

**Semester –VII (Final Year)**  
**Proposed Scheme w.e.f. July – 2023**

Course Category	Course Code	Course Title	Weekly Teaching Hrs			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
	BTCOC701	Artificial Intelligence	3	-	-	20	20	60	100	3
	BTCOC702	Cloud Computing	3	-	-	20	20	60	100	3
	BTCOE703	Elective – VI (A) Bioinformatics (B) Distributed System (C) Big Data Analytics	3	-	-	20	20	60	100	3
	BTCOE704	Open Elective – VII (A) Cryptography and Network Security (B) Business Intelligence (C) Block chain Technology	3	-	-	20	20	60	100	3
	BTCOE705	Open Elective – VIII (A) Virtual Reality (B) Deep Learning (C) Design Thinking	3	-	-	20	20	60	100	3
	BTHM706	Foreign Language Studies	-	-	4	-	-	-	-	Audit
	BTCOL707	Artificial Intelligence & Cloud Computing Lab	-	-	4	60	-	40	100	2
	BTCOS708	Project Phase – I	-	-	-	60	-	40	100	2
	BTCOF608	Field Training / Internship / Industrial Training	-	-	-	-	-	-	-	Audit
<b>TOTAL</b>			<b>15</b>	<b>-</b>	<b>8</b>	<b>220</b>	<b>100</b>	<b>380</b>	<b>700</b>	<b>19</b>

## BTCOC701: Artificial Intelligence

### [Unit1] Introduction

[7 Hours]

What Is AI? The Foundations of Artificial Intelligence, the History of Artificial Intelligence, the State of the Art. Intelligent Agents: Agents and Environments Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

### [Unit2] Problem-solving

[7 Hours]

Solving Problems by Searching, Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Defining Constraint Satisfaction Problems, Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs, Local Search for CSPs, The Structure of Problems. Adversarial Search, Games, Optimal Decisions in Games, Alpha-Beta Pruning.

### [Unit 3] Knowledge & Reasoning

[7 Hours]

Knowledge representation issues, Representation & mapping, Approaches to knowledge representation, Issues in knowledge representation. Using predicate logic: Representing simple fact in logic, Representing instant & ISA relationship, Computable functions & predicates, Resolution, Natural deduction. Representing knowledge using rules: Procedural verses declarative knowledge, Logic programming, Forward verses backward reasoning, Matching, Control knowledge.

### [Unit 4] Probabilistic Reasoning [7 Hours]

Representing knowledge in an uncertain domain, The semantics of Bayesian networks, Dempster-Shafer theory, Fuzzy sets & fuzzy logics, Planning: Overview, Components of a planning system, Goal stack planning, Hierarchical planning and other planning techniques.

### [Unit5] Natural Language processing: [7 Hours]

Introduction, Syntactic processing, Semantic analysis, Discourse & pragmatic processing.

Learning: Forms of learning, Inductive learning, Learning decision trees, explanation based learning, Learning using relevance information, Neural net learning & genetic learning. Expert Systems: Representing and using domain knowledge, Expert system shells and knowledge acquisition.

### Text Book:

1. Rich, E. and Knight K.: Artificial Intelligence, Tata McGraw- Hill

### Reference Books:

1. Peter Norvig, Artificial Intelligence: A Modern Approach, Third Edition.
2. Ivan Bratko, Prolog Programming for Artificial Intelligence, Addison-Wesley.

## BTCOE702 Cloud Computing

### [Unit 1] Introduction

[7 Hours]

Definition and evolution of Cloud Computing, Enabling Technologies, Service and Deployment Models, Popular Cloud Stacks and Use Cases, Benefits, Risks, and Challenges of Cloud Computing, Economic Models and SLAs, Topics in Cloud Security.

### [Unit 2] Cloud Infrastructure

[7 Hours]

Historical Perspective of Data Centres, Data centre Components: IT Equipment and Facilities, Design Considerations: Requirements, Power, Efficiency, & Redundancy, Power Calculations, PUE and Challenges in Cloud, Data Centres, Cloud Management and Cloud Software Deployment Considerations.

### [Unit 3] Virtualization

[7 Hours]

Virtualization (CPU, Memory, I/O) Case Study: Amazon EC2, Software Defined Networks (SDN). Software Defined Storage (SDS).

### [Unit 4] Cloud Storage

[7 Hours]

Introduction to Storage Systems, Cloud Storage Concepts, Distributed File Systems (HDFS, CephFS), Cloud Databases (HBase, MongoDB, Cassandra, DynamoDB),

### [Unit 5] Cloud Object Storage

[6 Hours]

Cloud Object Storage (Amazon S3, Open Stack Swift, Ceph).

#### Text Book:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2011.

#### Reference Books:

1. Gautam Shroff, Enterprise Cloud Computing - Technology, Architecture, Applications; Cambridge University Press, 2010.
2. Barrie Sosinsky, Cloud Computing Bible, Wiley-India, 2010.
3. Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley-India, 2010.
4. Anthony T. Velte, Toby J. Velte and Robert E, Cloud Computing – A Practical Approach, TMH, 2010

#### NPTEL Course:

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

## **BTCOE703 (A): Bioinformatics**

### **[Unit 1] Introduction to Bioinformatics**

**[6 Hours]**

The Brain of Biotechnology Evolutionary Biology Origin & History of Bioinformatics Origin of Bioinformatics/Biological Databases Importance of Bioinformatics Use of Bioinformatics Basics of Molecular Biology Definitions of Fields Related to Bioinformatics Applications. Biological Databases: Introduction Categories of Biological Databases The Database Industry Classification of Biological Databases The Creation of Sequence Databases Bioinformatics Programs and Tools Bioinformatics Tools Application of Programmes in Bioinformatics.

