d^{-1} is often used to measure the hydraulic conductivity, k. What would be its relationship with the SI-unit, m s^{-1}?

(b) In a permeability test, a head difference of 20 cm is being maintained between the top and bottom ends of a sample of 40 cm height. The inner diameter of the circular tube was 20 mm, and it was determined that in one minute, 35 cm^3 of water were collected in a measuring glass. Determine, for this sample, its hydraulic conductivity, k, in m s^{-1}.

(20 marks)

********** End of examination. Good luck! **********

UNIVERSITY OF ZAMBIA

UNIVERSITY OF ZAMBIA EXAMINATIONS: NOVEMBER - DECEMBER 2018

GGY 5149 – EXPLORATION GEOPHYSICS

INSTRUCTIONS: Answer any four questions. Draw figures wherever necessary. All questions carry equal marks.

Time 3 hours
Full Marks: 100

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1. Explain the following terms, briefly:

a) Target	2 marks
b) Spatial aliasing	2 marks
c) Active method	2 marks
d) Acoustic Impedance	2 marks
e) Geophone	2 marks
f) Self-Potential (SP)	2 marks
g) Noise	2 marks
h) Resistivity	2 marks
i) FTG	2 marks
j) Reduction To Pole (RTP) processing	7 marks

25 marks

2. Prepare a Table of geophysical methods, listing the following:

a) Name of the geophysical method
b) Type of method (i.e. potential or active)
c) Physical property or properties measured
d) Application (s)
e) Types of noise (s) the method is susceptible to, if any. **25 marks**

3. Describe five (5) factors or issues that need to be considered in the planning or design of a ground geophysical survey. **25 marks**

4. a) Explain the principles behind the operation of the Proton Precession Magnetometer including the "Over hauser Effect." **10 marks**

b) Describe how to conduct a ground magnetic survey. **15 marks**

5. a) Explain how to carry out a two dimensional (2-D) electrical imaging or tomography for the WennerArray with twenty (20) electrodes. **15 marks**

b) What are the limitations of a one dimensional (1-D) DC resistivity survey?

10 marks

6. a) Describe the conventional seismic reflection survey method for oil and gas exploration on land. **15 marks**

b) Briefly explain the passive seismic method of exploration for hydrocarbons, indicating its advantages and disadvantages over the method in (a). **10 marks**

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

UNIVERSITY OF ZAMBIA EXAMINATIONS: NOVEMBER – DECEMBER, 2018

GGY 5159 – ECONOMIC GEOLOGY OF METALLIFEROUS MINERAL DEPOSITS

PAPER I

INSTRUCTIONS: **Answer any four questions using sketches wherever possible. All questions carry equal marks.**

Time: **Three (3) Hours**
Full Marks: **100**

Q.1. (a) Briefly discuss how useful metals are to humanity or society. **(5 marks)**

(b) Define the following terms: (i) possible ore reserves and (ii) proven ore reserves. **(4 marks)**

(c) If the crustal abundance and minable grade of copper are 0.008 wt% and 0.5 wt% what is its concentration factor? **(2 marks)**

(d) Classify the following deposit types into either syngenetic or epigenetic and state why: volcanogenic massive sulphide, podiform chromite, and placer. **(6 marks)**

(e) Describe briefly how the Kabwe lead-zinc deposit formed in terms of the key ore minerals, host rocks, source of metals and sulphur, transportation of metals and sulphur, causes of precipitation and site for precipitation. **(8 marks)**

(25 marks)

Q.2. (a) A slightly acidic meteoric water has percolated downwards through a near vertical quartz and calcite vein composed of bornite, describe briefly the three zones which develop stating the key minerals formed and why. A diagram would be very useful. **(10 marks)**

(b) Describe briefly the stratiform chromite deposits in terms of tectonic setting, age and how they formed. State one example of stratiform chromite deposits and the country where it is found. **(10 marks)**

(c) What is isotope fractionation and how do sulphur stable isotopes help in the study of mineral deposits? **(5 marks)**

(25 marks)

Q.3. (a) Briefly describe generally the processes involved in the formation of a skarn deposit when a limestone country rock is intruded by a hot granitic body. **(10 marks)**

(b) State three key ground geophysical methods that may be employed in searching for skarn deposits and why such methods would be suitable. **(6 marks)**

(c) What is a primary fluid inclusion and what are the four pieces of information about mineral deposits would result from the study of such inclusions? **(6 marks)**

(d) How are hydrothermal fluids produced through metamorphism? **(3 marks)**

(25 marks)

Q.4. (a) Define the following terms: **(6 marks)**
(i) Solubility and saturation
(ii) Mesothermal Vein
(iii) Hypothermal Vein

(b) Describe briefly how Ni-Cu sulphide mineralisation is produced through a magmatic process called liquid immiscibility. **(10 marks)**

(c) Explain how pressure promotes solubility of metals in hydrothermal fluids. **(3 marks)**

(d) Explain what connate water is. **(3 marks)**

(e) What is phase separation and how does is promote precipitation of metals? **(3 marks)**

(25 marks)

Q.5. (a) Define the following terms **(10 marks):**
(i) Cation exchange
(ii) Laterite
(iii) Oxidation
(iv) Dissolution
(v) Hydration

(b) Describe briefly how alluvial (stream) gold deposits would form in terms of source, transport mechanism and deposition site conditions. **(10 marks)**

(d) New thoughts on the Zambian Copperbelt copper and cobalt mineralisation is partly of hydrothermal origin. With the aid of a diagram explain how copper mineralisation could have resulted from hydrothermal processes. **(5 marks)**

(25 marks)

Q.6. (a) Define the terms: **(8 marks)**
(i) Black smoker
(ii) Ophiolite
(iii) Greenstone belt
(iv) Porphyry copper deposit

(b) Briefly describe volcanogenic massive sulphide deposits in terms of age, tectonic setting, key ore minerals, sources of fluids, metals and sulphur and how they form. **(15 marks)**

(C) Explain the cause of exsolution textures involving chalcopyrite and bornite. **(2 marks)**

(25 marks)

----------Good Luck !!!----------

UNIVERSITY OF ZAMBIA

UNIVERSITY OF ZAMBIA EXAMINATIONS: NOVEMBER – DECEMBER, 2018

GGY 5159 – ECONOMIC GEOLOGY OF METALLIFEROUS MINERAL DEPOSITS

PAPER II

INSTRUCTIONS: Answer all questions

Time: One (1) Hour

Q.1.

You are provided with two polished sections X and Y. Using the reflected light microscope and optical properties identify the ore minerals present and describe the observed textures.

----------Good Luck!!!----------

UNIVERSITY OF ZAMBIA

UNIVERSITY OF ZAMBIA EXAMINATIONS: NOVEMBER – DECEMBER, 2018

GGY 5179-ECONOMIC GEOLOGY OF ENERGY AND INDUSTRIAL MINERAL DEPOSITS

INSTRUCTIONS: **There are two sections in this question paper. Answer five (5) questions and at least two (2) from each section. Well-labelled sketches are required where necessary for a full mark. All questions carry equal marks.**

Time: Three (3) hours
Full Marks: 100

SECTION A – ENERGY MINERAL DEPOSITS

Q1. (a) Write short notes on (i) Source rock, (ii) Reservoir Rock, (iii) Vitrinite reflectance and
(iv) Kerogen. (8 marks)
(b) Describe briefly how petroleum is formed? (5 marks)
(c) Describe briefly how natural gas is used to generate electricity ?(3 marks)
(d) How does petroleum usage contribute to acid rain and climate change?(4 marks)

20 Marks

Q2. (a) What is coal and how is it formed? (5 marks)
(b) Describe the key characteristics and uses of sub-bituminous, bituminous and anthracite types of coal. (9 marks)
(c) Discuss briefly how important coal has become to Zambia as an energy source. (4 marks)
(d) How is electricity produced from coal? (2marks)

20 Marks

Q3. (a) Describe briefly how the following uranium deposits form: (i) roll front and (ii) sedimentary & conglomerate. (8 marks)
(b) Briefly describe with reasons one geophysical method that would be suitable for exploring uranium deposits. (3 marks)
(c) How is nuclear energy and electricity produced through a uranium fission reaction? (5 marks)
(d) State and explain briefly, with reasons, two key negative impacts of uranium use. (4 marks)

20 Marks

SECTION B – INDUSTRIAL MINERAL DEPOSITS

Q4. (a) Write short notes on: (i) dimension stone and (ii) natural aggregate. (6 marks)

(b) How would each of the following factors affect the commercial production of industrial minerals?

