09-MMP-B8 Mine Management & Systems Analysis

National Exam

May, 2013

NAME: _____

DATE: _____

TIME LIMIT FOR EXAM IS 3 HOURS.

ANSWER ALL 5 QUESTIONS FOR A TOTAL OF 100 MARKS.

APPENDIX A WITH DISCOUNTED CASH FLOW TABLES IS ATTACHED.

THIS IS A CLOSED BOOK EXAM - ONLY A NON-PROGRAMMABLE CALCULATOR, WRITING AND DRAFTING IMPLEMENTS MAY BE USED.

CLEARLY STATE AND JUSTIFY ANY ASSUMPTIONS THAT YOU MAKE.
TOTAL NUMBER OF PAGES IS THIS EXAM SHEET IS 6.

PARTS OF QUESTIONS 4 AND 5 CAN BE ANSWERED DIRECTLY ON THESE SHEETS - ANSWER OTHER QUESTIONS AND SECTIONS IN THE BOOKLETS PROVIDED.

RETURN ALL 6 PAGES WITH YOUR EXAM BOOKLETS.

Question 1 - Mine Stages and Design. 20 Marks

a) Name and describe the 5 stages in the life of a mine.
b) Describe the 5 stages in terms of typical cash flows and sketch the corresponding cash flow diagram.
c) It has been stated that there has been a step change in mining in the last decade and that "Mines are designed for closure". What does this statement mean? Provide 2 examples of mine designs based on this design philosophy.

Question 2 - Feasibility Study and Financial Analysis. 20 Marks

This question is based on economic analysis of the mining project described in a recent press release:

> ***Newstrike outlines maiden resource at Ana Paula***
>
> ***2013-03-28 (Northen Miner)** - It has been a wild ride for Vancouver-based explorer Newstrike Capital (NES-V) at its flagship Ana Paula gold-silver project along the emerging gold belt in Guerrero State, Mexico. After acquiring the project roughly three years ago, Newstrike started up an aggressive exploration campaign that resulted in some impressive gold grades before culminating on March 27 when the company released its maiden resource estimate.*
>
> *Newstrike's ore body model and floating cone open pit analysis for the Ana Paula deposit assumes a 0.45 gram gold per tonne cut-off and a gold price of US$1,450 per oz. along with a silver price of US$28 per oz. Under the given constraints Ana Paula hosts 44.8 million measured-and-indicated tonnes grading 1.56 grams gold and 7.5 grams silver for 2.25 million oz. contained gold and 2.32 million oz. contained silver. Metallurgical tests done to date indicate that conventional flotation resulted in recoveries of 93% to 96% in concentrate.*
>
> *Ongoing economic analysis of the potential open pit mine and mill development indicates i) a 4 year preproduction development period totaling US$219 million, ii) a 10 year production life with a combined mining, milling and overhead annual operating costs of US$ 70 per tonne ore, and iii) a 2 year post-production closure and reclamation period totaling US$60 million.*

Conduct a discounted cash flow analysis of this project (as outlined below) **clearly stating and justifying all of the economic factors that you interpreted from the press release**. Note that DCF tables are provided in the attached Appendix A. From this information, determine:

i. The gross and net value of ore per tonne.
ii. Net Present Value and Present Value Ratio at a discount rate of 10% and payback period on a before-tax basis.
iii. Based on your analysis, would you recommend this project proceed to mine development? Justify your recommendation.

Question 3 - Project Scheduling. 20 Marks

You are planning the mine development and supporting activities to facilitate mining a new ore zone at an underground mine. For the following project development schedule and task dependencies, utilize the Critical Path Method to determine:

a) The sequence of tasks that forms the Critical Path to complete the project in the shortest possible time period.
b) The shortest time that the project can be completed.
c) The tasks that are not critical for the project to remain on schedule and why.