### **[Unit 2] Genomics & Proteomics**

**[7 Hours]**

DNA, Genes and Genomes DNA Sequencing Genome Mapping Implications of Genomics for Medical Science Proteomic Application of Proteomics to Medicine Difference between Proteomics and Genomics Protein Modeling. Sequence Alignment: Introduction Pairwise Sequence Alignment Sequence Alignment (MSA) Substitution Matrices Two Sample Applications.

### **[Unit 3] Phylogenetic Analysis**

**[7 Hours]**

Introduction Fundamental Elements of Phylogenetic Models Tree Interpretation Importance of Identifying Paralogs and Orthologs Phylogenetic Data Analysis Alignment Building the Data Model Determining the Substitution Model Tree-Building Methods Tree Evaluation. Microarray Technology: A Boon to Biological Sciences Introduction to Microarray Microarray Technique Potential of Microarray Analysis Microarray Products Microarray Identifying Interactions Applications of Microarrays.

### **[Unit 4] Bioinformatics in Drug Discovery**

**[6 Hours]**

A Brief Overview Introduction Drug Discovery Informatics and Medical Sciences Bioinformatics and Medical Sciences Bioinformatics in Computer-Aided Drug Design Bioinformatics Tools.

### **[Unit 5] Human Genome Project**

**[6 Hours]**

Human Genome Project: Introduction Human Genome Project Genome Sequenced in the Public (HGP) and Private Project Funding for Human Genome Sequencing DNA Sequencing Bioinformatics Analysis: Finding Functions Insights Learned from the Human DNA Sequence Future Challenges.

#### **Text Book:**

1. S. C. Rastorgi et al, Bioinformatics Concepts Skills and Applications; 2nd Edition, CBS Publishers & Distributors.

#### **NPTEL Course:**

1. Prof. M. Michael Gromiha, Algorithms and Applications.

## **BTCE703 (B): Distributed Systems**

### **[Unit1]Introduction**

**[7 Hours]**

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 Hours]**

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, Case studies: Sun RPC, DCE, RPC.

### **[Unit 3] Distributed Shared Memory**

**[6 Hours]**

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: Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms.

### **[Unit 4] Resource Management And Process Management**

**[6 Hours]**

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 Hours]**

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 Book:**

1. P. K. Sinha, Distributed Operating System, PHI Publication

### **Reference Books:**

1. Colorouis, Distributed Systems, Addison Wesley Publication.
2. M. L. Liu, Distributed Computing: Principles and Applications, Addison-Wesley, 2004.

### **NPTEL Course:**

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

## **BTCOE703 (C): Big Data Analytics**

### **[Unit 1] Introduction to Big Data**

**[6 Hours]**

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 Hours]**

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 Hours]**

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 Hours]**

Overview of Big Data Machine Learning, Mahout, Big Data Machine learning Algorithms in Mahout-kmeans, Naive 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 Hours]**

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, MongoDB query language.

#### **Text Book:**

1. Bart Baesens “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley and SAS Business Series.

#### **Reference Books:**

1. Rajkumar Buyya, Rodrigo N. Calheiros, Amir M Vahid Dastjerdi, Morgan Kaufmann, “Big Data Principals and Paradiagram”, Elsevier, ISBN: 978-0-12-805394-2
2. Kyle Banker, Peter Bakkum and Shaun Verch, “MongoDB in Action”, 2nd Edition Dream tech Press, ISBN: 978-9351199359.
3. Anand Rajaraman, Jeffrey D. Ullman, “Mining of Massive Datasets”, 3rd edition, Cambridge University Press
4. Sima Acharya, Subhashini Chhellappan, “BIG Data and Analytics”, ,Willey publication, ISBN: 978-8126554782.

#### **NPTEL COURSE:**

1. Big Data Computing by Prof. Rajiv Misra, Dept. of Computer Science and Engineering, IIT Patna

**BTCOE704 (A): Cryptography & Network Security****[Unit 1]****[6 Hours]**

Introduction and Mathematical Foundations: Introduction, Overview on Modern Cryptography, Number Theory, Probability and Information Theory. Classical Cryptosystems: Classical Cryptosystems, Crypt-analysis of Classical Cryptosystems, Shannon's Theory.

**[Unit 2]****[6 Hours]**

Symmetric Key Ciphers: Symmetric Key Ciphers, Modern Block Ciphers (DES), Modern Block Cipher (AES). Crypt-analysis of Symmetric Key Ciphers: Linear Crypt-analysis, Differential Crypt-analysis, other Crypt-analytic Techniques, Overview on S-Box Design Principles, Modes of operation of Block Ciphers.

**[Unit 3]****[6 Hours]**

Stream Ciphers and Pseudo-randomness: Stream Ciphers, Pseudo-random functions. Hash Functions and MACs: Hash functions: The Merkle Damgard Construction, Message Authentication Codes (MACs).

