



Model Answer SET 1
End-Sem Examination-I, Winter 2025

Academic Year: 2025-2026	Semester: I
Class: FYMTECH	Program: PG in VLSI & Embedded System
Branch Code: ETC	Pattern:
Name of Course: Research Methodology & IPR	Course Code: 2402505

Q. No.	Details	Max. Marks
Q.1.	1. Distinction (3 Marks): Research Methodology is the entire systematic approach, logic, and rationale of conducting the research. It answers "Why" a particular method is used. Research Techniques are the specific instruments, procedures, and practical steps used for performing a research operation, like data collection or processing. They answer "How" the task is executed. 2. Criteria for Good Research (3 Marks): Must be Systematic (following logical steps), Logical (guided by rules of reasoning), Empirical (based on real-life evidence), Verifiable/Replicable (results can be reproduced), and Objective (free from researcher bias).	[6]
Q.2.	1. Description (2 Marks): The Taguchi Method is a quality engineering technique aimed at designing products and processes that are robust (insensitive) to variations from uncontrollable factors (noise factors). It uses the Signal-to-Noise (S/N) Ratio to minimize variance and keep performance close to the target. 2. Steps for Planning (4 Marks): a) Identify Control Factors (designer settings) and Noise Factors (environmental/uncontrollable variables). b) Define the Quality Characteristic (measurable response). c) Select the appropriate Orthogonal Array (OA) to study multiple factors efficiently with fewer runs. d) Run the experiment under various noise conditions. e) Analyze results using the S/N ratio to find optimal control factor settings.	[6]
Q.3.	a) 1. Strategy Discussion (4 Marks): The strategy is the overall approach for choosing factor levels. Inefficient: Best-Guess Approach and One-Factor-at-a-Time (OFAT). Effective: Factorial Designs are the best strategy, as they vary factors simultaneously, allowing for the study of interactions (when the effect of one factor depends on the level of another). 2. Guidelines (4 Marks): a) Randomization: Running trials in a random order to neutralize the effect of lurking variables. b) Replication: Repeating runs to estimate the inherent experimental error (variance). c) Blocking: Grouping experimental units to minimize the variability from known, external sources (e.g., different batches of material). d) Selection of relevant factors, appropriate levels, and a measurable response variable. OR	[8]



	<p>b) 1. Basic Concepts (4 Marks): Mean and Variance: Measures of central tendency and spread/variability. Hypothesis Testing: Formal procedure to compare data against a null hypothesis. Probability Distributions: Models (like the Normal Distribution) describing variable behavior. Statistical Significance: Measured by p-value; the probability of observing the data if H₀ were true. 2. Regression Approach to ANOVA (4 Marks): ANOVA is a special case of the General Linear Model. It uses indicator (dummy) variables in a regression equation to represent the levels of a categorical factor. The null hypothesis of equal means ($\mu_1 = \mu_2 = \dots$) is tested by checking if all coefficients for the indicator variables are simultaneously zero.</p> <p>c) 1. Genetic Algorithms (GA) (4 Marks): GA is a search heuristic inspired by biological evolution and natural selection. Fundamentals: Starts with a Population of candidate solutions (chromosomes). Uses Selection (fitter solutions survive), Crossover (combining parts of parents to create offspring), and Mutation (randomly altering genes for diversity) to iteratively improve the population's fitness. 2. Simulated Annealing (SA) (4 Marks): A metaheuristic used for large-scale optimization, inspired by the annealing process in metallurgy. Fundamentals: Starts at a high "temperature" and gradually "cools." It accepts better moves, but also accepts worse moves with a probability that decreases as the temperature drops. This probabilistic acceptance allows the algorithm to escape local optima and search a wider space for the global optimum.</p> <p>OR</p> <p>d) 1. Sensitivity Theory (4 Marks): Quantifies how the output or performance of a system changes in response to variations in its input parameters. It often uses partial derivatives (sensitivity functions) to measure the rate of change. High sensitivity means the output is highly vulnerable to parameter variations. 2. Applications in Design (4 Marks): Robust Design: Identifying parameters with high sensitivity that require tight tolerance/control, and low-sensitivity parameters that can be allowed wider tolerance. Optimization: Guiding design changes toward variables that have the largest impact on performance. Tolerance Analysis: Setting manufacturing specifications (tolerances) for components to ensure overall system performance remains acceptable despite component variation.</p>	<p>[8]</p> <p>[8]</p> <p>[8]</p>
Q.4.	<p>a) 1. Procedure (4 Marks): a) State the Null (H₀) and Alternative (H₁) Hypotheses. b) Select the appropriate Test Statistic and Level of Significance (α). c) Determine the Critical Region (or p-value). d) Calculate the test statistic value from sample data. e) Make a Decision: If the test statistic falls in the critical region (or p-value $< \alpha$), reject H₀. 2. Test Statistics (2 Marks): A value calculated from</p>	[8]



	<p>sample data used to test the hypothesis (e.g., Z, t). It measures the discrepancy between the sample data and what is expected under H_0.</p> <p>3. Critical Region (2 Marks): The area(s) in the sampling distribution of the test statistic that lead to the rejection of H_0. Its boundaries are defined by the critical values corresponding to the chosen α.</p> <p>OR</p> <p>b) 1. Procedure (5 Marks): Used to test $H_0: p_1 = p_2$ (the proportions of a characteristic in two populations are equal). Assumptions: Large independent random samples. Test Statistic: The Z-statistic (using a pooled proportion, \bar{p}, under H_0) is calculated. Decision: Compare the calculated Z to the critical Z value (or use the p-value) to determine if the observed difference is statistically significant. 2. Industrial Application (3 Marks): A/B Testing in Marketing: Comparing the click-through rates (proportions) of two different website layouts or ad campaigns to see which performs better. Quality Control: Comparing the proportion of defective units produced by two different machines or two different shifts.</p> <p>c) 1. Use (5 Marks): The χ^2 Test for Independence determines if there is a statistical association between two categorical variables (attributes) in a population. H_0 is that the attributes are independent. The test compares the Observed Frequencies (O) from the data table to the Expected Frequencies (E) calculated assuming independence. $\chi^2 = \sum \frac{(O-E)^2}{E}$. 2. Cautions (3 Marks): Expected Frequencies should be ≥ 5 in all or most cells (a common guideline is $< 20\%$ of cells having $E < 5$). The observations must be independent. The test only proves association, not causation. The sample size must be large enough.</p> <p>OR</p> <p>d) 1. Description (5 Marks): This test (Test of Homogeneity of Proportions) is used to determine if the proportions of a characteristic are equal across k different populations (e.g., $H_0: p_1 = p_2 = \dots = p_k$). The data is organized in a $2 \times k$ contingency table. The χ^2 statistic is calculated in the same way as the test for independence, with $df = k - 1$. A large χ^2 value leads to the rejection of H_0. 2. Conditions for Validity (3 Marks): Must use independent random samples from each population. The expected frequency (E) in every cell must be ≥ 5 (or at least close to it).</p>	<p>[8]</p> <p>[8]</p> <p>[8]</p>
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