Vikram University, Ujjain –M.Phil./Ph.D. Entrance Syllabus for Computer Science

Syllabus of M.Phil./ Ph.D. Entrance Test

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PART-A

Research Methodology

Definition – History – Evolution of Scientific Inquiry, Scientific Research: Definition, Characteristics, types, need of research. Identification of the problem, assessing the status of the problem, formulating the objectives, preparing design (experimental or otherwise), Actual investigation. Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem Research Design – Need – Features – Inductive, Deductive and Development of models Developing a Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs.

Analysis of Literature Review – Primary and Secondary Sources, Web sources –critical Literature Review Hypothesis – Different Types – Significance – Development of Working Hypothesis, Null hypothesis Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive – Inductive logical process – Different types of inductive logical methods.

Sources of Data – Primary, Secondary and Teritary – Types of Data – Categorical, nominal & Ordinal. Methods of Collecting Data : Observation, field investigations, Direct studies – Reports, Records or Experimental observations. Sampling methods – Data Processing and Analysis strategies- Graphical representation – Descriptive Analysis – Inferential Analysis- Correlation analysis – Least square method - Data Analysis using statistical package – Hypothesis – testing – Generalization and Interpretation – Modeling.

Ethical Issues – Ethical Committees – Commercialization – copy right – royalty – Intellectual Property rights and patent law – Track Related aspects of intellectual property Rights – Reproduction of published material – Plagiarism – Citation and Acknowledgement – Reproducibility and accountability.

Use of word processing, spread sheet and database software. Plotting of graphs. Internet and its application: E-mail, WWW, Web browsing, acquiring technical skills, drawing inferences from data, Introduction to Statistics – Probability Theories - Conditional Probability, Poisson distribution, Binomial Distribution and Properties of Normal Distributions. Estimates of Means and Proportions; Chi Square Test, Association of Attributes t Test –Anova, Standard deviation Coefficient of variations. Co relation and Regression Analysis.

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PART-B

PROGRAMMING WITH 'C'

Character Set, Identifiers, Keywords, Variables, Character Strings, Qualifiers, Typecasting, Constants, Operator and Expression, Operator Precedence and Associativity, Input-Output Statements.

Control Statements : If, If-Else , Multi-way decision, Compound Statements, loops : for, while do-while, break, switch, continue statement, Arrays, Strings.

Functions : Why function ? Structured Programming, Parameter Passing : call by value , call by reference, return values, recursion vs iteration, scope extent , passing arrays and function to functions.

Dynamic memory allocation : Pointers, address operator, pointer variables, pointer arithmetic, pointer to pointer, pointer and arrays, pointers and functions, array of pointers, pointers and strings, pointer and string, function for dynamic memory allocation.

Structures : Operations, Structure within structure , self referential structure , array of structure, pointer and structure, structure and functions. Union : Scope of union. File : File handling function, file structure, file types, un-buffered and buffered files, error handling, low level file I/O, command line arguments.

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LOGICAL ORGANIZATION OF COMPUTER SYSTEMS

Digital computers and digital systems: Binary, decimal, hexadecimal numbers, Binary codes: BCD, ASCII codes, Complements, Boolean algebra and Logic Gates: AND, OR and NOT gates. NAND and NOR gates.

Basic theorems and properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Other logic Operations, IC Digital Logic Families.

Simplification of Boolean Functions: Karnaugh Maps and Karnaugh Simplification. Don't Care Condition, Design of Combinational Logic Circuits, Half Adders, Full Adders and Binary Parallel Adders, Decoders and Multiplexers.

Sequential Logic: Introduction, FLIP FLOPs- RS Latches/FF, Master-Slave Flip-Flop Level Clocking , D- Latches and flip flop, JK Flip-Flops, T-Flip Flop.

Registers, Counters and Memories, Buffer Registers. Shift Registers, Ripple Conters, Synchronous Counters, ROMs, PROMs, EPROMS, RAMS.
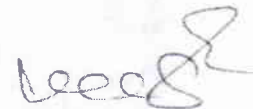
Programming with 'C' & 'C++'

Basic concepts of data structure : Primitive and composite data types, data object, data structure. Sequential Representation : arrays, stacks, queues.

