DIVISION OF MINERAL ENGINEERING

MIN350S – INTRODUCTION TO MINING

INSTRUCTOR: PROFESSOR W. F. BAWDEN

FINAL EXAM – DECEMBER 2001

TOTAL MARKS = 114

PLEASE ANSWER ALL QUESTIONS. NOTE THAT QUESTION 2 IS TO BE ANSWERED ON THE EXAM SHEET. SIGN THIS SHEET AND RETURN IT WITH YOUR EXAM

Student name: ---------- Student number: ----------

QUESTION # 1: [10 MARKS]

A new underground mine has been designed to use diesel powered six cubic meter ST-6 scooptrams, which will muck ore from a drawpoint to an ore pass, at a total distance of 200 m. The scooptram will haul 150 m on a level drift and then 50 m at a 15% grade. The material being mined is a lead-zinc ore grading between 12 – 15% and having an S.G. of 3.088 tonnes per cubic meter. Job conditions for loading and dumping are average and for blasting fragmentation is poor. The rated tramming capacity of the scooptram is 12.4 tonnes per bucket. Assume that the effective operating hour is 50 minutes to account for various delays.

(i) **Determine the hourly production capability of the scooptram.**
(ii) **How many scooptrams are required if a daily production rate of 6,000 tonnes is required working 2 – 8 hour shifts? [Note: Utilize the data sheets appended at the end of the exam]**

QUESTION # 2: [NOTE: HAND THIS PAGE IN WITH YOUR EXAM AND PUT YOUR NAME AND STUDENT NUMBER AT THE TOP] [10 MARKS]

The figure below shows a transverse section through an orebody showing a net present value block model. The blocks are equidimentional [25 m on each side]. Final pit slopes are to be at 45 degrees. It is planned to mine this orebody using open pit mining techniques. Using a manual floating cone technique determine the following:

(i) the ultimate pit outline for this section,
(ii) the overall stripping ratio for this section, and
(iii) state what assumption is necessary in order to calculate (ii).

-1	-1	-1	-1	-1	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	2	1	1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	2	3	2	4	1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	4	1	2	5	2	1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	5	4	2	3	2	1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	2	3	2	1	1	2	1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	3	4	3	2	4	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	2	5	3	5	1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1	3	2	1	1	4	1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	3	-1	-1	-1	-1	-1	-1	-1	-1

Show the final pit outline and how this was determined on the section provided above. Hand this page in with your final exam.

QUESTION # 3: [30 MARKS]

(a) Consider a tabular orebody 30 meters thick [hangingwall to footwall] and dipping about 80 degrees on average. A main production shaft has been sunk in the footwall about 100 meters distant from the orebody and main levels have been established at 100 meter vertical intervals. Sublevels have been established at 25 meter vertical intervals and all levels are interconnected by a spiral ramp. Haulage levels have been established in the footwall 25 meters from the ore. Transverse blasthole open stoping is planned to be used as the primary mining method for this orebody. It is planned to double lift the stopes. **Describe the additional detailed development that will be required in order to access, develop, blast and muck an individual stope in this mine. You may use both written descriptions and sketches to illustrate your answer.**

(b) As noted in Question 3 (a) the mine plans to produce ore from underground using a shaft hoisting system. Assume that the mining will be conduced on the 500 level [i.e. 500 m below surface] and that the bottom of the shaft is at the 1500 m level [i.e. 1500 m below surface]. Skip pockets have been established at the 1500 m level. **How do you recommend the ore be moved from the stope and delivered to the concentrator on surface? Describe all key infrastructure that you will require to accomplish this.** You may use hand descriptions and sketches to illustrate your answer.

QUESTION # 4: [10 MARKS]

(a) What are the five core elements of the 'Five Point Safety System'?
(b) What is the safety role of the supervisor at a mine?
(c) How do you reconcile safety at a mine site versus the need to reduce costs?

QUESTION # 5: [14 MARKS]

An open pit mine operator wishes to utilize the newest 320 tonne Caterpillar heavy haul trucks in order to optimize haulage efficiency. In order to maximize haul truck efficiency it has been proposed to incorporate a passing lane in the permanent haulage ramp on the final high wall of the mine. The truck width is 4.2 meters. The pit is designed with 15 meter bench heights with safety berm widths of $1/3^{rd}$ the bench height. The bench face angle is 70°. Please evaluate the following:

(i) What is the minimum haul road width?
(ii) What is the impact of the haul road on the Overall Stripping Ratio of a 450m deep transverse section of the pit where the haul road is located at a depth of 300 meters? The pit bottom is 50 meters wide and both highwall slope angles are the same. The ore is 50 meters wide and is vertical. $S.G._{ore} = S.G._{waste}$.
(iii) What are the overall slope angle and the inter-ramp slope angles?

