

Dr. Babasaheb Ambedkar Technological University
(Established as a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
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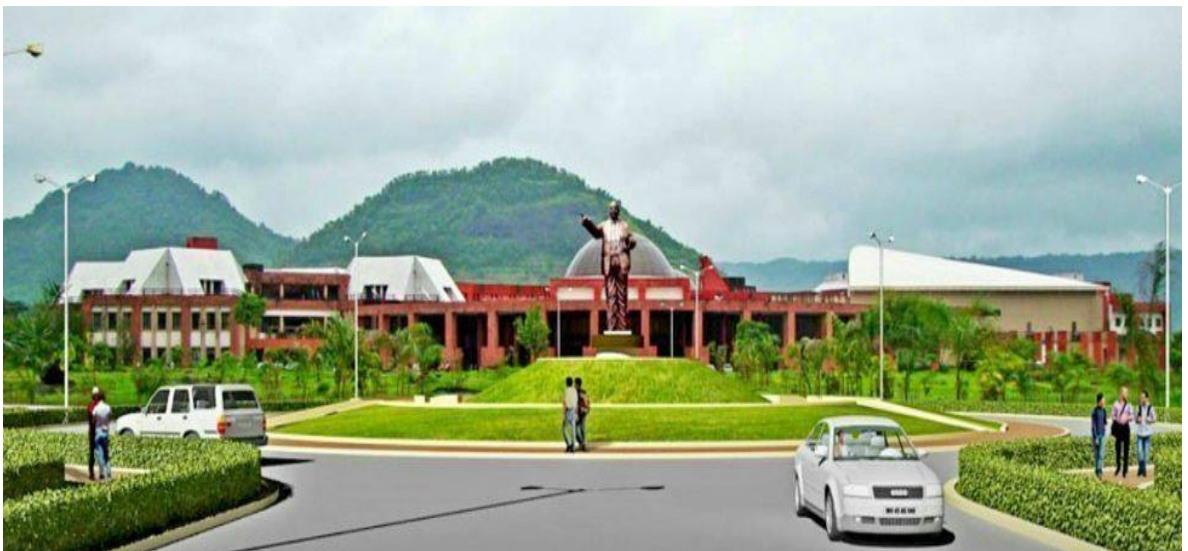
PROPOSED CURRICULUM

UNDER GRADUATE PROGRAMME

B.TECH

COMPUTER ENGINEERING

WITH EFFECT FROM THE ACADEMIC YEAR 2020-2021



Rules and Regulations

1. The normal duration of the course leading to B. Tech degree will be EIGHT semesters.
2. The normal duration of the course leading to M. Tech. degree will be FOUR semesters.
3. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid- July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session/Semester as well. For 1st year B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.
4. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.
5. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra-curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

REGISTRATION:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a UG/PG Programme:
A full time student of a particular UG/PG programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PG programme as stipulated in the specific Regulations pertaining to that UG/PG programme.
2. Mandatory Pre-Registration for higher semesters:
In order to facilitate proper planning of the academic activities of a semester, it is essential for the every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.
4. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

COURSE PRE-REQUISITES:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.
2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.
4. A student will be permitted to register in the next semester only if he fulfills the following conditions:
 - (a) Satisfied all the Academic Requirements to continue with the programme of Studies without termination
 - (b) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
 - (c) Paid all required advance payments of the Institute and hostel for the current semester;
 - (d) Not been debarred from registering on any specific ground by the Institute.

EVALUATION SYSTEM:

1. Absolute grading system based on absolute marks as indicated below will be implemented from academic year 2019-20, starting from I year B.Tech.

Percentage of Marks	Letter grade	Grade point
91-100	EX	10.0
86-90	AA	9.0
81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5
40-50	EE	5.0
<40	EF	0.0

2. Class is awarded based on CGPA of all eighth semester of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPA upto < 5.50	Pass Class
CGPA \geq 5.50 & < 6.00	Second Class
CGPA \geq 6.00 & < 7.50	First Class
CGPA \geq 7.50	Distinction
[Percentage of Marks = CGPA*10.0]	

3. A total of 100 Marks for each theory course are distributed as follows:

1	Mid Semester Exam (MSE) Marks	20
2	Continuous Assessment Marks	20
3	End Semester Examination (ESE)Marks	60

4. A total of 100 Marks for each practical course are distributed as follows:

1	Continuous Assessment Marks	60
2	End Semester Examination (ESE) Marks	40

It is mandatory for every student of B.Tech to score a minimum of 40 marks out of 100, with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.

This will be implemented from the first year of B.Tech starting from Academic Year 2019-20.

5. Description of Grades:

EX Grade: An 'EX' grade stands for outstanding achievement.

EE Grade: The 'EE' grade stands for minimum passing grade.

The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only.

If any of the student remain Absent for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.

FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance. The students who have been awarded 'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance:

1. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(A) Semester Grade Point Average (SGPA): The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{[\sum_{i=1}^n c_i g_i]}{[\sum_{i=1}^n c_i]}$$

Where

'n' is the number of subjects for the semester,

'ci' is the number of credits allotted to a particular subject, and

'gi' is the grade-points awarded to the student for the subject based on his performance as per the above table.

-SGPA will be rounded off to the second place of decimal and recorded as such.

(B) Cumulative Grade Point Average (CGPA): An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since she entered the Institute. CGPA is also calculated at the end of every semester (upto two decimal places). Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{[\sum_{i=1}^m c_i g_i]}{[\sum_{i=1}^m c_i]}$$

Where

‘m’ is the total number of subjects from the first semester onwards up to and including the semester S,

‘ci’ is the number of credits allotted to a particular subject, and

‘gi’ is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

-CGPA will be rounded off to the second place of decimal and recorded as such.

AWARD OF DEGREE OF HONOURS (MAJOR) DEGREE

The concept of Major and Minors at B.Tech level is introduced, to enhance learning skills of students, acquisition of additional knowledge in domains other than the discipline being pursued by the student, to make the students better employable with additional knowledge and encourage students to pursue cross-discipline research.

A. Eligibility Criteria for Majors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester.
2. Student willing to opt for majors has to register at the beginning of 5th Semester.
3. The Student has to complete 5 additional advanced courses from the same discipline specified in the curriculum. These five courses should be of 4 credits each amounting to 20 credits. The students should complete these credits before the end of last semester.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL / SWAYAM courses do not match with the existing subject proper scaling will be done.)

Student complying with these criteria will be awarded B.Tech (Honours) Degree.

B. Eligibility Criteria for Minors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester.
2. Student willing to opt for minors has to register at the beginning of 5th Semester.
3. The Student has to complete 5 additional courses from other discipline of their interest, which are specified in the respective discipline. These five courses should be of 4 credits each amounting to 20 credits.
4. Student may opt for the courses from NPTEL / SWAYAM platform. (if the credits of NPTEL / SWAYAM courses do not match with the existing subject proper scaling will be done.)

Student complying with these criteria will be awarded with B.Tech Degree in

-----Engineering with Minor in -----Engineering.

(For e. g.: B. Tech in Civil Engineering with Minor in Computer Engineering)

For applying for Honours and Minor Degree the student has to register themselves through the proper system.