Non-Sequential Representation : Linked Lists, Singly and Doubly linked lists, circular list,dynamic storage management, Garbage collection and compaction, Strings representation and strings manipulation.

Non-linear data representation : trees, binary trees, tree traversal algorithms.

Searching, Sorting and Merging Algorithms. Symbol Tables : Static Tree Tables, Dynamic Tree Tables, Hash Tables, Hashing Functions, Overflow Handing, Chaining.

Fields, records, files, index techniques, cylinder-surface indexing, tree indexing-B-trees, trie indexing, file organizations.

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OPERATING SYSTEMS AND SYSTEM SOFTWARE

Introduction, Early systems, Simple monitor, Buffering, Spooling, Batch processing, Multiprogramming, Time sharing. Types of operating system services. File system : Concept, Support, Access methods, Allocation methods, Directory systems, File protection.

PROCESSOR MANAGEMENT : Introduction , Scheduling levels ; Scheduling objectives ,Scheduling criteria, preemptive and non preemptive scheduling, Priorities, Deadline scheduling , FIFO scheduling, RR, SJF, SRT scheduling , Multilevel feedback Queues.

MEMORY MANAGEMENT :Storage Organization, Management, Hierarchy, Strategies, Fixed and variable partition Multiprogramming, Virtual Storage : Basic concepts, Paging, Segmentation, Paging/Segmentation combined Systems, Page Replacement Strategies : Locality, Working Sets, Page fault, Demand paging, LRU, FIFO, MFU, LFU, Optimal.

DISK, DRUM SCHEDULING AND DEADLOCKS :Physical Characteristics, Disk Scheduling Policies ; FCFS, Shortest Seek. Time First, SCAN, Disk scheduling Algorithms, DEADLOCK : Introduction, Necessary conditions, Deadlock Prevention, Avoidance, Detection, Recovery.

System software and application software, layered organisation of system software. Assemblers, Macros, Compilers, Cross compilers, Linking and loading, Relocation.

COMPUTER SYSTEM ARCHITECTURE AND PARALLEL PROCESSING

Programming and language : Relationship between Electronics & Programming. Flow Chart, Programming Language, assembly Language.

Computer Architecture, Microprocessor Architecture, Microprocessor Families, 6502 family, 6800/6808 family.

Addressing Modes, Arithmetic Instruction, Logical Instructions, 8086/8088 family.

Parallel Processing : Mechanism, Parallelism in uni-processor system, Parallel Computer Structure, Architecture Classification Scheme.

Pipeline and Vector Processing : Instruction and arithmetic Pipeline, SIMD Computers.

DATA BASE MANAGEMENT SYSTEM

Introduction to data base system concepts : An overview of a data base system , basic data base system terminology.

Entity relationship model, E.R. diagram, data independence, data definition and manipulation languages . an architecture for a data base system.

Data models, relational model hierarchical model, network model.

Storage structure, relational algebra, relational calculus, relational query language and manipulation.

Functional dependencies, normal forms, decomposition, integrity, protection ,security, concurrency, distributed data base.

COMPUTER ORIENTED OPTIMIZATION TECHNIQUES

Optimization and Operations Research: Linear Simultaneous Equations, Solution of Simultaneous Equations by Gauss-Jordan method, Linear Programming: Introduction, Formulation of LP Problems, Assumptions and Applications of linear programming.
Graphical Solution of LP Problems, Important geometric properties of LP Problems, Principles of simplex methods, Computational Procedure of Simplex Methods, Two Phase Method.

Duality in Linear Programming: Concepts of duality, Definition of Primal-Dual Problems, General rules for Converting Primal into It's Dual, Duality Theorems, Dual simplex method, sensitivity analysis.

Special types of Linear programming problems- Transportation and Assignment problems.

