



**Mak-32.253**

**Automation and Maintenance of Mining Equipment, EXAM**

**Total Point: 100**

**Time: 3 hours**

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### QUESTION ON AUTOMATION AND ROBOTICS

1. Define the term AUTOMATION and ROBOTICS? Discuss the potential and problems associated with automation and robotization of underground mining operation.
2. Define reliability. Why is it important to consider software and human reliability for an automatic operating system?
3. During our visit to Tamrock Test mine, we were detailed/explained about the advantages of Infra Free navigation system being used by the Test mine. Discuss them.

### QUESTIONS- ON MINE MAINTENANCE

Define maintenance and discuss the various sub processes that form the maintenance process.

1. What is the purpose of maintenance process in a production environment? You have been appointed as a maintenance manager of a mechanized mine. Discuss the factors that you would like to examine and analyze before deciding the maintenance goal (objective) and strategy for your plant.
2. What is meant by design out maintenance and design for maintenance?
3. Define 'failure' and the failure development process.
4. List the 4 basic tools for maintenance analysis (as discussed in the class) that can be used for studying maintenance problem.
5. Define availability and maintainability. Illustrate with example why it is important to consider both reliability and availability while purchasing a machine or a piece of equipment.
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. A certain unit has  $MTTF = 100$ . How many units of this type are needed in a parallel system to get  $R_p(100) > 0.90$  for a 100 hours of operating period.
8. Make a TTT-plot using the following times between failure data from an LHD machines at a mine: TBF: 18, 33, 50, 99, 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.
9. Describe different types of benchmarking being used by industries.
10. What are the key features in application of RCM and TPM?
11. Why should we need maintenance performance indicators? List 5 maintenance indicators being used in industry.
12. What is condition based maintenance. What are the different methods used for condition monitoring of a equipment?