**[Unit 4]****[6 Hours]**

Asymmetric Key Ciphers: Construction and Crypt-analysis: More Number Theoretic Results, The RSA Cryptosystem, Primality Testing, Factoring Algorithms, Other attacks on RSA and Semantic Security of RSA, The Discrete Logarithm Problem (DLP) and the Diffie-Hellman Key Exchange algorithm, The ElGamal Encryption Algorithm, Crypt-analysis of DLP.

**[Unit -5]****[6 Hours]**

Digital Signatures: Signature schemes: I, Signature schemes: II. Modern Trends in Asymmetric Key Cryptography: Elliptic curve based cryptography: I, Elliptic curve based cryptography: II. Network Security: Secret Sharing Schemes, A Tutorial on Network Protocols, Kerberos, Pretty Good Privacy (PGP), Secure Socket Layer (SSL), Intruders and Viruses, Firewalls.

**Text Book:**

1. Douglas Stinson, *"Cryptography Theory and Practice"*, 2nd Edition, Chapman & Hall/CRC.

**Reference Books:**

1. B. A. Forouzan, *"Cryptography & Network Security"*, McGraw Hill Publication.
2. William Stallings, *"Cryptography and Network Security"*, Pearson Education.
3. Dr. B. B. Meshram, *TCP/IP & Network Security*, SPD Publication.
4. Wenbo Mao, *"Modern Cryptography, Theory & Practice"*, Pearson Education.
5. Hoffstein, Pipher, Silverman, *"An Introduction to Mathematical Cryptography"*, Springer.
6. Alang.Konheim, *Computer Security and Cryptography*, Wiley Publication.
7. A. Joux, *"Algorithmic Crypt-analysis"*, CRC Press.
8. S. G. Telang, *"Number Theory"*, McGraw Hill.
9. Matt Bishop, *"Computer Security"*, Pearson Education.



## **BTCOE704 (B): Business Intelligence**

### **[Unit 1] Business Intelligence Introduction**

**[6 Hours]**

Definition, Leveraging Data and Knowledge for BI, BI Components, BI Dimensions, Information Hierarchy, Business Intelligence and Business Analytics, BI Life Cycle. Data for BI – Data Issues and Data Quality for BI.

### **[Unit 2] BI Implementation**

**[6 Hours]**

Key Drivers, Key Performance Indicators and operational metrics, BI Architecture/Framework, Best Practices, Business Decision Making. Business Analytics: Objective Curve, Web Analytics and Web Intelligence, Customer Relationship Management.

### **[Unit 3] Business/Corporate Performance Management**

**[6 Hours]**

Dash Boards and Scorecards, Business Activity Monitoring, Six Sigma. Advanced BI: Big Data and BI, Social Networks, Mobile BI, emerging trends. Working with BI Tools: Overview of managerial, strategic and technical issues associated with Business Intelligence and Data Warehouse design, implementation, and utilization. Critical issues in planning, physical design process, deployment and ongoing maintenance.

### **[Unit 4] Data Warehousing (DW)**

**[6 Hours]**

Data Warehousing (DW): Introduction & Overview; Data Marts, DW architecture – DW components, Implementation options; Meta Data, Information delivery. ETL: Data Extraction, Data Transformation – Conditioning, Scrubbing, Merging, etc., Data Loading, Data Staging, Data Quality.

### **[Unit 5] Dimensional Modeling**

**[6 Hours]**

Dimensional Modeling: Facts, dimensions, measures, examples; Schema Design – Star and Snowflake, Fact constellation, slowly changing Dimensions. OLAP: OLAP Vs OLTP, Multi-Dimensional Databases (MDD); OLAP – ROLAP, MOLAP, HOLAP; Data Warehouse Project Management: Critical issues in planning, physical design process, deployment and ongoing maintenance.

### **Text Book:**

1. Efraim Turban, Ramesh Sharda, Jay Aronson, David King, Decision Support and Business Intelligence Systems, 9th Edition, Pearson Education, 2009

### **Reference Books:**

1. David Loshin, Business Intelligence – The Savy Manager's Guide Getting Onboard with Emerging IT, Morgan Kaufmann Publishers, 2009.



## **BTCE704 (C): Blockchain Technology**

### **[Unit 1] Introduction**

**[6 Hours]**

Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Blockchain, Transactions, Distributed Consensus, Public vs. Private Blockchain, Understanding Crypto currency to Blockchain, Permissioned Model of Blockchain, Overview of Security aspects of Blockchain. Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic crypto currency.

### **[Unit 2] Bitcoin and Blockchain**

**[7 Hours]**

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) – 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**

**[7 Hours]**

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.

### **[Unit 4] Enterprise application of Blockchain**

**[6 Hours]**

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 5] Blockchain Application Development**

**[6 Hours]**

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 Book:**

1. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O’Reilly, 2015.

#### **Reference Books:**

1. Josh Thompsons, “Blockchain: The Blockchain for Beginners-Guide to Blockchain Technology and Leveraging Blockchain Programming”.
2. Daniel Drescher, “Blockchain Basics”, Apress; 1st Edition, 2017.
3. Anshul Kaushik, “Blockchain and Crypto Currencies”, Khanna Publishing House, Delhi.
4. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Packt Publishing.
5. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Blockchain”, Packt Publishing.
6. 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.

