THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
MASTER OF TECHNOLOGY IN INDUSTRIAL ENGINEERING – LEVEL 7
FINAL EXAMINATION – 2007/2008
MEX 7119 –MAINTENANCE MANAGEMENT
DATE : *4th May 2008*
TIME : *0930 hrs – 1230 hrs*
DURATION: *Three (03) hours*

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

1. (i) Discuss the Man Management issues that require special consideration when implementing Maintenance Functions in an organization. You may highlight your answer with suitable examples.

   (ii) With examples, discuss the difference between Maintenance and Maintainability.

   (iii) Why cleaning is considered to be an activity of prime importance in maintenance, although many operators give least importance to such an activity?

   (iv) What are the factors that should be considered during the design stage of an equipment in order to improve its Maintainability?

2. (i) Discuss the importance of implementing Preventive Maintenance with suitable examples.

   (ii) Maintenance Departments face intense pressure to reduce direct maintenance expenditure. State how a Preventive Maintenance System can be implemented under such pressures in order to achieve cost objectives while justifying the expenditure involved.

   (iii) Preventive Maintenance does involve risks. Do you agree? Give examples to justify your answer.

   (iv) Key to a successful Preventive Maintenance Program is scheduling and execution. Do you agree? With suitable, examples justify your answer.

3. (i) Discuss the objectives of Total Productive Maintenance (TPM).

(ii) List out the opportunities and possible threats that exist when implementing TPM.

(iii) Discuss the difference between TPM and Preventive Maintenance with suitable examples.

(iv) As a Maintenance Manager you have been asked to introduce a Reliability Centered Maintenance program in your maintenance department. Describe, with examples, the steps you would follow in implementing the program.

4. (i) Strategic Assets Management is one important approach to improve overall equipment effectiveness. Explain.

(ii) How does Strategic Assets Management differ from traditional maintenance approach?

(iii) What are the key requirements that should be ensured in order to facilitate the successful implementation of Strategic Assets Management process?

(iv) Discuss how matrics can be used to implement Strategic Assets Management process successfully.

5. (i) It is often said that the maintenance personnel are too involved in maintenance in order to improve the overall effectiveness of the plant.

In this context,

(a) What do you mean by over maintenance?
(b) Explain its influence on the total cost of maintenance.

(ii) Standardization is a popular topic in the field of maintenance. Discuss the advantages and disadvantages of standardization from the stand point of maintenance.

(iii) Discuss the process you would recommend to follow in order to improve the overall maintenance effectiveness of a workshop with bench marking.

6. (i) Describe how the Life Cycle Cost can be used to justify the decisions for Investment on Capital Equipment.

(ii) Describe the factors that should be considered when making decisions relating to Replacement of Equipment.

(iii) An engine of a Fork Lift machine used for material handling in a workshop has sized due to poor maintenance making the machine inoperative. The lowest offer received to repair the engine with a guarantee for trouble free operation for the next five years is Rs. 900,000.00. If the engine is not repaired, the company can dispose the machine at a salvage value of Rs. 200,000.00. However, according to the local agent, the cost of a reconditioned machine which performs the functions exactly in the same manner as the old machine with a 10 years guarantee would cost Rs. 1,500,000.00.

The annual operation and maintenance cost of the old machine and reconditioned machine is Rs. 150,000.00 and Rs.50,000.00 respectively.

(a) What would be the root cause for this type of failure?
(b) As the Maintenance Manager what steps would you recommend to avoid such failures.
(c) Select the most suitable offer for the workshop from the two above options presented. Give your reasons for the choice.

Cost of capital (i) is 20% and the Capital Recovery Factor (CRF) and it is given by the following equation.

$$CRF = i (1 + i)^n / \{(1 + i)^n - 1\}$$

7. A welding plant consists of three components identified as A, B and C. Assume that the plant has been assembled by fixing A, B and C in series and that their respective reliability figures are 0.6, 0.75 and 0.8.

(i) Determine the net reliability of the plant.

(ii) If component A has a redundant part in parallel having a reliability of 0.6, determine the net reliability of the plant.

(iii) If component A has two redundant parts with reliability of 0.6 each, find the net reliability of the plant.

(iv) If the cost of failure of the plant is Rs. 30,000.00 and component A has back-up units, and the cost of each back-up unit per production cycle is Rs. 3000.00, how many back-up units will be required to minimize the cost?

8. (i) Discuss the difference between "Intrinsic Availability" and the "Operational Availability"

(ii) A component has a failure rate of 3×10^{-6} failures per hour. Due to the implementation of a stringent quality control process, the premature failure rates have been eliminated. Hence a constant failure rate may be assumed.

(a) What is the reliability for an operating period of 1,000 hours if there are 3,000 items in the test?

(b) How many failures are expected in 1,000 hours?

(c) If the Mean Time Between Failures (MTBF) of the component is 200,000 hours, what is the reliability if the operating time is equal to 100,000 hours?

9. (i) Describe the basic steps involved in Fault Tree Analysis

(ii) Outline the basic differences between FMECA and Fault Tree Analysis.

(iii) Fire fighting system in a workshop consists of an electrically driven water pump which is supported by a fire detecting system. The failure of the motor, pump or the failure in detection of a fire may lead to the top event failure of the system.

Failure of motor can be due to the failure in erratical power supply. Power supply can fail due to the defects in main power supply or standby generator.

Failure in the fire detection system may be due to faulty fire detectors or faults in the power detection panel.

Mean down time and failure rate output of each component is given below.

Item	Mean down time (hrs)	Failure rate
Motor	168	0.50
Pump	24	0.60
Detection panel	24	0.10
Main Power supply	168	0.50
Standby generator	168	0.50

Find the top event failure rate output and the mean down time.

You may use the data given below for your calculations.

	AND Gate	OR Gate
Failure Rate Out Put	$\lambda_1 \times \lambda_2 (MDT_1 + MDT_2)$	$\lambda_1 + \lambda_2$
Mean Down Time (MDT)	$(MDT_1 \times MDT_2)/ (MDT_1 + MDT_2)$	$(\lambda_1 MDT_1 + \lambda_2 MDT_2)/ \lambda_1 + \lambda_2$