Integer Linear Programming: Introduction, Importance of Integer Programming Problems, Definitions, Branch and Bound techniques, Computational demonstration of Branch and Bound Method.

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Data & File Structure

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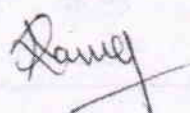
DATA COMMUNICATION AND COMPUTER NETWORKS

Network goals and application, Network structure, Network services, Example of networks and Network Standardization, Networking models : centralized, distributed and collaborative. Network Topologies : Bus, Star, Ring, Tree, Hybrid : Selection and Evaluation factors.

Theoretical Basis for Data communication, Transmission media, Twisted pair (UTP, STP), Coaxial Cable, Fiber optics : Selection and Evaluation factors. Line of Sight Transmission, Communication Satellites. Analog and Digital transmission. Transmission and switching, frequency division and time division multiplexing , STDM, Circuit switching, packet switching and message switching,

Brief Overview of LAN (Local Area Network) : Classification. Brief overview of Wide Area Network (WAN) . Salient features and differences of LAN with emphasis on : Media, Topology, Speed of Transmission, Distance, Cost. Terminal Handling, Polling, Token passing, Contention. IEEE Standards : their need and developments.

Open System : What is an Open System ? Network Architectures, ISO-OSI Reference Model, Layers : Application, Presentation, Session, Transport, Network, Data Link & Physical . Physical Layer - Transmission, Bandwidth, Signaling devices used, media type. Data Link Layer - : Addressing, Media Access Methods, Logical link Control, Basic algorithms/protocols.

Network Layer : Routing : Fewest-Hops routing, Type of Service routing, Updating Gateway routing information. Brief overview of Gateways, Bridges and Routers, Gateway protocols, routing daemons. OSI and TCP/IP model. TCP/IP and Ethernet. The Internet : The structure of the Internet, the internet layers, Internetwork problems. Internet Standards.

THEORY OF COMPILER DESIGN

Structure of a compiler, cross compiler, finite automata and lexical analysis : The roll of lexical analyzer ,design of lexical analyzer.

Regular expressions, finite automata, definite finite automata minimizing the no. of states of a DFA ,context free, grammers.

Derivations and parse trees , basic parsing techniques, parses, shift -reduce parsing , operator precedence ,parsing, top-down parsing.

Run-time Storage administrations, implementation of a simple stack, allocation scheme.

Implementation of block structured languages, storage allocation in block, structued languages, code generator.

COMPUTER GRAPHICS

Graphics Hardware: Basic of Computer Graphics, display technology, Raster Scan & Random scan display systems, Input devices.

Basic Raster Graphics for drawing 2_D primitives: Scan converting lines, circles, ellipse; filling rectangles, polygons, generating characters; antialiasing. Matrix representation and Homogeneous coordinates, two dimensional transformations, 2Dline clipping, polygon clipping algorithms, window to viewport transformation.

Viewing in 3D: Three dimensional transformation, projections : Parallel, prospective, view points.

Representation of curves & surfaces, Besier method, B-spline methods.Visible surface determination: Z-buffer, Algos, List priority algorithms, Scan line algorithms.Light and shading models: Illumination models, shading models for polygons, shading algorithms, Gouraud & Phong, color models like RGB, YIU, copy, HSV etc.

Introduction to multimedia, multimedia components; multimedia hardware, SCSI, IDE, MCI, Multimedia data and file formats, RTF, TIFF, MIDI, JPEG, DIB, MPEG, Multimedia tools, presentations tools, Authoring tools, presentations. Graphics animation : Tweeking, Morphing simulating accelerator, motion specification.

SOFTWARE ENGINEERING

Introduction to Software Engineering : Software development, and life cycle; Project size and its categories; Planning a software project.

Project control & Project team standards; Design of solution strategies; Software cost estimation and evaluation techniques.

Software Design : Various Design concepts and notations; Modern design techniques; Verification and validation methods; Documentation & implementation procedures; Performance of software systems; Software metrics and models. Documentation of Project-systems, manuals and implementation.