ATTENDANCE REQUIREMENTS

1. All students must attend every lecture, tutorial and practical classes.
2. To account for approved leave of absence (eg. Representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted.

If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination.

The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be.

In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

3. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.
4. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

TRANSFER OF CREDITS

The courses credited elsewhere, in Indian or foreign University / Institutions / Colleges /Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

- (a) 20% of the total credit will be considered for respective calculations.
- (b) Credits transferred will be considered for overall credits requirements of the programme.
- (c) Credits transfer can be considered only for the course at same level i.e. UG, PG etc.
- (d) A student must provide all details (original or attested authentic copies) such as course contents, number of contact hours, course instructor / project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.
- (e) A student has to get minimum passing grades / marks for such courses for which the credits transfers are to be made.
- (f) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.
- (g) In exceptional cases, the students may opt for higher credits than the prescribed.

Different Categories of Courses and Credits for Degree Requirements

a) Basic Science Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTBS101	Engineering Mathematics – I	(3-1-0) 4
2	BTBS102	Engineering Physics	(3-1-0) 4
3	BTBS107L	Engineering Physics Laboratory	(0-0-2) 1
4	BTBS201	Engineering Mathematics-II	(3-1-0) 4
5	BTBS202	Engineering Chemistry	(3-1-0) 4
6	BTBS207L	Engineering Chemistry Laboratory	(0-0-2) 1
7	BTBS301	Engineering Mathematics-III	(3-1-0) 4
8	BTBS404	Probability Theory and Random Processes	(3-0-0) 3
TOTAL			25

b) Engineering Science Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTES103	Engineering Graphics	(2-0-0) 2
2	BTES105	Energy and Environment Engineering	(2-0-0) 2
3	BTES106	Basic Civil and Mechanical Engineering	(2-0-0) Audit
4	BTES108L	Engineering Graphics Laboratory	(0-0-4) 2
5	BTES203	Engineering Mechanics	(2-1-0) 3
6	BTES204	Computer Programming	(3-0-0) 3
7	BTES205	Workshop Practices	(0-0-4) 2
8	BTES206	Basic Electrical and Electronics Engineering	(2-0-0) Audit
9	BTES208L	Engineering Mechanics Laboratory	(0-0-2) 1
10	BTES209L	Basic Computer Programming Laboratory	(0-0-2) 1
11	BTES405	Digital Logic Design & Microprocessors	(3-1-0) 4
TOTAL			20

c) Humanities and Social Science including Management Courses

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTHM104	Communication Skills	(2-0-0) 2
2	BTHM109L	Communication Skills Laboratory	(0-0-2) 1
3	BTHM403	Basic Human Rights	(3-0-0) 3
4	BTHM605	(A) Development Engineering (B) Employability and Skills Development (C) Consumer Behaviour	(3-0-0) 3
5	BTHM505	(A) Economics and Management (B) Business Communication	(3-0-0) 3
6	BTHM706	Foreign Language Studies	Audit
TOTAL			12

d) Professional Core Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTCOC302	Discrete Mathematics	(3-1-0) 4
2	BTCOC303	Data Structures	(3-1-0) 4
3	BTCOC304	Computer Architecture & Organization	(3-1-0) 4
4	BTCOL306	Data Structures Lab & Object Oriented Programming Lab	(0-0-4) 2
5	BTCOC401	Design & Analysis of Algorithms	(3-1-0) 4
6	BTCOC402	Operating Systems	(3-1-0) 4
7	BTCOC501	Database Systems	(3-1-0) 4
8	BTCOC502	Theory of Computation	(3-1-0) 4
9	BTCOC503	Software Engineering	(3-1-0) 4
10	BTCOL506	Database Management System & Software Engineering Lab	(0-0-4) 2
11	BTCOC601	Compiler Design	(3-1-0) 4
12	BTCOC602	Computer Networks	(3-1-0) 4
TOTAL			44

e) Professional Elective Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTCOE504	(A) Human Computer Interaction (B) Numerical Methods	(3-0-0) 3
2	BTCOE604	(A) Geographic Information System (B) Internet of Things (C) Embedded Systems	(3-0-0) 3
3	BTCOE703	(A) Bioinformatics (B) Distributed System (C) Big Data Analytics	(3-0-0) 3
TOTAL			09

f) Open Elective Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTCOE704	(A) Cryptography and Network Security (B) Business Intelligence (C) Block Chain Technology	(3-0-0) 3
2	BTCOE705	(A) Virtual Reality (B) Deep Learning (C) Design Thinking	(3-0-0) 3
TOTAL			06

g) Seminar / Mini Project / Internship

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	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).	Audit
2	BTCOS307	Seminar-I	(0-0-4) 2
3	BTCOS407	Seminar-II	(0-0-4) 2
4	BTCOM507	Mini Project-I	(0-0-4) 2
5	BTCOM607	Mini Project-II	(0-0-4) 2
6	BTCOS708	Project Phase-I	(0-0-4) 2
7	BTCOF801	Project Work / Internship	(0-0-24) 12
TOTAL			22

h) Emerging Courses

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTCOL305	Object Oriented Programming in Java	(3-1-0) 4
2	BTCOL406	Operating Systems & Python Programming Lab	(1-0-4) 3
3	BTCOC603	Machine Learning	(3-1-0) 4
4	BTCOL606	Competitive Programming & Machine Learning Lab	(1-0-4) 3
5	BTCOC701	Artificial Intelligence	(3-0-0) 3
6	BTCOC702	Cloud Computing	(3-0-0) 3
7	BTCOC707	Artificial Intelligence & Cloud Computing Lab	(0-0-4) 2
TOTAL			22

Category – wise total number of credits

Sr. No.	Category of courses	Minimum credits to be Earned
1	Basic Science Course (BSC)	25
2	Engineering Science Course (ESC)	20
3	Humanities and Social Science including Management Courses (HSSMC)	12
4	Professional Core Course (PCC)	44
5	Professional Elective Course (PEC)	09
6	Open Elective Course (OEC)	06
7	Seminar / Mini Project / Internship / Major Project	22
8	Emerging Courses	22
TOTAL		160

Programme Educational Objectives (PEO)

Name of Programme: Bachelor of Technology (Computer Engineering)

A graduate in the discipline of Computer Engineering is generally expected to have three kinds of knowledge. First, the graduate should have conceptual knowledge of the core topics of Computer Science. Second, she/he should have knowledge of mathematical formalism underlying various programming concepts. Third, graduates in the discipline of Computer Engineering should have the knowledge of the state of the technologies and tools so that he/she can apply the principles of Computer Science to solve real-life problems from diverse application domains. The programme of B.Tech in Computer Engineering at Dr. Babasaheb Ambedkar Technological University (DBATU) essentially aims to meet these broad expectations. At the same time, the program intends to comply with the courses and syllabus available at National Program on Technology Enhanced Learning (NPTEL) and SWAYAM. The following specific educational objective aims to achieve these global and regional expectations.

