

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB
Syllabus for B.Sc.in Cyber Security Programme
(Effective for Students Admitted in Academic Session 2019-2020)

Semester 3:

1. Database Management Systems & Distributed Databases

Unit 1: DBMS Concepts: Introduction, Significance of Database, Database System Applications; Data Independence; Data Modeling for a Database; Entities and their Attributes, Entities, Attributes, Relationships and Relationships Types, Advantages and Disadvantages of Database Management System, DBMS Vs RDBMS. -- 2L

Unit 2: Database System Architecture: Three Level Architecture of DBMS, The External Level or Subschema, The Conceptual Level or Conceptual Schema, The Internal Level or Physical Schema, Mapping; Architecture of MySQL, SQL Server and Oracle ; Database Management System Facilities, Data Definition Language, Data Manipulation Language; Database Management System Structure, Database Manager, Database Administrator, Data Dictionary; Distributed Processing, Information and Communications Technology System (ICT), Client / Server Architecture -- 4L

Unit 3: Database Models and Implementation: Data Model and Types of Data Model, Relational Data Model, Hierarchical Model, Network Data Model, Object/Relational Model, Object-Oriented Model; Entity-Relationship Model, Modeling using E-R Diagrams, Notation used in E-R Model, Relationships and Relationship Types; Associative Database Model -- 4L

Unit 4: File Organization for Conventional DBMS: Storage Devices and its Characteristics, Magnetic Disks, Physical Characteristics of Disks, Performance Measures of Disks, Optimization of Disk-Block Access; File Organization, Fixed-Length Records, Variable-Length Records, Organization of records in files; Sequential file Organization; Indexed Sequential Access Method (ISAM); Virtual Storage Access Method (VSAM) -- 4L

Unit 5: An Introduction to RDBMS: An informal look at the relational model; Relational Database Management System; RDBMS Properties, The Entity-Relationship Model; Overview of Relational Query Optimization; System Catalog in a Relational DBMS, Information Stored in the System Catalog, How Catalogs are Stored. -- 4L

Unit 6: Relational Algebra & Relational Calculus : Basic Operations, Union, Difference, Intersection, Cartesian Product; Additional Relational Algebraic Operations, Projection, Selection, JOIN, Division. **Relational Calculus:** Tuple Relational Calculus, Semantics of TRC Queries, Examples of TRC Queries; Domain Relational Calculus; Relational ALGEBRA vs Relational CALCULUS -- 4L

Unit 7: SQL – 1 : Categories of SQL Commands; Data Definition; Data Manipulation Statements, SELECT - The Basic Form, Subqueries, Functions, GROUP BY Feature, Updating the Database, Data Definition Facilities. **SQL – 2:** Views; Embedded SQL *, Declaring Variables and Exceptions, Embedding SQL Statements; Transaction Processing, Consistency and Isolation, Atomicity and Durability – 4L

Unit 10: Normalization: Functional Dependency; Anomalies in a Database; Properties of Normalized Relations; First Normalization; Second Normal Form Relation; Third Normal Form; Boyce-Codd Normal Form (BCNF); Fourth and Fifth Normal Form. – 3L

Unit 11: Query Processing and Optimization: Query Interpretation; Equivalence of Expressions; Algorithm for Executing Query Operations, External sorting, Select operation, Join operation, PROJECT and set operation, Aggregate operations, Outer join, Heuristics in Query Optimization. – 3L

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Unit 12: Distributed Databases: Structure of Distributed Database; Trade-offs in Distributing the Database, Advantages of Data Distribution, Disadvantages of Data Distribution; Design of Distributed Databases, Data Replication, Data Fragmentation - 4L

Text Books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Navathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System, McGraw-Hill
4. Gray Jim and Reuter Address, "Transaction Processing : Concepts and Techniques", Morgan Kaufman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.
7. Ullman JD., "Principles of Database Systems", Galgottia Publication.

Reference:

1. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
2. "Fundamentals of Database Systems", Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing Edition
3. "Database Management Systems", Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

2. Security Architecture and Models

Module I: Security Architecture and Information.

Introduction, History, Information Security, Critical Characteristics of Information, Components of an Information System, Securing the Components, Balancing Security and Access, Need for security, Business needs, Threats, Attacks, Legal, Ethical and Professional Issues. – 7L

Module II: Logical design and physical design.

Blueprint for security, Information Security policy, NIST Models, VISA International security model, Design of Security Architecture, Planning for continuity, Security Technology, IDS, Cryptography, Access Control Devices, Physical Security, Security and Personnel. – 7L

Module III: Low-level architecture.

Security Assessments, Security Architecture Basics, Architecture Patterns in Security, Cryptography, Trusted Code, Secure Communications. – 6L

Module IV: Mid-level architecture.

Middleware Security, Web Security, Application and OS Security, Database Security. – 6L

Module V: High-level architecture.

Security Components, Security and Other Architectural Goals, Enterprise Security Architecture. – 6L

Module VI: Business cases and security.

