**Dr. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY**

**(Established as State Technical University in the State of Maharashtra)**

**Under Maharashtra Act No. XXIX of 2014**

**Po. Lonere, Dist. Raigad, Pin 402 103, Maharashtra.**

**Telephone and Fax No. 02140 - 275142**

**www.dbatu.ac.in**

**Detailed Syllabus**

**for**

# *Proposed Final Year* B.Tech in Computer Engineering

**With effective from July 2020 - 21**

**Semester - I**
**Group A**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | **Mandatory** | **Induction Program** | **3 weeks duration in the beginning of the semester** | | | | | | |
| 2 | BTBS101 | Engineering Mathematics – I | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 3 | BTBS102 | Engineering Physics | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 4 | BTES103 | Engineering Graphics | 2 | - | - | 20 | 20 | 60 | 2 |
| 5 | BTHM104 | Communication Skills | 2 | - | - | 20 | 20 | 60 | 2 |
| 6 | BTES105 | Energy and Environment Engineering | 2 | - | - | 20 | 20 | 60 | 2 |
| 7 | BTES106 | Basic Civil and Mechanical Engineering | 2 | - | - | 50 | - | - | Audit |
| 8 | BTBS107L | Engineering Physics Lab | - | - | 2 | 60 | - | 40 | 1 |
| 9 | BTBS108L | Engineering Graphics Lab | - | - | 4 | 60 | - | 40 | 2 |
| 10 | BTHM109L | Communication Skills Lab | - | - | 2 | 60 | - | 40 | 1 |
| | | **TOTAL** | **14** | **2** | **8** | **330** | **100** | **420** | **18** |

**Semester - II**
**Group B**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | BTBS201 | Engineering Mathematics – II | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 2 | BTBS202 | Engineering Chemistry | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 3 | BTES203 | Engineering Mechanics | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 4 | BTES204 | Computer Programming in C | 2 | - | - | 20 | 20 | 60 | 2 |
| 5 | BTES205 | Workshop Practices | - | - | 4 | 60 | - | 40 | 2 |
| 6 | BTES206 | Basic Electrical and Electronics Engineering | 2 | - | - | 50 | - | - | Audit |
| 7 | BTES207L | Computer Programming Lab | - | - | 2 | 60 | - | 40 | 1 |
| 8 | BTBS208L | Engineering Chemistry Lab | - | - | 2 | 60 | - | 40 | 1 |
| 9 | BTES209L | Engineering Mechanics Lab | - | - | 2 | 60 | - | 40 | 1 |
| 10 | BTES210P | Mini Project | - | - | 2 | 60 | - | 40 | 1 |
| 11 | BTES211P | Field Training / Internship / Industrial Training (minimum of 4 weeks which can be completed partially in First Semester and Second Semester or in at one time). | - | - | - | - | - | - | Credit to be evaluated in III Sem |
| | | **TOTAL** | **12** | **3** | **12** | **430** | **80** | **440** | **19** |

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**Semester - III**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | BTBSC301 | Engineering Mathematics – III | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 2 | BTCOC302 | Discrete Mathematics | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 3 | BTCOC303 | Data Structures | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 4 | BTCOC304 | Computer Architecture & Organization | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 5 | BTCOC305 | Digital Electronics & Microprocessors | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 6 | BTHM3401 | Basic Human Rights | 2 | - | - | 50 | - | - | Audit |
| 7 | BTCOL306 | Python Programming | 1 | - | 2 | 60 | - | 40 | 2 |
| 8 | BTCOL307 | HTML and JavaScript | 1 | - | 2 | 60 | - | 40 | 2 |
| 9 | BTCOL308 | Data Structures Lab | - | - | 2 | 60 | - | 40 | 1 |
| 10 | BTCOL309 | Digital Electronics & Microprocessor Lab | - | - | 2 | 60 | - | 40 | 1 |
| 11 | BTES211P | Field Training / Internship / Industrial Training Evaluation | - | - | - | - | - | 50 | 1 |
| **TOTAL** | | | **15** | **5** | **8** | **390** | **100** | **510** | **23** |

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**Semester - IV**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | BTCOC401 | Design & Analysis of Algorithms | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 2 | BTCOC402 | Probability & Statistics | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 3 | BTCOC403 | Operating Systems | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 4 | BTCOE404 | **Elective-I**<br>(A) Object Oriented Programming in Java<br>(B) Object Oriented Programming in C++ | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 5 | BTID405 | Product Design Engineering | 1 | - | 2 | 60 | - | 40 | 2 |
| 6 | BTBS405A | Physics of Engineering Materials | 2 | 1 | - | 20 | 20 | 60 | 3 |
| | BTCOE406B | Numerical Methods | | | | | | | |
| | BTHM3402 | Soft skills and Personality Development | | | | | | | |
| 7 | BTCOL407 | Design & Analysis of Algorithms Lab | - | - | 2 | 60 | - | 40 | 1 |
| 8 | BTCOL408 | Introduction to Data Science with R | 1 | - | 2 | 60 | - | 40 | 2 |
| 9 | BTCOL409 | Object Oriented Programming Lab | - | - | 2 | 60 | - | 40 | 1 |
| 10 | BTCOL410 | Operating System Lab | - | - | 2 | 60 | - | 40 | 1 |
| 11 | BTCOF411 | Field Training / Internship / Industrial Training Evaluation | - | - | - | - | - | - | Credit to be evaluated in V Sem. |
| | | **TOTAL** | **12** | **5** | **10** | **400** | **100** | **500** | **22** |

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**Semester - V**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | BTCOC501 | Database Systems **$** | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 2 | BTCOC502 | Theory of Computations | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 3 | BTCOC503 | Machine Learning | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 4 | BTCOE504 | **Elective – III**<br>(A) Introduction to Research<br>(B) Cyber Laws<br>(C) Open Elective offered by other departments | 2 | - | - | 20 | 20 | 60 | 2 |
| 5 | BTCOE505 | **Elective – IV**<br>(A) Economics & Management<br>(B) Business Communication | 2 | - | - | 20 | 20 | 60 | 2 |
| 6 | BTCOC506 | Competitive Programming-I | 1 | - | 2 | 60 | - | 40 | 2 |
| 7 | BTCOL507 | Database System Laboratory | - | - | 2 | 60 | - | 40 | 1 |
| 8 | BTCOL508 | Machine Learning Laboratory | - | - | 2 | 60 | - | 40 | 1 |
| 9 | BTCOS509 | Seminar | - | - | 2 | 60 | - | 40 | 1 |
| 10 | BTCOF411 | Field Training / Internship / Industrial Training Evaluation | - | - | - | 60 | - | 40 | 1 |
| | | **TOTAL** | **14** | **3** | **8** | **400** | **100** | **500** | **22** |

$ Content of this subject is updated. Pl. find below the updated content of the Database Systems subject.

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**BTCOC501: Database Systems**

**[Unit 1] Introduction [6 Hrs]**

Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture **Data modeling using the Entity Relationship Model:** ER model concepts, notation for ER diagram, Constraints, keys, E-R Diagrams, Mapping Cardinality, Concepts of Super Key, candidate key, primary key, weak entity sets, Codd's rules, Extended ER model, Generalization, Aggregation, , Reduction of an ER diagrams to tables.

**[Unit 2] Relational Data Model, Relational Algebra and Calculus [10 Hrs]**

Structure of Relational Databases, Database Schema, Keys Relational algebra: Fundamental Operations, Additional Relational Algebra Operations, Extended Relational Algebra Operations. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.

**[Unit 3] Introduction to SQL [6 Hrs]**

Overview of SQL, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operators, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database

**Intermediate SQL :** Join Expressions, Views, Transactions, Integrity Constraints, SQL Data Types and Schema, Authorization, **Advanced SQL :** Assessing SQL from Programming Language, JDBC, ODBC, Embedded SQL, Functions and Procedures, Triggers,

**[Unit 4] Relational database design [8 Hrs]**

Normalization: Features of good relational designs, Functional dependencies, Normal forms, First, Second, Third normal forms, BCNF, Functional Dependency Theory, Multivalued Dependencies, Fourth Normal Form, Database Design Process

**[Unit 5] File Organiztion, Indexing and Hashing [6 Hrs]**

File Organization, Ordered Indices, B+tree Index files, B Tree Index File, Static Hashing, Dynamic Hashing, **Query processing:** Overview, Measures of Query Cost, Selection Operation, Evaluation of relational algebra expressions, Query Optimization, Query equivalence Rules, Join strategies.