(i) Demand, (ii) Labour rates, (iii) Transportation, and (iv) Road infrastructure. (8 marks)

(c) Describe briefly the following: (i) identified resource, (ii) reserve and (iii) inferred reserve. (6 marks)

20 Marks

Q5. (a) State three tectonic settings for industrial minerals and two industrial minerals associated with each setting. (5 marks)

(b) Explain why the following properties are important in the assessment of rocks *for road aggregate:*

(i) moisture content, (ii) strength and (iii) ability to bond with bitumen. (6 marks)

(c) Explain briefly how the following are geologically formed: (i) clay, (ii) sand and (iii) gravel. (9 marks)

20 Marks

Q6. (a) Distinguish limestone from lime. (3 marks)

(b) Describe how limestone and marble are geologically formed. (5 marks)

(c) Name and describe briefly, justifying your answers, three key techniques you would employ in assessing the quality of a limestone deposit for agriculture. (6 marks)

(d) State the three types of lime produced by Ndola Lime and their uses. (6 marks)

20 Marks

Q7. (a) State the two types of gypsum and describe how each geologically forms. (7 marks)

(b) Describe briefly how salt (sodium chloride) forms geologically. (5 marks)

(c) State two key uses of gypsum and give reasons why. (4 marks)

(d) State the two key uses of salt and give reasons why. (4 marks)

20 Marks

----------End of Examination----------

UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
UNIVERSITY EXAMINATION - NOVEMBER 2018

MET 5139- SPECIAL TOPICS IN MINERAL PROCESSING

Time : THREE hours
Answer: FIVE questions
All questions carry equal marks

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Q1. An ore containing 3% Cu in the form of chalcopyrite ($CuFeS_2$), the remainder being predominately siliceous gangue (s.g 2.7). The ore is crushed to –12mm and sampled before being further treated. The output from the crusher is fed to storage bins via a conveyor system at an average rate of 100 tonnes per hour. Assuming that the crushed material is thoroughly mixed, determine the limit of error (at 99% confidence limited) in the Cu assay introduced by taking a 1kg sample from the conveyor at intervals of 30 minutes. A test of the ore showed that the maximum Cu content of any piece is 10% Cu. The specific gravity of chalcopyrite is 4.2. Take the shape factor and size factor as 0.5 and 0.25 respectively.

Q2. (a) What are the advantages of using particle size distribution functions over the other methods of presenting sizing data?

(b) What is the general equation of particle size distribution function. Outline the significance of the parameters with reference to the Guadin-Schulmann and Rosin–Rammler functions. Show the relationship between the two functions.

(c) A particle size distribution of the ore is known to follow the G.S. function with 90% and 50% of the particle being less than 1mm and 0.5mm respectively. What is the weight percent between $10\,\mu m$ *and* $20\,\mu m$?

Q3. (a) Explain how an electrical double layer may be formed when minerals are put in a solution:

(b) What do you understand by the following terms?

- Electrophoresis
- Streaming potential
- Electro osmosis
- Sedimentation Potential

How can you measure the first two and give detailed explanation of how Electrophoresis will lead to establishing the zeta potentials and explain how this may be use in the separation of different minerals.

Q4. What is the purpose of particle size reduction in mineral processing?

(i) Give the various definitions of "Reduction Ratio" and identify the most important definitions.

(ii) In Energy-Size reduction relationships as used in the design of comminution equipment, empirical "laws" are normally used. Name these laws and explain on which basis each one is used. Using a generalised equation derive each on of them.

(iii) What do you understand by the term "Bond index?

Q5. (a) "Only regular geometrical shapes can have their sizes conveniently qualified". Discuss the implications of this statement with regards to:

(i) The various definition of "size"
(ii) Applications of these definitions size.

(b) Discuss the principle involved in incremental methods and show how the data obtained may be useful.

(c) Describe the Andreassen pipette and the interpretation/calculation of results. What are the main disadvantages of this apparatus?

Q6. The following data refer to the adsorption of Nitrogen on 0.92 g of a sample of silica gel at 77 K being the pressure and V the Volume adsorbed:

p/Kpa	3.7	8.5	15.2	23.6	31.5	38.2	46.1	54.8
Vol cm^3 (s.t.p.) g^-	82	106	124	142	157	173	196	227

Use the BET equation to calculate a specific surface area for silica gel sample taking the molecular surface area of the adsorbed Nitrogen at monolayer coverage as $16.2 \times 10^{-20} m^2$.

BET equation may be written as:

$$\frac{p}{n(p_o - p)} = \frac{1}{n_m C} + \frac{(C-1)}{n_m C}\left(\frac{p}{p_o}\right)$$

The cross sectional area of Nitrogen is 16.1×10^{-20} m.

END OF EXAMINATION IN MET 5139
GOOD LUCK.

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MET 5259

Special Topics in Extractive Metallurgy

Answer: Any Five Questions Time: 3 hours

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1.

a) What is scrap? [2 Marks]
b) What is the importance of metal recycling? [2 Marks]
c) What are the two sources from which scrap iron and steel originate? [2 Marks]
d) Why is the material classification important in scrap metal recycling? [2 Marks]
e) Describe the methods of recycling copper, zinc and gold in the relevant industries. [12 Marks]

2.

a) The exit gas composition from a Fe_2O_3 charged furnace is 24 vol % CO, 22 vol % CO_2 and 54 vol % N_2. The air blast is 1400 m^3/ 1000 kg of product Fe. The hot metal contains 5% C. Calculate:

   (i) Quantity of active carbon in kg / ton Fe; [5 Marks]
   (ii) Total carbon in kg. [4 Marks]

b) Describe the steps involved in the preliminary processing of electronic scrap. [6 Marks]

c) In a converter steel making process about 30% of steel scrap may be used. What are the three functions of the added steel scrap? [3 Marks]

d) What are the main problems of using scrap in steel making process? [2 Marks]

3.

a) What are the three main objectives of solvent extraction? [3 Marks]
b) Mention five properties a successful copper extractant must have. [5 Marks]
c) What is the essential difference between electrorefining and electrowinning? [2 Marks]
d) What are the two main sources of impurities in cathodes obtained through electrowinning? [2 Marks]
e) Why are electrowon cathodes lighter than electro-refining cathodes) [2 Marks]
f) Why are cathode current efficiencies in electrowinning plants rather low? [3 Marks]
g) The most difficult problem in copper-SX circuits is the crud formation. What is crud and how could it be minimised in practice? [3 Marks]

4.

(a) Convert the following parameters into numerical values for their equivalent blast furnace model variables: [9 Marks]

Operating parameters	Model variable
(i) Ore charge: hematite, Fe_2O_3	$\left(\frac{O}{Fe}\right)^x$
(ii) Blast: 1200 Nm^3 dry air per tonne of product Fe	n_O^B
(iii) Pig iron: 5 % C	$\left(\frac{C}{Fe}\right)^m$
(i) Total carbon in charge: 460 kg dry coke (90 % C) and 50 kg oil (85 % C) per tonne of Fe.	$n_c^i = n_c^o$
(v) Active carbon from (iii) and (iv)	n_C^A
(vi) Carbon in top gas from (v)	n_C^g
(vii) Top gas composition: 23.9 Vol. % CO, 20.5 % CO_2, 55.6 % N_2	$\left(\frac{O}{C}\right)^g$
(viii) Quantity of CO and CO_2 in top gas from (vi) and (vii)	n_{CO}^g, $n_{CO_2}^g$

(b) The heat demand, D of a hematite-charged blast furnace is 560 000 kJ per kg mole of product Fe. The total carbon in charge is 600 kg per tonne of product Fe. The pig iron product contains 5 % C. Calculate:

(i) The volume of blast air (Nm^3 per tonne Fe) which is required to keep this furnace operating at a steady state. [5 Marks]

(ii) Composition of the top gas. [6 Marks]

5.

(a) What is Isa-smelt technology? What are the advantages of this new technology over the conventional processes? Describe with a neat sketch the furnace for smelting the copper concentrates/ores. [18 Marks]

(b) Has this new technology any relevance to the Zambian copper smelting industry? [2 Marks]

6.

(a) Describe in general the solvent extraction (SX) process as applied in the recovery of copper from its ores. [1 Mark]

Describe: (i) Sulphuric acid leaching system; [4 Marks]

(ii) Ammonia leaching system; [4 Marks]

(iii) Concentrated chloride leaching system. [4 Marks]

What are the advantages of each Leaching system? [3 Marks]

(b) What are equilibrium modifiers? [2 Mark]

(c) Mention two disadvantages of using equilibrium modifiers.[2 Marks]

7.

(a) Discuss with the help of neat flowsheets the production of H_2SO_4 and elemental sulphur from smelter flue gases. [11 Marks]

(b) Describe with diagrams how the following gas cleaning equipments operate: [9 Marks]

(ii) electrostatic precipitators,
(iii) scrubbers, and
(iv) Bag Houses

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Given:

$$n_O^B + \left(\frac{O}{Fe}\right)^X = n_C^A \left(\frac{O}{C}\right)^g$$

$$n_O^B + \left(\frac{O}{Fe}\right)^X - \frac{D}{283000} = n_C^A \frac{172000}{283000}$$

$$X_{CO_2}^g = \left(\frac{O}{C}\right)^g - 1 \quad \text{and} \quad X_{CO}^g = 2 - \left(\frac{O}{C}\right)^g$$

DATA

Atomic Weights

Fe = 55.845; S = 32.06; O=15.999; C = 12.011

END OF EXAMINATION IN MET 5259

GOOD LUCK

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MET5349 FOUNDRY TECHNOLOGY

TIME: THREE HOURS

ANSWER ALL QUESTIONS AND MARKS FOR EACH ARE SHOWN

1.

