

**SULIT**

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Second Semester Examination  
2023/2024 Academic Session

July/August 2024

**EBS231/3 – Mining Methods  
(Kaedah-kaedah Perlombongan)**

Duration : 3 hours  
(Masa : 3 jam)

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Please check that this examination paper consists of **FOURTEEN** (14) pages of printed material including APPENDIX before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **EMPAT BELAS** (14) muka surat yang bercetak termasuk LAMPIRAN sebelum anda memulakan peperiksaan ini].*

**Instructions** : Answer **FIVE (5)** questions. **PART A is COMPULSORY**. Answer **TWO (2)** questions from PART B. All questions carry the same marks.

**Arahan** : Jawab **LIMA (5)** soalan. **Bahagian A WAJIB dijawab**. Jawab **DUA (2)** soalan daripada Bahagian B. Semua soalan membawa jumlah markah yang sama.]

In the event of any discrepancies, the English version shall be used.

*[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai].*

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**SULIT**

**SECTION A / BAHAGIAN A**

Answer **ALL** questions in this Section

Jawab **SEMUA** soalan di bahagian ini.

- (1). (a). A copper ore reserve has been estimated at 50,000,000 tons. The mining company decided to use the open pit mining method. Estimate the life of the mine and production rate based on Taylor's law. The related parameters for different conditions have been provided in Table 1.

*Rizab bijih kuprum telah dianggarkan sebanyak 50,000,000 tan. Syarikat perlombongan memutuskan untuk menggunakan kaedah perlombongan lubang terbuka. Anggarkan hayat lombong dan kadar pengeluaran berdasarkan undang-undang Taylor. Parameter yang berkaitan untuk keadaan yang berbeza telah disediakan dalam Jadual 1.*

**Table 1 : The parameters of Taylor's law for different conditions**  
**Jadual 1 : Parameter hukum Taylor untuk keadaan yang berbeza**

<b>Mine and reserve type/ Jenis lombong dan simpanan</b>	<b>a</b>	<b>b</b>
Unknown/ <i>tidak diketahui</i>	0.0143	0.75
Underground – Other/ <i>Bawah Tanah – Lain-lain</i>	0.297	0.562
Underground - Massive Sulfide/ <i>Bawah Tanah - Sulfida Besar-besaran</i>	0.0248	0.704
Open Pit-Block Caving – Other/ <i>Lubang Terbuka – Penampakan Bongkah-Lain-lain</i>	0.123	0.649
Open Pit – Gold-Silver/ <i>Lubang Terbuka – Emas-Perak</i>	0.416	0.587 4
Open Pit – Copper/ <i>Lubang Terbuka – Tembaga</i>	0.0236	0.74

(3 marks/markah)

...3/-

- (b). Explain the concept of break-even stripping ratio (BESR). Then, calculate BESR for this case:

*Terangkan konsep nisbah pelucutan pulang modal (BESR). Kemudian, kira BESR untuk kes ini:*

- Mining cost for ore: RM 80 per ton  
*Kos perlombongan bijih: RM 80 setan*
- Mining cost for waste: RM 50 per ton  
*Kos perlombongan untuk sisa: RM 50 setan*
- Overall recovery of mining operations: 80%  
*Pemulihan keseluruhan operasi perlombongan: 80%*
- Average grade of ore body: 25%  
*Gred purata badan bijih: 25%*
- Price of the metal: RM 2500 /ton  
*Harga logam: RM 2500 /tan*

(6 marks/markah)

- (c). Calculate the cut-off grade for the economic condition given below. Then calculate the economic block model for the geological block model given in figure 1 (the unit of numbers of blocks is %):

*Kira gred penggalan untuk keadaan ekonomi yang diberikan di bawah. Kemudian hitung model blok ekonomi untuk model blok geologi yang diberikan dalam rajah 1 (unit nombor blok ialah %):*

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- Metal price: RM 6000 /ton  
*Harga logam: RM 6000 /tan*
- Mining and milling cost: RM 200 /ton  
*Kos perlombongan dan pengilangan: RM 200 /tan*
- Mining cost (waste and ore): RM 100 /ton  
*Kos perlombongan (buangan dan bijih): RM 100 /tan*
- Dilution: 5%  
*Pencairan: 5%*
- Processing recovery: 90%  
*Memproses pemulihan: 90%*
- Dimensions of blocks: 10x10x10 m  
*Dimensi blok: 10x10x10 m*
- Average density of rocks: 3 ton/m<sup>3</sup>  
*Purata ketumpatan batuan: 3 tan/m<sup>3</sup>*