**[Unit 6] Transaction processing [6 Hrs]**

Transaction Concept, A simple Transaction Model, Transaction Atomicity and Durablility, Transaction Isolation, ACID Properties, Serializability Concurrency Control Techniques: Lock based Protocols, Deadlock handling, Multiple Granularity, Time stamp-Based Protocols, Recovery System

**Text Books:**

1. Henry Korth, Abraham Silberschatz & S. Sudarshan, *Database System Concepts*, McGraw-Hill Publication, 6th Edition, 2011.
2. Raghu Ramakrishnan, Johannes Gehrke, *Database Management Systems*, McGraw-Hill Publication, 3rd Edition, 2003.

**Reference Books:**

1. Joel Murach, *Murach's Oracle SQL and PL/SQL for Developers,* Mike Murach & Associates, 2nd Edition, 2014.
2. Wiederhold, *Database Design*, McGraw-Hill Publication, 2nd Edition, 1983.
3. Navathe, *Fundamentals of Database System*, Addison-Wesley Publication, 6th Edition, 2012.
4. Mark L. Gillenson, *Fundamentals of Database Management System*, Wiley Publication, 2nd Edition, 2011.
5. **Serge Abiteboul, Richard Hull, Victor Vianu, "Foundations of Databases", Reprint by Addison-Wesley.**

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**Semester – VI**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | BTCOC601 | Compiler Design | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 2 | BTCOC602 | Computer Networks | 3 | 1 | - | 20 | 20 | 60 | 4 |
| 3 | BTCOE603 | **Elective – V**<br>(A) Human Computer Interaction<br>(B) Artificial Intelligence<br>(C) Object-Oriented Analysis Design | 2 | 1 | - | 20 | 20 | 60 | 3 |
| 4 | BTCOE604 | **Elective – VI**<br>(A) Geographical Information System<br>(B) Biology<br>(C) Internet of Things **$** | 2 | - | - | 20 | 20 | 60 | 2 |
| 5 | BTCOE605 | **Elective – VII**<br>(A) Development Engineering<br>(B) National Social Service<br>(C) Consumer Behaviour | 2 | - | - | 20 | 20 | 60 | 2 |
| 6 | BTCOC606 | Competitive Programming-II | 1 | - | 2 | 60 | - | 40 | 2 |
| 7 | BTCOL607 | (A) Mobile Application Development<br>**OR**<br>(A) Internet of Things Laboratory | 1 | - | 2 | 60 | - | 40 | 2 |
| 8 | BTCOL608 | Computer Networks Laboratory | - | - | 2 | 60 | - | 40 | 1 |
| 9 | BTCOF609 | Field Training / Internship / Industrial Training | - | - | - | - | - | - | Credit to be Evaluated in VII Sem. |
| | | **TOTAL** | **14** | **3** | **6** | **280** | **100** | **420** | **20** |

$ Content of this subject is updated. Pl. find below the updated content of the IoT subject.

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## BTCOE604 (B): Internet of Things

**[Unit 1] IoT Introduction** **[6 Hrs]**

Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

**[Unit 2] Smart Objects** **[6 Hrs]**

The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

**[Unit 3] IP Layer** **[6 Hrs]**

IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

**[Unit 4] Data and Analytics for IoT** **[7 Hrs]**

An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of IoT Security, Common Challenges in IoT Security, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment

**[Unit 5] IoT Physical Devices and Endpoints** **[8 Hrs]**

Buildingiot with Arduino: Arduino–Interfaces-Arduino IDE–Programming , RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples.

**REFERENCE BOOKS :**

[1].David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1 st Edition, Pearson Education

[2].Srinivasa K G, "Internet of Things", CENGAGE Leaning India, 2017.

[3].Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1 st Edition, VPT, 2014.

[4].Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017.

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**Semester - VII**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | BTCOC701 | Software Engineering | 3 | - | - | 20 | 20 | 60 | 3 |
| 2 | BTCOE702 | **Elective-VIII**<br>(A) Big Data Analytics<br>(B) Distributed System<br>(C) Fundamental of Digital Image Processing | 3 | - | - | 20 | 20 | 60 | 3 |
| 3 | BTCOE703 | **Elective-IX**<br>(A) Cloud Computing<br>(B) Business Intelligence<br>(C) Natural Language Processing | 3 | - | - | 20 | 20 | 60 | 3 |
| 4 | BTCOE704 | **Open Elective-X**<br>(A) Cryptography and Network Security<br>(B) Computer Graphics<br>(C) Embedded Systems | 3 | - | - | 20 | 20 | 60 | 3 |
| 5 | BTCOL705 | Full Stack Development (LAMP/MEAN) | 1 | - | 2 | 60 | - | 40 | 2 |
| 6 | BTCOL706 | System Administration | 1 | - | 2 | 60 | - | 40 | 2 |
| 7 | BTCOL707 | Elective – VIII Lab | - | - | 2 | 60 | - | 40 | 1 |
| 8 | BTCOL708 | Elective – IX Lab | - | - | 2 | 60 | - | 40 | 1 |
| 9 | BTCOL709 | Elective – X Lab | - | - | 2 | 60 | - | 40 | 1 |
| 10 | BTCOP710 | Project-I | - | - | 4 | 60 | - | 40 | 2 |
| 11 | BTCOF609 | Field Training / Internship / Industrial Training | - | - | - | - | - | 50 | 1 |
| | | **TOTAL** | **14** | **-** | **14** | **440** | **80** | **530** | **22** |

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**Semester - VIII**

| Sr. No. | Course Code | Course Title | Weekly Teaching hrs | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | |
| 1 | BTCOE801 | **Elective-XI**[#]<br>(A) Software Product Design<br>(B) Quantum Computing<br>(C) Software Testing<br>(D) Deep Learning<br>(E) Wireless and Sensor Network | 3 | - | - | 20 | 20 | 60 | 3 |
| 2 | BTCOE802 | **Open Elective-XII**[#]<br>(A) 3D Printing and Design<br>(B) Robotics<br>(C) Advanced Database Techniques<br>(D) Virtual Reality<br>(E) Blockchain Technology | 3 | - | - | 20 | 20 | 60 | 3 |
| 3 | BTCOE803 | Project - II (In-house)[$] / Internship and Project in Industry [*] | - | - | 24 | 60 | - | 40 | 12 |
| | | **TOTAL** | **6** | **-** | **24** | **100** | **40** | **160** | **18** |

# These subjects are to be studied on self –study mode using SWAYAM / NPTEL/ Any other source.

* Six months of Internship and Project in the industry.

$ This is for those students who are not doing Internship and Project in the Industry, they can do project in the department.

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## BTCOC701: Software Engineering

**[Unit 1] Introduction** **[6 Hrs]**

Professional software development, Software engineering ethics, Case studies.

**Software processes:** Software process models, Process activities, Coping with change, The rational unified process.

**[Unit 2] Agile software development** **[6 Hrs]**

Agile methods, Plan-driven and agile development, Extreme programming, Agile project management, Scaling agile methods.

**Requirements engineering:** Functional and non-functional requirements, The software requirements document, Requirements specification, Requirements engineering processes, Requirements elicitation and analysis, Requirements validation, Requirements management.

**[Unit 3] System modeling** **[6 Hrs]**

Context models, Interaction models, Structural models, Behavioral models, Model-driven engineering. **Architectural design:** Architectural design decisions, Architectural views, Architectural patterns, Application architectures.

**[Unit 4] Design and implementation** **[6 Hrs]**

Object-oriented design using UML, Design patterns Implementation issues, Open source development.

**[Unit 5] Testing** **[6 Hrs]**

Software testing, Development testing, Test-driven development, Release testing, User testing.

**[Unit 6]** **[6 Hrs]**

Dependability properties, Availability and reliability, Safety Security.

**Text Books:**


1. Ian Sommerville, *Software Engineering*; 9th Edition, Addison-Wesley Publishing Company, USA.


**Reference Books:**


1. Software Engineering, S. A. Kelkar, Prentice Hall of India, 2007
2. Software Engineering, Pressman, Tata McGraw Hill, 2006
3. Software Engineering, Pankaj Jalote, Narosa Publishers, 2006.


**NPTEL Course:**

6. Software Engineering, Prof. Rajib Mall, Department of Computer Science and Engineering, IIT Kharagpur.

**Elective - VIII**
**BTCOE702 (A): Big Data Analytics**

**[Unit 1] Introduction to Big Data [6 Hrs]**
Why Big Data and Where did it come from?, Characteristics of Big, Challenges and applications of Big Data, Enabling Technologies for Big Data, Big Data Stack, Big Data distribution packages.

