SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

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DEPARTMENT OF MECHANICAL ENGINEERING

M.E. INDUSTRIAL SAFETY ENGINEERING

Question Bank

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III SEMESTER

1914301 RELIABILITY ENGINEERING

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DEPARTMENT OF MECHANICAL ENGINEERING

M.E. INDUSTRIAL SAFETY ENGINEERING

SUB CODE/SUBJECT : 1914301 RELIABILITY ENGINEERING
YEAR/SEM. : II/III ME-ISE

UNIT -I

RELIABILITY CONCEPT

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) – A priori and a posteriori concept - mortality curve – useful life – availability – maintainability – system effectiveness.

PART- A (2 Marks)

Q.No	Questions	BT Level	Competence
1.	Quote a short note on reliability.	BT1	Remember
2.	Express a short note on availability.	BT2	Understand
3.	Describe some conditions required for quality maintenance.	BT1	Remember
4.	Define how are reliability and maintainability inter related.	BT1	Remember
5.	Identify the different types of quality assurance methods.	BT1	Remember
6.	List the various parameters in reliability.	BT1	Remember
7.	Describe what do you understand by reliability functions.	BT2	Understand
8.	Summarize how hazard rate is estimated.	BT2	Understand
9.	Quote about MTBF.	BT1	Remember
10.	Interpret the different methods in reliability measurement.	BT2	Understand
11.	Express the assumptions in reliability measurement.	BT2	Understand
12.	Define design life.	BT1	Remember
13.	Examine priori probability.	BT2	Understand
14.	Name the optimization curve.	BT1	Remember
15.	Define posteriori probability.	BT1	Remember
16.	Describe mortality of a component.	BT2	Understand
17.	Identify the methods of mortality.	BT1	Remember
18.	Express the advantage of continuous availability.	BT2	Understand
19.	Define what is bath tub curve.	BT1	Remember
20.	List the types of life calculation.	BT1	Remember

	PART- B (13 Marks)		
1.	(i) Analyze reliability with reference to quality control systems. (7) (ii) Point out the importance of quality management techniques in reliability. (6)	BT4	Analyze
2.	(i) Illustrate the reliability evaluation techniques with reference to maintainability and availability. (7) (ii) Show the evolution of condition based monitoring system. (6)	BT3	Apply
3.	Explain reliability economics for the development of a product and contribution of same for the cost reduction.	BT4	Analyze
4.	Explain monitoring and growth in concurrent cases of reliability. Also examine the different aspects in concurrent methodology.	BT4	Analyze
5.	Demonstrate the causes and effect of hazard rate in maintainability.	BT3	Apply
6.	Illustrates the importance regarding the measures of reliability in monitoring.	BT3	Apply
7.	(i) Explain the terms failure rate, MTBF, and MTTF. (7) (ii) Analyze the failure modes of components with respect to common life characteristic curve. (6)	BT4	Analyze
8.	Classify the characteristics and functions of a bath tub curve.	BT3	Apply
9.	Explain the basic reliability theory with respect to dynamic function.	BT4	Analyze
10.	Illustrate the priori and posteriori probabilities with suitable example.	BT3	Apply
11.	Infer the characteristics and functions of a probability density function.	BT4	Analyze
12.	Demonstrate the importance and different aspects of regarding mortality curve.	BT3	Apply
13.	Analyze the useful life calculation methods in maintainability and repeatability.	BT4	Analyze
14.	Discover the concurrent techniques used in reliability for monitoring.	BT3	Apply
	PART- C (15 Marks)		
1	Formulate monitoring and growth in contemporary Manufacturing systems of reliability.	BT6	Create
2	Summarize the characteristics and functions of a bath tub curve and relate them to a concurrent example.	BT5	Evaluate
3	Evaluate the importance of mortality curve in automobile components.	BT5	Evaluate
4	Develop the relevance of probability density function in random sampling and risk assessment.	BT6	Create

UNIT II

FAILURE DATA ANALYSIS

Time to failure distributions – Exponential, normal, Gamma, Weibull, ranking of data – probability plotting techniques – Hazard plotting.

