HELSINKI UNIVERSITY OF TECHNOLOGY
Department of Materials Science and Rock Engineering

October 24, 2003

Mak-32.253
Automation and Maintenance of Mining Equipment, EXAM

TOTAL MARKS: 100
PASS MARK: 40

QUESTION ON AUTOMATION AND ROBOTICS

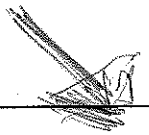
1. Discuss the trends in "mining automation" (You can use Caterpillar's vision of mine automation to make your points clear)
2. Discuss the potential and problems associated with automation and robotization of mining operation.
3. Discuss the different types of underground navigation systems available in market for possible use by the mining companies. What is an Infra free navigation system?
4. Why is it important to consider software and human reliability for an automatic operating system?

QUESTIONS- ON MINE MAINTENANCE

1. You have been appointed as a maintenance manager of a newly built process plant. Discuss the factors that you would like to examine and analyze before deciding the maintenance strategy for your plant.
2. What is the purpose of maintenance in an industrial environment?
3. We know that it is difficult to track down the indirect cost (e.g. extra capacity, cost of quality, production losses, high insurance premium, cost of idle labour etc.). List the factors that affect the indirect costs. Give examples to support your arguments.
4. Discuss the three cost elements considered in LCC calculations.
5. Define 'failure' and the failure development process.
6. List the different basic tools of maintenance analysis that can be used for studying maintenance problem.
7. Discuss the application of Pareto's plot in Maintenance.
8. Define reliability & maintainability and discuss the desirable maintenance characteristics.
9. Calculate the mean time to failure of a series system consisting of 2 units with failure times, which are exponentially distributed and have different mean value.
10. A certain unit has R (10) = 0.8 How many units of this type are needed in a parallel system to get $R_p(10) > 0.90$?
11. Make a TTT-plot using the following times between failure data from an LHD machines at the LKAB Kiruna mine: TBF: 20, 35, 50, 69, 98. (in hours). What are your conclusions from the plot? Estimate the optimal maintenance interval given that the cost of repair is 3 times if the bearing fails during operation compared to the preventive maintenance costs.
12. Describe different types of benchmarking being used by industries.
13. What are the key features in application of RCM and TPM?
14. Why should we need maintenance performance indicators? List 5 maintenance indicators being used in industry.
15. What is condition based maintenance. What are the different methods used for condition monitoring of a equipment?

EMC/HELSINKI EXAMS 2006

Tuesday Oct 17, 14.00 at lecture hall 1	Mining Tech. and Economics
Friday Oct 20, 14.00 at lecture hall 1	Applied Rock Mechanics
Monday Oct 23, 13.00 at lecture hall 1	Numerical Mine Modeling
Wednesday Oct 25, 09.00 at lecture hall 2	Automation and Maintenance



EMC EXAMINATION FOR Automation and Maintenance **2005** (EXTRA)

Total Point: 100
Pass : 40 p
Time 3 Hours
Examiner Uday Kumar

QUESTION ON AUTOMATION AND ROBOTICS (10 p each question) Total 30 p

1. Define the term AUTOMATION and ROBOTICS? Discuss the potential and problems associated with automation and robotization of underground mining operation.
2. Discuss the different types of underground navigation systems available in market for possible use by the mining companies.
3. What is Infra free navigation system used by Tamrock test mine?

QUESTIONS- ON MINE MAINTENANCE (7p each) Total 70

1. Define 'failure' and the failure development process.
2. List the basic tools for maintenance analysis (as discussed in the class) that can be used for studying maintenance problem. What is the Central idea of Paretos Plot
3. Draw a cumulative diagram using the failure statistics: 120, 90, 100, 80, 50. What is your conclusion from this analysis?
4. Define reliability, availability and maintainability.
5. Discuss the factors that you would like to examine and analyze before deciding the maintenance goal (objective) and strategy for your plant. Define maintenance and discuss the various sub processes that form the maintenance process.
6. . Calculate the mean time to failure of a series system consisting of 4 units with failure times which are exponentially distributed and have different mean value.
7. Make a TTT-plot using the following times between failure data from an LHD machines at a mine: TBF: 17, 32, 50, 100, 68. (in hours). What are your conclusions from the plot ? Estimate the optimal maintenance interval given that the cost of repair is double if the bearing fails during operation compared to the preventive maintenance costs.
8. Describe different types of benchmarking being used by industries.
9. What are the key features in application of RCM and TPM?
10. What is condition based maintenance. What are the different methods used for condition monitoring of a equipment?