Objective Identifier	Objectives
PEO1	To provide knowledge of sound mathematical principles underlying various programming concepts.
PEO2	To develop an ability to understand complex issues in the analysis, design, implementation and operation of information systems.
PEO3	To provide knowledge of mechanisms for building large-scale computer-based systems.
PEO4	To develop an ability to provide computer-based solutions to the problems from other disciplines of science and engineering.
PEO5	To impart skills necessary for adapting rapid changes taking place in the field of information and communication technologies.
PEO6	To provide knowledge of ethical issues arising due to deployment of information and communication technologies in the society on large scale.

Programme Outcomes (PO)

After undergoing the learning process of four years, students of B.Tech. (Computer Engineering) at Dr. Babasaheb Ambedkar Technological University will have an ability to build information systems and provide computer based solutions to real life problems. The graduates of this programme will demonstrate following abilities and skill sets.

Outcome Identifier	Outcomes
PO1	The graduates will possess the knowledge of various discrete mathematical structures, Logic and numerical techniques.
PO2	The graduates will have an ability to apply mathematical formalism of Finite Automata and Probability in modeling and analysis of systems.
PO3	The graduates will have knowledge of core programming paradigms such as database orientation, object orientation, and agent orientation and concepts essential to implement software based system.
PO4	The graduates will have an ability to analyze problem, specify algorithmic solutions to them and to evaluate alternative solutions.
PO5	The graduate will have broad understanding of the impact of a computer based solutions in economic, environmental and social context and will demonstrate use of analytical tools in gathering requirements and distilling relevant information to provide computer based solutions.
PO6	The graduates will demonstrate the ability to build human centric interfaces to computers.
PO7	The graduates will possess the knowledge of advanced and emerging topics in the fields of operating systems, databases and computer networks.
PO8	The graduates will possess skills necessary to communicate design engineering ideas. The skills set include verbal, written and listening skills.
PO9	The graduates will understand ethical issues in providing computer based solutions also they will have an ability and attitude to address the ethical issues.
PO10	The graduates will understand the role of system software such as operating systems, database management systems, compilers, middle-ware and internet protocols in realizing distributed information environment

Semester –V (Third Year)
Proposed Scheme w.e.f. July – 2022

Course Category	Course Code	Course Title	Weekly Teaching Hrs			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
	BTCOC501	Database Systems	3	1	-	20	20	20	100	4
	BTCOC502	Theory of Computation	3	1	-	20	20	20	100	4
	BTCOC503	Software Engineering	3	1	-	20	20	20	100	4
	BTCOE504	Elective – II (A) Human computer Interaction (B) Numerical Methods	3	-	-	20	20	20	100	3
	BTHM505	Elective – III (A) Economics and Management (B) Business Communication	3	-	-	20	20	20	100	3
	BTCOL506	Database Systems & Software Engineering Lab	-	-	4	60	-	40	100	2
	BTCOM507	Mini-project – I	-	-	4	60	-	40	100	2
	BTCOF408	Field Training / Internship / Industrial Training Evaluation	-	-	-	-	-	-	-	Audit
TOTAL			15	3	8	220	100	380	700	22

Semester –VI (Third Year)
Proposed Scheme w.e.f. January – 2023

Course Category	Course Code	Course Title	Weekly Teaching Hrs			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
	BTCOC601	Compiler Design	3	1	-	20	20	60	100	4
	BTCOC602	Computer Networks	3	1	-	20	20	60	100	4
	BTCOC603	Machine Learning	3	1	-	20	20	60	100	4
	BTCOE604	Elective – IV (A) Geographic Information System (B) Internet of Things (C) Embedded Systems	3	-	-	20	20	60	100	3
	BTHM605	Elective – V (A) Development Engineering (B) Employability and Skill Development (C) Consumer Behaviour	3	-	-	20	20	60	100	3
	BTCOL606	Competitive Programming & Machine Learning Lab	1*	-	4	60	-	40	100	3
	BTCOM607	Mini-project – II	-	-	4	60	-	40	100	2
	BTCOF608	Field Training / Internship / Industrial Training	-	-	-	-	-	-	-	Audit to be Evaluated in VII Sem.
TOTAL			16	3	8	220	100	380	700	23

*Note: Lecture should be conducted only for Competitive Programming

BTCOC501: Database Systems**[Unit 1] Introduction****[7 Hours]**

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**[7 Hours]**

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**[7 Hours]**

Overview of SQL, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operators, Set Operations, Null Values, Aggregate Functions, Nested Sub queries, 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 and File Organization, Indexing & Hashing**[7 Hours]**

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.

File Organization, Ordered Indices, B+tree Index files, B Tree Index File, Static Hashing, Dynamic Hashing,

[Unit 5] Transaction Processing**[7 Hours]**

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

Text Book:

1. Henry Korth, Abraham Silberschatz & S. Sudarshan, Database System Concepts, McGraw-Hill Publication, 6th Edition, 2011.

Reference Books:

1. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-HillPublication, 3rd Edition, 2003.
2. Joel Murach, Murach's Oracle SQL and PL/SQL for Developers, Mike Murach & Associates, 2nd Edition, 2014.
3. Wiederhold, Database Design, McGraw-Hill Publication, 2nd Edition, 1983.
4. Navathe, Fundamentals of Database System, Addison-Wesley Publication, 6th Edition, 2012.
5. Mark L. Gillenson, Fundamentals of Database Management System, Wiley Publication, 2nd Edition, 2011.
6. Serge Abiteboul, Richard Hull, Victor Vianu, "Foundations of Databases", Reprint by Addison-Wesley.

BTCOC502: Theory of Computation

[Unit 1] Finite Automata and Regular Expressions [7 Hours]

Definition of deterministic finite automata, Non-deterministic finite automata, Moore and Mealy machines and their conversions, Regular expressions, Recursive definition, NFA with ϵ -moves, Inter-conversion between NFA and DFA, Regular expression and FA, Pumping lemma.

[Unit 2] Context Free Grammars [7 Hours]

Definition, Production rules, Ambiguous grammar, Removal of ambiguity, Chomsky hierarchy, Context Free Grammar (CFG) – definition, Simplification of CFG.

[Unit 3] Context Free Languages [7 Hours]

Definition of context free languages, Regular grammar definition, Left linear, Right linear grammar, Inter-conversion between left linear and right linear regular grammar, Regular grammar and finite automata, CNF, GNF, Derivation graphs, Type 0 and Type 1 grammars.

[Unit 4] Push down Automata [7 Hours]

Formal definition, Pushdown automata (PDA), Deterministic Pushdown automata (DPDA) – definition, Non-deterministic Pushdown automata (NPDA) - definition, relative powers of DPDA and NPDA.

[Unit 5] Turing Machines and Undecidability [7 Hours]

Definition, Computing with Turing machine, Extensions of Turing machines, Random access Turing machines, Non-deterministic Turing machines, Grammars, The Church's Turing hypothesis, Universal Turing machines, The Halting problem, Unsolvable problems about Turing machines.

Text Book:

1. Hopcroft, Ullman, Motwani, *Introduction to Automata Theory, Languages, and Computation*, Addison Wesley Publication, 2nd Edition, 2001.