PART- A (2 Marks)

1.	Describe a short note on failure data analysis.	BT1	Remember
2.	Write a short note on empirical methods.	BT2	Understand
3.	Quote some characteristics of Censored data.	BT1	Remember
4.	Define how do ungrouped and grouped differ.	BT1	Remember
5.	Classify the different types of data collection.	BT2	Understand
6.	List the various functions of data analysis.	BT1	Remember
7.	Describe what do you understand by FMEA.	BT1	Remember
8.	Express how segregation of data is done.	BT2	Understand
9.	Summarize the various applications of data collection in empirical method.	BT2	Understand
10.	Identify the different methods in induction and deduction.	BT1	Remember
11.	Name the assumptions in probability of failures.	BT2	Understand
12.	Define failure in time.	BT1	Remember
13.	Interpret weibull distribution.	BT2	Understand
14.	Contrast the complete vs censored data curve.	BT2	Understand
15.	Describe exponential distribution.	BT1	Remember
16.	Define about manual hazard plotting.	BT2	Understand
17.	Describe a short note on parameter estimation.	BT2	Understand
18.	Express a short note on coefficient of determination.	BT2	Understand
19.	Quote some conditions required for goodness-of-fit.	BT1	Remember
20.	Identify how are reliability and maintainability inter related.	BT1	Remember

PART- B (13 Marks)			
1.	(i) Illustrate the different methods of failure data analysis. (7) (ii) Discover the importance of FMEA in reliability. (6)	BT3	Apply
2.	(i) Analyze the characteristics and functions of empirical probabilities. (7) (ii) Explain the evolution of different empirical methods. (6)	BT4	Analyze
3.	Illustrate about grouped data used in failure data analysis.	BT3	Apply
4.	Explain empirical and theoretical probability in functional distributions.	BT4	Analyze
5.	Demonstrate the empirical evidence used in FDA and sampling.	BT3	Apply
6.	Explain the importance of theoretical probability used in empirical methods.	BT4	Analyze
7.	(i) Examine about ungrouped data used in failure data analysis. (6) (ii) Relate the sorting techniques used in FDA. (7)	BT3	Apply
8.	Analyze the characteristics and functions of sampling bias.	BT4	Analyze
9.	Illustrate fault tree analysis and its relevance to grouped data.	BT3	Apply
10.	Illustrate exponential distribution with suitable example.	BT3	Apply
11.	Explain the following (i) Failure density function (5) (ii) Cumulative failure distribution (5) (iii) Hazard rate (3)	BT4	Analyze
12.	Illustrate in detail about weibull distribution properties and formulations.	BT3	Apply
13.	Analyze the normal density function in selective sampling method.	BT4	Analyze
14.	Show the consequence of fit tests for concurrent techniques used in reliability for monitoring.	BT3	Apply
PART- C (15 Marks)			
1	Evaluate the characteristics and functions of a probability density function in production sampling.	BT5	Evaluate
2	Develop the hazard plotting used in empirical and normative methods.	BT6	Create

3	A data sample is taken from a number of pieces of equipment operating in the field. Eight times-to-failure were recorded. These data in rank order are 215, 44.2, 71.2, 87.1, 105.4, 142.1, 162.1, 180.1 and 197.1 hr. Fit a Weibull distribution and evaluate the shape parameter *f3* and the scale parameter α. Estimate the reliability for a similar piece of equipment for a mission of 100 hr.	BT5	Evaluate
4	Each automobile leaving a particular plant is equipped with five tires made by a certain manufacturer. The tires on each of 100 automobiles were examined for defects with the following results: Number of tires with defects on each car 0 1 2 3 4 5, Number of cars 6 1 32 5 0 1 1 (i) What theoretical distribution would be expected to fit this data? (ii) Design a test at the 1 % level of significance whether data is a good fit to this theoretical distribution.	BT6	Create

UNIT III

RELIABILITY PREDICTION MODELS

Series and parallel systems – RBD approach – Standby systems – m/n configuration – Application of Bayes' theorem – cut and tie set method – Markov analysis – Fault Tree Analysis – limitations.

PART- A (2 Marks)

1.	Quote a short note on reliability assessment.	BT1	Remember
2.	Interpret a short note on reliability improvement index.	BT2	Understand
3.	Name some characteristics of redundancy scheme.	BT1	Remember
4.	Describe how do passive redundancy and active redundancy differ.	BT1	Remember
5.	Summarize the different types of reliability assessment.	BT2	Understand
6.	List the various series and parallel components.	BT1	Remember
7.	Define what do you understand by TMR.	BT1	Remember
8.	Examine reliability block diagram.	BT1	Remember
9.	Discuss the various applications of dependence diagram.	BT2	Understand
10.	Identify fault tree in RBD.	BT1	Remember
11.	List out the assumptions in de Markov analysis.	BT1	Remember
12.	Define failure rate.	BT1	Remember
13.	Briefly examine Baye's theorem.	BT2	Understand
14.	Define the Baye's inference curve.	BT1	Remember
15.	Define hyper parameter.	BT1	Remember
16.	Summarize Bayesian probability.	BT2	Understand
17.	Describe a short note on cut and tie sets.	BT2	Understand
18.	Define fault tree analysis.	BT1	Remember
19.	Predict some conditions required for standby system.	BT2	Understand
20.	Define how are reliability and redundancy inter related.	BT1	Remember