Software Reliability : Definition and concept of software reliability; software errors, faults, repair and availability; Re-availability & availability models; Use of database as a study tool.

Modern Programming Language Features Relevant to Software Engineering: data abstraction, exception handling, concurrency mechanism, etc; Software development environments.

ARTIFICIAL INTELLIGENCE

Introduction of Artificial Intelligence : What is AI ? The Importance of AI. AI and related fields. Introduction to Natural Language Processing .

Knowledge : General Concepts, Definition and Importance of Knowledge, Knowledge based system, representation of Knowledge, Knowledge Organization , Knowledge Manipulation , Acquisition of Knowledge.

LISP AND AI PROGRAMMING LANGUAGES : Introduction to LISP : Syntax and Numeric Functions, Basic List Manipulation Functions in LISP , Functions, Predicates, and Conditionals, Input, Output, and Local Variables, Iteration and Recursion, Property List and arrays, PROGLOG and Other AI Programming Languages,

FORMALIZED SYMBOLIC LOGICS : Introduction , Syntax and Semantics for Propositional Logic , Syntax and Semantics for FOPL , Properties of Wffs , Conversion to Clausal Form, Inference Rules , The Resolution Principle , Representations Using Rules.

Introduction to Expert System , Characteristics features of Expert System, Applications of Expert System. Importance of Expert System.

DATA MINING

Introduction : Data Mining: Definitions, KDD v/s Data Mining, DBMS v/s Data Mining , DM techniques, Mining problems, Issues and Challenges in DM, DM Application areas. Association Rules & Clustering Techniques: Introduction, Various association algorithms like A Priori, Partition, Pincer search etc., Generalized association rules.

Clustering paradigms; Partitioning algorithms like K-Medioid, CLARA,CLARANS; Hierarchical clustering, DBSCAN, BIRCH, CURE; categorical clustering algorithms, STIRR, ROCK, CACTUS. Other DM techniques & Web Mining: Application of Neural Network, AI, Fuzzy logic and Genetic algorithm, Decision tree in DM. Web Mining, Web content mining, Web structure Mining, Web Usage Mining.

Temporal and spatial DM: Temporal association rules, Sequence Mining, GSP, SPADE, SPIRIT, and WUM algorithms, Episode Discovery, Event prediction, Time series analysis. Spatial Mining, Spatial Mining tasks, Spatial clustering, Spatial Trends.

Data Mining of Image and Video : A case study. Image and Video representation techniques, feature extraction, motion analysis, content based image and video retrieval, clustering and association paradigm, knowledge discovery.

The vicious cycle of Data mining, data mining methodology, measuring the effectiveness of data mining data mining techniques. Market baskets analysis, memory based reasoning, automatic cluster detection, link analysis, artificial neural networks, generic algorithms, data mining and corporate data warehouse, OLA

Design and Analysis of Algorithms

Introduction and Review: What is an Algorithm, Algorithm's Performance, order architecture: Θ-Notation, O-Notation, Ω-Notation, Algorithm Analysis: time space complexities, **Worst-case Complexity, Average-case Complexity.**
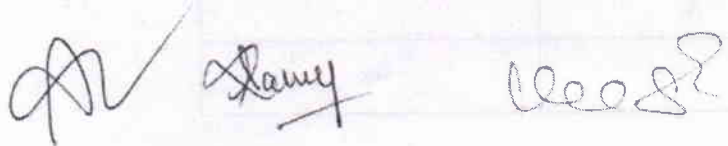
Divide and conquer: Structure of divide-and –conquer algorithms: examples, Binary search, quick sort, Analysis of divide and conquer, run time recurrence relations.

Graph Searching and Traversal: Overview, Traversal methods: depth first and breadth first search.

Greedy Method: Overview of the greedy method, Minimum spanning trees, Single source shortest paths.

Dynamic programming: The general method, principle of optimality, difference between dynamic programming and greedy method, Applications: optimal binary search trees, **Back tracking:** The general method, 8-queens problem.