(a) The Scheil equation, which describes the composition of the solid and liquid during solidification is derived from a function of the fraction solidified and bulk liquid composition. This is based on an assumption of no diffusion in the solid but perfect mixing in the liquid.

Write down the mathematical or differential relation that shows that and evaluate the solute composition, C_S, given the initial or boundary conditions ($f_S = 0$ when $C_s = kC_o$) and explain fully the terms involved.

Use derived solute relation to estimate the solute composition for a Cu-Sn alloy 85% solidified with partition coefficient value of 0.10 and containing 8% tin. Why is the partition coefficient, k, assumed constant during the solidification process? [15]

(b) Explain the one main difference between a jobbing and a production foundry and give a suggestion where additive manufacturing (AM) would best fit in both of the two processes. [5]

2.

(a) The total free energy change accompanying solidification has two main energy components. Write down the derived expression and explain the significance of the two terms and show how the critical radius and free energy, r* and ΔG^*, may be derived from the relationship. You may include a plot of the energies. [10]

(b) If the volume free energy term is expressed as $\Delta G_V = \frac{L\Delta T}{T_m}$, re-write the expressions for critical radius and critical free energy. [10]

3.

(a) Describe the microstructure of a cast ingot in terms of the three zones or grain types obtaining with the help of an illustration. What influence does the degree of undercooling have on the formation of each of the three structures? [12]

(b) What is meant by segregation in cast structures and in how many forms do you think segregation will occur? What remedies can one apply either during casting or post casting to minimize or eliminate segregation altogether? [8]

4.

(a) Using the model of a top poured sand casting with a gating system consisting of basin, down-sprue, runner and in-gates, determine the main dimensions (or cross-sectional areas) of the system which has a gating ratio of 1:0.6:0.4 given that its basin and sprue heights are 18cm and 22cm respectively.

Assume that the flowrate in the system is $1.8 \times 10^{-4} m^3/sec$ and that a relationship exists between its potential energies and sprue entry and exit areas. [15]

(b) Suggest what precautions can be applied or used in the pouring basin to prevent unclean metal entering the gating system as well as maintaining a sufficiently hot bath throughout casting. [5]

5.

(a) It is known that the rate of solidification of a metal alloy during casting is influenced by the following three major factors;

(i) The excess heat in the liquid metal on pouring,

(ii) The amount of heat produced by the solidification of the alloy (the latent heat of fusion),

(iii) The rate at which this heat can be dissipated from the alloy

For each of the above factors, write some brief comments on how it arises and what measures can be applied to ensure a successful casting process. [12]

(b) The flow of molar species in the situation described above may be quantified with the help of Fick's laws

$$J_H\,(x,y,z,t) = -\,k.\nabla\, T(x,y,z,t)$$

$$J_S\,(x,y,z,t) = -\,\nabla\,\{D(T(x,y,z,t))\,.\,c\,(x,y,z,T(x,y,z,t))\}$$

(i) What species do the above two equations represent and why is a three dimensional model preferable in representing them in this case?

(ii) Do you think the two equations are related and if so in what way?

[8]

END OF EXAMINATION IN MET5349

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MIN 5019 – GEOTECHNICAL ENGINEERING

TIME: THREE (3) HOURS **Total Marks 100**

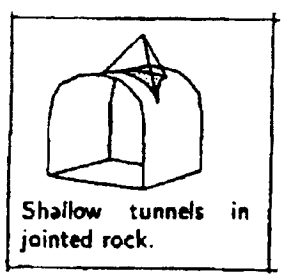
INSTRUCTIONS: ANSWER ALL QUESTIONS

Question One

Shallow tunnels in jointed rock find many uses in civil engineering and community health works including water reticulation and supply systems.

Discuss in detail Shallow tunnels in jointed rock in association with the following headings:

(a) Typical problems [5 marks]
(b) Critical parameters [5 marks]
(c) Analysis Methods [5 marks]
(d) Acceptability Criteria [5 marks]



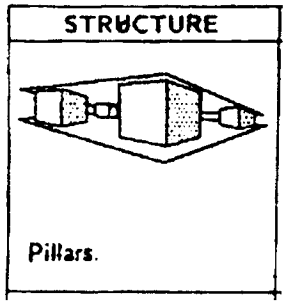
Shallow tunnels in jointed rock.

Question Two

Pillars find many uses in miming and civil engineering works. There are many types of pillars viz chain, rib, crown, gravity and tributary pillars.

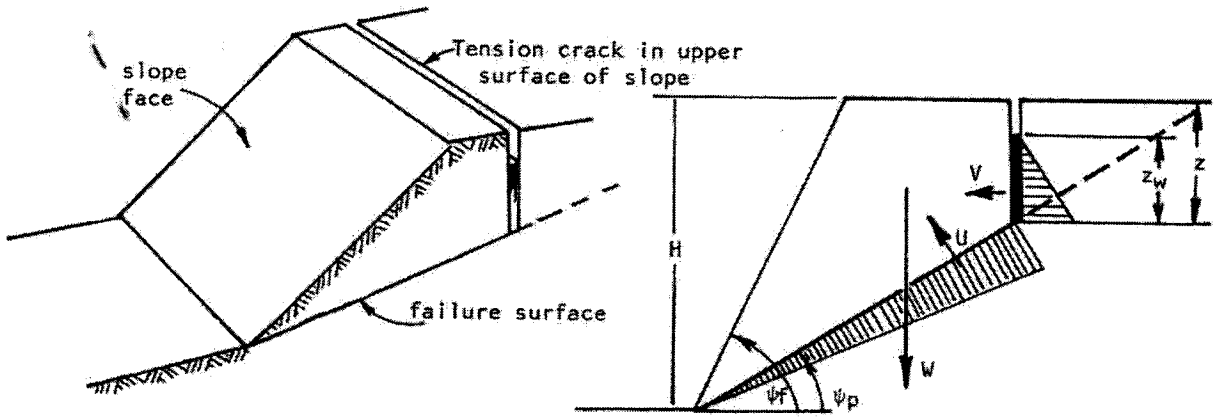
Discuss the incidence of mining pillars in the undergroung coal mining of tabular deposits.

(a) Typical Problems [5 marks]
(b) Critical Parameters [5 marks]
(c) Analysis Methods [5 marks]
(d) Acceptability Criteria [5 marks]



Question Three

A 80m high slope with a face angle of 60° is found to have a bedding plane running through it at a dip of 30°. A tension crack occurs 20m behind the crest of the slope and from an accurately drawn cross section of the slope, the tension crack is found to have a depth of 40m.



The unit weight of the rock is γ = 30KN/m^3 and that of the water γ_w = 9.81KN/m^3. Assuming that the cohesive strength of the bedding plane C = 50.50KN/m^2 and the friction angle $\acute{\varphi}$ is = 30°.

(a) Find the influence of the water level Z_w upon the Fctor of Safety of the slope. [10 Marks]

(b) Find the Factor of Safety of the slope graphically if the tension crack is only half full of water. [5 Marks]

(c) Make general comments/observations on your findings. [5 Marks]

Question Four

Water has potentially disatrous effects when present in rock slopes and many other earth works including other natural earth structures.
Write short notes on the following in as far as the influence of rain and ground water on stability of earth works is concerned:

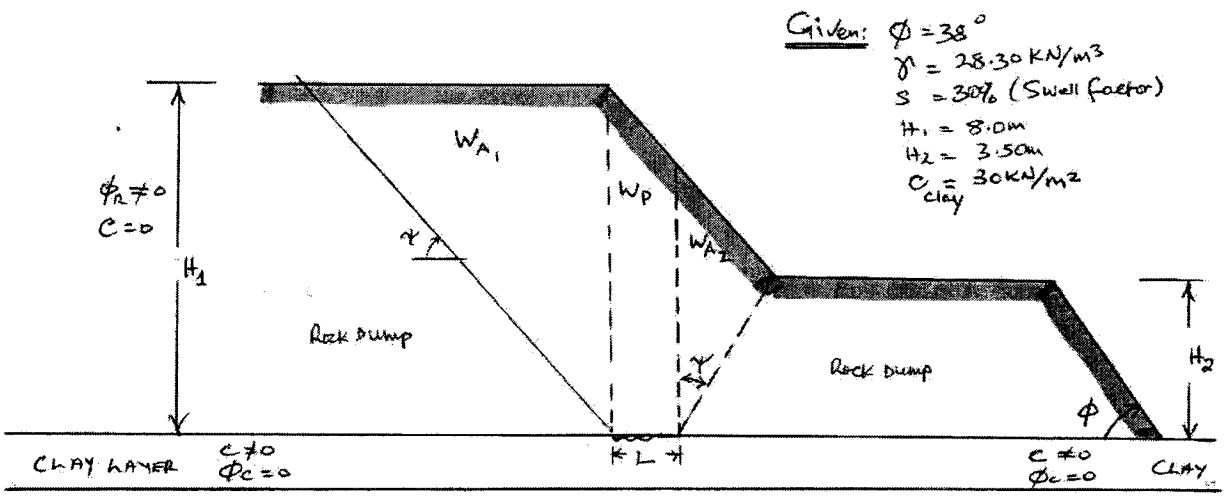
(i)	Dry Slopes	[5 marks]
(ii)	Water in slope tension crack	[5 marks]
(iii)	Water in tension crack only	[5 marks]
(iv)	Water in tension crack and on sliding surface	[5 marks]
(v)	Saturated slope with heavy re-charge.	