Reference Books:

1. Daniel I. A. Cohen, *Introduction to Computer Theory*, Wiley Publication, 1st Edition, 1986.
2. John C. Martin, *Introduction to Languages and Theory of Computation*, McGraw-Hill Publication, 4th Edition, 2010.
3. Krithivasan Kamala, *Introduction to Formal Languages, Automata Theory and Computation*, Pearson Education, 1st Edition, 2009.
4. Papadimitriou, Lewis, *Elements of the Theory of Computations*, PHI Publication, 2nd Edition, 1997.
5. E. V. Krishnamurthy, *Introductory Theory of Computer Science*, Springer-Velang New York Inc., 1st Edition, 1985.

BTCOC503: Software Engineering

[Unit 1] [7 Hours]

Introduction: Professional software development, Software engineering ethics, Case studies. Software processes: Software process models, Process activities, Coping with change, The rational unified process.

[Unit 2] [7 Hours]

Agile software development: 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] [7 Hours]

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

[Unit 4] [7 Hours]

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

[Unit 5] [7 Hours]

Software testing, Development testing, Test-driven development, Release testing, User testing. Dependability properties, Availability and reliability, Safety Security.

Text Book:

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

Reference Books:

1. S.A. Kelkar, *Software Engineering*, , Prentice Hall of India, 2007.
2. Pressman, *Software Engineering*, Tata McGraw Hill, 6th Edition, 2006.
3. Pankaj Jalote, *Software Engineering*, Narosa Publishers, 3rd Edition, 2006.

NPTEL Course:

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

BTCOE504 (A): Human Computer Interaction

[Unit 1] [7 Hours]

Introduction: Course objective and overview, Historical evolution of the field, The Human, The Computer, The Interaction.

[Unit2] [7 Hours]

Design processes: Interaction Design basics, Concept of usability – definition and elaboration, HCI in the Soft- ware Process, Design Rules.

[Unit3] [7 Hours]

Implementation and Evaluation: Implementation Support, Evaluation Techniques, Universal Design, Use Support.

[Unit4] [7 Hours]

Models: Cognitive Models, Socio – Organizational Issues and Stakeholders Requirements, Communication and Collaboration models. Theories: Task Analysis Dialog notations and Design Models of the system Modeling Rich Interactions.

[Unit5] [7 Hours]

Modern Systems: Group ware, Ubiquitous Computing and Augmented Realities, Hypertext, Multimedia and World Wide Web.

Text Book:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale “Human Computer Interaction”, Pearson Education, 3rd Edition, 2003.

Reference Books:

1. B. Shneiderman, Designing the User Interface, Addison-Wesley Publishing Company.
2. Jenny Preece, Helen Sharp, Yvonne Rogers, Interaction Design: Beyond Human-Computer Interaction, Wiley Publication, 4th Edition, 2015.
3. Gerard Jounghyun Kim, Human–Computer Interaction: Fundamentals and Practice, CRC Press, 2015.
4. Jenifer Tidwell, Designing Interfaces, Patterns for Effective Interaction Design, O’Reilly Media, 2nd Edition, 2010.

NPTEL Course:

1. Human Computer Interaction, Prof. K. Ponnurangam, Dept. of Computer Science and Engineering, IIT Delhi.

BTCE504 (B): Numerical Methods

[Unit 1] **[7 Hours]**

Solution of Algebraic and Transcendental Equation: Bisection method, Method of false position, Newton's method and Newton-Raphson method.

[Unit 2] **[7 Hours]**

Solution of Linear Simultaneous Equation: Gauss elimination method, Gauss-Jordan method, Iterative method of solution- Jacobi iteration method, Gauss-Seidal iteration method, Relaxation method.

[Unit 3] **[7 Hours]**

Finite Differences: Forward difference operator, Backward difference operator, Central difference operator, Newton's interpolation formulae, Newton's forward-backward-central interpolation formulae.

[Unit 4] **[7 Hours]**

Differentiation and Integration: Newton-Cotes formula, Trapezoidal rule, Simpson one-third rule, Simpson three-eighth rule.

[Unit 5] **[7 Hours]**

Numerical Solution of ODE: Picard's methods, Taylor series method, Euler's method, Modified Euler's method, Runge Kutta method.

Text Book:

1. B. S Grewal, Higher Engineering Mathematics, 40th edition, Khanna publication

Reference Books:

1. S. S. Shastri, Introduction to Numerical Methods, PHI publication.
2. V. Rajaraman, Computer Oriented Methods, 3rd edition, PHI publication.
3. Conte and De boor, Elementary Numerical Analysis, BPB publication.
4. E. Kreyszig, Advanced Engineering Mathematics, BPB publication.
5. Steven C Chapra, Numerical Methods for Engineers, 5th edition, McGraw Hill publication.

NPTEL Course:

1. Numerical Methods, Prof. Ameet Kumar Nayak and Prof. Sanjeev Kumar, IIT Roorkee.

BTHM505 (A): Economics and Management

[Unit 1] **[7 Hours]**

Introduction, Market Equilibrium: Demand and Supply, Elasticity of Demand Forecasting, Production, Exercises on Economics, Cost-Volume-Profit Relationships, Cost Management Systems and Activity Costing System.

[Unit 2] **[7 Hours]**

Relevant Information and Decision Making, Cost Allocation, Exercises on Economics, Double-Entry Bookkeeping, Job Costing, Process Costing, The Master Budget, Flexible Budgets and Variance Analysis.

[Unit 3] **[7 Hours]**

Financial Statements, Analysis of Financial Statements, Time Value of Money, Comparison of Alternatives.

[Unit 4] **[7 Hours]**

Depreciation Accounting, Evolution of Management Thoughts, Functions of Management Directing.

[Unit 5] **[7 Hours]**

Product Development, Forecasting Revisited, Capacity Planning, Product / Services Strategies and Plant Layout, Production Planning and Control.

Text Book:

1. R. Paneerselvam, Engineering Economics, PHI publication.

Reference Books:

1. Robbins S.P. and Decenzo David A., Fundamentals of Management: Essential Concepts and Applications, Pearson Education.
2. L. M. Prasad, Principles and Practices of Management.
3. K. K. Dewett & M. H. Navalur, Modern Economic Theory, S. Chand Publications.

NPTEL Course:

1. Economics / Management / Entrepreneurship, by Prof. P. K. J. Mohapatra Department of Industrial Engineering & Management, IIT Kharagpur.

BTHM505 (B): Business Communication

[Unit 1] **[6 Hours]**

Introduction, Definitions & Concepts, Communicative Competence.

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

Intercultural Communication, Nonverbal Communication, Thought and Speech, Translation as Problematic Discourse.

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

Barriers to Communication, Listening, Communication Rules, Communication Style.

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

Interpersonal Communication, Relational Communication, Organizational Communication. Collaboration, Communication in Groups and Teams, Persuasive Communication.

[Unit 5] **[7 Hours]**

Negotiation and Conflict Management, Leadership, Written Communication in International Business, Role of Technology in international Business Communication, Moving to Another Culture, Crisis Communication, Ethics in Business Communication.

Text Book:

1. Mary Ellen Guffey, Essentials of Business Communication, Sixth Edition, South-Western College Publishing

Reference Books:

1. Bovee, Courtland, John Thill & Mukesh Chaturvedi, Business Communication Today: Dorling kindersley, Delhi.
2. Kaul, Asha, Business Communication, Prentice-Hall of India, Delhi.
3. Monippally, Matthukutty M. Business Communication Strategies. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Sharma, Sangeeta and Binod Mishra, Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd., New Delhi.