New Ore Zone Development:

Task	Description	Duration (Months)	Dependent on Task #
1	Drive new ramp Phase A	8	none
2	Develop new shaft for hoisting and ventilation	36	1
3	Drive new ramp Phase B	12	1
4	Develop new u/g exploration drilling gallery	2	1
5	Complete new u/g exploration drilling program, ore body model and mining schedule	18	4
6	Reconfigure mine ventilation system for new zone	4	3
7	Expand u/g diesel powered equipment fleet	4	6
8	Develop upper mining level for new zone	12	7
9	Develop lower mining level for new zone	14	3
10	Develop slot raises for initial stope blocks	2	8, 9
11	Drill open stoping blastholes for initial 2 stopes	1	10, 5
12	First production from stopes in new zone	N/A	11, 2

Question 4 - Mineral Resource Block Modelling and Pit Limits. 20 Marks

The 2-D geological block model shown in Fig. 4.1a gives ore grades for a disseminated mineral deposit in percent. Open pit limit analysis for this block model is based on the following criteria:

- Block dimensions are 10 m by 10 m by 10 m;
- Ore and waste densities are both 3000 kg/m^3;
- Grade cutoff of 1.5% is used to differentiate between ore and waste.
- Net processed mineral value (including NSR and transportation charges) is $4200/tonne;
- Mine recovery is 100%;
- Mill recovery is 95%;
- Combined mining costs are $20/tonne;
- Combined milling costs are $15/tonne;
- Combined overhead costs are $15/tonne.

a) From this data, develop the equivalent economic block model (Fig. 4.1b) where the mineral grade is each block is replaced by either the cost to mine waste blocks or the net revenue generated by mining and processing ore blocks and selling the recovered mineral.

b) Using the economic block model from (a), conduct a 2-D Lerchs-Grossman or Floating Cone analysis to determine the most profitable open pit outline.

c) What is the net economic value of the optimal pit outline from part b?

Geological Block Model (% grade):

nil	nil	2	3	4	3	1	1
nil	nil	1	4	4	nil	1	nil
nil	nil	1	4	nil	3	nil	nil
1	1	1	2	3	1	nil	nil
nil	1	1	2	2	1	nil	nil

(a)

Economic Block Model ($):

(b)

Optimum Pit Outline:

(c)

Fig. 4.1 (a) Geological block model, (b) Economic block model, and (c) Optimum pit outline.

Question 5. Shovel-Truck Fleet Analysis. 20 Marks

For a particular working area of a surface mine, the haul route from the shovel to the crusher is i) 300 m of level in-pit haulage, ii) climbing through 175 m of elevation change up a 10% ramp, and iii) traveling a horizontal distance of 850 m to the crusher. The rolling resistance of all road surfaces is maintained at approximately 6% and downhill speed limits of 30 km/h are imposed. Time study data for loading and dumping times are given in Fig. 5.1 and the truck performance charts are given in Fig. 5.2. Using these data, determine (a) the expected range of truck cycle times, and (b) the optimum number of trucks to assign to a single shovel. Clearly justify any assumptions you make regarding the use of the provided data.

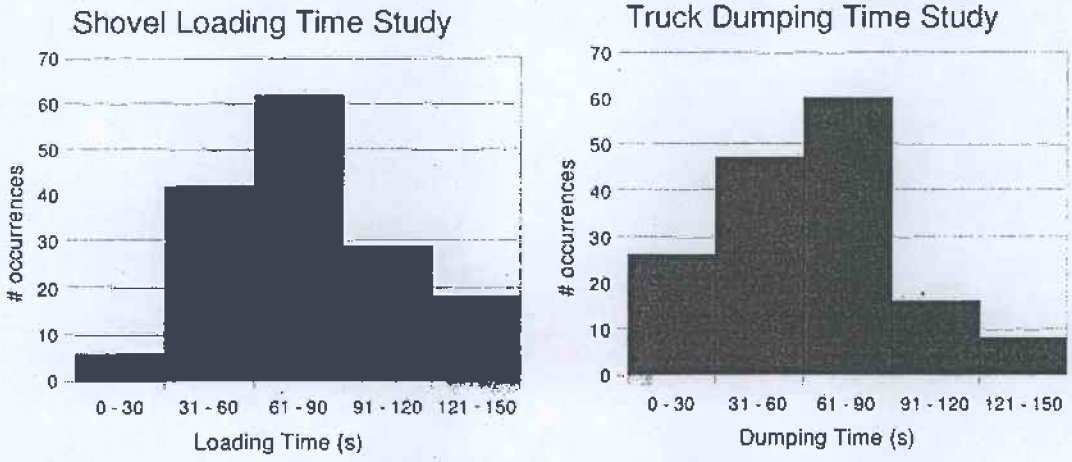


Fig. 5.1 Histograms of shovel loading and truck dumping times.