Question Five

Mining Operations procduce a lot of waste rock material which of necessity must be stored or dumped somewhere to make mining operations accessible and sustainable. The construction of these dumps or embarkments is important as more often than not ,they can fail with disatrous effects especially when dumping is near populated areas or on ground higher than the surrounding areas. **(Refer to the Diagram of the two berm Embarkment given below).**

(a) What does the Term ''Waste Embarkment'' mean and include?
[5 Marks]

(b) Given a two berm dump with the material specifications as listed, find the length L at which the condition of limiting eguilibrium in the embarkment will be established. [15 Marks]



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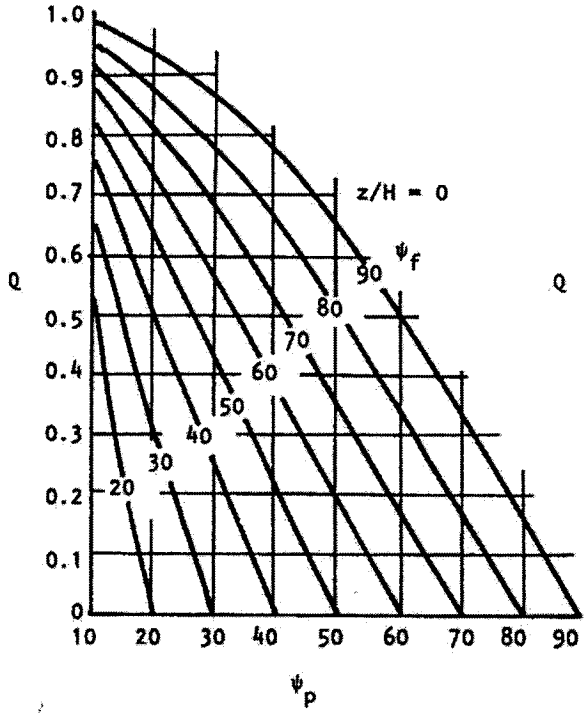
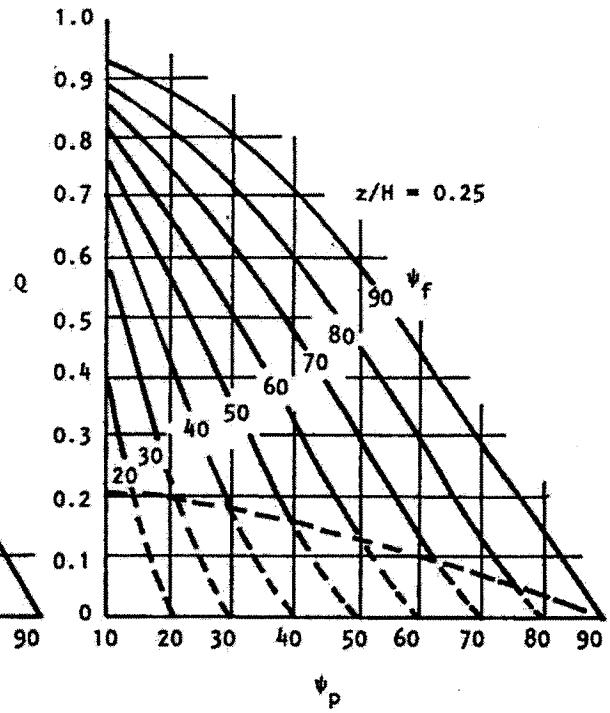
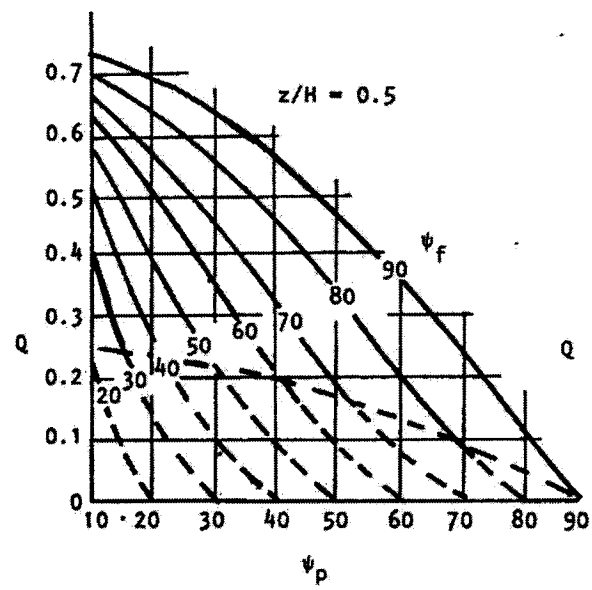
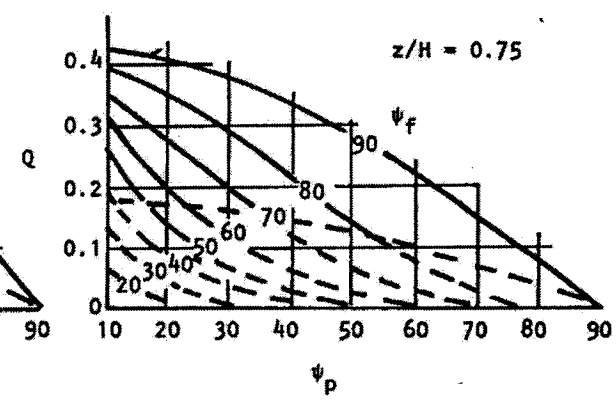
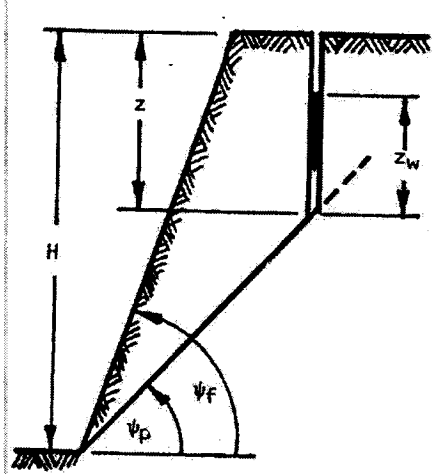




Note:
Dashed lines refer to tension crack in slope face.







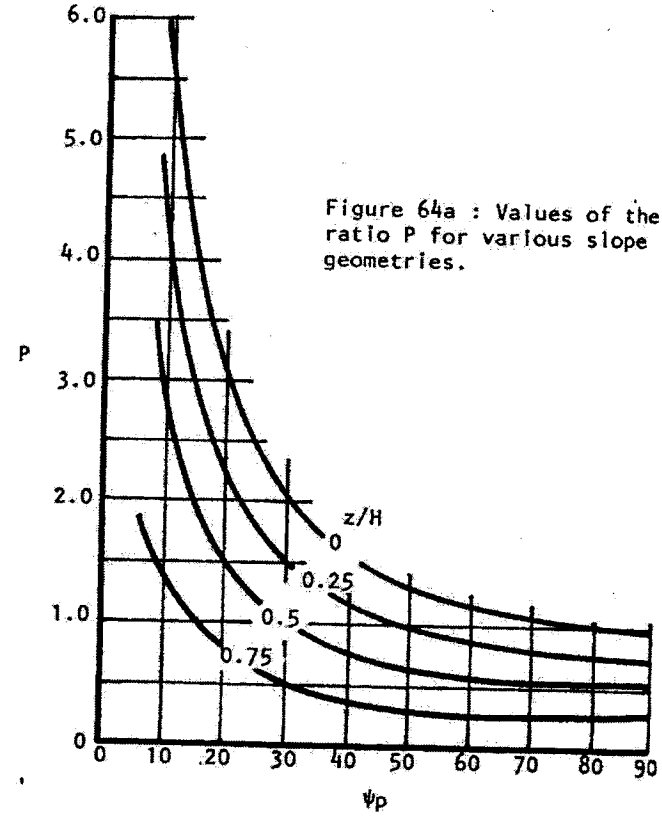


Figure 64a : Values of the ratio P for various slope geometries.