## **BTCOE705 (A): Virtual Reality**

### **[Unit 1] Introduction to Virtual Reality**

**[6 Hours]**

Virtual Reality and Virtual Environment: Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

### **[Unit 2] Geometric Modelling**

**[6 Hours]**

From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

### **[Unit 3] Virtual Environment**

**[6 Hours]**

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

### **[Unit 4] Physical Simulation**

**[4 Hours]**

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

### **[Unit 5] VR Hardware and Software**

**[6 Hours]**

Human factors: The eye, the ear, the somatic senses. VR Hardware: Sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML.

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

### **Text Book:**

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.

### **Reference Books:**

1. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
2. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
3. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
4. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.
5. [www.vresources.org](http://www.vresources.org)
6. [www.vrac.iastate.edu](http://www.vrac.iastate.edu)
7. [www.w3.org/MarkUp/VRML](http://www.w3.org/MarkUp/VRML)

## BTCOE705 (B): Deep Learning

### [Unit 1] [6 Hours]

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feed forward Neural Networks.

### [Unit 2] [6 Hours]

FeedForward Neural Networks, Backpropagation. Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp. Principal Component Analysis and its interpretations, Singular Value Decomposition.

### [Unit 3] [6 Hours]

Auto encoders and relation to PCA, Regularization in auto encoders, Denoising auto encoders, Sparse auto encoders, Contractive auto encoders. Regularization: Bias Variance Tradeoff, 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] [6 Hours]

Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Learning Vectorial Representations of Words,

### [Unit 5] [6 Hours]

Recurrent Neural Networks, Back propagation through time, Encoder Decoder Models, Attention Mechanism, Attention over images.

#### Text Book:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", 1st Edition, MIT Press

#### Reference Books:

1. Raúl Rojas, Neural Networks: A Systematic Introduction, 1996.
2. Christopher Bishop, Pattern Recognition and Machine Learning, 2007.

#### NPTEL Courses:

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

## **BTCOE705 (C): Design Thinking**

### **[Unit 1] Overview of Design Thinking Process**

**[6 Hours]**

Design Thinking Process: Business context of innovation for applying design thinking, two models of design thinking, phases of design thinking, correlation with other philosophies. Introduction to design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs. Design thinking, Problem solving, Understanding design thinking and its process model, Design thinking tools. Human-Centered Design (HCD) process - Empathize, Define, Ideate, Prototype and Test and Iterate or Empathize, Analyze, Solve and Test.

### **[Unit 2] Empathize**

**[5 Hours]**

Design thinking phases, How to empathize, Role of empathy in design thinking, purpose of empathy maps, Things to be done prior to empathy mapping, creation of user personas, customer journey mapping, How might we questions.

### **[Unit 3] Analyze or Define**

**[5 Hours]**

Root cause analysis, conflict of interest, perspective analysis, big picture thinking through system operator, big picture thinking through function modeling Silent brainstorming, metaphors for ideation, CREATE and What-If tool for ideation, introduction to TRIZ, Inventive principles and their applications.

### **[Unit 4] Test (Prototyping and Validation)**

**[5 Hours]**

Prototyping, Assumptions during the design thinking process, Validation in the market, best practices of presentation.

### **[Unit 5] Design Innovation**

**[5 Hours]**

Benefits of iteration in the design thinking process, taking the idea to the market, introduction to innovation management in a company.

### **Text Book:**

1. Bala Ramadurai, “Karmic Design Thinking”, First Edition, 2020.

### **Reference Books:**

1. Vijay Kumar,” 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization “.
2. Human-Centered Design Toolkit: An Open-Source Toolkit to Inspire New Solutions in the Developing World by IDEO.
3. This is Service Design Thinking: Basics, Tools, Cases by Marc Stickdorn and Jakob Schneider.
4. Ulrich, Karl T. Design: Creation of artifacts in society, 2011.

## **BTCOL706 Artificial Intelligence**

### **List of Experiments:**

1. Study of PROLOG. Write the following programs using PROLOG.
2. Write a program to solve 8 queens problem.
3. Solve any problem using depth first search.
4. Solve any problem using best first search.
5. Solve 8-puzzle problem using best first search.
6. Solve Robot (traversal) problem using means End Analysis.
7. Solve traveling salesman problem.

## **BTCOL706 Cloud Computing**

### **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.

### **BTCOS707: Project phase - I**

### **BTCOF801: Project phase – II (In-house) / Internship and Project in the Industry**

In this course, it is expected that students will go to industry for internship for one semester and do industry based project in that period. Student will be assigned one dept. one Industry guide to monitor progress of the student. After, completion of the Internship student will submit project report to the dept. and project examination will be conducted in consultation with the Industry guide.

In case, if student not opting / not doing Internship in the Industry, such students can do project work in the dept.