Business Cases for Security. – 2L

Text Books Books:

1. Brook S. E. Schoenfield "Securing Systems: Applied Security Architecture and Threat Models" CRC Press 1st Edition 2015
2. John Sherwood, Andrew Clark, David Lynas " Enterprise Security Architecture: A Business-Driven Approach" CRC Press 1st Edition 2005

3. Operating Systems

UNIT –I OPERATING SYSTEM OVERVIEW: Operating System Objectives and Functions, The Evolution of Operating Systems, Developments Leading to Modern Operating Systems, Virtual Machines. OS Design Considerations for Multiprocessor and Multicore architectures, Microsoft Windows Overview, Modern UNIX Systems, Linux, Android. Booting Process of all the above operating systems. – 4L

UNIT -II PROCESS DESCRIPTION AND CONTROL: Process: Concept of a Process, Process States, Process Description, Process Control (Process creation, waiting for the process/processes, Loading programs into processes and Process Termination), Execution of the Operating System. Threads: Processes and Threads, Concept of Multithreading, Types of Threads, Thread programming Using pthreads, Multicore processors and threads, Linux Process and Thread Management, Android Process and Thread Management. Scheduling: Uniprocessor Scheduling - Types of Scheduling, Scheduling Algorithms, and Thread Scheduling, An introduction to Multiprocessor and Real-Time Scheduling, Traditional UNIX Scheduling, Linux Scheduling. – 8L

UNIT -III CONCURRENCY: MUTUAL EXCLUSION AND SYNCHRONIZATION - Concurrency: Process/thread Synchronization and Mutual Exclusion. Principles of Concurrency, Requirements for Mutual Exclusion, Mutual Exclusion: Hardware Support, Operating System Support (Semaphores and Mutex), Programming Language Support (Monitors), Classical synchronization problems: Readers/Writers Problem, Producer and Consumer problem. Concurrency: Deadlock and Starvation Principles of Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock detection, An Integrated Deadlock Strategy, Example: Dining Philosophers Problem, Linux inter-process communication and concurrency mechanisms, Android Inter-process communication mechanisms and concurrency mechanisms -- 8L

UNIT -IV MEMORY MANAGEMENT: Memory Management: Memory Management Requirements, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Buddy System, Relocation, Paging, Segmentation. Virtual Memory: Hardware and Control Structures, Operating System Software, Linux Memory Management, Windows Memory Management, Android Memory Management. – 6L

UNIT –V INPUT/OUTPUT AND FILES: I/O Management and Disk Scheduling: I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling, Disk Cache, Linux I/O. File Management: Overview, File Organization and Access, File Directories, File Sharing, Record Blocking, Secondary Storage Management, Linux Virtual File System, Android File Management. – 4L

UNIT -VI RECENT AND FUTURE TRENDS IN OS: Linux Kernel Module Programming, Embedded Operating Systems: Characteristics of Embedded Systems, Embedded Linux, and Application specific OS. Basic services of NACH Operating System. Introduction to Service Oriented Operating System (SOOS), Introduction to Ubuntu EDGE OS, etc. – 6L

Text Books

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition, 2014, ISBN-10: 0133805913
• ISBN-13: 9780133805918
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley & Sons, Inc., 9th Edition, 2012, ISBN 978-1-118-06333-0
3. Maurice J. Bach, "Design of UNIX Operating System", PHI

Reference Books

1. Tom Adelstein and Bill Lubanovic, Linux System Administration, O'Reilly Media, Inc., 1st Edition, 2007. ISBN-10: 0596009526 | ISBN-13: 978-0596009526
2. Harvey M. Deitel, Operating Systems, Prentice Hall, 3rd Edition, 2003, ISBN-10: 0131828274 | ISBN-13: 978-0131828278

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3. Andrew S. Tanenbaum, Modern Operating System, Prentice Hall, 3rd Edition, 2007, ISBN-10: 0136006639 | ISBN-13: 978-0136006633

4. Operating System in depth by Thomson

4. Vulnerability Analysis, Penetration Testing, and Incident Handling

Module I: Intro & Pen Test Methodologies.

Testing methodologies (Black Box/White Box/Fuzz) , Engagement practices. – 2L

Module II: Information Gathering

Passive Information gathering, Open source information gathering, Active Information gathering, Enumeration. – 4L

Module III: Vulnerability Management

Vulnerability discovery, Vulnerability mitigation, Proxy Chain. – 4L

Module IV: Exploitation

System Vulnerability Exploitation, Buffer overflow, Fuzzing, Pivoting, Peripheral Device Exploitation SQL Injection, Cross Site Scripting, Cross Site Request Forgery, File Upload, Local File Inclusion, Remote File Inclusion. Post Exploitation, Privilege Escalation, –14L

Module V: Advanced binary exploitation

Introduction to Reverse Engineering, Introduction to Exploit Writing, Static code Analysis, Binary Analysis – 10L