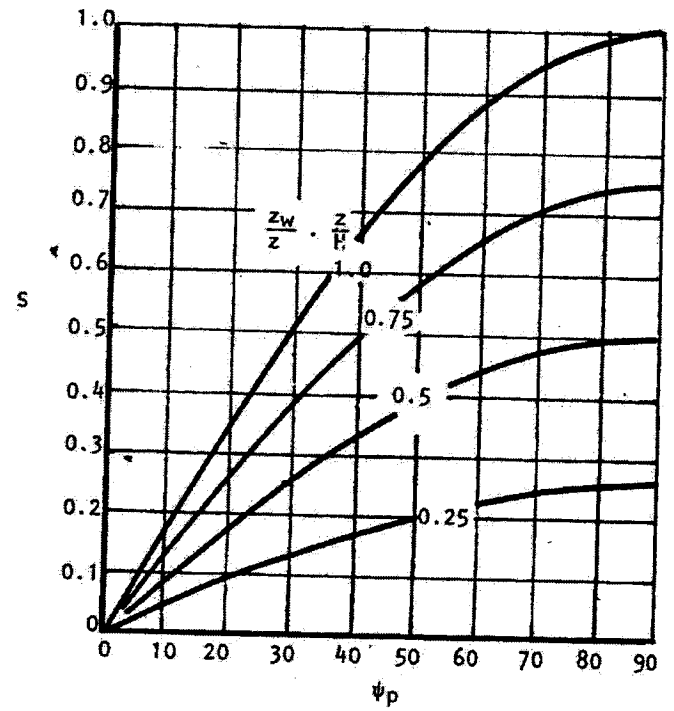


Figure 64b: Values of the ratio S for various geometries

MIN 5019 Geotechnical Engineering

Some Equations

$$F.S = \frac{C.A + (W*\cos\psi\rho - U - V*\sin\Psi\rho)\tan\theta}{W*\sin\Psi\rho + V*\cos\Psi\rho}$$

$$P = (1 - z/H) * \mathrm{Cosec}\Psi\rho$$

$$Q = [\,(1 - (z/H)2\,)\,\mathrm{Cot}\Psi\rho - \mathrm{Cot}\Psi f\,]\,\sin\Psi\rho$$

$$Q = [\,(1-z/H)2\,\cos\Psi\rho\,(\mathrm{Cot}\Psi\rho * \tan\Psi_f - 1)]$$

$$R = \gamma_w/\gamma * Zw/Z * Z/H$$

$$S = Zw/Z * Z/H\,\sin\Psi\rho$$

$$A = (H-Z)_* \,\mathrm{Cosec}\Psi\rho$$

$$U = 1/2\gamma_{w*}Z_w.(H-Z)_* \,\mathrm{Cosec}\Psi\rho$$

$$V = \tfrac{1}{2}\,\gamma_w * Z^2_w$$

$$F = \frac{(2C/\gamma H_*\rho + (Q_*\mathrm{Cot}\Psi\rho - R(P+S))\tan\Phi}{Q + R_*{}_,S\mathrm{Cot}\Psi\rho}$$

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MIN 5029 – COAL MINING METHODS

INSTRUCTIONS: **ANSWER QUESTION ONE AND ANY OTHER FIVE. ANSWERS TO BE IN THE ORDER THEY APPEAR IN THE QUESTION PAPER**

TIME: **3 HOURS** TOTAL MARKS: **100**

QUESTION 1

(a) The plant debris converts into coal in two stages. Explain the stages briefly (05 marks)

(b) Write the equation to predict the convergence of road way in a coal mine (05 marks)

(c) What is the purpose of the panel in a room and pillar method of mining? Explain how the size (number of coal pillars) of panel is determined (05 marks)

(d) Explain the circumstances when gasification of coal is done. Name the technological gases which are produced during gasification (05 marks)

QUESTION 2

(a) Why is there generally a variation in the thickness of coal seam, chemical composition and amount of impurities present? (08 marks)

(b) Explain, with the help of diagrams, how the ash content of the coal can be reduced (08 marks)

QUESTION 3

(a) You are required to design a longwall advancing face to give an annual output of one million tonnes. Draw the layout of the face for this purpose and show the position of the equipment (in plan) and other items you expect for this purpose based on the following information:

- Thickness of the seam = 2.0m
- Web of the DERD =70cm
- Speed of the sheerer = 3.5m/min
- Width of the face = 2.8m
- Number of working days/year = 250
- Specific gravity of coal = 1.27
- Number of productive shifts = 3
- DERD can cut coal (from one end to another) 3 times/shift

(08 marks)

(b) Where would you recommend longwall retract mining method? Write three advantages and three disadvantages over longwall advancing. (08 marks)

QUESTION 4

(a) A coal seam of degree three (in terms of methane content) to be mined from a depth of 150 metres below the surface. There is a river close to the coal deposit. Suggest a method

to extract such coal deposit, giving the reasons of your choice. Write the advantages if any, of the method suggested. (08 marks)

(b) As a ventilation officer at a coal mine, when would you consider that the mine is getting adequately ventilated? (08 marks)

QUESTION 5

(a) The concept of using the "room and pillar" method in which the mine road is supported by equally spaced pillars of square cross section. Calculate the cross-sectional area of the pillar which will be needed from the data given below:

The area of the panel (A) = 100 x 100m

Depth of the coal from the surface (z) = 100m

Density of overlaying overburden () = 25KN/m^3

Compressive strength of coal (s) = 10Mpa

Factor of safety to be maintained = 1.2

Number of pillars in the panel = 9 (10 marks)

(b) Explain how the pillars in the room and pillar method are formed (06 marks)

QUESTION 6

(a) Some coals are highly prone for spontaneous heating. Suggest a mining method for this purpose giving reasons for your choice. (08 marks)

(b) The following is an analysis of an air sample from return airways, what do the figures indicate?

- Oxygen = 19.90
- Nitrogen = 78.67
- Methane = 1.00
- Carbon dioxide = 0.40
- Carbon monoxide = 0.03

(Note: The values given above are in percentage) (08 marks)

QUESTION 7

(a) How were the faults originated? What problem may be created if present in a coal mine? (06 marks)

(b) What is the difference between normal fault and reverse fault? Explain with the help of a diagram (05 marks)

(c) Calculate the throw of the fault if the angle of head of fault is 30° and the displacement is 15m (05 marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MIN 5049 – APPLICATION OF SOFTWARES IN MINING

INSTRUCTIONS: **ANSWER ALL QUESTIONS – SAVE ALL FILES IN DIFFERENT LAYERS**

TIME: **3 HOURS** TOTAL MARKS: **100**

Question 1

The following is a DTM file of Millennium copper deposit (see Figure 1).

- Millennium_copper_deposit.dtm

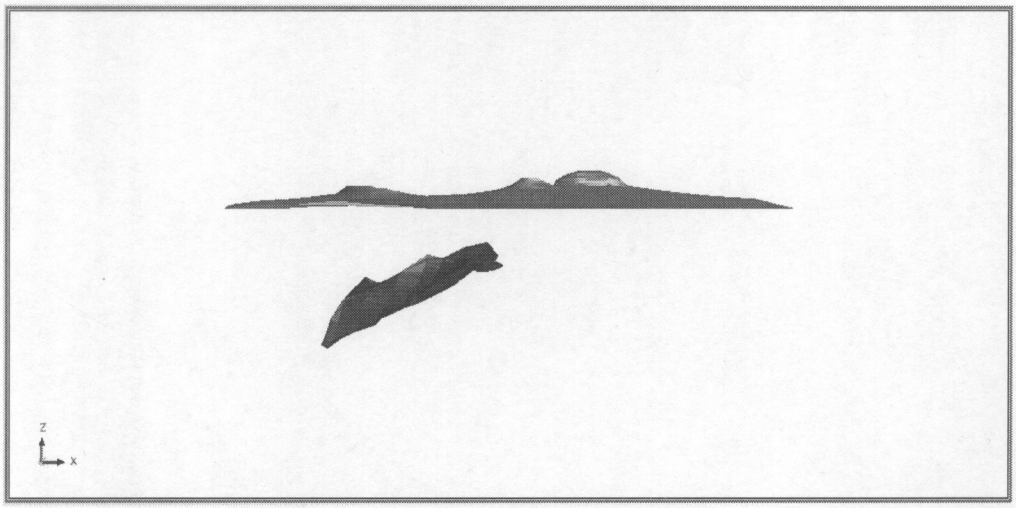


Figure 1: String files of Millennium copper deposit

Hired as a mine planning engineer, use Surpac mining software to:

(a) Design a 5.5 m x 5.5 m Decline having the following attributes:

- Starting point on surface – (5408.317, 4010.397, 460)
- Turning radius – 30 metres
- Gradient – 1 in 8 **[15 marks]**

(b) Design a sublevel transverse mining layout having the following attributes:

(i) Three 5 m x 5 m evenly spaced haulages **[5 marks]**
(ii) Three 4.5 m x 4.5 m evenly spaced footwall drives **[5 marks]**
(iii) 4.5 m x 4.5 m evenly spaced cross cuts on each level **[5 marks]**
(iv) Four 4.5 m x 4.5 m evenly spaced extraction drives **[5 marks]**

(c) Design the following

(i) 2 ore passes (3 metres in diameter connecting all three levels) **[6 marks]**
(ii) Hoisting shaft (6 metres in diameter) **[6 marks]**
(iii) Haulage level (5.5 m x 5.5 m) **[4 marks]**

(d) Determine the volume of material to be extracted from;

(i) Decline **[3 marks]**
(ii) Transverse mining layout **[4 marks]**
(iii) Hoisting shaft **[2 mark]**

Question 2

The following are the DTM files of a copper deposit (see Figure 2);

- obwest_wftr.dtm, and
- topoptr.dtm.