**[Unit 2] Big Data Platforms [7 Hrs]**
Overview of Apache Spark, HDFS, YARN, MapReduce, MapReduce Programming Model with Spark, MapReduce Example: Word Count, Page Rank etc, CAP Theorem, Eventual Consistency, Consistency Trade-O-s, ACID and BASE, Zookeeper and Paxos, Cassandra, Cassandra Internals, HBase, HBase Internals.

**[Unit 3] Big Data Streaming Platforms [6 Hrs]**
Big Data Streaming Platforms for Fast Data, Streaming Systems, Big Data Pipelines for Real-Time computing, Spark Streaming, Kafka, Streaming Ecosystem.

**[Unit 4] Big Data Applications [6 Hrs]**
Overview of Big Data Machine Learning, Mahout, Big Data Machine learning Algorithms in Mahout- kmeans, Naïve Bayes etc. Machine learning with Spark, Machine Learning Algorithms in Spark, Spark MLlib, Deep Learning for Big Data, Graph Processing: Pregel, Giraph, Spark GraphX

**[Unit 5] Database for the Modern Web [7 Hrs]**
Introduction to mongoDB key features, Core server tools, MongoDB through the JavaScript' sshell, Creating and querying through Indexes, Document-oriented, principles of schema design, Constructing queries on databases, collections and documents, MongoDBquery language.

**Text Books:**

3. "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Bart Baesens, Wiley and SAS Business Series.
4. "Big Data Principals and Paradiagram", Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi, Morgan Kaufmann, Elsevier, ISBN: 978-0-12-805394-2
5. "MongoDB in Action", Kyle Banker, Peter Bakkum and Shaun Verch, 2nd Edition Dream tech Press, ISBN: 978-9351199359.
6. "Mining of Massive Datasets", Anand Rajaraman, Jeffrey D. Ullman, 3rd edition, Cambridge University Press

**Reference Books:**

1. "BIG Data and Analytics", Sima Acharya, Subhashini Chhellappan,Wiley publication, ISBN: 978-8126554782.

**NPTEL COURSE:**

1. Big Data Computing by PROF. RAJIV MISRA, Dept. of Computer Science and Engineering, IIT Patna.

**Elective - VIII**
**BTCOE702 (B): Distributed Systems**

**[Unit 1] Introduction [7 Hrs]**
Introduction to Distributed Computing System, Evolution of Distributed Computing System, Distributed Computing System models, Distributed Computing System Gaining Popularity, Distributed Operating System, Introduction to Distributed Computing Environment (DCE), Desirable Features of a Good Message-Passing System, Issues in IPC by Message-Passing, Synchronization, Buffering, Multidatagram message, Encoding and Decoding of message data, Process addressing, Failure Handling, Group Communication, Case Study: BSD UNIX IPC Mechanism.

**[Unit 2] Remote Procedure Calls [7 Hrs]**
Introduction, the RPC model, Transparency of RPC, Implementing RPC Mechanism, Stub Generation, RPC messages, Marshaling arguments and Results, Server Management, Parameter Passing Semantics, Call Semantics, Communication Protocols for RPCs, Complicated RPCs, Client- Server Binding, Exception Handling, Security, Some Special Types of RPCs, RPC in Heterogeneous Environments, Lightweight RPC, Optimization for Better Performance, Case studies: Sun RPC, DCE, RPC.

**[Unit 3] Distributed Shared Memory [6 Hrs]**
Introduction, general Architecture of DSM Systems, Design and Implementation Issues of DSM, Granularity, Structure of Shared Memory Space, Consistency Models, Replacement Strategy, Thrashing, Other Approaches to DSM, Heterogeneous DSM, Advantages of Synchronization: Introduction, Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms.

**[Unit 4] Resource Management [6 Hrs]**
Introduction, Desirable Features of a Good Global Scheduling Algorithm, Task assignment Approach, Load-Balancing Approach, load Sharing Approach, Process Migration, Threads.

**[Unit 5] Distributed File System [6 Hrs]**
Introduction, Desirable Features of a Good Distributed File System, File Models, File Accessing Models, File Sharing Semantics, File Caching Schemes, File Replication, Fault Tolerance, Atomic Transactions, Design Principles, Case Study: DCE Distributed File Service.

**Text Books:**

1. P. K. Sinha, *Distributed Operating System*, PHI Publication.
2. Colorouis, *Distributed Systems*, Addison Wesley Publication.
3. M. L. Liu, *Distributed Computing: Principles and Applications*, Addison-Wesley, 2004.

**NPTEL Course:**

1. Distributed Systems, Prof. Rajiv Mishra, IIT Patna.

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**Elective - VIII**

**BTCOE702 (C): Fundamental of Digital Image Processing**

**[Unit 1] Digital Image Fundamentals and Image Transform [6 Hrs]**

What is Digital Image Processing? The Origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Digital image representation, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of visual perception, Image sampling and quantization, Basic relationship between pixels, Discrete Fourier transform, Properties of 2D DFT.

**[Unit 2] Image Enhancement Techniques [6 Hrs]**

Spatial Domain Techniques, Point processing, Neighborhood processing, Spatial domain filtering, Image smoothing and Image sharpening using spatial domain filters, Enhancement based on histogram modeling, Frequency domain filtering, Image smoothing and Image sharpening using frequency domain filters.

**[Unit 3] Image Compression [6 Hrs]**

Fundamentals, Types of redundancies, Lossy and Lossless compression, Dictionary based coding, Run-length coding, LZW coding, Huffman coding, Arithmetic coding, Image compression model.

**[Unit 4] Image Segmentation [6 Hrs]**

Detection of Discontinuities - Point, Line and Edge detection, finding gradients using masks, Thresholding based image segmentation, global and local thresholding, Region based segmentation.

**[Unit 5] Applications in different domains [6 Hrs]**

Applications of image processing in satellite, sonar, radar and medical areas.

**Text Books:**


1. R. C. Gonzalez and Richard E Woods, “Digital Image Processing”, 3’rd Edition, Pearson Education, ISBN 978-81-317-1934-3, 2008.
2. R.C. Gonzalez and R.E. Woods, “Digital Image Processing Using Matlab”, Pearson Education, ISBN: 978-8177588989.
3. Anil K Jain, “Fundamentals of Digital Image Processing”, Prentice Hall, ISBN: 0133361659, 9780133361650

**Elective - IX**
**BTCOE703 (A): Cloud Computing**

**[Unit 1] Introduction to Cloud** **[6 Hrs]**

Cloud Computing at a Glance, the Vision of Cloud Computing, Defining a Cloud, A Closer Look, Cloud Computing Reference Model, Characteristics and Benefits, Challenges Ahead, Historical Developments.

**Virtualization:** Introduction, Characteristics of Virtualized Environment, Taxonomy of Virtualization Techniques, Virtualization and Cloud computing, Pros and Cons of Virtualization, Technology Examples- VMware and Microsoft Hyper-V.

**Before the Move into the Cloud:** Know Your Software Licenses, The Shift to a Cloud Cost Model, Service Levels for Cloud Applications.

**[Unit 2] Cloud Computing Architecture** **[6 Hrs]**

Introduction, Cloud Reference Model, Architecture, Infrastructure / Hardware as a Service, Platform as a Service, Software as a Service, Types of Clouds, Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds, Economics of the Cloud, Open Challenges, Cloud Interoperability and Standards, Scalability and Fault Tolerance.

**Ready for the Cloud:** Web Application Design, Machine Image Design, Privacy Design, Database Management, Data Security, Network Security, Host Security, Compromise Response.

**[Unit 3] Defining the Clouds for Enterprise** **[6 Hrs]**

Storage as a service, Database as a service, Process as a service, Information as a service, Integration as a service and Testing as a service; Scaling a cloud infrastructure - Capacity Planning, Cloud Scale. **Disaster Recovery:** Disaster Recovery Planning, Disasters in the Cloud, Disaster Management.

**[Unit 4] Aneka: Cloud Application Platform** **[6 Hrs]**

Framework Overview, Anatomy of the Aneka Container, From the Ground Up: Platform Abstraction Layer, Fabric Services, Foundation Services, Application Services, Building Aneka Clouds, Infrastructure Organization, Logical Organization, Private Cloud Deployment Mode, Public Cloud Deployment Mode, Hybrid Cloud Deployment Mode, Cloud Programming and Management, Aneka SDK, Management Tools.

**[Unit 5] Cloud Applications** **[6 Hrs]**

Scientific Applications – Health care, Geo-science and Biology; Business and Consumer Applications- CRM and ERP, Social Networking, Media Applications and Multiplayer Online Gaming.

**Cloud Platforms in Industry:** Amazon Web Services- Compute Services, Storage Services, Communication Services and Additional Services. Google AppEngine-Architecture and Core Concepts, Application Life-Cycle, cost model.Microsoft Azure- Azure Core Concepts, SQL Azure.