**Figure 1: Geological block model**

**Rajah 1 : Model blok geologi**

0	0	2%	4%	5%	0	1%
0	2.5%	4.5%	4%	7%	6%	0
0	1%	0	6.5%	4%	0	0

(7 marks/markah)

...5/-

- (d). Determine the ultimate pit limit and overall stripping ratio for this economic block model shown in Figure 2 according to the floating cone algorithm.

*Tentukan had pit muktamad untuk model blok ekonomi ini yang ditunjukkan dalam Rajah 2 mengikut algoritma kon terapung.*

**Figure 2 : Economic block model**

**Rajah 2 : Model blok ekonomi**

-1	-1	-1	+2	-1	-1	-1	-1
-1	+4	+2	-1	-1	-1	-1	-1
-1	-1	-1	+5	+1	+2	-1	-1

(4 marks/markah)

- (2). (a). Explain the major steps involved in the in-situ leaching process for mining rare earth minerals.

*Terangkan langkah-langkah utama yang terlibat dalam proses larut lesap in-situ untuk perlombongan mineral nadir bumi.*

(4 marks/markah)

- (b). Discuss the importance of monitoring and controlling parameters during in-situ leaching operations.

*Bincangkan kepentingan memantau dan mengawal parameter semasa operasi larut lesap in-situ.*

(4 marks/markah)

...6/-

- (c). (i). Discuss the concept of sustainable mining and its importance in the modern mining industry.

*Bincangkan konsep perlombongan lestari dan kepentingannya dalam industri perlombongan moden.*

(4 marks/markah)

- (ii). Identify and explain the key principles and pillars of sustainable mining practices

*Kenal pasti dan terangkan prinsip dan tunggak utama amalan perlombongan lestari.*

(4 marks/markah)

- (iii). Using examples, evaluate the environmental, social, and economic challenges associated with conventional mining methods and discuss how sustainable mining practices address these challenges

*Menggunakan contoh yang sesuai, nilaikan cabaran alam sekitar, sosial dan ekonomi yang berkaitan dengan kaedah perlombongan konvensional dan membincangkan bagaimana amalan perlombongan mampan menangani cabaran ini*

(4marks/markah)

- (3). (a). Describe three categories of underground mining methods based on its supporting mechanism. List two or more examples for each category.

*Perihalkan dengan ringkas tiga kategori kaedah perlombongan bawah tanah berdasarkan mekanisme sokongan. Senaraikan dua atau lebih contoh bagi setiap kategori.*

(4 marks/markah)

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- (b). Discuss the characterization of the sedimentary ore that best suite to the underground mining method as follows. List one advantage and disadvantage for each method.

*Bincangkan ciri-ciri mendapan bijih yang bersesuaian dengan kaedah perlombongan di bawah. Senaraikan kebaikan dan keburukan setiap kaedah.*

- (i). Block Caving  
*Perampakan bongkah*  
(4 marks/ *markah*)
- (ii). Sublevel caving  
*Perampakan subparas*  
(4 marks/ *markah*)
- (iii). Room and Pillar  
*Bilik-dan-tiang*  
(4 marks/ *markah*)
- (iv). Cut and Fill  
*Potong-dan-isi*  
(4 marks/ *markah*)

**...8/-**

**PART B / BAHAGIAN B**

**Answer any two (2) questions**

**Jawab mana-mana dua (2) soalan**

- (4). (a). Differentiate mineral resources and mineral reserves and classify them according to the exploration information accuracy.

*Bezakan sumber mineral dan rizab galian dan kelaskannya mengikut ketepatan maklumat penerokaan.*

(4 marks/markah)

- (b). Explain the main topics needed to be considered in a feasibility study.

*Jelaskan topik utama yang perlu dipertimbangkan dalam kajian kebolehlaksanaan.*

(4 marks/markah)

- (c). List 4 examples of activities in development stage of a mine.

*Senaraikan 4 contoh aktiviti dalam peringkat pembangunan lombong.*

(2 marks/markah)

- (d). Compare the main differences between surface and underground mining methods.

