

UNIVERSITY OF CALICUT
Ph.D (Computer Science) Programme
Entrance Examination – 2023
Modal Question Papers

Time: 2 Hours

Total Marks: 100

PART A

Answer **ALL** Questions. Each Question Carries **Two** Marks

(25 x 2 = 50)

1. Research is classified on the basis of and methods
 - A. Purpose
 - B. Intent
 - C. Methodology
 - D. Techniques
2. Research undertaken for knowledge sake is
 - A. Pure/fundamental Research
 - B. Action Research
 - C. Pilot study
 - D. Survey
3. Summarizing raw data and displaying them on compact statistical tables for analysis is
 - A. Tabulation
 - B. Coding
 - C. Transcription
 - D. Editing
4. An essential Criterion of Scientific study is
 - A. Belief
 - B. Value
 - C. Objectivity
 - D. Subjectivity
5. “Empirically verifiable observation” is
 - A. Theory
 - B. Value
 - C. Fact
 - D. Statement
6. Facts or information’s are analyzed and critical evaluation is made in
 - A. Survey
 - B. Action research
 - C. Analytical research
 - D. Pilot study

7. X is a normally distributed variable with mean $\mu = 30$ and standard deviation $\sigma = 4$, then $P(x > 30)$ is.....
- A. 0
 - B. $1/4$
 - C. $1/2$
 - D. None of these
8. ----- is the task of discovering groups and structures in the data.
- A. Regression
 - B. Clustering
 - C. Summarization
 - D. Classification
9. What does a p-value in statistical analysis indicate?
- A. The size of the sample
 - B. The strength of the relationship between variables
 - C. The number of research participants
 - D. The probability of obtaining results by chance
10. Which sampling method gives every individual in the population an equal chance of being selected?
- A. Convenience sampling
 - B. Purposive sampling
 - C. Quota sampling
 - D. Random sampling
11. Which one of the following is a non-probability sampling?
- A. Simple random
 - B. Systematic
 - C. Stratified
 - D. Purposive
12. Which of the following is not a type of research question?
- A. A hypothesis
 - B. Evaluating a phenomenon
 - C. Predicting an outcome
 - D. Developing good practice
13. All cause non sampling errors except
- A. Faulty tools of measurement
 - B. Defect in data collection
 - C. Inadequate sample
 - D. Non response
14. Where can we use the Bayes rule?
- A. To increase the complexity
 - B. To decrease the complexity
 - C. To solve queries
 - D. To answer probabilistic queries

15. Name the algorithms that acquire from complex environments to generalize, approximate and simplify solution logic.
- Ecorithms
 - Fuzzy set
 - Fuzzy Relational DB
 - None of the above
16. A perceptron can be defined as _____
- A double layer auto-associative neural network
 - A neural network with feedback
 - An auto-associative neural network
 - A single layer feed-forward neural network with pre-processing
17. If we convert
 $\exists u \forall v \forall x \exists y (P(f(u),v, x, y) \rightarrow Q(u,v,y))$ to
 $\forall v \forall x (P(f(a),v, x, g(v,x)) \rightarrow Q(a,v,g(v,x)))$
 This process is known as
- Simplification
 - Unification
 - Skolemization
 - Resolution
18. A 4-input neuron has weights 1, 2, 3, and 4. The transfer function is linear, with the constant of proportionality being equal to 2. The inputs are 4, 10, 5, and 20, respectively. The output will be:
- 76
 - 238
 - 123
 - 119
19. Which of the following takes input as an object described by a set of attributes?
- Graph
 - Decision graph
 - Tree
 - Decision tree
20. Regular grammar corresponding to language $L = \{ a^n b^m: n+ m \text{ is even} \}$
- $S \rightarrow aaS/A, A \rightarrow bbA/t$
 - $S \rightarrow ASbb/A, A \rightarrow aA/t$
 - $S \rightarrow aaSb/t$
 - $S \rightarrow aSbb/t$

21. Travelling Sales man Problem belongs to
- A. Class P
 - B. Class NP but not NP-Complete
 - C. N.P. Complete
 - D. N.P. Hard
22. Which one of the following is the tightest upper bound that represents the time complexity of inserting an object into a binary search tree of n nodes?
- A. $O(1)$
 - B. $O(\log n)$
 - C. $O(n)$
 - D. $O(n \log n)$
23. _____ deals with uncertainty problems with its own merits and demerits
- A. Neuro-fuzzy
 - B. Neuro-genetic
 - C. Fuzzy-genetic
 - D. None
24. Which of the following grey level intensities help in increasing the grey levels dynamic range in the image?
- A. Contrast Stretching
 - B. Negative Transformations
 - C. Power-law Transformations
 - D. None of the above
25. In which of the following areas can we use the low pass filters?
- A. Machine perception, along with some application of character recognition
 - B. Printing and publishing industry
 - C. Satellite processing and aerial images
 - D. All of the above

PART B

Answer Any FIVE Questions. Each Question Carries TEN Marks.