**Text Books:**

1. Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi from TMH2013.
2. George Reese Cloud Application Architectures, First Edition, O"Reilly Media 2009.
3. Cloud Computing and SOA Convergence in Your Enterprise *A Step-by-Step Guide* by David S. Linthicum from Pearson 2010.
4. Cloud Computing 2nd Edition by Dr. Kumar Saurabh from Wiley India2012.
5. Cloud Computing – web based Applications that change the way you work and ollaborate Online – Micheal Miller, Pearson Education.

**NPTEL Course:**

1. Cloud Computing, Prof. Soumya Kanti Ghosh, Department of Computer Science and Engineering, IIT Kharagpur.

**Elective - IX**
**BTCOE703 (B): Business Intelligence**

**[Unit 1] Introduction to Business Intelligence** **[6 Hrs]**
Introduction to digital data and its types – structured, semi-structured and unstructured, Introduction to OLTP and OLAP (MOLAP, ROLAP, HOLAP).

**[Unit 2] Basics of BI** **[6 Hrs]**
BI Definitions & Concepts, BI Framework, Data Warehousing concepts and its role in BI, BI Infrastructure Components – BI Process, BI Technology, BI Roles & Responsibilities, Business Applications of BI, BI best practices.

**[Unit 3] Data Integration** **[6 Hrs]**
Concepts of data integration, needs and advantages of using data integration, introduction to common data integration approaches, Meta data –types and sources.

**[Unit 4] Data Processing** **[6 Hrs]**
Introduction to data quality, data profiling concepts and applications, Introduction to ETL (Extract-Transform-Loading) using Open Source Software

**[Unit 5] Data and Dimension Modeling** **[6 Hrs]**
Introduction, ER Modeling, multidimensional data modeling, concepts of dimensional, facts, cubes, attribute, hierarchies, star and snowflake schema, Introduction to business metrics and KPLs, creating OLAP using Application Software.

**Basic of Enterprise Reporting:** A typical enterprise, Malcolm Baldrige – quality performance framework, balanced scorecard, enterprise dashboard, balanced scorecard vs. enterprise dashboard, enterprise reporting using software tools, best practices in the design of enterprise dashboards.

**Text Books:**

1. R. N. Prasad and Seema Acharya, “Fundamentals of Business Analytics”, Wiley Publication.

**Reference Books**

1. Raiph Kimball, Ross, “The Data Warehouse Lifecycle Toolkit” Wiley Publication, 2nd edition.
2. Anahory& Murray, “Data Warehousing in the Real World” Pearson Edt Ponniah, “Data Warehousing Fundamentals”, Wiley Publication

**Elective - IX**
**BTCOE703 (C): Natural Language Processing**

**[Unit 1] Introduction** **[6 Hrs]**
Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

**[Unit 2] Word level Analysis** **[7 Hrs]**
Morphology fundamentals; Morphological Diversity o f Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

**[Unit 3] Syntax Analysis** **[6 Hrs]**
Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

**[Unit 4] Semantic Analysis** **[7 Hrs]**
Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Coreferences.

**[Unit 5] Applications** **[6 Hrs]**
Sentiment Analysis; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

**Text Books:**

1. Allen, James, *Natural Language Understanding*, 2nd Edition, Benjamin / Cumming, 1995.
2. Charniack, Eugene, *Statistical Language Learning*, MIT Press, 1993.
3. Jurafsky, Dan and Martin, James, *Speech and Language Processing*, Second Edition, Prentice Hall, 2008.
4. Manning, Christopher and Heinrich, Schutze, *Foundations of Statistical Natural Language Processing*, MIT Press, 1999.

**NPTEL Course:**

1. Natural Language Processing, Prof. Pushpak Bhattacharyya, Department of Computer Science and Engineering, IIT Bombay.

**Elective - X**

**BTCOE704 (A): Cryptography and Network Security**

**[Unit 1] Introduction** **[6 Hrs]**

Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanism, A model for Network Security.

**[Unit 2] Classical Encryption Techniques** **[6 Hrs]**

Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor machines, Stegnography.

**Block Cipher and Data Encryption Standard:** Block cipher principles, Data Encryption Standard, The Strength of DES, Differential and Linear Cryptanalysis, Block cipher Design Principles.

**[Unit 3] Advanced Encryption Standard and Number Theory** **[6 Hrs]**

Evaluation Criteria for AES, AES Cipher, Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms.

**[Unit 4] Public Key Cryptography and Key Management** **[6 Hrs]**

Principles of Public-Key Cryptosystems, RSA Algorithm, Key Management, Diffie-Hellman Key Exchange, Elliptic curve Arithmetic, Elliptic curve Cryptography, ElGamal Cryptosystems, Hash Functions, Secure Hash Algorithm.

**[Unit 5] Digital Signature, Firewall, and Web Security** **[6 Hrs]**

Digital Signatures, Authentication Protocols, Digital Signature Standards, Firewall Design Principles, Trusted Systems.

Introduction to Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.

**Text Books:**


1. William Stallings, *"Cryptography and Network Security"*, Pearson Education / PHI, 2006.
2. V. K. Jain, *"Cryptography and Network Security"*, Khanna Publishing House.
3. Gupta Sarika, *"Information and Cyber Security"*, Khanna Publishing House, Delhi.
4. Atul Kahate, *"Cryptography and Network Security"*, McGraw Hill.
5. V. K. Pachghare, *"Cryptography and Information Security"*, PHI Learning.
6. Nina Godbole, *"Information System Security"*, Wiley.
7. Bothra Harsh, *"Hacking"*, Khanna Publishing House, Delhi.

**Elective - X**
**BTCOE704(B): Computer Graphics**

**[Unit 1] Basic Concepts** **[6 Hrs]**
Introduction to computer graphics, lines, line segments, pixels and frame buffers, anti-aliasing techniques and character generation methods. Graphics Display devices (monochrome, color) interactive devices, Scanners and digitizers, touch panels, tablets, mouse, joysticks, trackball, light pen.

**[Unit 2] 2D Transformation** **[7 Hrs]**
Line and circle plotting using Breshemham's and other algorithms, transformation matrices, scaling, rotation, translation, picture transformation, mirror image.
**Window and Clipping:** Introduction, viewing transforms, 2-D clipping, Sutherland Cohen approach, Cyrus Beck Method, Midpoint subdivision algorithm, Liang-Barsky line clipping algorithm, polygon clipping, text clipping, generalized clipping.

**[Unit 3] 3D Graphics** **[7 Hrs]**
Introduction, 3-D geometry, Coordination system, 3D transformation, rotation about an arbitrary axis, orthogonal projections, multiple views, isometric projection, perspective projections, 3-D clipping.
**Hidden Surfaces and Lines:** Introduction, Back face removal algorithm, Z-buffers, Scan line and Painter's algorithm hidden surface removal, curved surface generation, generation of solids, sweep method, interpolation.

**[Unit 4] Graphical User Interface** **[6 Hrs]**
X-Windows, use of graphics tools like OPENGL, DirectX, Windows and Motif, Graphic Standards.

**[Unit 5] Animation** **[6 Hrs]**
Introduction, devices for producing animation, computer assisted animation, real time animation, method for controlling animation (fully explicit control, procedural).

**Text Books:**

1. Peter Shirley, Michael Ashikhmin, Steve Marschner, *Fundamental of Computer Graphics*, 4th Edition, CRC Press.
2. Newman, Sprouall, *Interactive Computer Graphics*, McGraw-Hill Publication.
3. Hearn, Baker, *Computer Graphics*, PHI Publication.
4. Krishnamurthy, *Introduction to Computer Graphics*, McGraw-Hill Publication.
5. ISRD Group, *Computer Graphics*, McGraw-Hill Publication.

**NPTEL Course:**

1. Computer Graphics, Prof. Sukhendu Das, Department of Computer Science and Engineering, IIT Madras.

## Elective - X
## BTCOE704 (C): Embedded Systems

**[Unit 1] Introduction** **[6 Hrs]**

Embedded system overview, Design challenge, Processor technology, IC technology, Design technology, Custom single processor technology, Hardware-combinational logic, Sequential logic, Custom single purpose processor design, RT-level custom single purpose processor design, Optimizing custom single purpose processors.

**[Unit 2] General purpose processor Software** **[6 Hrs]**

Basic architecture, Operation, Programmers view, Development environment, Application specific instruction set processor, Selecting a microprocessor, General purpose processor design. Introduction, ARM7TDMI-S processor, Block diagram, Memory mapping, Memory accelerator module.