## COURSE CURRICULUM MAPPING WITH MOOC PLATFORM NPTEL

Sr. No.	Name of Subject as per Curriculum	Course Code	Semester	SWAYAM/ NPTEL Course And Web Link	Name of Institute offering course	Relevance %	Duration of Course
1	Linear Algebra	BTES301	III	<a href="https://nptel.ac.in/courses/111/101/111101115/">https://nptel.ac.in/courses/111/101/111101115/</a> <a href="https://nptel.ac.in/courses/111/106/111106051/">https://nptel.ac.in/courses/111/106/111106051/</a>	IIT, Madras	85 90	8 Weeks 12 Weeks
2	Discrete Mathematics	BTCOC302	III	<a href="https://nptel.ac.in/courses/106/106/106106094/">https://nptel.ac.in/courses/106/106/106106094/</a> <a href="https://nptel.ac.in/courses/111/107/111107058/">https://nptel.ac.in/courses/111/107/111107058/</a>	IIT, Madras IIT, Roorkee	90 90	8 Weeks
3	Data Structures	BTCOC303	III	<a href="https://nptel.ac.in/courses/106/102/106102064/">https://nptel.ac.in/courses/106/102/106102064/</a>	IIT, Delhi	90	Not mentioned
4	Computer Architecture & Organization	BTCOC304	III	<a href="https://nptel.ac.in/courses/106/106/106106092/">https://nptel.ac.in/courses/106/106/106106092/</a> <a href="https://nptel.ac.in/courses/106/103/106103180/">https://nptel.ac.in/courses/106/103/106103180/</a> <a href="https://nptel.ac.in/courses/106/106/106106166/">https://nptel.ac.in/courses/106/106/106106166/</a> <a href="https://nptel.ac.in/courses/106/105/106105163/">https://nptel.ac.in/courses/106/105/106105163/</a> <a href="https://swayam.gov.in/nd1_noc20_cs64/preview">https://swayam.gov.in/nd1_noc20_cs64/preview</a>	IIT, Madras IIT, Guwahati IIT, Madras ,IIT, Kharagpur IIT, Kharagpur	85 75 70 85 85	12 weeks
5	Object Oriented Programming in C++	BTCOC305	III	<a href="https://nptel.ac.in/courses/106/105/106105151/">https://nptel.ac.in/courses/106/105/106105151/</a>	IIT, Kharagpur	58	8 weeks
6	JAVA Programming	BTCOL306	III	<a href="https://nptel.ac.in/courses/106/105/106105191/">https://nptel.ac.in/courses/106/105/106105191/</a>	IIT, Kharagpur	90	12 Weeks
7	Design & Analysis of Algorithms	BTCOC401	IV	<a href="https://nptel.ac.in/courses/106/101/106101060/">https://nptel.ac.in/courses/106/101/106101060/</a> <a href="https://nptel.ac.in/courses/106/105/106105164/">https://nptel.ac.in/courses/106/105/106105164/</a> <a href="https://swayam.gov.in/nd1_noc20_cs71/preview">https://swayam.gov.in/nd1_noc20_cs71/preview</a>	IIT, Kharagpur IIT, Madras Chennai Mathematical Institute	40	12 weeks
8	Probability & Statistics	BTBS402	IV	<a href="https://nptel.ac.in/courses/111/106/111106112/#">https://nptel.ac.in/courses/111/106/111106112/#</a> <a href="https://nptel.ac.in/courses/111/105/111105090/">https://nptel.ac.in/courses/111/105/111105090/</a>	IIT, Madras IIT, Kharagpur	80 90	4 weeks 12 weeks
9	Operating Systems	BTCOC403	IV	<a href="https://nptel.ac.in/courses/106/108/106108101/">https://nptel.ac.in/courses/106/108/106108101/</a> <a href="https://nptel.ac.in/courses/106/106/106106144/">https://nptel.ac.in/courses/106/106/106106144/</a>	IISc, Bangalore IIT, Madras	1. 85 2. 80	1. 8 Weeks 2. 8 Weeks
10	Basic Human Rights	BTHM404	IV	<a href="https://nptel.ac.in/courses/109/104/109104068/">https://nptel.ac.in/courses/109/104/109104068/</a>	IIT, Kanpur	75	30 Hours