Text Books:

1. Jon Erickson "Hacking: The Art of Exploitation" , No Strach Press 2nd Edition 2008
2. Jim O'Gorman, Devon Kearns, Mati Aharoni "Metasploit: The Penetration Tester's Guide" , No Strach Press 1st Edition 2011

5. Cyber Threat and Modelling

Unit-1: Introduction to Threat Model, Learning to Threat Model. Strategies for Threat Modelling, Approach to Your Threats, Structured Approaches to Threat Modelling, Models of Software. – 4L

Unit-2: Finding Threats, STRIDE, Spoofing Threats, Tampering Threats, Repudiation Threats, Information Disclosure Threats, Denial-of-Service Threats. Attack Trees, Working with Attack Trees, Representing a Tree, Real Attack Trees. Attack Libraries, Properties of Attack Libraries. – 6L

Unit-3: Managing and Addressing Threats, Processing and Managing Threats, Starting the Threat Modelling Project, Digging Deeper into Mitigations, Tracking with Tables and Lists, Scenario-Specific Elements of Threat Modelling. Defensive Tactics and Technologies, Tactics and Technologies for Mitigating Threats, Addressing Threats with Patterns, Mitigating Privacy Threats. – 6L

Unit-4: Threat Modelling Tools, Generally Useful Tools, Open-Source Tools, Commercial Tools. Web and Cloud Threats, Web Threats, Cloud Tenant Threats, Cloud Provider Threats, Mobile Threats. – 6L

Unit-5: Threats to Cryptosystems, Cryptographic Primitives, Classic Threat Actors, Attacks against Cryptosystems, Building with Crypto, Things to Remember about Crypto Experimental Approaches, Looking in the Seams, Operational Threat Models, Threats to Threat Modelling Approaches, How to Experiment. – 8L

Text Books:

1. Adam Shostack, "Threat Modeling: Designing for Security" Wiley publication, Edition, 2008.
2. Frank Swiderski, Window Snyder "Threat Modeling (Microsoft Professional)" Microsoft Press, Edition, 2008.

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DBMS Lab:

Structured Query Language

1. **Creating Database:** Creating a Database, creating a Table, Specifying Relational Data Types, Specifying Constraints, Creating Indexes
2. **Table and Record Handling:** INSERT statement; Using SELECT and INSERT together; DELETE, UPDATE, TRUNCATE statements; DROP, ALTER statements
3. **Retrieving Data from a Database:** The SELECT statement; Using the WHERE clause; Using Logical Operators in the WHERE clause; Using IN, BETWEEN, LIKE, ORDER BY, GROUP BY and HAVING Clause; Using Aggregate Functions; Combining Tables Using JOINS; Subqueries
4. **Database Management:** Creating Views, Creating Column Aliases, Creating Database Users, Using GRANT and REVOKE
5. **PL/SQL:** Cursors in Oracle PL / SQL Writing Oracle PL / SQL Stored Procedures
6. **Application:** Implement simple Database Application codes using PHP/Java with MySQL/Oracle.

Operating Systems Lab:

1. **Managing Unix/Linux Operating System:** - Creating a bash shell script, making a script executable, shell syntax (variables, conditions, control structures, functions, commands). Partitions, Swap space, Device files, Raw and Block files, Formatting disks, Making file systems, Superblock, I-nodes, File system checker, Mounting file systems, Logical Volumes, Network File systems, Backup schedules and methods Kernel loading, init and the inittab file, Run-levels, Run level scripts. Password file management, Password security, Shadow file, Groups and the group file, Shells, restricted shells, user-management commands, homes and permissions, default files, profiles, locking accounts, setting passwords, Switching user, Switching group, Removing users & user groups. – **8P**
2. **Process:** Starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process. – **4P**
3. **Signal:** signal handling, sending signals, signal interface, signal sets. – **4P**
4. **Semaphore:** Programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v). – **6P**
5. **POSIX Threads:** Programming with pthread functions (viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel) -**6P**
6. **Inter-process communication:** pipes(use functions pipe, popen, pclose), named pipes(FIFOs, accessing FIFO), message passing & shared memory(IPC version V). – **6P**
7. **Linux Kernel configuration:** compilation and rebooting from the newly compiled kernel. – **3P**
8. **Implement a new system call:** add this new system call in the Linux kernel (any kernel source, any architecture and any Linux kernel distribution) and demonstrate the use of same. – **3P**

VAPT Lab:

1. Information Gathering and Vulnerability assessment using NMAP, Nessus, Dirbuster, Nikto, Wpscan, Acunetix etc.
2. Exploitation Metasploit , Sqlmap, Manual sql injection. Burpsuit. Writing Script for XSS and CSRF. Exploit the vulnerability LFI RFI
3. Implementation of Proxy Chain.
4. Advanced exploitation by Writing basic exploit, Basic Analysis of Malware, OllyDbg, Immunity Debugger
5. Problem Solving and Report Writing.