**[Unit 3] System control** **[7 Hrs]**

Pin description, Register description, Crystal oscillator, External interrupt inputs, Other system controls, Memory mapping control, Phase locked loop, Power control, Reset, APB divider, Wakeup timer. GPIO: GPIO register map, Timer-TIMER / COUNTER0 and TIMER / COUNTER1 register map, Example timer operation, Architecture.

**[Unit 4] UART** **[6 Hrs]**

UART0/1 - UART0/1 register map, UART0/1 baud rate, UART0/1 auto-baud, UART0/1 block diagram. Serial peripheral interface: SPI data transfers, SPI pin description, SPI register map, SPI block diagram; I2C-bus interface: I2C bus configuration, I2C operating modes, I2C Bus serial interface block diagram, Summary of I2C registers.

**[Unit 5] Process scheduling** **[7 Hrs]**

Examples of RTOS, Microprocessor and microcontroller based system design, typical design examples, system design and simulation using simulation software such as Proteus VSM. Digital Camera Example Introduction, Introduction to a Simple Digital Camera; User's Perspective, Designer's perspective requirements specification non functional requirements, Informal functional specification, Refined functional specification, Design

**Text Books:**

1. "Embedded System Design- A Unified system Hardwar/Software Introduction", Frank Vahid (3rd Edition, John Wiley India) ISBN 978-81-265-0837-2.
2. LPC 214x User manual (UM10139) www.nxp.com.
3. "ARM System Developer's Guide – Designing and Optimizing System Software", Andrew N. Sloss, Dominic Symes and Chris Wright (ELSEVIER) ISBN: 1-55860-874-5.

**Reference Books:**

1. LPC 17xx User manual (UM10360) :- www.nxp.com
2. ARM architecture reference manual : - www.arm.com
3. "An Engineer's Introduction to the LPC2100 series" Trevor Martin (Hitex (UK) Ltd.)
4. "ARM System-on-Chip Architecture" Steve Furber (2nd Edition, Addison-Wesley Professional)ISBN-13: 9780201403527

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**BTCOL705: Full Stack Development (LAMP / MEAN)**

**[Unit 1] Basic HTML, Advanced HTML [4 Hrs]**

**HTML5:** HTML5 Doctype, Some New HTML5 Elements, HTML5 Header And Footer, Allow spell check and editable areas, Adding audio, Drag & drop, User location: geolocation, Saving information - localStorage, Saving information - sessionStorage.

**[Unit 2] CSS [6 Hrs]**

What Is CSS?, How to write CSS: syntax, Using style sheets, Using external style sheets, Identities and classes, Style entire elements, CSS Comments, Change background colors, Setting background images, Change text color, Text formatting using CSS, Font Properties, Text Properties, Styling hyperlinks using CSS, Styling lists using CSS, Setting element width and height, Adding borders, Spacing: margin & padding, Change the mouse type: cursor, Hide, show and display elements, What to do with overflowing content.

**CSS Advanced:** Grouping & Nesting, Maximum & Minimum Dimensions, Move an element from its default position, Relative location & layering, Floating, Clear, Pseudos, Alignment Sprites: the most efficient way to load images, Make elements translucent: opacity, Different media types, Style elements based on their attributes, Browser prefixes.

**[Unit 3] Javascript Basics [6 Hrs]**

JavaScript Essentials, What is JavaScript?, JavaScript: Internal vs. External, JavaScript comments, document.write(); Display info from the browser: alert & confirm, Prompting the user for information, Programming fundamentals: Variables, Add two sentences together: concatenation, Basic math in JavaScript, Redirecting users and opening new windows, Creating empty hyperlinks, String Manipulation, Comparing variables and values, Programming fundamentals: If...Else Statements, Else...If Statements, Switch Statements, Functions; JavaScript Events, Selecting HTML elements using getElementById(), Escaping content, Programming fundamentals: Arrays, For Loops, While Loops, Breaking Out Of Loops, Skipping A Loop Cycle.

**Javascripts Advanced:** Getting parts of a value: split & substr, Programming fundamentals: Try...Catch And Throw, Getting the users date and time, Some more complex math (no homework), Programming fundamentals: Regular Expressions, Get the users browser (navigator), Add timing: setInterval & setTimeout.

**[Unit 4]** Ajax, jQuery, PHP, PHP Advanced. **[4 Hrs]**

**Text Books:**


1. Colin Ihrig, Full Stack JavaScript Development With MEAN: MongoDB, Express, AngularJS, and Node.JS, SitePoint; 1st Edition.
2. https://www.w3schools.com/whatis/whatis_fullstack.asp**.**
3. Robin Nixon, Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites, O'Reilly Media; 3rd edition,
4. Callum Macrae, Learning from jQuery, O'Reilly Media.

## BTCOL706: System Administration

1. Installations of various Linux flavors (Optionally using Virtualbox): Centos (with LVM, without LVM), Ubuntu (with LVM, without LVM), Debian (with LVM, without LVM).
2. SSH Server (CentOS and Ubuntu): enable/disable root login.
3. Telnet server (CentOS and Ubuntu).
4. FTP Server (CentOS and Ubuntu).
5. Using command upload/download files from FTP Server.
6. Samba Server (CentOS and Ubuntu).
7. HTTP Server (CentOS and Ubuntu).
8. Configuration of Proxy Server.

**Reference Books:**

1. Tom Adelstein, Bill Lubanovic, *Linux System Administration: Solve Real-life Linux Problems Quickly*, O'Reilly Media.
2. Æleen Frisch, *Essential System Administration*, Third Edition, O'Reilly Media.
3. Terry Collings, Kurt Wall, *Red Hat Linux Networking and System Administration*, 3rd Edition, Wiley Publication.

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**Elective - VIII Laboratory**
**BTCOL707 (A): Big Data Analytics Laboratory**

**List of Experiments:**

1. Perform setting up and Installing Hadoop in its two operating modes:
    a) Pseudo distributed,
    b) Fully distributed.
2. Implement the following file management tasks in Hadoop:
    a) Adding files and directories
    b) Retrieving files
    c) Deleting files
3. To understand the overall programming architecture using Map Reduce API
4. Store the basic information about students such as roll no, name, date of birth and address Of student using various collection types such as List, Set and Map
5. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
    a) Find the number of occurrence of each word appearing in the input file(s)
    b) Performing a MapReduce Job for word search count (look for specific keywords in a file)
6. Install and Run Hbase then use HbaseDDl and DML commands
7. Install, Deploy & configure Apache Spark Cluster. Run apache spark applications usingScala.
8. Basic CRUD operations in MongoDB
9. Retrieve various types of documents from students collection
10. Data analytics using Apache Spark on Amazon food dataset, find all the pairs of itemsfrequently reviewed together.
    a) Write a single Spark application that:
        i. Transposes the original Amazon food dataset, obtaining a PairRDD of the type:<user_id> → <list of the product_ids reviewed by user_id>
        ii. Counts the frequencies of all the pairs of products reviewed together;
        iii. Writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.

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**Elective - VIII Laboratory**
**BTCOL707 (B): Distributed Systems Laboratory**

**List of Experiments:**

1. Implement the concept of RPC.
2. Implement the concept of RMI.
3. Design a Distributed Application using Message passing Interface for remote computation.
4. Implementation of Clock Synchronization (logical/physical).
5. To write Program multi-threaded client/server processes.
6. Implement concurrent echo client-server application
7. Implement concurrent day-time client-server application.
8. Configure following options on server socket and tests them:
   SO_KEEPALIVE,SO_LINGER, SO_SNDBUF, SO_RCVBUF, TCP_NODELAY .
9. Incrementing a counter in shared memory.
10. To Study Implementation of Election algorithm.
11. To study Implementation of Mutual Exclusion algorithms.
12. Implement Network File System (NFS).

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**Elective - VIII Laboratory**
**BTCOL707 (C): Fundamental of Digital Image Processing Laboratory**

**List of Experiments:**

1. Study of Matlab environment and implementation of matlab commands, functions and programming constructs.
2. Point processing in spatial domain
    a. Negation of an image
    b. Thresholding of an image
    c. Contrast Stretching of an image
3. Program to implement Bit Plane Slicing
4. Program for plotting a Histogram of an image
5. Program to implement Histogram Equalization
6. To write a Program for Histogram Specification
7. Zooming an image by interpolation and replication
8. Filtering in spatial domain
    a. Low Pass Filtering
    b. High Pass Filtering
    c. Median filtering
9. Edge Detection using derivative filter mask
    a. Prewitt
    b. Sobel
    c. Laplacian
10. Data compression using Huffman coding
11. Filtering in frequency domain
    a. Low pass filter
    b. High pass filter

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**Elective - IX Laboratory**
**BTCOL708 (A): Cloud Computing Laboratory**

**List of Experiments:**
(Pl. Note: List of Experiments should be as per theory covered in the class based on Cloud Environments. Following list can be used as a reference.)