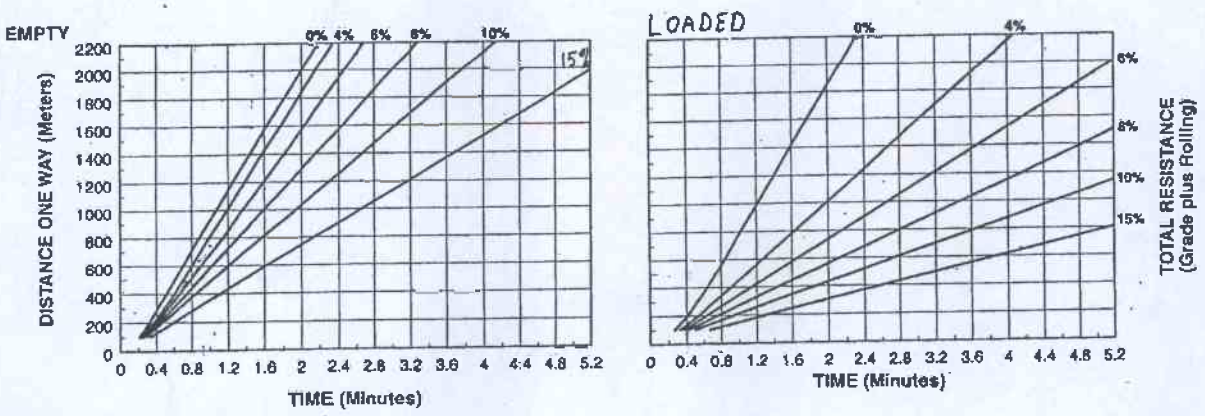
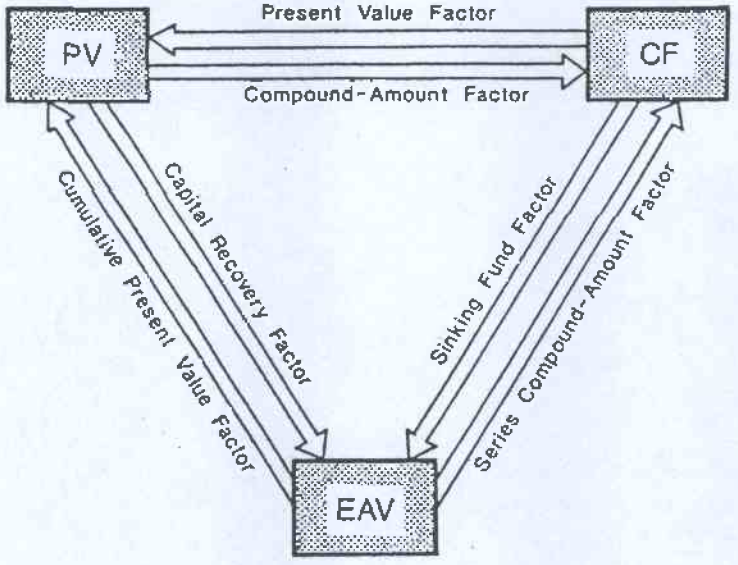


Fig. 5.2 Truck performance charts.