	PART- B (13 Marks)		
1.	Consider a two component non-repairable system in which both components have times-to-failure that are exponentially distributed and a failure rate of 1 f/yr. Analytically and by simulation the probability of the system surviving for mission times of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 years without failure if only	BT4	Analyze
2.	Illustrate the preventive maintenance analysis in REL assessment.	BT3	Apply
3.	Explain reliability allocation in the fault tree and root cause analysis.	BT4	Analyze
4.	(i) Illustrate repairable system analysis in redundancy system. (7) (ii) Examine about series and parallel systems in RPM. (6)	BT3	Apply
5.	Analyze the m/n configuration in REL functions and analysis.	BT4	Analyze
6.	Discover the importance of multiple censored data in redundancy.	BT3	Apply
7.	(i) Analyze maintenance analysis used in reliability allocation. (7) (ii) Point out the need for standby system in RPM. (6)	BT4	Analyze
8.	Demonstrate the Baye's formula in reliability assessment perspective and derive the equation.	BT3	Apply
9.	Analyze the cut and tie set Method for large complex systems.	BT4	Analyze
10.	Illustrate the fault tree analysis with suitable example.	BT3	Apply
11.	Analyze the characteristics and functions of tie sets in RBD.	BT4	Analyze
12.	Evaluate the importance of standby system used in redundancy.	BT3	Apply
13.	Analyze the probabilistic risk assessment programme and its effect on reliability.	BT4	Analyze
14.	(i) Relate active and passive redundancy. (7) (ii) Examine the role of Markov analysis in reliability prediction models (6)	BT3	Apply
	PART- C (15 Marks)		
1	Evaluate the series and parallel systems used in sampling and probability estimation of failure during production control.	BT5	Evaluate
2	Develop the probabilistic risk assessment programme and its effect on RBD of tool maintenance.	BT6	Create
3	Evaluate the fault tree analysis using CNC lathe and milling operation.	BT5	Evaluate

4	What is the importance regarding stand by system for robotic actuators and manipulators?	BT6	Create

UNIT IV

RELIABILITY MANAGEMENT

Reliability testing – Reliability growth monitoring – Non-parametric methods – Reliability and life cycle costs – Reliability allocation – Replacement model.

PART- A (2 Marks)

1.	Give a note on accelerated life testing.	BT2	Understand
2.	Express a short note on impact of ALT.	BT2	Understand
3.	Name some characteristics of high wear-out.	BT1	Remember
4.	Quote how do failure terminated and time terminated models differ.	BT1	Remember
5.	Express the different types of reliability monitoring. .	BT2	Understand
6.	List the various functions of failure terminated cases.	BT1	Remember
7.	Define what do you understand by Sequential Testing.	BT1	Remember
8.	Examine how stopping rule is used.	BT2	Understand
9.	Identify the various applications of sequential estimation.	BT1	Remember
10.	Describe the different methods in termination.	BT2	Understand
11.	Define the assumptions in probability ratio test.	BT1	Remember
12.	Define reliability growth model.	BT1	Remember
13.	Discuss the factors that cause failure in general.	BT2	Understand
14.	List the reliability allocation parameters.	BT1	Remember
15.	Define criticality.	BT1	Remember
16.	Describe about complexity.	BT2	Understand
17.	Quote a short note on software reliability.	BT1	Remember
18.	Summarize a short note on mean life of software.	BT2	Understand
19.	Examine some of the problems faced by software reliability test.	BT1	Remember
20.	Express how is compactness measured in replacement model.	BT2	Understand