1. Sketch out and analyze architecture of Moodle cloud portal and moodle cloud site and create different entities dynamically.
2. Create a scenario in wordpress for Social Marketing, Search engine and Sharing Tools.
3. Working in Cloud9 to demonstrate different language.
4. Working in Codenvy to demonstrate Provisioning and Scaling of a website.
5. Implement and configure Google App Engine to deploy Python Program application.
6. Installation and configuration of virtual machine with guest OS.
7. Demonstrate the use of map and reduce tasks.
8. Implementation of SOAP Web services in C#/JAVA Applications.
9. Categorize Amazon Web Service (AWS) and implement its various cloud entities using its Cloud Toolbox support.
10. Implement and use sample cloud services with the help of Microsoft Azure.
11. Design and analyze architecture of Aneka / Eucalyptus / KVM identify different entities to understand the structure of it.
12. Make and perform scenario to pause and resume the simulation in Aneka / Eucalyptus entity, and create simulation entities dynamically.
13. Organize a case in Aneka / Eucalyptus for simulation entities in run-time using a its toolkit support and manage virtual cloud.

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**Elective - IX Laboratory**
**BTCOL708 (B): Business Intelligence Laboratory**

**List of Experiments:**

1. Installation of SQL server and Power BI.
2. Import the legacy data from different sources such as (Excel, SqlServer, Oracle etc.) and load in the target system.
3. Perform the Extraction Transformation and Loading (ETL) process to construct the database in the Sqlserver / Power BI.
4. Create the cube with suitable dimension and fact tables based on ROLAP, MOLAP and HOLAP model.
5. Create the ETL map and setup the schedule for execution.
6. Execute the MDX queries to extract the data from the data warehouse.
7. Apply the what – if Analysis for data visualization. Design and generate necessary reports based on the data warehouse data.
8. Implementation of Classification algorithm in R Programming.
9. Practical Implementation of Decision Tree using R Tool.
10. Prediction Using Linear Regression.
11. Data Analysis using Time Series Analysis.

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**Elective - IX Laboratory**
**BTCOL708 (C): Natural Language Processing Laboratory**

**List of Experiments:**

Practical may be implemented using programming Python / Java. Concern faculty member may add more experiments in the list make it minimum 10 to 12.

1. Preprocessing of text (Tokenization, Filtration, Script Validation, Stop Word Removal, Stemming)
2. Morphological Analysis
3. N-gram model
4. POS tagging
5. Chunking
6. Named Entity Recognition
7. Case Study/ Mini Project based on Application mentioned in Module.

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**Elective - X Laboratory**
**BTCOL709 (A): Cryptography and Network Security Laboratory**

Students are expected to implement programming assignments using Open Source / Free / Trial Tools such as Nmap, zenmap, Port Scanners, Network scanners, Wireshark, Cain & abel, Concern faculty member may add more experiments in the list make it minimum 10 to 12.

**List of Experiments:**

Implementation of

1. Cryptographic algorithms DES.
2. Cryptographic algorithms AES.
3. Write a Java program to implement RSA Algorithm.
4. Implement the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript.
5. Hash Values Calculations SHA1, SHA256, SHA 512.
6. Digital Signature
7. Firewall
8. Implementation of REST/SOAP web services and Security implementations.

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**Elective - X Laboratory**
**BTCOL709 (B): Computer Graphics Laboratory**

**List of Experiments:**

1. DDA algorithm
2. Bresenham's Algorithm
3. Midpoint Circle generation algorithmic
4. Ellipse Generation
5. Coloring the picture
6. 2-D transformations
7. 3-D transformations
8. 3-D clipping
9. Animation
10. Use any graphics tool like OPENGL, DirectX

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**Elective - X Laboratory**
**BTCOL709 (C): Embedded Systems Laboratory**

Students are expected to perform practical assignments in embedded C based on ARM7 family members such as LPC21xx using Keil and development board.

**List of Experiments:**

1. 8 Bit LED and Switch Interface.
2. 7 Segment display interface.
3. Time delay program using built in Timer / Counter feature.
4. Displaying a message in a 2 line x 16 Characters LCD display.
5. I2C Interface – 7 Segment display / EPROM.
6. Interface with UART.
7. Interface with SPI.
8. Serial communication.
9. Interface with LED control ON_OFF.
10. Interface with passive infrared sensor.
11. Interface with temperature sensor.
12. Interface with push button / Interface push button to make sound box.
13. Interface a circuit to measure CPU usage with RGB LEDs. 14. Interface a circuit to make motion sensor alarm.

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## BTCOP710: Project – I

**Guidelines for the project phase – I:**

The project should enable the students to combine the theoretical and practical concepts studied in his / her academics. The project work should enable the students to exhibit their ability to work in a team, develop planning and execute skills and perform analyzing and trouble shooting of their respective problem chosen for the project. The students should be able to write technical report, understand the importance of teamwork and group task. The students will get knowledge about literature survey, problem definition, its solution, and method of calculation, trouble shooting, costing, application and scope for future development.

**Project work:**

The project work is an implementation of learned technology. The knowledge gained by studying various subjects separately supposed to utilize as a single task. A group of 03/04 students will have to work on assigned work. The topic could be a product design, specific equipment, live industrial problem etc. The project work involves experimental/theoretical/computational work. It is expected to do necessary literature survey by referring current journals belonging to Information Technology reference books and internet. After finalization of project, requisites like equipments, data, tools etc. should be arranged.

**Project Activity:**

The project groups should interact with guide, who in turn advises the group to carry various activities regarding project work on individual and group basis. The group should discuss the progress every week in the project hours and follow further advice of the guide to continue progress. Guide should closely monitor the work and help the students from time to time. The guide should also maintain a record of continuous assessment of project work progress on weekly basis.

**Phase - I:**

1. Submission of project/problem abstract containing problem in brief, requirements, broad area, applications, approximate expenditure if required etc.
2. Problem definition in detail.
3. Literature survey.
4. Requirement analysis.
5. System analysis (Draw DFD up to level 2, at least).
6. System design, Coding/Implementation (20 to 30%).

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**BTCOF609: Field Training / Internship / Industrial Training**

Guidelines for Field Training / Internship / Industrial Training Industrial Training:

1. To apply for a suitable Industrial Training, submit an application form to respective organization concerned one semester before the Industrial Training Programme commences.
2. Student can also apply through online platforms such as Internshala for industrial training.
3. Submit one copy of the offer letter for the Industrial Training to the Head of the department or Faculty coordinator (Industrial Training).
4. To complete the Industrial Training process within the specified time based on the Industrial Training Programme schedule.
5. Assessment within the Industrial Training context aims to evaluate the student's work quality and appropriateness to the field of study with reference to the learning outcomes of the Industrial Training Programme.
6. Evaluation of the students' performance should be done in the next upcoming semester.
7. Those students who fails, they can also complete online certification courses which are available at free of cost on various MOOC platforms.

**Elective - XI**
**BTCOE801 (A): Software Product Design**

**[Unit 1] Introduction to Software Architecture** **[5 Hrs]**
The 4+1 View of Software Architecture, Examples of Software Architecture, and Architecture Design: Quality attributes.

**[Unit 2] Attribute Driven Design** **[5 Hrs]**
Architecture Centric Software Development Methodology, Design Patterns, Software Design: Function Oriented versus Object Oriented; Documenting Software Architecture: Stakeholders, Views, View-sets, View-based documentation, IEEE 1471, ISO 42010. Books full stack development

**[Unit 3] Architecture** **[5 Hrs]**
Architecture Description Languages, Architecture Evaluation.

**[Unit 4] Product line architectures** **[5 Hrs]**
Product line architectures, Enterprise Architecture, Architecture Knowledge Management.

**Text Books:**

1. *"Software Architecture in Practice"*, Len Bass, Paul Clements, Rick Kazman.
2. *"Documenting Software Architectures: Views and Beyond"*, Paul Clements, Felix Bachmann, Len Bass, David Garlen, James Ivers, Reed Little, Robert Nord and Judith Stafford.
3. Jan Bosch, *"Design and Use of Software Architectures"*, Addision-Wesley-Pearson Education.
4. Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Miachel Stal, Douglas Schmidt, *"Pattern oriented software architecture"*, Volumes 1 & 2, Wiley Publication.