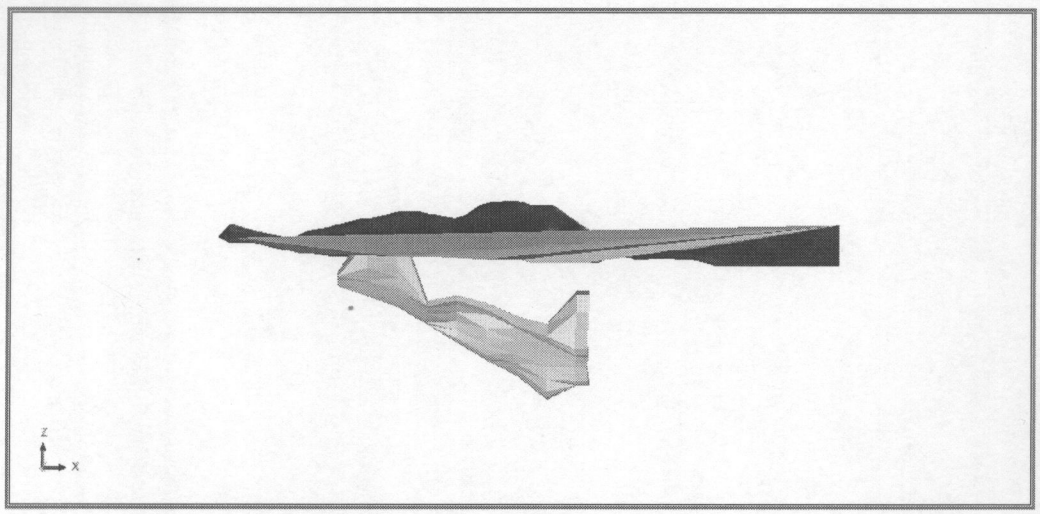


Figure 2: DTM files of copper deposit

(a) Hired as a mine planning engineer use Surpac mining software to:

(i) Design a conceptual open pit mine to extract the entire deposit. The open pit mine should have the following attributes:

- Overall pit slope angle – 45^0
- Haul road width – 44 metres
- Bench height – 10 metres
- Number of switch backs – 2
- Ramp width = 25 m
- Bench height = 10 m
- Berm width = 5 m
- Ramp gradient = 10^0 **[25 marks]**

(ii) Calculate the stripping ratio of your pit design in (i) **[5 marks]**

(b) The following is technical-financial information of the project in Question 2 (a) (see Table 1)

Table 1: Technical-financial information

Parameter	Value
Copper price ($/tonne)	6000
Mill cutoff grade (%)	0.5
Concentrator grade (%)	0.3
Density of copper ore (t/m^3)	2.7
Operating cost ($/tonne)	3000
Extraction rate of ROM (t/year)	134,267.49
Corporate Income Tax	25%
Metallurgical recovery (%)	90
Discount rate (%)	12

Project Assumptions:

- Copper price is constant throughout the mine life;
- Production is constant throughout the mine life; and
- Tonnage of the entire deposit to be treated as economically exploitable reserves.

Using an Excel spreadsheet,

(i) Is it economically feasible to mine the above deposit using surface mining based on the Net Present Value (NPV)? (Show all relevant calculations) **[10 marks]**

NOTE: Use engineering judgement in the design process

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS NOVEMBER 2018

MIN 5059 – MINE MANAGEMENT

INSTRUCTIONS: ANSWER ANY 5 QUESTIONS **TOTAL MARKS 100**
TIME: 3 HOURS

QUESTION 1

Write short notes on the following key functions of management:

i)	Planning	**[5 marks]**
ii)	Organizing	**[5 marks]**
iii)	Directing/leading	**[5 marks]**
iv)	Controlling/monitoring	**[5 marks]**

QUESTION 2

In planning, management must develop SMART goals. Discuss the following attributes which a goal should have:

i)	Specific	**[4 marks]**
ii)	Measurable	**[4 marks]**
iii)	Attainable	**[4 marks]**
iv)	Responsive	**[4 marks]**
v)	Time bound	**[4 marks]**

QUESTION 3

(i)	What is risk?	**[5 marks]**
(ii)	Discuss the steps that may be taken in risk analysis	**[15 marks]**

QUESTION 4

(i)	What is work place conflict?	**[5 marks]**
(ii)	Discuss steps that may be taken to manage conflict	**[15 marks]**

QUESTION 5

Discuss the major differences between policies and procedures **[20 marks]**

QUESTION 6

Discuss the importance of effective industrial relations **[20 marks]**

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MIN 5069 - SAFETY, HEALTH AND ENVIRONMENT

INSTRUCTIONS: ANSWER ALL 5 QUESTIONS. TOTAL MARKS: 100

TIME: 3 HOURS

QUESTION 1

(i) What are the

(a) business definitions of *safety and environment?* ***[2 marks]***
(b) the general definition of *health?* ***[2 marks]***

(ii) Briefly elaborate 6 concerns related to Lifespan and Healthspan for
(a) developed world ***[3 marks]***
(b) countries like Zambia. ***[3 marks]***

(iii) What are the two inter-dependent classes of environment, and give at least four (3) examples for each class? ***[4 marks]***

(iv) Define topography and provide five situations how it impacts on the environment. ***[6 marks]***

QUESTION 2

(i) What is the most widely accepted definition of sustainable development, and what does it mean for the mineral's sector? ***[4 marks]***

(ii) What are the 6 key dimensions defining sustainable development in Zambia? Justify your answers in two (2) sentences per dimension. ***[12 marks]***

(iii) Discuss the concept of Leading Practice in Sustainable Mining in four (4) points. ***[4 marks]***

QUESTION 3

Describe the diagram in Figure 1 in terms of the interplay involving Local Natural Resources, Investments, Outputs, Environment and Net Result for the host country / community

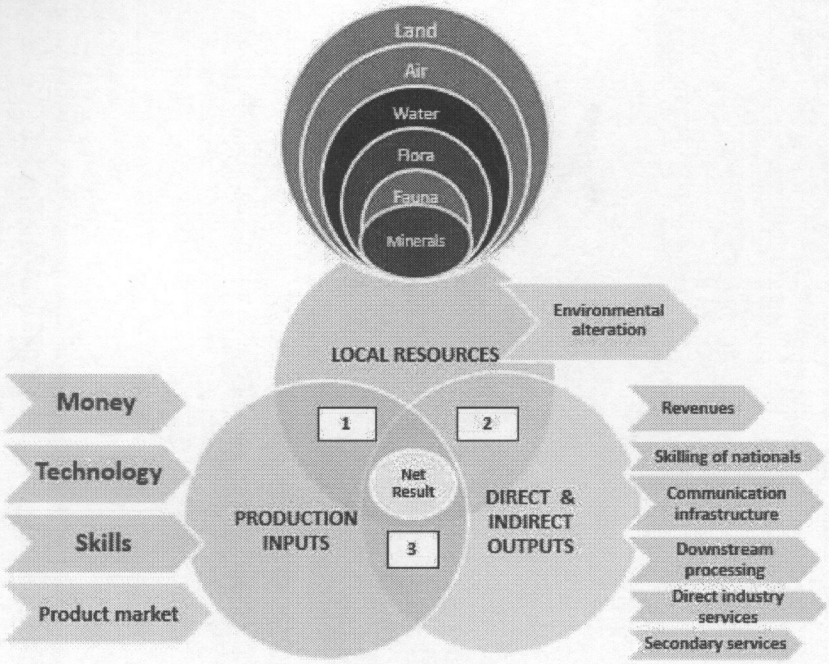


Figure 1

[20 marks]

QUESTION 4

The **source-pathway-receptor model** considers where pollution can come from, how the pollution can travel through the environment, and what could be affected. With the help of the diagram below, describe physical and chemical changes of **pollutants listed** up to when they reach a receptor.

Emissions / pollutants and examples of sources	→	**Atmospheric transportation**	→	**Examples of receptors and impacts**
1). Heavy metals 2). Sulphur dioxide 3). Mercury 4). Particulate matters		Describe **for each case**? ***1 mark each***		**For each case**, what/who suffers and how? ***4 marks each***

Sub-Total = ***[20 marks]***

QUESTION 5

(i) Draw a sequence of underground mining activities from development/tunnelling to hoisting of rock material. ***[3 marks]***

(ii) Which activity in Question 5(i) is the most hazardous work area and why? ***[2 marks]***

(iii) Using 6 bullet points for each, what can you say about the effects of

a) **P**hysical strain ***[3 marks]***
b) **V**ibrations ***[3 marks]***
c) **H**eat and humidity ***[3 marks]***
d) **N**oise ***[3 marks]***
e) **D**ust and oil mist ***[3 marks]***

when working with a jack hammer underground?