NPTEL Course:

1. International Business Communication, by Aradhana Malik, IIT Kharagpur.

BTCOL506: Database Systems Laboratory

List of Experiments:

1. Defining schema for applications.
2. Creating tables, Renaming tables, Data constraints (Primary key, Foreign key, Not Null), Data insertion into a table.
3. Grouping data, aggregate functions, Oracle functions (mathematical, character functions).
4. Sub-queries, Set operations, Joins.
5. Creation of databases, writing SQL and PL/SQL queries to retrieve information from the databases.
6. Assignment on Triggers & Cursors.
7. Normal Forms: First, Second, Third and Boyce Codd Normal Forms.
8. Assignment in Design and Implementation of Database systems or packages for applications such as office automation, hotel management, hospital management.
9. Deployment of Forms, Reports Normalization, Query Processing Algorithms in the above application project.
10. Large objects – CLOB, NCLOB, BLOB and BFILE.
11. Distributed data base Management, creating web-page interfaces for database applications using servlet.

BTCOL506: Software Engineering Laboratory

List of Experiments:

1. To perform the system analysis: Requirement analysis, SRS. (Both Functional and Nonfunctional requirements. For a set of 10 sample problems, from a book on Software Engineering by Rajib Mall.)
2. To perform the function oriented diagram: DFD and Structured chart.
3. To perform the user's view analysis: Use case diagram.
4. To draw the structural view diagram: Class diagram, object diagram.
5. To draw the behavioral view diagram: Sequence diagram, Collaboration diagram.
6. To draw the behavioral view diagram: State-chart diagram, Activity diagram.
7. To draw the implementation view diagram: Component diagram.
8. To draw the environmental view diagram: Deployment diagram.
9. To perform various testing using the testing tool unit testing, integration testing

BTCOM507: Mini Project-1

In this subject head, it is expected that the student should complete the following tasks.

1. Identify problem statement / idea which is solving one problem preferably local problem may be in their University / College / near by vicinity.
2. Do the literature survey,
3. Design the solutions
4. Implement solution using latest technology
5. Write 20-25 pages report using latex
6. Present / demonstrate the solution in front of faculty member

BTCOC601: Compiler Design

[Unit 1] Introduction to Compiling

[7 Hours]

Definition, analysis of the source program, the phases of a compiler, the grouping of phases, Compiler Construction tools, A simple one-pass compiler,

[Unit 2] Lexical Analysis

[7 Hours]

The role of the Lexical analyzer, Input buffering, Specification of Tokens, A Language for Specifying Lexical Analyzers, Design of a Lexical Analyzer generator.

[Unit 3] Syntax Analysis

[7 Hours]

The role of the Parser, Context-free grammars, Writing a Grammar, Top-Down Parsing, Bottom-Up Parsing, Operator-precedence Parsing, LR Parsers, Using Ambiguous Grammars, Parser Generators.

[Unit 4] Syntax-Directed Translation

[7 Hours]

Definitions, Construction of Syntax Trees, Bottom-Up Evaluation of S- Attributed definitions, Top-Down Translation, Bottom-Up Evaluation of Inherited attributes. Intermediate Languages, Declarations, Assignment Statements, Boolean Expressions, Case Statements, Back patching, Procedure Calls.

[Unit 5] Code Generation

[7 Hours]

Issues in the Design of a Code Generator, The target Machine, Run-Time Storage Management, Basic Blocks and Flow Graphs, Next-Use Information, Simple Code Generator, Register allocation and Assignment, The DAG Representation of Basic Blocks, Generating Code from DAGs, Dynamic Programming, Code-Generation Algorithm, Code-Generators.

Text Book:

1. Aho, Sethi, Ullman, Compilers Principles, Techniques and Tools, Pearson Education India, 2nd Edition, 2013

Reference Books:

1. Hopcroft, Motwani and Ullman, Introduction to Automata Theory, Languages and Computation, Pearson Publication, 2nd Edition, 2001.
2. Dick Grune, Kees van Reeuwijk, Henri E. Bal, Criel J. H. Jacobs and Koen Langendoen, Modern Compiler Design, Springer, 2nd Edition, 2012.

BTCOC602: Computer Networks

[Unit 1] Introduction

[7 Hours]

Applications of computer networks, Network hardware, Network software: Protocol Hierarchy, Design Issue, connection oriented vs. connectionless, Service Primitives, Reference models: OSI and TCP/IP, Example networks: Internet, Network standardization, Performance: Bandwidth and Latency, Delay and bandwidth product, High-Speed Network, Application Performance Needs.

[Unit 2] LAN Technologies

[7 Hours]

X5, Frame relay, ATM, Ethernet (802.3), FDDI, Token Rings, Resilient Packet Rings, Wireless LANs: Wi-Fi (802.11), Cell Phone Technologies, Broadband Wireless: Wi-MAX (802.16), Bluetooth (802.15.1), RFID.

[Unit 3] Data Link Layer

[7 Hours]

Data Link Layer Design Issues: Service provided to network layer Framing, Error Control, Flow Control, Error Detection and Correction: error correcting codes, error detecting codes.

[Unit 4] Network Layer and Congestion Control

[7 Hours]

IPv4/IPv6, Routers and Routing Algorithms distance vector link state. TCP UDP and sockets, General principles, Congestion prevention policies, Load shading, Jitter control, Quality of service: Packet scheduling, Traffic shaping, integrated Services.

[Unit 5] Application Layer Protocols

[7 Hours]

DNS, SMTP, POP, FTP, HTTP. Network Security: Authentication, Basics of public key and private key cryptography, digital signatures and certificates, firewalls.

Text Book:

1. A. Tanenbaum, Computer Networks, PHI Publication, 5th Edition, 2011.

Reference Books:

1. B. Forouzan, Data Communications and Networking, McGraw Hill Publication, 5th Edition, 2013.
2. Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach, Morgan Kaufman Publication, 5th Edition, 2012.
3. S. Keshav, An Engineering Approach to Computer Networking, Addison-Wesley Professional.
4. D. Comer, Computer Networks and Internet, Pearson Education, 6th Edition, 2014.
5. M. Gallo, W. Hancock, Computer Communications and Networking Technologies, Brooks/Cole Publisher, 2001.
6. Natalia Olifer, Victor Olifer, Computer Networks: Principles, Technologies and Protocols for Network Design, Wiley Publication, 2005.

BTCOC603: Machine Learning

[Unit 1] **[7 Hours]**

Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation, Linear regression, Decision trees, over fitting, Instance based learning, Feature reduction, Collaborative filtering based recommendation

[Unit 2] **[7 Hours]**

Probability and Bayes learning, Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM.

[Unit 3] **[7 Hours]**

Perceptron, multilayer network, back propagation, introduction to deep neural network.

[Unit 4] **[7 Hours]**

Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning.

[Unit 5] **[7 Hours]**

Clustering k-means, adaptive hierarchical clustering, Gaussian mixture model.