**Elective - XI**
**BTCOE801 (B): Quantum Computing**

**[Unit 1] Introduction to Quantum Computing** **[5 Hrs]**
Motivation for studying Quantum Computing; Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.); Origin of Quantum Computing; Overview of major concepts in Quantum Computing: Qubits and multi-qubits states, Bra-ket notation, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement.

**[Unit 2] Math Foundation for Quantum Computing** **[5 Hrs]**
Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.

**[Unit 3] Building Blocks for Quantum Program** **[5 Hrs]**
Architecture of a Quantum Computing platform; Details of q-bit system of information representation: Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perceptive e.g. Bell State, Operation on qubits: Measuring and transforming using gates, Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc.; Programming model for a Quantum Computing Program: Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits.

**[Unit 4] Quantum Algorithms** **[5 Hrs]**
Basic techniques exploited by quantum algorithms: Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks; Major Algorithms: Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch-Jozsa Algorithm; OSS Toolkits for implementing Quantum program: IBM quantum experience, Microsoft Q, Rigetti PyQuil (QPU/QVM).

**Text Books:**

1. Michael A. Nielsen, *"Quantum Computation and Quantum Information",* Cambridge University Press.
2. David McMahon, *"Quantum Computing Explained"*, Wiley.
3. IBM Experience: https://quantumexperience,ng,bluemix.net
4. Microsoft Quantum Development Kit: https://www.microsoft.com/en-us/quantum/development-kit
5. Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/

**NPTEL Course:**

1. Quantum Computing, Prof. Debabrata Goswami, Department of Chemistry, IIT Kanpur

**Elective - XI**
**BTCOE801 (C): Software Testing**

**[Unit 1] Principles of Testing** **[5 Hrs]**

The pesticide paradox, Software Development Life Cycle Model, Phases of software project, Quality, Quality assurance and quality control, Testing, Verification and validation, Process models to represent various phases, Life cycle models, Software testing life cycle.

**White Box Testing (WBT):** Static testing: by human, Static Analysis Tool; Structural testing: unit/code functional testing, Code coverage Testing, code complexity Testing; Challenges in White Box Testing.

**[Unit 2] Black Box Testing** **[5 Hrs]**

What, Why and When used black box testing How to do Black Box Testing: Requirement based testing, Positive and negative testing, Boundary value analysis, Decision Tables, Equivalence Partitioning, State based or graph based testing, Compatibility Testing, Domain Testing.

**Integration Testing:** Integration Testing as a type of testing: Top-down, Bottom-up Integration, Bi-directional Testing, System Integration, choosing Integration method; As a phase testing; Scenario testing: System and use case scenario, Defect bash.

**[Unit 3] System and Acceptance Testing** **[5 Hrs]**

What, Why is system testing done?, Functional Versus Non Functional testing, Functional system testing: Design/Architecture verification, Business Vertical Testing, Deployment Testing, Beta Testing, Certification, Standards and Testing for compliance; Non-functional system testing: setting up the configuration, Coming up with Entry/Exit criteria, Balance Key Resources, Scalability Testing, Reliability Testing, Stress Testing, Inter-operability Testing;

**Acceptance testing:** Acceptance Criteria, Selecting Test Cases, Executing Test cases; Summary of Testing Cases.

**Performance Testing:** Introduction, Factor Governing performance Testing, Methodology of Performance Testing, Tools for Performance Testing, Process for performance Testing.

**[Unit 4] Regression Testing** **[5 Hrs]**

What and When to do regression Testing, Types, How to do regression testing? Best Practices in regression testing.

**Internationalization testing:** Introducing, Primer on Internationalization, Test Phases, Enabling Testing, Local Testing, Internationalization Validation, Fake Language Testing, Language Testing, Localization Testing, Tools.

**Ad-hoc Testing:** Overview, Buddy Testing, Pair Testing, Exploratory Testing, Iterative Testing, Agile and Extreme Testing, Defect Seeding.

**Text Books:**

1. Paul C. Jorgensen, Software Testing: A Craftsman's Approach, Fourth Edition, CRC Press.
2. Shriniwasan Desikan, Gopalswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education.
3. Loise Tamres, "Introducing Software Testing", Pearson Education.

4. Aditya P. Mathur, “Foundations of Software Testing”, Pearson Education, 2008.
5. Cem Kaner, Jack Falk, Hung Quoc Nguyen, Testing Computer Software, 2nd Edition, Wiley Publication.

**Reference Books:**

1. Boris Beizer, "Software Testing Techniques", Dream Tech. Publication.
2. Ross Patton, "Software Testing", Pearson Education.
3. Elfriede Dustin, “Effective Software Testing”, First Edition, Pearson Education, 2003.
4. Renu Rajani, Pradeep Oak, “Software Testing – Effective Methods, Tools and Techniques”, McGraw Hill, 2004.
5. Kshirasagar Naik, Priyadarshi Tripathy, Software Testing and Quality Assurance: Theory and Practice, Wiley Publication.

**Elective - XI**
**BTCOE801 (D): Deep Learning**

**[Unit 1] History of Deep Learning** **[6 Hrs]**
Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perception Learning Algorithm; Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks.

**[Unit 2] FeedForward Neural Networks** **[6 Hrs]**
Back propagation, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp; Principal Component Analysis and its interpretations, Singular Value Decomposition.

**[Unit 3] Autoencoders and relation to PCA** **[6 Hrs]**
Regularization in auto encoders, De-noising auto-encoders, Sparse auto-encoders, Contractive auto-encoders; Regularization: Bias Variance Trade-off, L2 regularization, early stopping, Dataset augmentation, Parameter sharing and tying; Greedy Layer-wise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization.

**[Unit 4] Convolutional Neural Networks** **[6 Hrs]**
LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Learning Vectorial Representations of Words, Recurrent Neural Networks, Back-propagation through time, Encoder Decoder Models, Attention Mechanism, Attention over images.

**Text / Reference Books:**

1. Ian Good fellow, and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press http://www.deeplearningbook.org
2. Skansi Sandro, Introduction to Deep Learning, Springer International Publishing AG
3. Josh Patterson, Adam Gibson, Deep Learning, Shroff/O'Reilly 2017

**NPTEL COURSE:**

1. Deep Learning (Part-I) by Prof. Mitesh M. Khapra and Prof. Sudarshan Iyengar, Department of Computer Science and Engineering, IIT Madras & IIT Ropar.

**Elective - XI**

**BTCOE801 (E): Wireless and Sensor Networks**

**[Unit 1] Introduction** **[6 Hrs]**

Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum – Radio propagation Mechanisms – Characteristics of the Wireless Channel -mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs): concepts and architectures; Applications of Ad Hoc and Sensor networks; Design Challenges in Ad hoc and Sensor Networks.

**[Unit 2] Mac Protocols For Ad Hoc Wireless Networks** **[6 Hrs]**

Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols- Contention based protocols with Reservation Mechanisms- Contention based protocols with Scheduling Mechanisms – Multi channel MAC-IEEE 802.11

**[Unit 3] Routing Protocols & Transport Layer in Ad Hoc Wireless Networks** **[6 Hrs]**

Issues in designing a routing and Transport Layer protocol for Ad hoc networks- proactive routing, reactive routing (on-demand), hybrid routing- Classification of Transport Layer solutions- TCP over Ad hoc wireless Networks.

**[Unit 4] Wireless Sensor Networks (WSN) and Mac Protocols** **[6 Hrs]**

Single node architecture: hardware and software components of a sensor node – WSN Network architecture: typical network architectures-data relaying and aggregation strategies -MAC layer protocols: self-organizing, Hybrid TDMA/FDMA and CSMA based MAC- IEEE 802.15.4.

**[Unit 5] WSN Routing, Localization & QOS** **[6 Hrs]**

Issues in WSN routing – OLSR- Localization – Indoor and Sensor Network Localization absolute and relative localization, triangulation-QOS in WSN-Energy Efficient Design-Synchronization- Transport Layer issues.

**Text Book:**

1. C. Siva Ram Murthy, and B. S. Manoj, “Ad Hoc Wireless Networks: Architectures and Protocols “, Prentice Hall Professional Technical Reference, 2008.
2. Holger Karl and Andreas Willig “Protocols and Architectures for Wireless Sensor Networks”, Wiley, 2005.

**Reference Books:**

1. Carlos De MoraisCordeiro, Dharma PrakashAgrawal “Ad Hoc & Sensor Networks: Theory and Applications”, World Scientific Publishing Company, 2006.
2. Feng Zhao and LeonidesGuibas, “Wireless Sensor Networks”, Elsevier Publication – 2002.