END OF EXAM

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MIN 5079 – ROCK MECHANICS II

INSTRUCTIONS: **ANSWER QUESTION ONE AND ANY OTHER FIVE. ANSWERS TO BE IN THE ORDER THEY APPEAR IN THE QUESTION PAPER**

TIME: **3 HOURS** TOTAL MARKS: **100**

QUESTION 1

(a) Explain briefly what causes rock bursts, out bursts and earthquakes (05 marks)
(b) Explain how chimney caving is induced due to mine subsidence? (05 marks)
(c) Explain typical application of soil mechanics (05 marks)
(d) What is the difference between rock mechanics, rock engineering and fracture engineering? (05 marks)

QUESTION 2

(a) A tetrahydral block of a rock has to be stabilized using rock bolts. Write the parameters needed to keep its safety factor as decided (10 marks)
(b) Explain how the length of the rock bolt and spacing between the two bolts (both along and in transverse direction) can be calculated (06 marks)

QUESTION 3

(a) Mining induced surface subsidence could be either uniform or erratic type. Explain using figures why this happens (10 marks)
(b) A gratified mineral deposit of 3.0m thickness at a depth of 650m to be exploited using longwall method of mining. What should be the maximum length of the longwall face so that subsidence effect should not reach to the surface? (06 marks)

QUESTION 4

(a) A headgear structure has to be installed for hoisting of men and material. Write clearly, step by step, the geotechnical investigations you will make to ensure that the structure remains safe. (10 marks)
(b) Calculate the allowable bearing pressures on rock beneath the head gear legs footings, given the unconfined compressive strength (q_u) calculated from (Mohr –Coulomb curves) equal to 150 MPa and angle of internal friction (φ) is 42° (06 marks)

QUESTION 5

(a) Explain what happens when stress is applied on an elastic body? Can this strain energy be calculated? (08 marks)

(b)Find (i) the greatest amount of strain energy per unit volume and (ii) the total strain energy that can be stored in a rock specimen subjected to uniaxial compressive stress. Take the elastic limit to be 200 GPa and Young's modulus of 80 GPa. The dimension of the rock specimen has the diameter of 6.0 cm and length of 12.0 cm. (08 marks)

QUESTION 6

(a) Explain why some rocks are weakened when they come in contact with water and also it raises the pore water pressure (p_w) (04 marks)

(b) What value of pore water pressure (p_w) will cause fracture in a reservoir if the rock sample was tested under triaxial condition under the condition given below.

Test	σ_3 (MPa)	σ_1 (MPa)
1	05.0	30.0
2	10.0	50.0
3	15.0	75.0

(12 marks)

QUESTION 7

(a)Write the conditions under which the rock bolts may not be effective (6 marks)

(b)Given:

- Span of excavation = 4.8 m
- ESR for permanent mine opening = 2.0

Calculate the length of the bolt you would recommend in (i) roof and (ii) in the walls. (5 marks)

(c)What is the difference between rock grouting and shotcreting? Where are they used in mining? (5 marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – NOVEMBER 2018

MIN 5089 – MINE PLANNING AND DESIGN

INSTRUCTIONS: ANSWER **FIVE (05)** QUESTIONS TOTAL MARKS: **100**
TIME: **3 HOURS**

Question 1

(a) Explain briefly the objectives of production scheduling and types of schedules in open pit and undeground mining **[8 marks]**

(b) Choose **ONE** mining method below and discuss the method in detail under the following headings;

- Development **[4 marks]**
- Operations **[4 marks]**
- Production **[4 marks]**

Use a clear and well labelled diagram to illustrate your answer where possible.

(i) Shrinkage Mining Method
(ii) Longwall Mining Method

Question 2

Consider an idealized diagram in Figure 1 showing blocks of ore from 1 to 8 and corresponding diamond shaped blocks showing waste to be removed.

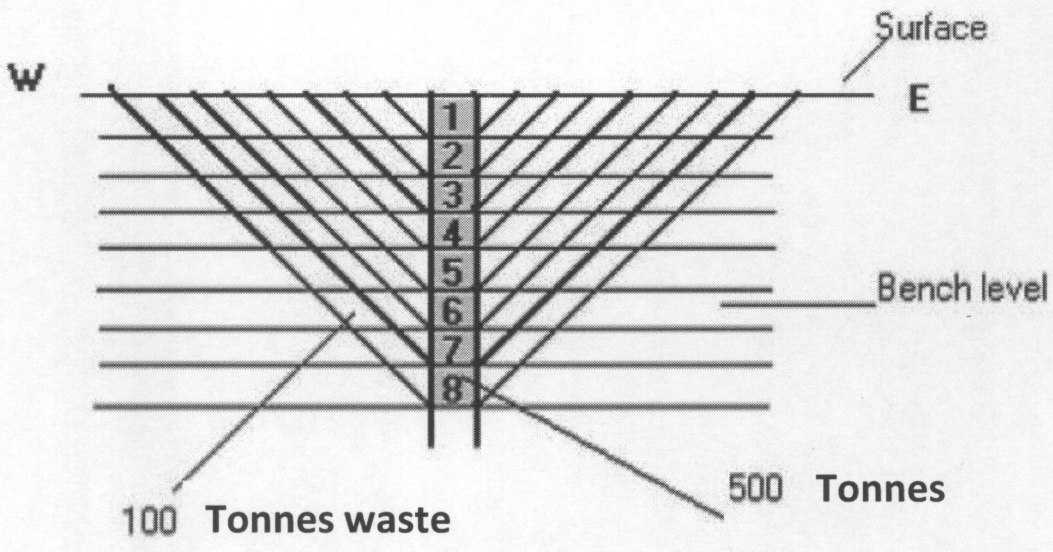


Figure 1: Blocks of ore

Each bench in the diagram shown above contains 500 tonnes of ore and each diamond shaped blocked of waste represents 100 tonnes.

(a) Calculate the pit values **[8 marks]**

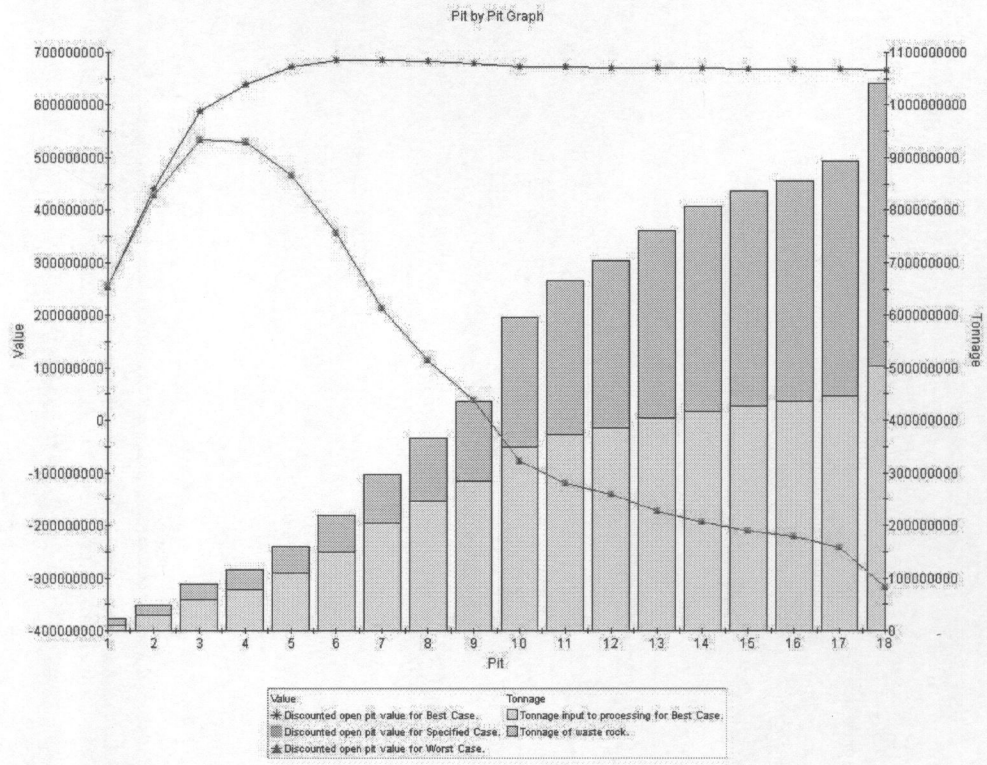
(b) Determine the optimum pit with the help of the graph if ore is worth $200.00 per tonne after all ore mining and processing costs have been paid and if waste costs $100.00 per tonne to remove. **[12 marks]**