*Bandingkan perbezaan antara kaedah perlombongan permukaan dan bawah tanah.*

(2 marks/markah)

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- (e). List the factors affecting mining method selection.



Senaraikan faktor yang mempengaruhi pemilihan kaedah perlombongan.

(3 marks/markah)

- (f). According to the information provided for the ore body shown in the figure 3, first determine the geometric description of the ore body according to the Nicholas geometrical scale in the table provided in Appendix 1, THEN score and rate the mining methods for this ore body based on the geometry and grade distribution ranking of Nicholas methodology based on the scoring table provided in Appendix 2.

Mengikut maklumat yang diberikan untuk badan bijih yang ditunjukkan dalam rajah 3, tentukan terlebih dahulu penerangan geometri badan bijih mengikut skala geometri Nocolas dalam jadual yang disediakan dalam Lampiran 1, KEMUDIAN skor dan nilaikan kaedah perlombongan untuk badan bijih ini berdasarkan geometri dan pemeringkatan taburan gred metodologi Nicholas berdasarkan jadual pemarkahan yang disediakan dalam Lampiran 2.

(5 marks/markah)

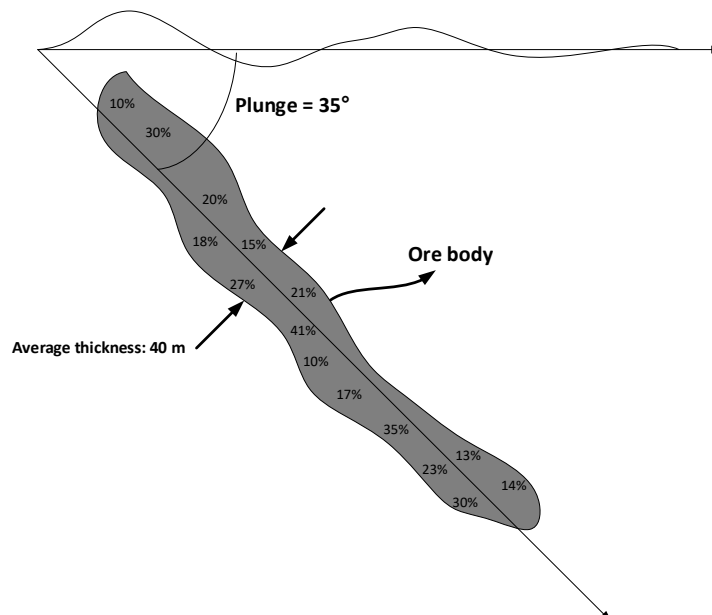


Figure 3 : Section of the ore body/ *Rajah 3: Bahagian badan bijih*

...10/-

- (5). (a). Discuss the basic factors which must be taken into account for evaluation of a prospective surface mine

*Bincangkan faktor asas yang mesti diambil kira untuk penilaian ke atas prospek lombong permukaan*

(5 marks/markah)

- (b). Discuss the pit planning and design for surface mining  
*Bincangkan perancangan dan reka bentuk lubang untuk perlombongan permukaan*

(5 marks/markah)

- (c). A mining company is planning to develop an open-pit mine for extracting gold ore. The ore deposit is located at a depth of 100 meters below the surface. The overburden thickness above the ore deposit is estimated to be 50 meters. The estimated average grade of the gold ore is 2 grams per ton (g/t), and the estimated recovery rate is 90%. The current gold price is RM350 per gram.

Calculate the stripping ratio for the proposed open-pit mine.

*Sebuah syarikat perlombongan merancang untuk membangunkan lombong terbuka untuk mengekstrak bijih emas. Mendapan bijih terletak pada kedalaman 100 meter di bawah permukaan. Ketebalan tanggungan atas deposit bijih dianggarkan 50 meter. Anggaran purata gred bijih emas ialah 2 gram setiap tan (g/t), dan anggaran kadar pemulihan ialah 90%. Harga emas semasa ialah RM350 segram.*

*Kira nisbah pelucutan untuk lombong terbuka yang dicadangkan.*

(5 marks/markah)

...11/-

- (d). Describe the factors that should be considered when calculating the cut-off grade for quarry operations. How do these factors differ from those considered in other mining operations, such as underground mining or open-pit mining?