**NPTEL Course:**

1. Wireless Ad Hoc and Sensor Networks by Prof. Sudip Mishra (IITKGP)

**Elective - XII**
**BTCOE802 (A): 3D Printing and Design**

**[Unit 1] 3D Printing (Additive Manufacturing) [6 Hrs]**
Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.
**CAD for Additive Manufacturing:** CAD Data formats, Data translation, Data loss, STL format.

**[Unit 2] Additive Manufacturing Techniques [6 Hrs]**
Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Process, Process parameter, Process Selection for various applications, Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools.

**[Unit 3] Materials [6 Hrs]**
Polymers, Metals, Non-Metals, Ceramics; Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties; Support Materials.

**[Unit 4] Additive Manufacturing Equipment [6 Hrs]**
Process Equipment- Design and process parameters; Governing Bonding Mechanism; Common faults and troubleshooting; Process Design; Post Processing: Requirement and Techniques.

**Text Books:**

1. Lan Gibson, David W. Rosen and Brent Stucker, *"Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing"*, Springer, 2010.
2. Andreas Gebhardt, *"Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing"*, Hanser Publisher, 2011.
3. Khanna Editorial, *"3D Printing and Design"*, Khanna Publishing House, Delhi.
4. CK Chua, Kah Fai Leong, *"3D Printing and Rapid Prototyping-Principles and Applications"*, World Scientific, 2017.
5. J.D. Majumdar and I. Manna, *"Laser-Assisted Fabrication of Materials"*, Springer Series in Material Science, 2013.
6. L. Lu, J. Fuh and Y.S. Wong, *"Laser-Induced Materials and Processes for Rapid Prototyping"*, Kulwer Academic Press, 2001.
7. Zhiqiang Fan And Frank Liou, *"Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy"*, InTech, 2012.

**Elective - XII**
**BTCOE802 (B): Robotics**

**[Unit 1] Introduction to Robotics [6 Hrs]**
Types and components of a robot, Classification of robots, closed loop and open-loop control systems; Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.

**[Unit 2] Robot Kinematics and Dynamics [6 Hrs]**
Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics Dynamic Modelling: Equations of motion: Euler-Lagrange formulation.
**Sensors and Vision System:** Sensor, Contact and Proximity, Position, Velocity, Force, Tactile etc.; Introduction to Cameras: Camera calibration, Geometry of Image formation, Euclidean/ Similarity/ Affine/ Projective transformations Vision applications in robotics.

**[Unit 3] Robot Control Basics of control [6 Hrs]**
Transfer functions, Control laws: P, PD, PID Non-linear and advanced controls.

**[Unit 4] Robot Actuation Systems [6 Hrs]**
Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

**[Unit 5] Control Hardware and Interfacing Embedded systems [6 Hrs]**
Architecture and integration with sensors, actuators, components, Programming for Robot Applications.

**Text Books**

1. Saha, S. K., “Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., “Robotics”, Oxford, New Delhi, 2006.
3. Niku Saeed B., “Introduction to Robotics: Analysis, Systems, Applications”, PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., “Robotics and Control”, Tata McGraw Hill.
5. Mukherjee S., “Robotics and Automation”, Khanna Publishing House, Delhi.
6. Craig, J. J., “Introduction to Robotics: Mechanics and Control”, Pearson, New Delhi, 2009.
7. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modelling and Control”, John Wiley and Sons Inc, 2005.
8. Steve Heath, “Embedded System Design”, 2 nd Edition, Newnes, Burlington, 2003.
9. Merzouki R., Samantaray A. K., Phathak P. M. and Bouamama B. Ould, “Intelligent Mechatronic System: Modeling, Control and Diagnosis”, Springer.

**Elective - XII**

**BTCOE802 (C): Advanced Database Techniques**

**[Unit 1] Transactions** **[6 Hrs]**

Transaction concept, transaction model, storage structure, transaction atomicity and durability, transaction isolation, serializability, transaction isolation and atomicity, transaction isolation levels, implementing isolation levels, transaction as SQL statements.

**[Unit 2] Concurrency Control** **[6 Hrs]**

Lock based protocols, Deadlock handling, multiple granularity, timestamp based protocols, validation based protocols, multiversion schemes, Insert -delete operations and predicate reads.

**[Unit 3] Recovery System** **[6 Hrs]**

Failure classification, storage, recovery and atomicity, recovery algorithm, buffer management, failure with loss of non volatile storage, early lock release and logical undo operations, remote backup systems.

**[Unit 4] Database System Architectures** **[6 Hrs]**

Centralized and client-server architecture, Server system architectures, Parallel systems, Distributed systems.

**[Unit 5] Parallel Databases** **[6 Hrs]**

Introduction to parallel databases, interquery and intraquery parallelism, intraoperation and interoperation parallelism, query optimization, parallelism on multicore processors, design of parallel system.

**Text Books:**

1. Korth, Silberchatz, Sudarshan, Database System concepts, 6th Edition, TMH Publication.
2. C. J. Date, Database Management System, TMH Publication.
3. Stefano Ceri, Giuseppe Pelagatti, Distributed databases-Principles and system, MGH Publication.

## Elective - XII
## BTCOE802 (D): Virtual Reality

**[Unit 1] Introduction to Virtual Reality** **[6 Hrs]**

Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark;

3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modeling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

**[Unit 2] Geometric Modelling** **[6 Hrs]**

Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection;

Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

**[Unit 3] Virtual Environment** **[6 Hrs]**

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system.

Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

**[Unit 4] VR Hardware and Software** **[6 Hrs]**

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware,

Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML

**VR Applications:** Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction.

**TEXT BOOKS:**


1. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.
2. Anand R., “Augmented and Virtual Reality”, Khanna Publishing House, Delhi.
3. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000.
4. Grigore C. Burdea, Philippe Coiffet, “Virtual Reality Technology”, Wiley Inter Science, 2nd Edition, 2006.
5. William R. Sherman, Alan B. Craig, “Understanding Virtual Reality: Interface, Application and Design”, Morgan Kaufmann, 2008.
6. www.vresources.org
7. www.vrac.iastate.edu
8. www.w3.org/MarkUp/VRM

## Elective - XII
## BTCOE802 (E): Blockchain Technology

**[Unit 1] Introduction** **[6 Hrs]**

Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Blockchain, Transactions, Distributed Consensus, Public vs. Private Blockchain, Understanding Cryptocurrency to Blockchain, Permissioned Model of Blockchain, Overview of Security aspects of Blockchain.

**Basic Crypto Primitives:** Properties of a hash function, Hash pointer and Merkle tree.

**[Unit 2] Bitcoin and Blockchain** **[6 Hrs]**

Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.

**Working with Consensus in Bitcoin:** Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

**[Unit 3] Permissioned Blockchain** **[6 Hrs]**

Permissioned model and use cases, Design issues for Permissioned blockchains, Execute contracts, State machine replication, Overview of Consensus models for permissioned blockchain-Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.

**Enterprise application of Blockchain:** Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, We Trade –Trade Finance Network, Supply Chain Financing, Identity on Blockchain.

**[Unit 4] Blockchain Application Development** **[6 Hrs]**

Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.

**Text Books:**


1. Melanie Swan, *"Blockchain: Blueprint for a New Economy"*, O'Reilly, 2015.
2. Josh Thompsons, *"Blockchain: The Blockchain for Beginners-Guide to Blockchain Technology and Leveraging Blockchain Programming"*
3. Daniel Drescher, *"Blockchain Basics"*, Apress; 1st Edition, 2017.
4. Anshul Kaushik, *"Blockchain and Crypto Currencies"*, Khanna Publishing House, Delhi.
5. Imran Bashir, *"Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained"*, Packt Publishing.
6. Ritesh Modi, *"Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain"*, Packt Publishing.
7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "*Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer"*, Import, 2018.


**NPTEL Course:**

1. Prof. Sandip Chakraborty, Department of Computer Science And Engineering, IIT Kharagpur; and Dr. Praveen Jayachandran, Research Staff Member, IBM.

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

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**BTCOP803 Project – II[$] / Internship and Project in Industry***

**$** This is for those students who are not doing Internship and Project in the Industry, they can do project in the department.

* Six months of Internship and Project in the industry.

This is continuous work to the project phase - I. Every students will have to submit a completed report (3 copies)* of the project work. Report preparation guidelines should be followed as per given format. The students will prepare a power point presentation of the work. Panel of examiners comprising of guide, internal examiner, senior faculty, external examiner, etc. will assess the performance of the students considering their quality of work.

**Phase - II**

1. Coding/Implementation.
2. Use cases.
3. Testing/Trouble shooting.
4. Data dictionary/ Documentation.
5. Finalization of project in all respect.

*(For guide, Personal copy, Departmental library)

**In a presentation, the students should focus to clarify problem definition and analysis of the problem.**

**###End of the syllabus###**