Question 3

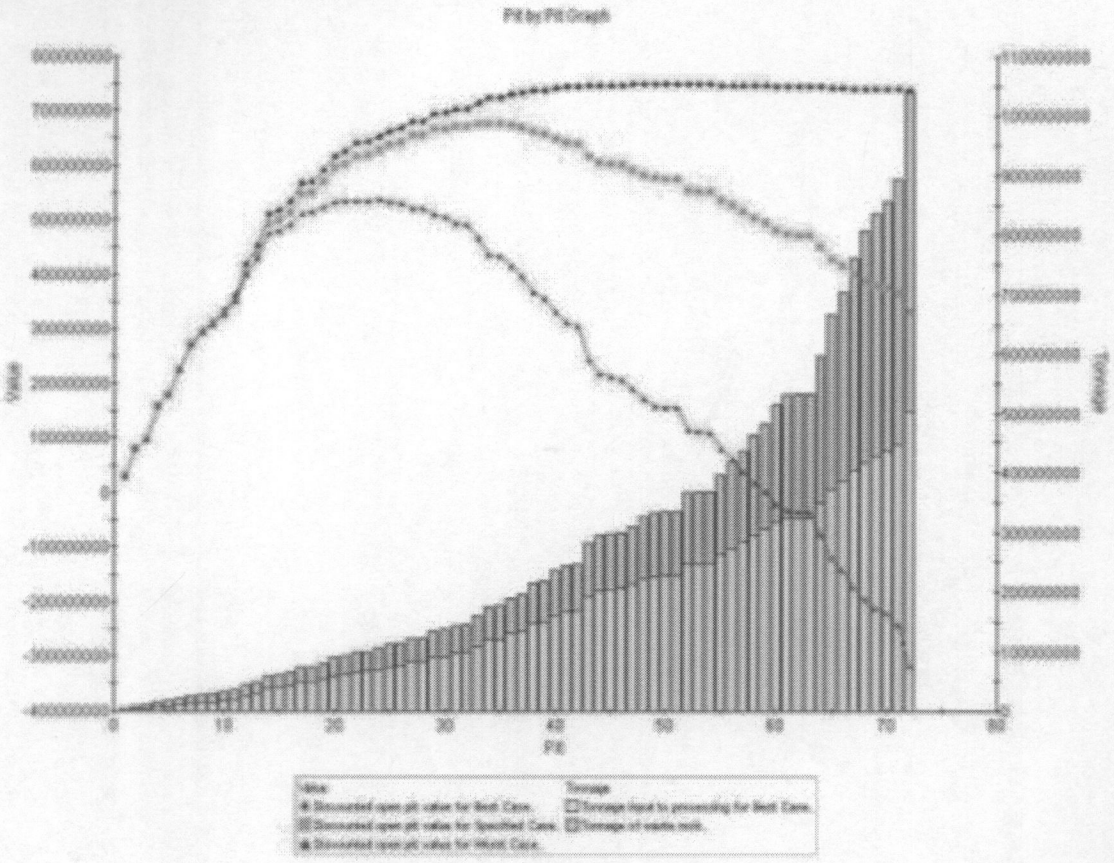
(a) Explain the following terms as they relate to Whittle Optimization;

(i) Block Model **[2 marks]**
(ii) Revenue Factor **[2 marks]**
(iii) Pushback (cutback) in open pit mining; **[2 marks]**
(iv) Mining CAF **[2 marks]**
(v) Worst Case Scenario in Whittle software **[2 marks]**

(b) The figures below show the Pit-by-Pit graph from Whittle optimization software;



(a)



(b)

Figure 2: Pit-by-Pit graph from Whittle optimization software

(i) Discuss the difference between Graph (a) and Graph (b) **[2 marks]**

(ii) Explain briefly the meaning of "Specified Case" in Whittle; **[4 marks]**

(iii) Discuss the process of selecting pushbacks from pit shells using Whittle; **[4 marks]**

Question 4

(a) A small metallurgical plant may be operated at 4 different levels of production, with costs and incomes given in Table 1. Consider life to be 10 years, without any salvage value at the end of life. The minimum acceptable rate of return is 10%. These production alternatives are mutually exclusive.

Table 1: Production levels and incomes

	Unit Production/year (tonnes/year)	**Initial Investment ($)**	**Annual Costs ($)**	**Unit selling price ($)**
Level 1	12000	100000	36000	5
Level 2	18954	150000	60000	5
Level 3	23116	185000	80000	5
Level 4	29180	260000	90000	5

What is the economically most attractive level of production on the basis of **Payback Period**? **[8 marks]**

(b) A mine is considering the installation of automated equipment in its processing plant to reduce labour costs from;

$300,000 to $220,000 in year 1
$330,000 to $240,000 in year 2
$360,000 to $260,000 in year 3
$400,000 to $290,000 in year 4

The equipment will cost $200,000 now with an expected salvage value of $50,000 in four years. The minimum rate of return is 20%. Use **NPV analysis** to determine if the equipment should be installed. **[12 marks]**

Question 5

At an Open Stoping operation the vein dips from 65^0 to vertical to the southeast and strikes N 40-70^0 E. Average width of the vein is 6.7m. The dimensions of the ore chute being mined are roughly 305m along strike by 160m vertically, although the lower limit of the chute is defined by the limitations of the mining method employed rather than ore tenor or mineralogical change. Draw points located at the bottom of the mine would be driven on 15.2-m centres from a lateral drift parallel to the vein in the footwall. This drift is located a minimum 15.2 m from the footwall of the vein in order to provide maximum ground stability and ensure that Bogger units would have a straight shot at the muck pile when bogging out of the draw points. Each draw point would be coned up to an undercut level, driven in ore approximately 10.7m above the draw point brows, with the formation of pillar apexes at the undercut sill elevation.

The mine is laid out with a centrally located ramp system (10% grade) serving each of the five sub levels 35m apart. This ramp system consists of extremely elongated spirals located in the footwall of the vein with their long axis' positioned perpendicular to the strike of the vein. All openings are 3.6m high by 4.3m wide.

a) Draw a vertical section (transverse) normal to the strike of the ore body. Show the vein and the ramp system and the location of the sub levels. **[5 marks]**
b) Draw a vertical longitudinal section showing the draw points, the cones, the undercut, and the ore up to the first sub level. **[5 marks]**
c) Draw a horizontal section (plan) at the draw point level. **[5 marks]**
d) Draw the 3-dimensional perspective of this mining system. **[5 marks]**

Question 6

(a) Briefly discuss the reasons that may lead to the replacement of an asset. **[5 marks]**

(b) An open-pit mine with a fleet of dump trucks makes pit-to-concentrator deliveries. Past records (Table 2) modified to account for recent price trends indicate a cost pattern over a 6-year period that is expected to apply to depreciation and maintenance for future truck acquisition. The purchase price per truck is US$3000.

Table 2: Past records modified to account for recent price trends

Year	**1**	**2**	**3**	**4**	**5**	**6**
Operating cost (US$)	800	1000	1300	1600	2000	2500
Resale price (US$)	1600	1000	600	500	400	300

Assume a zero interest rate and that all the trucks are going to be replaced at one time, how many years should they be kept in service before replacement? **[15 marks]**

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS - NOVEMBER 2018

MIN 5099 MINERAL ECONOMICS AND MANAGEMENT

INSTRUCTIONS: ANSWER ANY 5 QUESTIONS **TOTAL MARKS 100**
TIME: 3 HOURS

QUESTION 1

Discuss the five criteria a Perfect Competition in a market structure must fulfill.

[20 marks]

QUESTION 2

Why is "SWOT" analysis important in project planning? Discuss the various aspects of this analysis. **[20 marks]**

QUESTION 3

(i) Discuss why project monitoring is important during implementation. **[10 marks]**

(ii) Briefly comment on the following project management tools indicating advantages and setbacks:

a) Fishbone (Ishikawa) diagram **[3 marks]**
b) Gantt chart **[3 marks]**
c) Critical Path Analysis Flow Diagrams **[4 marks]**

QUESTION 4

Discuss the major reasons why cartels such as OPEC or the De Beers diamond eventually fail in their ambition to control markets. **[20 marks]**

QUESTION 5

If the marginal revenue function of the firm is given by MR = 100,000-20n, where n is the total amount of copper produced in tonnes and TC is the total cost. Estimates of the next year's cost of production has yielded the following total cost relationship:

$$TC = 0.2n^2 + 10{,}000{,}000$$

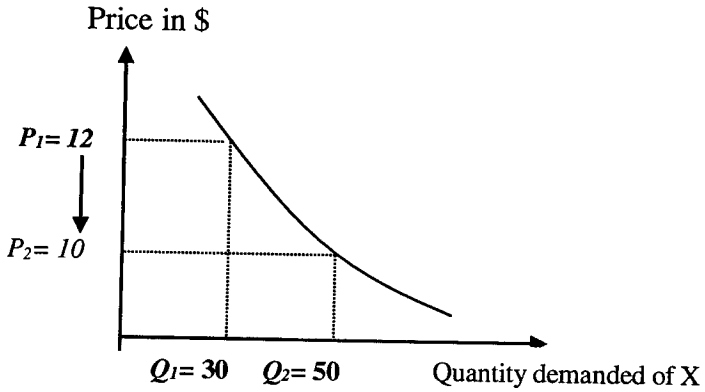
What volumes of production would have the following characteristics?

a) Break- even point **[8 marks]**
b) Maximum profit **[6 marks]**
c) Minimum average cost **[6 marks]**

QUESTION 6

i) Define elasticity of demand **[5 marks]**

ii) Given details in the following diagram below, determine the degree of responsivess of the quantity demanded to a decrease in price from $12 to $10. **[15 marks]**



END OF EXAMINATION