Text Book:

1. Tom Mitchell, Machine Learning, First Edition, McGraw Hill, 1997.

Reference Books:

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition,

BTCOE604 (A): Geographic Information System

[Unit 1] **[6 Hours]**

What is Geographic Information Systems?, Different components of GIS, Different types of vector data, Raster data models and their types TIN data model.

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

Advantages and disadvantages associated with vector, raster and TIN Non-spatial data attributes and their type Raster data compression techniques Different raster data file formats spatial database systems and their types.

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

Pre-processing of spatial datasets Different map projections, Spatial interpolation techniques Different types of resolutions Digital Elevation Model (DEM).

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

Quality assessment of freely available DEMS GIS analysis-1

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

GIS analysis-2 and applications Errors in GIS Key elements of maps.

Text Book:

1. Ian Heywood, Sarah Cornelius and Steve Carver, An Introduction to Geographical Information Systems (4th Edition) 2012.

Reference Books:

1. Chang Kang-tsung (Karl), Introduction to Geographic Information Systems, 2006
2. Tor Bernhardsen Geographic Information Systems: An Introduction, May 2002

NPTEL Course:

1. Dr. Arun K. Saraf, Introduction to Geographical Information System, IIT Roorkee.

BTCOE604 (B): Internet of Things

[Unit 1] IoT Introduction

[7 Hours]

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

[7 Hours]

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

[Unit 3] IP Layer

[7 Hours]

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 Hours]

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

[7 Hours]

Building iot 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.

Text Book:

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

Reference Books:

1. Srinivasa K G, “Internet of Things”, CENGAGE Learning India, 2017.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
3. Raj Kamal, “Internet of Things: Architecture and Design Principles”, 1st Edition, McGraw Hill Education, 2017.

BTCOE604 (C): Embedded Systems

[Unit 1]

[7 Hours]

Introduction: 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]

[7 Hours]

General purpose processor Software: 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]

[7 Hours]

System control: 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]

[7 Hours]

UART: 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]

[7 Hours]

Introduction, Process scheduling, 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.

Text Book:

1. Frank Vahid "Embedded System Design- A Unified system Hardwar/Software Introduction", (3rd Edition, John Wiley India) ISBN 978-81-265-0837-2.

Reference Books:

1. LPC 214x User manual (UM10139):- www.nxp.com..
2. Andrew N. Sloss, Dominic Symes and Chris Wright "ARM System Developer's Guide – Designing and Optimizing System Software", (Elsevier) ISBN: 1-55860-874-5.
3. LPC 17xx User manual (UM10360) :- www.nxp.com
4. ARM architecture reference manual : - www.arm.com
5. Steve Furber "An Engineer's Introduction to the LPC2100 series" Trevor Martin (Hitex (UK) Ltd.)."ARM System-on-Chip Architecture" (2nd Edition, Addison-Wesley Professional)ISBN-13: 9780201403527

BTHM605 (A): Development Engineering

[Unit 1] **[7 Hours]**

Introduction, Various Definitions of Development Engineering.

[Unit 2] **[7 Hours]**

World Poverty and Development, Poverty in the India, Sustainable Development, Culture and Global Competence, The Engineer's Role.

[Unit 3] **[7 Hours]**

Social Justice, Social Justice and Engineering, Religious Perspectives, Secular Perspectives.

[Unit 4] **[7 Hours]**

Development Strategies: Society, Technological Change, and Development, Development Economists' Perspectives, Global Health Perspective, International Education Perspective, Social Business Perspectives.

[Unit 5] **[7 Hours]**

Engineering for Sustainable Community Development: The Engineer as a Helper Participatory Community Development, Teamwork and Project Management, Community Assessment: Learning About a Community, Project Selection, Humanitarian Technology, Participatory Technology Development, Humanitarian STEM Education. ICT for Development, AI for Humanitarian purposes, Blockchain and Social Development.

Text Book:

1. Kevin M. Passino, Humanitarian Engineering: Advancing Technology for Sustainable Development.

BTHM605 (B): Employability and Skill Development

[Unit 1] Soft Skills & Communication basics:

[7 Hours]

Soft skills Vs hard skills, Skills to master, Interdisciplinary relevance, Global and national perspectives on soft skills, Resume, Curriculum vitae, How to develop an impressive resume, Different formats of resume Chronological, Functional, Hybrid, Job application or cover letter, Professional presentation- planning, preparing and delivering presentation, Technical writing.

[Unit 2] Arithmetic and Mathematical Reasoning and Analytical Reasoning and Quantitative Ability:

[7 Hours]

Aspects of intelligence, Bloom taxonomy, multiple intelligence theory, Number sequence test, mental arithmetic (square and square root, LCM and HCF, speed calculation, remainder theorem).

Matching, Selection, Arrangement, Verifications (Exercises on each of these types). Verbal aptitude (Synonym, Antonym, Analogy).

[Unit 3] Grammar and Comprehension:

[7 Hours]

English sentences and phrases, Analysis of complex sentences, Transformation of sentences, Paragraph writing, Story writing, Reproduction of a story, Letter writing, précis writing, Paraphrasing and e-mail writing.

[Unit 4] Skills for interviews:

[7 Hours]

Interviews- types of interviews, preparatory steps for job interviews, interview skill tips, Group discussion- importance of group discussion, types of group discussion, difference between group discussion, panel discussion and debate, personality traits evaluated in group discussions, tips for successful participation in group discussion, Listening skills- virtues of listening, fundamentals of good listening, Non-verbal communication-body movement, physical appearance, verbal sounds, closeness, time.

[Unit 5] Problem Solving Techniques:

[7 Hours]

Problem solving model: 1. Define the problem, 2. Gather information, 3. Identify various solution, 4. Evaluate alternatives, 5. Take actions, 6. Evaluate the actions.

Problem solving skills: 1. Communicate. 2. Brain storming, 3. Learn from mistakes.

Text Book:

1. R. Gajendra Singh Chauhan, Sangeeta Sharma, "Soft Skills- An integrated approach to maximize personality", ISBN: 987-81-265-5639-7, First Edition 2016

Reference Books:

1. Wiley Wren and Martin, "English grammar and Composition", S. Chand publications.
2. R. S. Aggarwal, "A modern approach to verbal reasoning", S. Chand publications.
3. Philip Carter, "The Complete Book of Intelligence Test", John Willey & Sons Ltd.
4. Philip Carter, Ken Russell, "Succeed at IQ test", Kogan Page.
5. Eugene Ehrlich, Daniel Murphy, "Schaum;s Outline of English Grammar", McGraw Hills.
6. David F. Beer, David A. McMurrey, "A Guide to Writing as an Engineer", ISBN: 978- 1-118-30027-5 4th Edition, 2014, Wiley.

BTHM605 (C): Consumer Behavior

[Unit 1] [7 Hours]

Introduction to the Study of Consumer Behavior: Defining Consumer Behavior, Scope and Application of Consumer Behavior, Why Study Consumer Behavior, Evolution of Consumer Behavior as a Field Of Study and its relationship with Marketing: Behavioral Dimension, The Interdisciplinary Nature of Consumer Behavior. Market Research and Consumer Behavior, Relevance of Market Research with Consumer Behavior, Approaches to Consumer Behavior Research, Quantitative Research, Qualitative Research.