*Huraikan faktor-faktor yang perlu dipertimbangkan semasa mengira gred potong untuk operasi kuari. Bagaimanakah faktor ini berbeza daripada yang dipertimbangkan dalam operasi perlombongan lain seperti perlombongan bawah tanah atau perlombongan permukaan?*

(5 marks/markah)

- (6). (a). Briefly discuss the special considerations required in development of underground mine.

*Secara ringkas, bincangkan keperluan-keperluan khusus yang diperlukan di dalam pembangunan lombong bawah tanah.*

(5 marks/markah)

- (b). Elaborate on the following topic related to the environmental hazard of longwall mining method

*Huraikan berkenaan topik-topik berikut yang dikaitkan dengan kesan alam sekitar terhadap kaedah perlombongan "longwall"*

- (i). Subsidence  
*Penenggelaman*

(6 marks/markah)

- (ii). Rock burst  
*"Rock burst"*

(6 marks/markah)

...12/-

- (c). Estimate the unit profit in mining and processing a 0.6% copper ore deposit if the selling price of copper in the concentrate is RM 3.90/kg and overall unit costs are RM13.35/tonne. Overall recovery is 85%.

Calculate the cutoff grade for the copper deposit.

*Anggarkan kadar keuntungan bagi perlombongan dan pemprosesan 0.6% endapan bijih tembaga berdasarkan harga konsentrat tembaga pada RM3.90/kg dan kos keseluruhan pada RM13.35/tan. Perolehan keseluruhan adalah 85%.*

*Kirakan gred penggalan bagi endapan tembaga tersebut.*

(3 marks /markah)

- (7). (a). Explain four (4) reasons for the use of underground mine  
*Huraikan empat (4) sebab penggunaan lombong bawah tanah.*

(4 marks/markah)

- (b). Write and discuss on these topics in which relate to an underground mining operation:

*Tulis dan bincangkan topik-topik yang berkenaan dengan operasi perlombongan bawah tanah berikut:*

- (i). Mine life

*Hayat Lombong*

- (ii). Main access opening

*Akses utama bukaan*

...13/-

(iii). Number of opening

*Bilangan bukaan*

(iv). Shape and size of opening

*Bentuk dan saiz bukaan*

(16 marks/*markah*)

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**APPENDIX 1/LAMPIRAN 1**

General shape	equi-dimensional	all dimensions are on the same order of magnitude
	platy-tabular	two dimensions are many times the thickness, which does not usually exceed 100 m
	irregular	dimensions vary over short distances
Ore thickness	narrow	< 10 m
	intermediate	10 – 30 m
	thick	30 – 100 m
	very thick	> 100 m
Plunge	flat	< 20°
	intermediate	20 – 55°
	steep	> 55°
Depth below surface	/	provide actual depth
Grade distribution	uniform	the grade at any point in the deposit does not vary significantly from the mean grade for that deposit
	gradational	grade values have zonal characteristics, and the grades change gradually from one to another
	erratic	grade values change radically over short distances and do not exhibit any discernible pattern in their changes

**APPENDIX 2/LAMPIRAN 2**

Mining Method	General Shape			Ore Thickness				Ore Plunge			Grade Distribution		
	M	T/P	I	N	I	T	VT	F	I	S	U	G	E
Open Pit	3	2	3	2	3	4	4	3	3	4	3	3	3
Block Caving	4	2	0	-49	0	2	4	3	2	4	4	2	0
Sublevel Stopping	2	2	1	1	2	4	3	2	1	4	3	3	1
Sublevel Caving	3	4	1	-49	0	4	4	1	1	4	4	2	0
Longwall	-49	4	-49	4	0	-49	-49	4	0	-49	4	2	0
Room & Pillar	0	4	2	4	2	-49	-49	4	1	0	3	3	3
Shrinkage Stopping	2	2	1	1	2	4	3	2	1	4	3	2	1
Cut & Fill	0	4	2	4	4	0	0	0	3	4	3	3	3
Top Slicing	3	3	0	-49	0	3	4	4	1	2	4	2	0
Square Set	0	2	4	4	4	1	1	2	3	3	3	3	3
M = Massive T/P = Tabular or Platy I = Irregular	N = Narrow I = Intermediate T = Thick VT = Very Thick			F = Flat I = Intermediate S = Steep			U = Uniform G = Gradational E = Erratic						