Appendix A – Discounted Cash Flow Analysis Tables and Charts



	PVF				CPVF				SFF			
years	10%	20%	30%	40%	10%	20%	30%	40%	10%	20%	30%	40%
1	0.9091	0.8333	0.7692	0.7143	0.9091	0.8333	0.7692	0.7143	1.0000	1.0000	1.0000	1.0000
2	0.8264	0.6944	0.5917	0.5102	1.7355	1.5278	1.3609	1.2245	0.4762	0.4545	0.4348	0.4167
3	0.7513	0.5787	0.4552	0.3644	2.4869	2.1065	1.8161	1.5889	0.3021	0.2747	0.2506	0.2294
4	0.6830	0.4823	0.3501	0.2603	3.1699	2.5887	2.1662	1.8492	0.2155	0.1863	0.1616	0.1408
5	0.6209	0.4019	0.2693	0.1859	3.7908	2.9906	2.4356	2.0352	0.1638	0.1344	0.1106	0.0914
6	0.5645	0.3349	0.2072	0.1328	4.3553	3.3255	2.6427	2.1680	0.1296	0.1007	0.0784	0.0613
7	0.5132	0.2791	0.1594	0.0949	4.8684	3.6046	2.8021	2.2628	0.1054	0.0774	0.0569	0.0419
8	0.4665	0.2326	0.1226	0.0678	5.3349	3.8372	2.9247	2.3306	0.0874	0.0606	0.0419	0.0291
9	0.4241	0.1938	0.0943	0.0484	5.7590	4.0310	3.0190	2.3790	0.0736	0.0481	0.0312	0.0203
10	0.3855	0.1615	0.0725	0.0346	6.1446	4.1925	3.0915	2.4136	0.0627	0.0385	0.0235	0.0143
11	0.3505	0.1346	0.0558	0.0247	6.4951	4.3271	3.1473	2.4383	0.0540	0.0311	0.0177	0.0101
12	0.3186	0.1122	0.0429	0.0176	6.8137	4.4392	3.1903	2.4559	0.0468	0.0253	0.0135	0.0072
13	0.2897	0.0935	0.0330	0.0126	7.1034	4.5327	3.2233	2.4685	0.0408	0.0206	0.0102	0.0051
14	0.2633	0.0779	0.0254	0.0090	7.3667	4.6106	3.2487	2.4775	0.0357	0.0169	0.0078	0.0036
15	0.2394	0.0649	0.0195	0.0064	7.6061	4.6755	3.2682	2.4839	0.0315	0.0139	0.0060	0.0026
16	0.2176	0.0541	0.0150	0.0046	7.8237	4.7296	3.2832	2.4885	0.0278	0.0114	0.0046	0.0018
17	0.1978	0.0451	0.0116	0.0033	8.0216	4.7746	3.2948	2.4918	0.0247	0.0094	0.0035	0.0013
18	0.1799	0.0376	0.0089	0.0023	8.2014	4.8122	3.3037	2.4941	0.0219	0.0078	0.0027	0.0009
19	0.1635	0.0313	0.0068	0.0017	8.3649	4.8435	3.3105	2.4958	0.0195	0.0065	0.0021	0.0007
20	0.1486	0.0261	0.0053	0.0012	8.5136	4.8696	3.3158	2.4970	0.0175	0.0054	0.0016	0.0005
21	0.1351	0.0217	0.0040	0.0009	8.6487	4.8913	3.3198	2.4979	0.0156	0.0044	0.0012	0.0003
22	0.1228	0.0181	0.0031	0.0006	8.7715	4.9094	3.3230	2.4985	0.0140	0.0037	0.0009	0.0002
23	0.1117	0.0151	0.0024	0.0004	8.8832	4.9245	3.3254	2.4989	0.0126	0.0031	0.0007	0.0002
24	0.1015	0.0126	0.0018	0.0003	8.9847	4.9371	3.3272	2.4992	0.0113	0.0025	0.0006	0.0001
25	0.0923	0.0105	0.0014	0.0002	9.0770	4.9476	3.3286	2.4994	0.0102	0.0021	0.0004	0.0001
26	0.0839	0.0087	0.0011	0.0002	9.1609	4.9563	3.3297	2.4996	0.0092	0.0018	0.0003	0.0001
27	0.0763	0.0073	0.0008	0.0001	9.2372	4.9636	3.3305	2.4997	0.0083	0.0015	0.0003	0.0000
28	0.0693	0.0061	0.0006	0.0001	9.3066	4.9697	3.3312	2.4998	0.0075	0.0012	0.0002	0.0000
29	0.0630	0.0051	0.0005	0.0001	9.3696	4.9747	3.3317	2.4999	0.0067	0.0010	0.0001	0.0000
30	0.0573	0.0042	0.0004	0.0000	9.4269	4.9789	3.3321	2.4999	0.0061	0.0008	0.0001	0.0000