[Unit 2] [7 Hours]

Market Segmentation and Positioning, Market Segmentation, Basis for Segmentation, Alternatives available for Segmentation, Positioning. The Consumer Decision Making Process: Buying Motives, Buying Roles, Consumer Decision Making Process, Levels of Consumer Decision Making, Perspectives to Consumer Decision Making, Consumer Decision Making Process.

[Unit 3] [7 Hours]

Models of Consumer Behavior: The Economic model, Learning model, Psychoanalytic model, The sociological model. The Howard Sheth model of Buying Behaviour, The Nicosia model, The Engel - Kollat - Blackwell Model, Engel, Blackwell and Miniard (EBM) model.

[Unit 4] [7 Hours]

Psychological Influences on Consumer Decision Making: Consumers Needs & Motivation, Emotions and Mood, Consumer Involvement, Consumer Learning, Personality, Self-concept and Self-image, Consumer Perception, Risk and Imagery. Consumer Attitude: Belief, Affect, Attitude and Intention, Attitude Formation and Attitude Change, Consumer Communication. Sociological Influences on Consumer Decision Making: Consumer groups, Consumer reference groups, Family and Life cycle, Social class and mobility, lifestyle analysis, Culture; Sub-Culture, Cross Culture, Interpersonal Communication and influence, Opinion Leadership.

[Unit 5] [7 Hours]

Diffusion of innovation Diffusion Process, Adoption Process, Consumer Innovators, Multiplicative innovation adoption (MIA) model. Organizational Buying: Differences between Industrial Markets and Consumer Markets, Differences between Organizational and Consumer Buying, Buying Decisions in Organizational Buying Process, Types of Decision Making, Organization Buyer's Decision Making Process, and Factors influencing Organizational Buying Behaviour, Decision Makers in Organizational Buying, Webster and Wind model of Organizational buying behaviour, The Sheth model of Industrial buying, The Sheth model of Industrial buying Consumer Behavior Analysis and Marketing Strategy: Consumer Behavior and Product Strategy, Consumer Behavior and Pricing Strategy, Consumer Behavior and Distribution Channel Strategy, Consumer Behavior and Promotion Strategy.

Text Book:

1. Consumer Behavior, Schiffman, L.G. and Kanuk L.L., Prentice Hall, India.

Reference Books:

1. Consumer Behavior, Concepts and Applications, Loudon, D.L. and Bitta, A.J.D, Tata McGrawHill.
2. Consumer Behavior and Marketing Startegy, Peter, J.P. and Olson, J.C., Schiffman, L.G. and Kanuk L.L., Prentice Hall, India.

BTCOL606: Competitive Programming**[Unit 1]****[7 Hours]**

Introduction: Online Judge The Programming Challenges Robot Judge, Understanding Feedback From the Judge, Choosing Programming Languages, Reading Our Programs, Standard Input/Output, Programming Hints, Elementary Data Types.

Challenging Problems

(1) The $3n + 1$ Problem (2) Minesweeper (3) The Trip, (4) LCD Display (5) Graphical Editor (6) Interpreter (7) Check the Check (8) Australian Voting.

[Unit 2]**[7 Hours]**

Elementary Data Structures: Data Structures: Elementary Data Structures, Stacks, Dictionaries, Priority Queues Sets, Object Libraries, The C++ Standard Template Library, The Java java.util Package, Program Design Example: Going to War, Hitting the Dec, String Input/Output, Winning the War, Testing and Debugging.

Challenging Problems

(1) Jolly (2) Poker Hands (3) Hartals (4) Crypt Kicker (5) Stack 'em Up (6) Erdős Numbers (7) Contest Scoreboard (8) Yahtzee.

[Unit 3]**[7 Hours]**

Strings: Character Codes, Representing Strings, Program Design Example: Corporate Renamings, Searching for Patterns, Manipulating Strings, Completing the Merger, String Library Functions.

Challenging Problems

(1) WERTYU (2) Where's Waldorf? (3) Common Permutation (4) Crypt Kicker II (5) Automated Judge Script (6) File Fragmentation (7) Doublets (8) Fmt

[Unit 4]**[7 Hours]**

Sorting: Sorting, Sorting Applications Sorting Algorithms, Program Design Example: Rating the Field, Sorting Library Functions, Rating the Field.

Challenging Problems

(1) Vito's Family (2) Stacks of Flapjacks (3) Bridge (4) Longest Nap (5) Shoemaker's Problem (6) CDVII (7) Shell Sort (8) Football.

[Unit 5]**[8 Hours]**

Arithmetic and Algebra: Machine Arithmetic, Integer Libraries, High-Precision Integers, High-Precision Arithmetic, Numerical Bases and Conversion, Real Numbers, Dealing With Real Numbers, Fractions, Decimals, Algebra, Manipulating Polynomials, Root Finding, Logarithms, Real Mathematical Libraries.

Challenging Problems

(1) Primary Arithmetic (2) Reverse and Add (3) The Archeologist's Dilemma (4) Ones (5) A Multiplication Game (6) Polynomial Coefficients (7) The Stern-Brocot Number System (8) Pairsumonious Numbers.

Combinatorics: Basic Counting Techniques, Recurrence Relations, Binomial Coefficients, Other Counting Sequences, Recursion and Induction Problems.

Challenging Problems

(1) How Many Fibs? (2) How Many Pieces of Land? (3) Counting (4) Expressions (5) Complete Tree Labeling (6) The Priest Mathematician (7) Self-describing Sequence (8) Steps

List of Practical:

At least twenty five problems solving on competitive programming platforms such as, <https://uva.onlinejudge.org>, <http://hackerrank.com/>, <http://codechef.com/>

Text Book:

1. Steven S. Skiena Miguel A. Revilla, Programming Challenges The Programming Contest Training Manual, Springer

Reference Books:

1. Antti Laaksonen, Competitive Programmer's Handbook.
2. Steven Halim, Competitive Programming 3: The Lower Bounds of Programming Contests.
3. Gayle Lakaman Cracking the Coding Interview.
4. The Hitchhiker's Guide to the Programming Contests.

BTCOL606: Machine Learning Laboratory

As a part of lab exercises for Machine Learning Laboratory, it is suggested that the student should get hands-on experience by solving data analysis problems available on Machine Learning competition platforms such as Hacker Earth and Kaggle. Some of the suggestive list of problem solving is given below. Knowledge of R programming or Python is required to solve these problems, students get this prerequisite in Second Year.

1	Regression Analysis and Plot interpretation.
2	Logistic Regression Analysis in R.
3	Random Forest and Parameter Tuning in R.
4	Clustering Algorithms and Evaluation in R.
5	Machine Learning Project in Python on Hourse Prices Data.