Branch and Bound Algorithm: The **Branch and bound** method, FIFO and LIFO branch and bound, LC (Least Cost) search, Traveling Salesman Problem, LCBB on Traveling Salesman Problem.

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NETWORK SECURITY

Convention Encryption : Conventional Encryption Model , Stenography , Classical Encryption Techniques, Simplified DES , Block Cipher Principles , The Data Encryption Standard, The Strength of DES , Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher Modes of operation, Conventional

Encryption algorithms: Public Key Encryption And Hash Functions Public Key Cryptography , Principles of Public Key Cryptosystems , The RSA Algorithm , Key Management , Diffie Hellman Key Exchange , Elliptic Curve Cryptography.

Message Authentication and Hash Functions Authentication Requirements, Authentication Functions, Message Authentication Codes , Hash Functions , Security of Hash Functions

Hash And Mac Algorithms MD5 Message Digest Algorithm , Secure Hash Algorithm (SHA-I) , RIPEMD ,HMAC

Digital Signatures and Authentication Protocols Digital Signatures . Authentication Protocols - Digital Signature Standard Authentication Applications , IP Security , Web Security Intruders, Viruses and Worms Intruders , Viruses and Related Threats Firewalls Firewall Design Principles , Trusted Systems

Project Management with JAVA

The Java Environment: History of Java: Comparison of Java and C++; Java as an object oriented language: Java buzzwords; A simple program, its compilation and execution; the concept of CLASSPATH; Basic idea of application and applet; **Basics**: Data types; Operators- precedence and associativity; Type conversion; The decision making – if, if..else, switch; loops – for, while, do...while; special statements--return, break, continue, labeled break, labeled continue; Modular programming methods; arrays; memory allocation and garbage collection in java keywords. **Object Oriented Programming in Java:** Class; Packages; scope and lifetime; Access specifies; Constructors; Copy constructor; this pointer; finalize () method; arrays; Memory allocation and garbage collection in java keywords **Inheritance** : Inheritance basics, method overriding, dynamics method dispatch, abstract classes.

Interfaces : defining an interface, implementing & applying interfaces, variables in interfaces, extending interfaces. **Multithreading and Exception Handling:** Basic idea of multithreaded programming; The lifecycle of a thread; Creating thread with the thread class and runnable interface; Thread synchronization; Thread scheduling; Producer-consumer relationship; Daemon thread, Selfish threads; Basic idea of exception handling; The try, catch and throw; throws Constructor and finalizers in exception handling; Exception Handling.

Applets: Applet security restrictions; the class hierarchy for applets; Life cycle of applet; HTML Tags for applet.**The AWT:** The class hierarchy of window fundamentals; The basic user interface components Label, Button, Check Box, Radio Button, Choice menu, Text area, Scroll list, Scroll bar; Frame; Layout managers flow layout, Grid layout, Border layout, Card layout. **The Java Event Handling Model:** Java's event delegation model – Ignoring the event, Self contained events, Delegating. **Events:** The event class hierarchy; The relationship between interface, methods called, parameters and event source; Adapter classes; Event classes action Event, Adjustment Event, Container Event, Focus Event, Item Event, Key Event, Mouse Event, Text Event, Window Event.

Input/Output : Exploring Java i.o., Directories, stream classes The Byte stream : Input stream, output stream, file input stream, file output stream, print stream, Random access file, the character streams, Buffered reader, buffered writer, print writer, serialization. **JDBC**: JDBC-ODBC bridge; The connectivity model; The driver manager; Navigating the result set object contents; java.sql Package; The JDBC exception classes; Connecting to Remote database.

Networking & RMI: Java Networking : Networking Basics : Socket, Client server, reserved sockets, proxy servers, Inet address, TCP sockets, UDP sockets. ; RMI for distributed computing; RMI registry services; Steps of creating RMI Application and an example. **Collections:** The collections framework, collection interfaces, collection classes.