(5 x 10 = 50)

1. (a) What is a hypothesis? What are the characteristics of a good research hypothesis? (5)
(b) Explain the important concepts related to research design. (5)

2. (a) It has been claimed that 70% of all the service sectors modified with IT enabled office automations, the total service satisfaction among clients increased by 40%. If so, what are the probabilities that the client satisfaction will be increased by 40% in (i) at most 1 out of 5 service sectors modified with IT enabled office automations (ii) at least 4 out of 5 service sectors modified with IT enabled office automations. (5)
- (b) What are the various types of research reports? Explain the important components of a research paper? (5)
3. (a) Solve the following system of linear equations (5)
- $$3x - 2y + z = 12; \quad x + 3y + z = -4; \quad 2x + 2y - 4z = 6$$
- (b) Find the eigen values and eigen vectors of the matrix (5)
- $$\begin{bmatrix} 2 & 6 \\ 1 & 3 \end{bmatrix}$$
4. (a) Is set of all integers a cyclic group with respect to addition? Why? If so, what is its generator? (5)
- (b) Explain use of Hash Functions to provide source authentication with and without using public key encryption (5)
5. (a) Suppose that you form a low pass special filter that averages the four immediate neighbors of a point (x, y) but excludes the point itself. Find the equivalent filter $H(u, v)$ in the frequency domain. (5)
- (b) Explain how Fourier transforms are useful in digital image processing? (5)
6. (a) Differentiate fuzzy set from classical set. (4)
- (b) Describe the concept of information extraction. Write short notes on (6)
- (i) Similarity measures (ii) Ranking algorithms.
7. (a) Explain clearly how the Perceptron training algorithm is implemented on a digital computer for pattern recognition (5)
- (b) What is Bayes' Theorem? How is it useful in a machine learning context? (5)
8. (a) Find a DFA for the following language on $\varepsilon = \{a, b\}$ (5)
- $$L = \{w: n_a(w) \bmod 3 > n_b(w) \bmod 3\}$$
- (b) Given an adjacency list representation of a directed graph, how long does it take to complete out-degree of every vertex? (5)

UNIVERSITY OF CALICUT
Syllabus for Ph.D. (Computer Science) Entrance
Examination - 2023

Computer Science

Discrete Structures: Propositional and first order logic. Set Theory: Sets; Relations; Functions; Partial Orders; Lattice; Groups: Group Theory-Definition and Elementary Properties -Subgroups-Cosets and Lagrange's Theorem, Rings and Fields-Definitions and examples of Rings, Integral Domains and Fields. Graph Theory-Paths and Cycles, Graph Isomorphism, Trees-Spanning Trees, Cayley's theorem, Kruskal's Algorithm, Prim's Algorithm. Dijkstra's Algorithm to Find Shortest Path in Weighted Graphs.

Data Structures and Algorithms: Programming in C/C++, Asymptotic Notations, stacks, queues, linked lists, trees, binary search trees, binary heaps, Graphs, Searching, Sorting and Hashing. Algorithm design techniques: divide-and-conquer, Greedy, Dynamic programming and Backtracking, NP-Hard and Complete.

Theory of Computation: Regular languages and finite automata, Context free languages and Pushdown automata, Turing machine, Computability- Closure properties of recursive and recursively enumerable language.

Compiler Design: Lexical analysis, syntax analysis, syntax-directed translation, runtime environment, intermediate code generation, code generation and optimization, data flow analysis.

Operating Systems: Processes, Threads, Inter-process communication, Concurrency, Semaphores, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

Database Systems: ER-model, Database design (integrity constraints, normal forms), Query languages (SQL).

Artificial Intelligence: Problem space and search- Production system- characteristics- the predicate calculus, Inference rules, Structures and strategies for state space search, strategies for space search Heuristics Search: state space search, Generate and test, Hill climbing, Depth first search, Breadth first search, Best first search, A*, Problem Reduction, AO*, Constraint Satisfaction, Means-ends analysis, Heuristic in games, Complexity issues.

Machine Learning: Division of machine learning tasks - supervised and unsupervised. Learning, predicting and classifying using machine learning. Deep Learning, Feed Forward Networks, Gradients and Learning, Back-Propagation, Computation graph for Deep Learning, Convolutional Networks, Recurrent Neural Networks, Unsupervised learning and Transfer learning, Reinforcement learning.

Regression analysis, Regularisation techniques, Clustering, Cluster validation. Classification, algorithms for classification, Accuracy of classification techniques, Confusion matrix.

Digital Image Processing: digital image representation, simple image model sampling and quantization, relationship between pixels, image geometry. Image transforms, introduction to Fourier transform, discrete Fourier transform (DFT), properties DFT, other separable image transforms, Walsh, Hadamard and Discrete Cosine transforms. Image enhancement, basic grey level transformation, histogram equalization, image subtraction, Image averaging, spatial filtering, smoothing, sharpening filters, Laplacian filters. Enhancement in the frequency domain, frequency domain filters, smoothing, sharpening filters, homomorphic filtering.

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Research Methodology

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of research Concept, Construct, Definition, Variable. Research Process.

Types of research: Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. Research Process.

Problem Identification & Formulation: Research Question - Investigation Question - Measurement Issues - Hypothesis - Qualities of a good Hypothesis - Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance.

Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Data Collection and Analysis: Execution of the research - Observation and Collection of data - Methods of data collection – Modelling, Mathematical Models for research, Sampling Methods- Data processing and Analysis strategies. Data Analysis with Statistical Packages – Hypothesis-testing, Generalization-and Interpretation.

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