**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	https://nptel.ac.in/courses/111/101/111101115/	IIT, Madras	85	8 Weeks
				https://nptel.ac.in/courses/111/106/111106051/		90	12 Weeks
2	Discrete Mathematics	BTCOC302	III	https://nptel.ac.in/courses/106/106/106106094/	IIT, Madras	90	8 Weeks
				https://nptel.ac.in/courses/111/107/111107058/	IIT, Roorkee	90	
3	Data Structures	BTCOC303	III	https://nptel.ac.in/courses/106/102/106102064/	IIT, Delhi	90	Not mentioned
4	Computer Architecture & Organization	BTCOC304	III	https://nptel.ac.in/courses/106/106/106106092/	IIT, Madras	85	12 weeks
				https://nptel.ac.in/courses/106/103/106103180/	IIT, Guwahati	75	
				https://nptel.ac.in/courses/106/106/106106166/	IIT, Madras ,IIT, Kharagpur	70	
				https://nptel.ac.in/courses/106/105/106105163/	IIT, Kharagpur	85	
				https://swayam.gov.in/nd1_noc20_cs64/preview		85	
5	Object Oriented Programming in C++	BTCOC305	III	https://nptel.ac.in/courses/106/105/106105151/	IIT, Kharagpur	58	8 weeks
6	JAVA Programming	BTCOL306	III	https://nptel.ac.in/courses/106/105/106105191/	IIT, Kharagpur	90	12 Weeks
7	Design & Analysis of Algorithms	BTCOC401	IV	https://nptel.ac.in/courses/106/101/106101060/	IIT, Kharagpur IIT,	40	12 weeks
				https://nptel.ac.in/courses/106/105/106105164/	Madras		
				https://swayam.gov.in/nd1_noc20_cs71/preview	Chennai Mathematical Institute		
8	Probability & Statistics	BTBS402	IV	https://nptel.ac.in/courses/111/106/111106112/#	IIT, Madras	80	4 weeks
				https://nptel.ac.in/courses/111/105/111105090/	IIT, Kharagpur	90	12 weeks
9	Operating Systems	BTCOC403	IV	https://nptel.ac.in/courses/106/108/106108101/	IISc, Bangalore	1. 85 2. 80	1. 8 Weeks 2. 8 Weeks
				https://nptel.ac.in/courses/106/106/106106144/	IIT, Madras		
10	Basic Human Rights	BTHM404	IV	https://nptel.ac.in/courses/109/104/109104068/	IIT, Kanpur	75	30 Hours

11	Digital Electronics & Microprocessors	BTES405	IV	https://nptel.ac.in/courses/108/105/108105132/ https://nptel.ac.in/courses/108/103/108103157/	IIT, Kharagpur IIT, Guwahati	50	12 weeks
12	Python Programming	BTCOL406	IV	https://nptel.ac.in/courses/106/106/106106182/	IIT, Ropar	95	12 weeks
14	Database Systems	BTCOC501	V	http://nptel.ac.in/courses/106/1/106093/	IIT, Madras	95	12 Weeks
15	Theory of Computation	BTCOC502	V	https://nptel.ac.in/courses/106/104/106104028/ https://nptel.ac.in/courses/106/106/106106049/	IIT, Kharagpur IIT, Madras	92	45 Hrs 42 Hrs
16	Machine Learning	BTCOC503	V	https://nptel.ac.in/courses/106/105/106105152/	IIT, Kharagpur	100	8 Weeks
17	Human Computer Interaction	BTCOE504 (A)	V	https://nptel.ac.in/courses/106/103/106103115/#	IIT, Guwahati	70	8 Weeks
18	Numerical Methods	BTCOE504 (B)	V	https://nptel.ac.in/courses/111/107/111107105/	IIT, Roorkee	90	8 Weeks
19	Economics and Management	BTHM505 (A)	V	https://nptel.ac.in/courses/110/105/110105067/	IIT, Kharagpur	90	8 Week
20	Business Communication	BTHM505 (B)	V	https://nptel.ac.in/courses/110/105/110105052/	IIT, Kharagpur	90	8 Weeks
21	Compiler Design	BTCOC601	VI	https://nptel.ac.in/courses/106/108/106108113/ https://nptel.ac.in/courses/106/104/106104123/	IISc, Bangalore IIT Kanpur	80	40 Hrs
22	Computer Networks	BTCOC602	VI	https://nptel.ac.in/courses/106/105/106105081/ https://nptel.ac.in/courses/106/105/106105080/	IIT Kharagpur	90	12 Weeks
23	Software Engineering	BTCOC603	VI	https://nptel.ac.in/courses/106/105/106105182/	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	https://nptel.ac.in/courses/106/105/106105166/	IIT, Kharagpur	60	12 Weeks
26	Embedded Systems	BTCOE604 (C)	VI	https://nptel.ac.in/courses/106/105/106105193/	IIT, Kharagpur	80	8 Weeks
27	Development Engineering	BTCOE605 (A)	VI	https://nptel.ac.in/courses/109/103/109103023/ https://nptel.ac.in/courses/109/104/109104074/	IIT, Guwahati IIT, Kanpur	30 40	8 Weeks
28	Employability and Skills Development	BTCOE605 (B)	VI	https://nptel.ac.in/courses/109/105/109105144/	IIT, Kharagpur	75	8 Weeks
29	Consumer Behaviour	BTCOE605 (C)	VI	https://nptel.ac.in/courses/110/105/110105054/	IIT Kharagpur	90	40 Hrs

30	Artificial Intelligence	BTCOC701	VII	https://nptel.ac.in/courses/106/106/106106126/ https://nptel.ac.in/courses/106/105/106105078/	IIT, Madras IIT, Kharagpur	70	48 Hrs 41 Hrs
31	Cloud Computing	BTCOE702	VII	https://nptel.ac.in/courses/106/104/106104182/ https://nptel.ac.in/courses/106/105/106105167/	IIT, PATNA IIT, Kharagpur	30 40	8 weeks
32	Bioinformatics	BTCOE703 (A)	VII	https://nptel.ac.in/courses/102/106/102106065/	IIT, Madras	50	12 Weeks
33	Distributed Systems	BTCOE703 (B)	VII	https://nptel.ac.in/courses/106/106/106106168/	IIT, PATNA	50	8 Weeks
34	Big Data Analytics	BTCOE703 (C)	VII	https://nptel.ac.in/courses/106/104/106104189/	IIT, PATNA	50	8 Weeks
35	Cryptography and Network Security	BTCOE704 (A)	VII	https://swayam.gov.in/nd2_no_u19_cs08/preview	Uttarakhand Open University, Haldwani	20	12 Weeks
36	Business Intelligence	BTCOE704 (B)	VII	https://nptel.ac.in/courses/106/104/106104220/	IIT, Kharagpur	10	12 Weeks
37	Blockchain	BTCOE704 (C)	VII	https://nptel.ac.in/courses/106/104/106104220/	IIT, KANPUR	60	8 Weeks
38	Virtual Reality	BTCOE705 (A)	VII	https://nptel.ac.in/course/106/106/106106138	IIT Madras & UIUC	30	8 Weeks
39	Deep Learning	BTCOE705 (B)	VII	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs85/	IIT Madras & IIT Ropar	100	12 Weeks
40	Design Thinking	BTCOE705 (C)	VII	https://nptel.ac.in/courses/110/106/110106124/	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) https://www.coursera.org/learn/discrete-mathematics/home/welcome 2) https://www.coursera.org/specializations/discrete-mathematics	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) Princetone 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	UCSanDiego	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> https://www.coursera.org/learn/software-Processes	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	https://www.edx.org/course/advanced-algorithmics-and-graph-theory-with-python	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> https://www.edx.org/course/software-engineering-essentials	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