Cloud Computing

Historical development, Vision of Cloud Computing, Characteristic of Cloud Computing As Per NIST, Cloud Computing Reference Model, Cloud computing Environments, Cloud service requirements, cloud and dynamic infrastructure, cloud adaptation and rudiments. Overview of cloud application: ECG Analysis in the cloud, Protein Structure prediction, Gene Expression Data Analysis, Satellites Image Processing, CRM and ERP, Social networking.

Cloud Computing Architecture: Cloud Reference model types of cloud, cloud interpretability and standards, scalability and fault tolerance, cloud solutions, cloud eco- system, cloud business process management, cloud service management, cloud offerings, cloud analytics, testing under control, virtual desktop infrastructure.

Cloud Management and virtualization and technology Resilliency, Provisioning, Asset Management, Concepts of MAP reduce, Cloud governance, High availability and disaster recovery, virtualization, fundamentals concepts of compute storage, networking, desktop and application virtualization, virtualization benefits, sever virtualization, block and file level storage virtualization, hypervisor management software, infrastructure requirements, virtual LAN (VLAN), and virtual SAN (VSAN) and their benefits.

Cloud security: Cloud information security fundamentals, cioud security services, design principles, Secure cloud software requirements, policy implementations, cloud computing security challenges, virtualization security management, cloud computing security architecture.

Market based Management of clouds, federated clouds/ inter cloud: Characterization and definition, Cloud federation status, third party cloud services. Case study: Google App Engine, Hadoop, Amazon, Aneka.

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Internetwork Application

TCP/IP Model : Comparison with ISO -OSI reference model. TCP/IP Protocol Family: Transport : Transmission Control Protocol, TCP Header Format, UDP Routing : IP Addressing , limitations , Brief overview of IPV6 i.e. the next generation IP, IP header format. Network Addresses: ARP, Domain Name System (DNS), RARP.

User Services /Applications : File Transfer Protocol (FTP) : Channel Connection, Command : internal & Users, Connections, debugging option with FTP, third party transfer, anonymous FTP, FTP Servers, TFTP, Telnet, BOOTP, Gateway Protocols : brief overview of EGP, CGP & IGP, Other protocols : NFS, NIS, RPC, SMTP, SNMP.

Internet : Uses, Goals/advantages, WWW, Intranet : Goals, benefits, how TCP/IP, bridges, routers, E-mail works in an intranet, Intranet and WWW : IP Networks, HTTP, Commands, Intranet applications : Overview of Web-Servers : essential & desirable features of a web server : authentication , authorization and encryption ; proxy services ; Subnetting an intranet.

Overview of an intranet security system : Security and access policies, Server Security, Firewalls, General Security. WAN : overview of DDS, T-1, T-3 , Frame Relay, Sonet, SMDS, ATM Services, WAN implementation, Connecting the LANs : Bridges, routers, Accessing WAN, Message handling system : X.400 & X.500 , Message Transfer Agents (MTA), Mailbox.

Development of the Socket Programming Interface : Socket Services, Creating a Socket , Binding the Socket , Connecting to the Destination , open Command , Sending Data , Receiving Data , Server Listening , Closing a Connection , Aborting a Connection , UNIX Forks.
Network services - file servers, message servers , Directory servers, print servers, application servers.

Distributed System

Introduction to Distributed Systems: Goal of Distributed Systems, Hardware and Software concepts, the client server model, Remote procedure call, remote object invocation, message and stream oriented communications.

Process and synchronization in distributed system: Threads, Client Server codes, migration, clock synchronization, mutual exclusion, Bully and Ring algorithm, Distributed transactions.

Consistency, Replication, fault tolerance and security: Object replication, data centric, consistency model, client centric consistency models, introduction to fault tolerance, process resilience, recovery, distributed security architecture, security management, KERBEROS, secure socket layer, cryptography.

Distributed Object based and file systems : CORBA, Distributed COM, Goals and Design Issues of Distributed file system, types of distributed file system, sun network file system.

Distributed shared memory, DSM servers, shared memory consistency model, distributed document based systems, the world wide web, distributed coordination based system: JNI.