PART- B (13 Marks)			
1.	(i) Illustrate the influence of wear out in quality sustainment. (7) (ii) Discover the importance of termination models in reliability monitoring. (6)	BT3	Apply
2.	(i) Explain the reliability monitoring techniques with reference to sustainability. (7) (ii) Explain the evolution of condition based monitoring system. (6)	BT4	Analyze
3.	Discover failure terminated model with a suitable example.	BT3	Apply
4.	Examine time terminated model in reliability monitoring.	BT3	Apply
5.	Analyze the important characteristics of sequential Testing.	BT4	Analyze
6.	Examine the parameters and functions of probability ratio test.	BT3	Apply
7.	(i) Explain the term reliability growth cycle. (6) (ii) Analyze the idealized growth curve. (7)	BT4	Analyze
8.	Illustrate the characteristics and functions of a Duane growth model.	BT3	Apply
9.	Point out the AMSAA growth model in time estimation of models.	BT4	Analyze
10.	Illustrate the criticality and complexity in RM with a suitable example.	BT3	Apply
11.	Analyze the characteristics and functions of a probability density function.	BT4	Analyze
12.	Explain the importance of software reliability test.	BT3	Apply
13.	Analyze the mean life of software used in reliability growth cycle.	BT4	Analyze
14.	Deduce the replacement models and concurrent techniques used in reliability for monitoring.	BT3	Apply
PART- C (15 Marks)			
1	Evaluate the failure terminated model with suitable example in industrial automation.	BT5	Evaluate
2	Formulate the probability density function used in reliability testing.	BT6	Create
3	Explain the reliability allocation model in sustainability curve.	BT5	Evaluate
4	Develop the importance of replacement model in up gradation of CNC programming.	BT6	Create

UNIT V

RISK ASSESSMENT

Definition and measurement of risk – risk analysis techniques – risk reduction resources – industrial safety and risk assessment.

PART- A (2 Marks)

1.	Quote a short note on risk factor.	BT1	Remember
2.	Describe a brief note on risk impact.	BT2	Understand
3.	List some characteristics of qualitative risk.	BT1	Remember
4.	Interpret how do qualitative risk and quantitative risk differ.	BT1	Remember
5.	Express the different types of risk measurement. .	BT2	Understand
6.	List the various functions of risk analysis.	BT1	Remember
7.	Define what are the five main steps in risk analysis.	BT1	Remember
8.	Describe how failure prediction is done.	BT2	Understand
9.	Quote the various applications of predictive techniques.	BT1	Remember
10.	Describe the different methods in time distribution for risk analysis.	BT2	Understand
11.	Define briefly about risk reduction.	BT1	Remember
12.	Define cascading failure.	BT1	Remember
13.	List the factors that influence industrial safety.	BT1	Remember
14.	Describe the impact of preventive maintenance in safety.	BT2	Understand
15.	Define first aid.	BT1	Remember
16.	Summarize about electric hazards.	BT2	Understand
17.	Express a short note on thermal hazards.	BT2	Understand
18.	Define a short note on risk assessment.	BT1	Remember
19.	Name some problems in implementation of safety in industries.	BT1	Remember
20.	Express how safety factor is calculated corresponding to risk assessment.	BT2	Understand

PART- B (13 Marks)			
1.	(i) Examine the influence of failure prediction in safety. (7) (ii) Show the importance of measurement of risk. (6)	BT3	Apply
2.	(i) Examine the rate losses in qualitative risk. (7) (ii) Discover the evolution of quantitative risk system. (6)	BT3	Apply
3.	Analyze time distribution and characteristics of risk assessment modules.	BT4	Analyze
4.	Examine planned down time and risk factor for availability methods.	BT3	Apply
5.	Illustrate the important characteristics of system MTTR in risk analysis.	BT3	Apply
6.	Classify the functions of failure analysis softwares.	BT3	Apply
7.	Explain the down time analysis techniques for risk management.	BT4	
8.	Demonstrate the characteristics of operational availability in risk reduction.	BT3	Apply
9.	Explain the impact of safety management in industries.	BT4	Analyze
10.	Illustrate the measures of maintainability for safety with suitable example.	BT3	Apply
11.	Analyze the characteristics and functions of predictive techniques in industrial safety management.	BT4	Analyze
12.	Discover the characteristics and functions of hazard prevention measures.	BT3	Apply
13.	Analyze the availability parameters that are used in risk assessment and risk reduction.	BT4	Analyze
14.	Illustrate the importance of flexible schedule in industrial safety management.	BT3	Apply
PART- C (15 Marks)			
1	Assess the predictive techniques model used for risk assessment with suitable example in CNC machines.	BT5	Evaluate
2	Develop the risk reduction techniques used in system availability for CIM.	BT6	Create
3	Evaluate the risk measurement techniques used in contemporary manufacturing techniques.	BT5	Evaluate
4	Compose the importance of hazard management in automated machines.	BT6	Create