QUESTION # 6: [40 MARKS]

Briefly [using a few sentences or a short paragraph] answer the following questions;

(i) What is the difference between 'entry' and 'non-entry' mining methods?
(ii) What is 'superelevation rate' on a haul road in an open pit?
(iii) In open pit mining how is access to the next lower bench initially developed?
(iv) How is caving established in block cave mining and what is the principal advantage of this method?
(v) In open stope mining what are two major causes of mining versus geological dilution?
(vi) For open pit mining define the 'cut-off-stripping-ratio'.
(vii) What are the differences between 'room and pillar' and 'post-pillar cut and fill' mining?
(viii) What is backfill and why is it used in underground mines?
(ix) What is the impact of radial end sections on the stripping ratio in an open pit mine?
(x) Define 'geological resource' and 'mining reserve'.
(xi) What is an Alimak Raise Climber'?

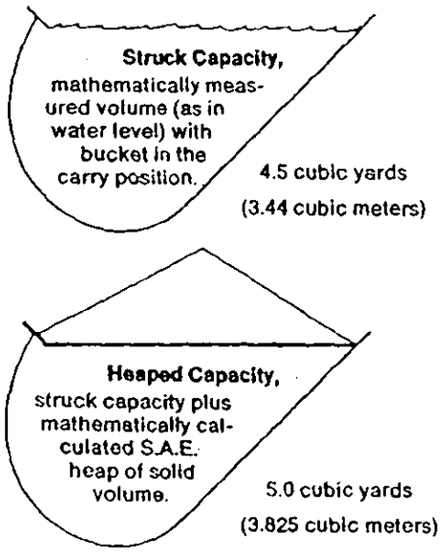
Underground Equipment Selection
Scooptrams & Haulage Trucks
Material Weight and Volume

"IN BANK" WEIGHTS		
SPECIFIC GRAVITY	lbs/y^3	kg/m^3
1.6	2694	1597
1.7	2862	1697
1.8	3030	1798
1.9	3199	1896
2.0	3367	1996
2.1	3536	2096
2.2	3704	2196
2.3	3872	2295
2.4	4041	2395
2.5	4209	2495
2.6	4377	2595
2.7	4546	2695
2.8	4714	2794
2.9	4882	2894
3.0	5051	2994
3.1	5219	3094
3.2	5387	3193
3.3	5556	3293
3.4	5724	3393
3.5	5892	3493

AVERAGE MATERIAL WEIGHTS, ESTIMATED SWELL FACTORS						
MATERIAL	AVERAGE WEIGHT "IN BANK"		% SWELL	SWELL FACTOR	AVERAGE "LOOSE" WEIGHT	
	lbs/y^3	kg/m^3			lbs/y^3	kg/m^3
ASBESTOS	5000	2964	51	0.66	3300	1956
BARITES	7250	4298	56	0.64	4640	2750
BASALT	5000	2964	51	0.66	3300	1956
BAUXITE, DRY	2900	1719	33	0.75	2175	1289
BAUXITE, WET	4300	2548	45	0.69	2967	1759
COAL, ANTHRACITE	2300	1363	35	0.74	1702	1009
COAL, BITUMINOUS	1700	1008	35	0.74	1258	746
CONCRETE MIX, WET					3650	2164
COPPER ORE	4500	2667	45	0.69	3105	1841
DOLOMITE	4200	2490	61	0.62	2604	1544
GRANITE	4400	2608	60	0.63	2772	1643
GYPSUM	4600	2727	60	0.63	2898	1718
IRON ORE, HEMATITE	6600	3912	51	0.66	4356	2582
IRON ORE, MAGNITE	7500	4446	65	0.65	4875	2890
LEAD ORE 30%	6000	3557	50	0.67	4020	2383
LEAD ZINC 16%-7%	5200	3082	50	0.67	3484	2065
LIMESTONE	4300	2549	70	0.59	2537	1504
POTASH	3500	2074	60	0.63	2205	1307
PYRITE	6700	3971	50	0.67	4489	2661
SANDSTONE	4140	2454	50	0.67	2774	1644
SHALE	2800	1660	33	0.75	2100	1245
SLATE	4725	2801	30	0.77	3638	2156
TACONITE	4700	2786	54	0.65	3055	1811
URANIUM ORE	4200	2490	40	0.71	2982	1768

