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THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
MASTER OF TECHNOLOGY IN INDUSTRIAL ENGINEERING – LEVEL 7
FINAL EXAMINATION – 2009/2010
MEX 7119 – MAINTENANCE MANAGEMENT

DATE : 21 March 2010

TIME : 0930 hrs – 1230 hrs

DURATION: Three (03) hours

Answer any five (05) questions. All questions carry equal marks.

- 1 (i) What is reliability?
- (ii) Describe the important and specific attributes of reliability with suitable examples.
- (iii) Discuss the factors affecting the reliability of a product with suitable examples.
- (iv) Solenoid of the control valve of a hydraulic system is observed to have a failure rate of 3×10^{-6} failures per hour. The solenoids are designed to have 20,000 hrs of life time. The plant can produce 3,000 such solenoids in one batch. Determine the following.
- (a) Reliability of the solenoids.
- (b) How many failures are expected during the first 20,000 hrs of operation?
- (c) If the mean time between failures of the solenoids is to 2×10^5 , find the reliability to have 1×10^5 hours operating time.
- 2 (i) Discuss the difference between "Maintenance" and "Maintainability" with suitable examples.
- (ii) Describe the main features of maintainability.
- (iii) What are the important factors to be considered in improving maintainability? Give suitable examples wherever possible.
- (iv) Discuss the steps that you are recommending to minimize the down time of the plant and machinery which comes under your supervision.
- 3 (i) Describe major activities involved in effective maintenance planning with suitable examples.
- (ii) As the Maintenance Manager of a manufacturing enterprise describe the factors you have to consider in organizing its maintenance activities effectively.

- (iii) Discuss with suitable examples, the major control activities the Maintenance Manager should follow in order to improve the effectiveness of the maintenance process.
 - (iv) A "Work Order" can be considered as a work request form, a planning document, a work allocation chart, etc. for the Maintenance Department. In order to fulfill the requirements, describe the vital information that should be included when designing a "Work Order".
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- (i) "Maintenance is the measures taken by the users of a product to keep it in an operable condition or repair it to restore it to an operable condition". Describe the key indicators with suitable examples of best maintenance measures in order to achieve this objective.
 - (ii) Waste in maintenance is a key issue that the Maintenance Manager should consider seriously. Do you agree? Justify your answer.
 - (iii) The objective of an effective Maintenance Program is to improve the availability of equipment while minimizing the cost involved. Discuss the important steps you can take as the Maintenance Manager to achieve this objective.
 - (iv) Discuss the difference between "inherent availability" and "operational availability".
- 5
- (i) The development of a sound maintenance quality control system is imperative in order to ensure maximum availability through high quality maintenance process. Discuss the issues relating to the quality of maintenance you are required to address.
 - (ii) Suggest suitable steps to improve the quality of maintenance functions coming under your purview.
- 6
- (i) What do you mean by overall equipment effectiveness?
 - (ii) Operational records maintained regarding the production equipment/machine for a month with 31 days are as follows.

Number of failures and days it was observed to be out of order.

Failure 1	2 days
Failure 2	1 day
Failure 3	3 days

- Calculate the following for the month under consideration.
- a. Availability of the production equipment/machine
 - b. Percentage down time
 - c. Mean time between failures
 - d. Mean time to repair

- (iii) Kiln in a cement factory is required to operate 300 days per year producing cement at the rate of 1,200 tones per day. Its performance during the year is as given below.

Scheduled operation time	300 days
Number of breakdowns	6
Delays due to breakdowns	180 hours
Time taken for Preventive maintenance	80 hours
Shutdown due to lack of feed	120 hours
Process slowdowns,	60 hours at 60% rate
Wet feed slow downs,	40 hours at 60% rate
Total rejected production	2,000 tones
Second quality production	3,000 tones at 50% value

Determine following

- Utilization of production capacity
- Availability of the Kiln
- Process rate
- Quality rate
- Overall equipment effectiveness

- Explain "functionability" with an example known to you.
 - Explain the "technical effectiveness" of the example selected in 7(i)
 - Explain the "operational effectiveness" of the example selected by you in 7(i)
 - Explain "Metrics and its importance" for the Maintenance Manager.
- Describe the factors that are to be considered when dealing with equipment replacement issues.
 - Bench marking is one of the important activities which helps to improve the effectiveness of the maintenance process. Describe how you would carry out process of benchmarking to achieve this objective.
 - Engine driven water pump, which is used as the standby unit, was observed to be of poor performance due to its old age. It needs to be overhauled at a total cost of Rs. 800,000/- in order to improve its reliability. This pump so overhauled is expected to function satisfactorily for 10 years with an annual operational and maintenance cost of Rs. 150,000/-. The Maintenance Manager was also able to obtain a quotation for a new pump with similar specifications. The total cost of the new pump is Rs. 1,800,000/- and its annual operation and maintenance cost is estimated to be Rs. 75,000/-. The old pump is having a disposal value of Rs. 150,000/-. The cost of capital is 20%. What would be your recommendation to the management? Advice the maintenance manager. Assume that the Capital Recovery Factor is given as $i(1+i)^n / [(1+i)^n - 1]$.