11	Digital Electronics & Microprocessors	BTES405	IV	<a href="https://nptel.ac.in/courses/108/105/108105132/">https://nptel.ac.in/courses/108/105/108105132/</a> <a href="https://nptel.ac.in/courses/108/103/108103157/">https://nptel.ac.in/courses/108/103/108103157/</a>	IIT, Kharagpur IIT, Guwahati	50	12 weeks
12	Python Programming	BTCOL406	IV	<a href="https://nptel.ac.in/courses/106/106/106106182/">https://nptel.ac.in/courses/106/106/106106182/</a>	IIT, Ropar	95	12 weeks
14	Database Systems	BTCOC501	V	<a href="http://nptel.ac.in/courses/106/1/06093/">http://nptel.ac.in/courses/106/1/06093/</a>	IIT, Madras	95	12 Weeks
15	Theory of Computation	BTCOC502	V	<a href="https://nptel.ac.in/courses/106/104/106104028/">https://nptel.ac.in/courses/106/104/106104028/</a> <a href="https://nptel.ac.in/courses/106/106/106106049/">https://nptel.ac.in/courses/106/106/106106049/</a>	IIT, Kharagpur IIT, Madras	92	45 Hrs 42 Hrs
16	Machine Learning	BTCOC503	V	<a href="https://nptel.ac.in/courses/106/105/106105152/">https://nptel.ac.in/courses/106/105/106105152/</a>	IIT, Kharagpur	100	8 Weeks
17	Human Computer Interaction	BTCOE504 (A)	V	<a href="https://nptel.ac.in/courses/106/103/106103115/#">https://nptel.ac.in/courses/106/103/106103115/#</a>	IIT, Guwahati	70	8 Weeks
18	Numerical Methods	BTCOE504 (B)	V	<a href="https://nptel.ac.in/courses/111/107/111107105/">https://nptel.ac.in/courses/111/107/111107105/</a>	IIT, Roorkee	90	8 Weeks
19	Economics and Management	BTHM505 (A)	V	<a href="https://nptel.ac.in/courses/110/105/110105067/">https://nptel.ac.in/courses/110/105/110105067/</a>	IIT, Kharagpur	90	8 Week
20	Business Communication	BTHM505 (B)	V	<a href="https://nptel.ac.in/courses/110/105/110105052/">https://nptel.ac.in/courses/110/105/110105052/</a>	IIT, Kharagpur	90	8 Weeks
21	Compiler Design	BTCOC601	VI	<a href="https://nptel.ac.in/courses/106/108/106108113/">https://nptel.ac.in/courses/106/108/106108113/</a> <a href="https://nptel.ac.in/courses/106/104/106104123/">https://nptel.ac.in/courses/106/104/106104123/</a>	IISc, Bangalore IIT Kanpur	80	40 Hrs
22	Computer Networks	BTCOC602	VI	<a href="https://nptel.ac.in/courses/106/105/106105081/">https://nptel.ac.in/courses/106/105/106105081/</a> <a href="https://nptel.ac.in/courses/106/105/106105080/">https://nptel.ac.in/courses/106/105/106105080/</a>	IIT Kharagpur	90	12 Weeks
23	Software Engineering	BTCOC603	VI	<a href="https://nptel.ac.in/courses/106/105/106105182/">https://nptel.ac.in/courses/106/105/106105182/</a>	IIT, Kharagpur	70	9 weeks
24	Geographic Information System	BTCOE604 (A)	VI	Introduction to Geographic Information Systems	IIT, Roorkee	90	4 weeks
25	Internet of Things	BTCOE604 (B)	VI	<a href="https://nptel.ac.in/courses/106/105/106105166/">https://nptel.ac.in/courses/106/105/106105166/</a>	IIT, Kharagpur	60	12 Weeks
26	Embedded Systems	BTCOE604 (C)	VI	<a href="https://nptel.ac.in/courses/106/105/106105193/">https://nptel.ac.in/courses/106/105/106105193/</a>	IIT, Kharagpur	80	8 Weeks
27	Development Engineering	BTCOE605 (A)	VI	<a href="https://nptel.ac.in/courses/109/103/109103023/">https://nptel.ac.in/courses/109/103/109103023/</a> <a href="https://nptel.ac.in/courses/109/104/109104074/">https://nptel.ac.in/courses/109/104/109104074/</a>	IIT, Guwahati IIT, Kanpur	30 40	8 Weeks
28	Employability and Skills Development	BTCOE605 (B)	VI	<a href="https://nptel.ac.in/courses/109/105/109105144/">https://nptel.ac.in/courses/109/105/109105144/</a>	IIT, Kharagpur	75	8 Weeks
29	Consumer Behaviour	BTCOE605 (C)	VI	<a href="https://nptel.ac.in/courses/110/105/110105054/">https://nptel.ac.in/courses/110/105/110105054/</a>	IIT Kharagpur	90	40 Hrs

30	Artificial Intelligence	BTCOC701	VII	<a href="https://nptel.ac.in/courses/106/106/106106126/">https://nptel.ac.in/courses/106/106/106106126/</a> <a href="https://nptel.ac.in/courses/106/105/106105078/">https://nptel.ac.in/courses/106/105/106105078/</a>	IIT, Madras  IIT, Kharagpur	70	48 Hrs  41 Hrs
31	Cloud Computing	BTCOE702	VII	<a href="https://nptel.ac.in/courses/106/104/106104182/">https://nptel.ac.in/courses/106/104/106104182/</a> <a href="https://nptel.ac.in/courses/106/105/106105167/">https://nptel.ac.in/courses/106/105/106105167/</a>	IIT, PATNA  IIT, Kharagpur	30  40	8 weeks
32	Bioinformatics	BTCOE703 (A)	VII	<a href="https://nptel.ac.in/courses/102/106/102106065/">https://nptel.ac.in/courses/102/106/102106065/</a>	IIT, Madras	50	12 Weeks
33	Distributed Systems	BTCOE703 (B)	VII	<a href="https://nptel.ac.in/courses/106/106/106106168/">https://nptel.ac.in/courses/106/106/106106168/</a>	IIT, PATNA	50	8 Weeks
34	Big Data Analytics	BTCOE703 (C)	VII	<a href="https://nptel.ac.in/courses/106/104/106104189/">https://nptel.ac.in/courses/106/104/106104189/</a>	IIT, PATNA	50	8 Weeks
35	Cryptography and Network Security	BTCOE704 (A)	VII	<a href="https://swayam.gov.in/nd2_no_u19_cs08/preview">https://swayam.gov.in/nd2_no_u19_cs08/preview</a>	Uttarakhand Open University, Haldwani	20	12 Weeks
36	Business Intelligence	BTCOE704 (B)	VII	<a href="https://nptel.ac.in/courses/106/104/106104220/">https://nptel.ac.in/courses/106/104/106104220/</a>	IIT, Kharagpur	10	12 Weeks
37	Blockchain	BTCOE704 (C)	VII	<a href="https://nptel.ac.in/courses/106/104/106104220/">https://nptel.ac.in/courses/106/104/106104220/</a>	IIT, KANPUR	60	8 Weeks
38	Virtual Reality	BTCOE705 (A)	VII	<a href="https://nptel.ac.in/course/106/106/106106138">https://nptel.ac.in/course/106/106/106106138</a>	IIT Madras & UIUC	30	8 Weeks
39	Deep Learning	BTCOE705 (B)	VII	<a href="https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs85/">https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs85/</a>	IIT Madras & IIT Ropar	100	12 Weeks
40	Design Thinking	BTCOE705 (C)	VII	<a href="https://nptel.ac.in/courses/110/106/110106124/">https://nptel.ac.in/courses/110/106/110106124/</a>	IIT Madras	75	4 Weeks

**DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE**  
**COURSE CURRICULUM MAPPING WITH MOOC PLATFORM COURSERA**

Sr. No.	Name of Subject as per Curriculum	Course Code	Semester	Coursera Course	Name of Institute offering course	Relevance %	Duration of Course
1	Discrete Mathematics	BTCOC302	III	1) <a href="https://www.coursera.org/learn/discrete-mathematics/home/welcome">https://www.coursera.org/learn/discrete-mathematics/home/welcome</a> 2) <a href="https://www.coursera.org/specializations/discrete-mathematics">https://www.coursera.org/specializations/discrete-mathematics</a>	1) Shanghai Jiao Tong University 2) University of California San Diego National Research University Higher School of Economics	1) 75 2) 90	8 Weeks
2	Data Structures	BTCOC303	III	1) Data Structures 2) Data Structures & Algorithms	1) UC San Diego 2) UC San Diego	1) 90 2) 80	1) 6 Weeks 2) 6 Weeks
3	Computer Architecture & Organization	BTCOC304	III	Computer Architecture	Princeton University, US	25	4 Weeks
4	Object Oriented Programming in C++	BTCOC305	III	C++ For C Programmers, Part A	University of California, Santa Cruz	27	5 Weeks
5	Digital Electronics & Microprocessors	BTES403	IV	1) Digital Systems: From Logic Gates to Processors	1) Universitat Autònoma de Barcelona 2) Princeton University	20	4 Weeks
6	Design & Analysis of Algorithms	BTCOC401	IV	Algorithms Specialization	Stanford University	40	16 Weeks
7	Probability & Statistics	BTBS402	IV	Probability Theory, Statistics and Exploratory Data Analysis	National Research University Higher School of Economics	80	6 Weeks
8	Operating Systems	BTCOC403	IV	Operating Systems and You: Becoming a Power User	Google	20	6 Weeks
9	Database Systems	BTCOC501	V	Relational database systems	Universidad Nacional Autónoma de México	30	4 Weeks
10	Theory of Computation	BTCOC502	V	Computer Science: Algorithms, Theory, and Machines	Princeton University	25	4 Weeks
11	Machine Learning	BTCOC503	V	Machine Learning with Python	IBM	50	6 Weeks
12	Human Computer Interaction	BTCOE504 (A)	V	Interaction Design Specialization	UC San Diego	30	13 Weeks
13	Economics and Management	BTHM505 (A)	V	Managerial Economics and Business Analysis Specialization	University of Illinois	30	4 Weeks

14	Business Communication	BTHM505 (B)	V	Communication theory: bridging academia and practice	National Research University Higher School of Economics	35	9 Weeks
15	Compiler Design	BTCOC601	VI	Nil	Nil	Nil	Nil
16	Computer Networks	BTCOC602	VI	The Bits and Bytes of Computer Networking	Google	50	4 Weeks
17	Software Engineering	BTCOC603	VI	<u>Software Development Processes and Methodologies</u> <a href="https://www.coursera.org/learn/software-Processes">https://www.coursera.org/learn/software-Processes</a>	University of Minnesota	25	4 Weeks
18	Geographic Information System	BTCOE604 (A)	VI	1. GIS, mapping, and spacial analysis Specialization	University of Toronto	40	6 months
19	Internet of Things	BTCOE604 (B)	VI	Internet of Things Specialization	UC San Diego	40	6 Months
20	Development Engineering	BTCOE605 (A)	VI	Revolutionary Ideas: Utility, Justice, Equality, Freedom	Rutgers the State University of New Jersey	30	5 Weeks
21	Consumer Behaviour	BTCOE605 (C)	VI	Digital Marketing Specialization	Illinois	70	6 Months
22	Artificial Intelligence	BTCOC701	VII	Introduction to Artificial Intelligence (AI)	IBM	40	4 Weeks
23	Cloud Computing	BTCOE702	VII	Cloud Computing Applications, Part 1: Cloud Systems and Infrastructure	University of Illinois at Urbana-Champaign	70	4 Weeks
24	Bioinformatics	BTCOE703 (A)	VII	Bioinformatics Capstone: Big Data in Biology	University of California San Diego	20	3 Weeks
25	Distributed System	BTCOE703 (B)	VII	Distributed Programming in Java	Rice University	30	4 Weeks
26	Cryptography and Network Security	BTCOE704 (A)	VII	Information Security: Context and Introduction	Royal Holloway, University of London	40	4 Weeks
27	Business Intelligence	BTCOE704 (B)	VII	Business Intelligence Concepts, Tools, and Applications	University of Colorado System	30	5 Weeks