Underground Equipment Selection
Scooptrams & Haulage Trucks

Bucket Rated Capacity



Underground Equipment Selection
Scooptrams & Haulage Trucks

Bucket Actual Capacity

BUCKET FILL FACTORS		
BLASTING FRAGMENTATION	FILL FACTOR	JOB CONDITIONS
GOOD	1.00	EXCELLENT
AVERAGE	0.95	AVERAGE
POOR	0.90	SEVERE

Underground Equipment Selection
Scooptrams & Haulage Trucks

Cycle Times

• **Fixed Time** - portion of the production cycle spent in Loading and Dumping the bucket and the maneuvering to accomplish those functions

JOB CONDITIONS	TIME MINUTES
EXCELLENT	0.80
AVERAGE	1.10
SEVERE	1.40

Underground Equipment Selection
Scooptrams & Haulage Trucks

Cycle Times

• Variable Time - portion of the production cycle spent in Tramming. May contain elements of both level an on grade haulage. Estimates of the average speeds should be made for each element including allowances for Job Conditions

AVERAGE TRAMMING SPEEDS, LEVEL, NEAR LEVEL

Job Conditions	Diesel						Electric			
	HST-1A ST-1.3A		ST-2D ST-3-1/2		ST-5B to ST-13		EHST-05 EHST-1A		EST-2D to EST-8A	
	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h
EXCELLENT	3.0	4.8	5.0	8.1	6.0	9.7	3.0	4.8	3.5	5.6
AVERAGE	2.0	3.2	4.0	6.4	4.8	7.7	2.0	3.2	2.3	3.7
SEVERE	1.2	1.9	2.5	4.0	2.9	4.7	1.0	1.6	1.2	1.9

NOTE: Electrical vehicles are rated @ 50hz.

Some common Rolling Resistances :are:

Ground Surface	Rolling Resistance
Asphalt	1.5%
Concrete	1.5%
Dirt-Smooth, hard, dry; well-maintained; free of loose material	2.0%
Dirt-Dry, but not firmly packed; some loose material	3.0%
Dirt-Soft, unplowed; poorly maintained	4.0%
Dirt-Soft, plowed	8.0%
Dirt-Unpacked fills	8.0%
Dirt-Deeply rutted	16.0%
Gravel-Well compacted; dry; free of loose material	2.0%
Gravel-Not firmly compacted; but dry	3.0%
Gravel-Loose	10.0%
Mud-With firm base	4.0%
Mud-With soft, spongy base	16.0%
Sand-Loose	10.0%
Snow-Packed	2.5%
Snow-To 4" depth; loose	4.5%

Scooptram Tramming Speeds

TABLE 4. KILOMETERS PER HOUR

Maximum Speeds Up Grade: Estimated "Safe" Speeds Down n Grade

Popular Scooptram Model	5% - 2.9° Load Up	5% - 2.9° Empty Down	10% - 5.7° Load Up	10% - 5.7° Empty Down	15% - 8.5° Load Up	15% - 8.5° Empty Down	20% - 11.3° Load Up	20% - 11.3° Empty Down	25% - 14.0° Load U Up	25% - 14.0° Empty Down
Hardrock										
HST-1A	12.2	12.2	6.3	10.2	6.4	7.6	5.1	6.4	4.4 3	5.6
ST-1.3A	9.2	9.7	4.0	7.1	3.9	4.0	3.4	3.5	2 2.9	2.7
ST-2D	9.8	13.4	6.8	8.5	4.8	5.6	4.0	4.2	2 2.7	4.3
ST-3-1/2	12.9	17.2	8.4	9.2	4.5	8.1	4.0	6.4	3 3.7	4.9
ST-5B	12.9	19.3	8.4	12.6	6.3	8.5	4.5	5.2	4 4.0	4.5
ST-5H	11.9	18.4	7.6	11.3	5.6	7.6	4.0	6.4	3 3.7	5.2
ST-6C	11.9	18.0	7.4	10.9	5.6	7.2	4.3	6.3	3 3.5	5.6
ST-8A	12.9	18.2	8.2	12.1	6.9	8.1	4.3	7.1	3 3.9	6.9
ST-13	10.6	16.0	6.6	8.6	3.8	6.7	3.7	3.8	3 3.5	3.5