

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL ENGINEERING

SYSTEMS MAINTENANCE & RELIABILITY – TIE 3211

2nd SEMESTER EXAMINATIONS APRIL/MAY 2000

Time Allowed: 3 Hours

Instructions:

Answer ALL questions

Write legibly

Write the numbers of questions you decided to answer on the front page of the script. Indicate the beginning of each sub-question.

Qu. 1 In the context of "Principles for establishing a maintenance plan and schedule" explain:

- a.
 - i) The main functions of the maintenance manager
 - ii) What is he supposed to understand?
 - iii) How is he to define the maintenance objectives?
- b.
 - i) The Production Maintenance System as a dynamic model
 - ii) States of a system and how to calculate the availability
 - iii) The function of maintenance
- c. The six steps methods for establishing of a maintenance plan and schedule. [25]

Qu. 2 In the context of "Planning and scheduling of plant shutdowns"

- a.
 - i) Explain what is a wall-mounted barchart. Give an example.
 - ii) Give an example of system of planning using network analysis.
 - iii) Give an example of identifying the relationship between the activities.
 - iv) Give an example of a logic diagram with activity duration indicated.
 - v) Give an example for network analysis.
- b.
 - i) Show a histogram of the earliest start aggregation.
 - ii) Show a histogram of resource availability
 - iii) Show a histogram of resource allocation [25]

Qu. 3 a.

- i) Explain the significance of Reliability and Maintainability for the profitability of modern industry.
- ii) Explain what is Operating Standards
- iii) Give an example of machinery reliability assessment effort

- iv) In context of "The meaning of reliability" explain what is: machines, system and mission, failure and failure rate, failure mode and reliability.
- b.
 - i) Give two definitions of probability.
 - ii) Considering the example tossing coins explain the probability distribution
 - iii) Explain how the historical reliability of a machine is defined.
- c.
 - i) Explain how the reliability of a system having more than two components set up parallel, when at least one component must survive has to be calculated.
 - ii) Explain how the reliability of a system consisting of **m** elements must be calculated if at least **n** of the elements must remain operating. [25]

Qu. 4 Solve the problems:

- a. You work for a petrochemical pumping station and are requested to decide whether the company needs a parallel redundant pumping system. You know that the failure rate for the available pumps is $\lambda = 0.5$ per year. The calculations must be done for a period of 1 year. The time to repair a pump is $t' = 5$ days.
- b. Three identical pumps are connected in parallel and are statistically independent. The system operates if at least one pump operates. For each pump the failure rate is constant, $\lambda = 0.005$ per hour. Compare the survival probability of this system, after 100 hours with that of a single pump.
- c. Three valves connected in series, are statistically independent and each has a constant failure rate $\lambda = 0.0025$ per hour. What is:
 - i. the reliability at 1000 hours running time;
 - ii. the average time to failure of the system (MTTF)?
- d. Let the availability required of the system be 0.65 and the mean running time to failure (MTTF) of the system be 400 hours. Calculate the mean-time-to-repair for the system.
- e. Calculate what is the probability of having two heads if you toss a coin 10 times. Consider also the case of having eight tails. Explain the case. [25]

End of Exam