## COURSE CURRICULUM MAPPING WITH MOOC PLATFORM

### Edx

Sr. No.	Name of Subject as per Curriculum	Course Code	Semester	Edx Course	Name of Institute offering Course	Relevance %	Duration of Course
1	Discrete Mathematics	BTCOC302	III	<a href="https://www.edx.org/course/advanced-algorithmics-and-graph-theory-with-python">https://www.edx.org/course/advanced-algorithmics-and-graph-theory-with-python</a>	IMT Atlantique, a french technological university	50	6 Weeks
2	Data Structures	BTCOC303	III	1) Foundations of Data Structures 2) Algorithms and Data Structures	1) IIT Bombay 2) UCSanDiego	1) 90 2) 70	1) 6 Weeks 2) 4 Weeks
3	Computer Architecture & Organization	BTCOC304	III	1. Computer Organization 2. Computer Architecture	1. MITx 2. MITx	1. 20 2. 20	10 Weeks
4	Object Oriented Programming in C++	BTCOC305	III	Object-oriented Programming	IIT BombayX	53	4 Weeks
5	Design & Analysis of Algorithms	BTCOC401	IV	Algorithm Design and Analysis	University of Pennsylvania	40	4 Weeks
6	Probability & Statistics	BTBS402	IV	Introduction to Probability	Harvard University	50	8 Weeks
7	Operating Systems	BTCOC403	IV	Computer Hardware and Operating Systems	New York University	40	6 Weeks
8	Digital Electronics & Microprocessors	BTES405	IV	Computer System Design: Advanced Concepts of Modern Microprocessors	1) Edx Edge	10	6 Weeks
9	Database Systems	BTCOC501	V	Databases: SQL	Stanford Online	50	8 Weeks
10	Theory of Computations	BTCOC502	V	Automata Theory	Stanford University	60	7 Weeks
11	Machine Learning	BTCOC503	V	Machine Learning with Python: A Practical Introduction	IBM	50	5 Weeks
12	Human Computer Interaction	BTCOE504 (A)	V	Human-Computer Interaction	Georgia Tech	30	12 Weeks
13	Economics and Management	BTHM505 (A)	V	Introduction to Managerial Economics	<u>IIM Bangalore</u>	30	6 Weeks
14	Business Communication	BTHM505 (B)	V	Effective Business Communication	<u>IIM Bangalore</u>	40	6 Weeks
15	Compiler Design	BTCOC601	VI	Compilers	Stanford University	45	10 Weeks

16	Computer Networks	BTCOC602	VI	Introduction to Networking	New York University	40	7 Weeks
17	Software Engineering	BTCOC603	VI	<u>Software Engineering Essentials</u> <a href="https://www.edx.org/course/software-engineering-essentials">https://www.edx.org/course/software-engineering-essentials</a>	TUMx	40	8 Weeks
18	Geographic Information System	BTCOE604 (A)	VI	No Program available	NA	NA	NA
19	Internet of Things	BTCOE604 (B)	VI	Getting Started with the Internet of Things (IoT)	Microsoft	30	4 Weeks
20	Development Engineering	BTCOE605 (A)	VI	Human Rights, Human Wrongs: Challenging Poverty, Vulnerability and Social Exclusion	SDGAcademyX, Middlesex University	40	11 Weeks
21	Consumer Behaviour	BTCOE605 (B)	VI	Consumer Behaviour	IITMB	50	4 Weeks
22	Artificial Intelligence	BTCOC701	VII	CS50's Introduction to Artificial Intelligence with Python	Harvard University	35	7 Weeks
23	Bioinformatics	BTCOE703 (A)	VII	Bioinformatics	University of Maryland	40	24 Weeks
24	Distributed Systems	BTCOE703 (B)	VII	Reliable Distributed Algorithms - Part 1	KTHx	30	5 Weeks
25	Cloud Computing	BTCOE703 (C)	VII	Cloud Computing Management	University of Maryland	20	8 Weeks
26	Cryptography and Network Security	BTCOE704 (A)	VII	Cyber security	Rochester Institute of Technology	50	40 Weeks
27	Business Intelligence	BTCOE704 (B)	VII	Business Intelligence for IoT Solutions	Microsoft	20	4 Weeks
28	Block Chain	BTCOE704 (C)	VII	1. Block chain Technology 2. Block chain Fundamentals	Berkeley University Of California	60	14 Weeks
29	Virtual Reality	BTCOE705 (A)	VII	How Virtual Reality Works	Ucsan Diego	10	6 Weeks
30	Deep Learning	BTCOE705 (B)	VII	Deep Learning Fundamentals with Keras	IBM	15	5 Weeks