

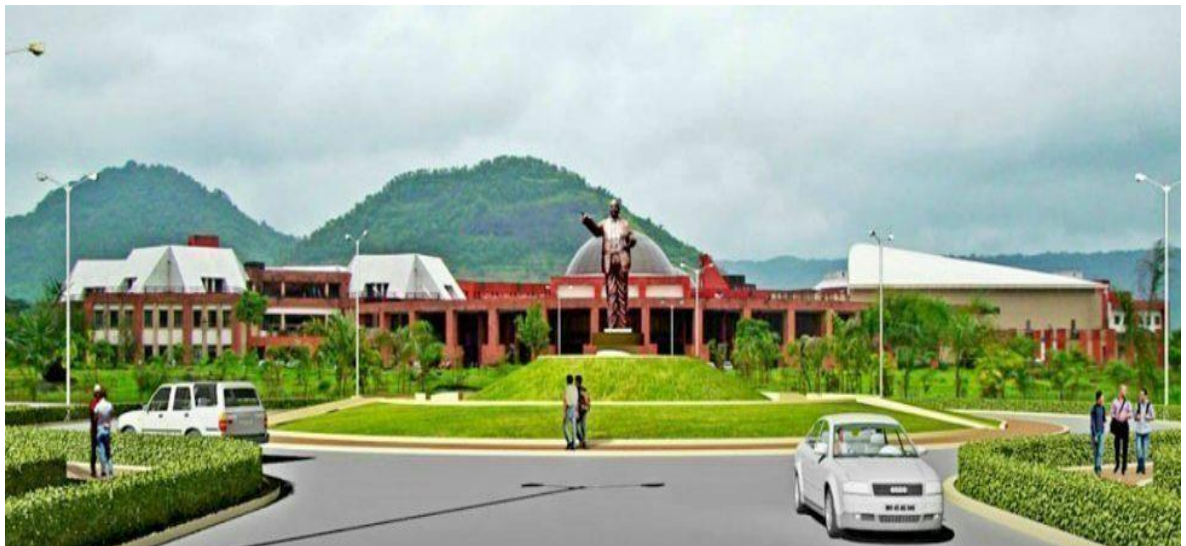
DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

**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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# **CURRICULUM FOR UNDER GRADUATE PROGRAMME S.Y.B.TECH**

**(COMPUTER ENGINEERING/COMPUTER SCIENCE &  
ENGINEERING (ARTIFICIAL INTELLIGENCE & MACHINE  
LEARNING/ ARTIFICIAL INTELLIGENCE (2020-2021)/  
(COMPUTER SCIENCE & DESIGN /DATA SCIENCE(W.E.F. 2022-  
2023))**



## 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,

'c<sub>i</sub>' is the number of credits allotted to a particular subject, and

'g<sub>i</sub>' 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 (up to 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 (e.g. 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            | BTBSC404    | Probability and Statistics       | (3-0-0) 3       |
| <b>TOTAL</b> |             |                                  | <b>25</b>       |

## 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       |
| <b>TOTAL</b> |             |  | <b>20</b>       |

**c) Humanities and Social Science including Management Courses**

| <b>Sr. No.</b> | <b>Course Code</b> | <b>Course Name</b>  | <b>(L-T-P) Credits</b> |
|----------------|--------------------|---|------------------------|
| 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<br>(B) Employability and Skills Development<br>(C) Consumer Behaviour | (3-0-0) 3              |
| 5              | BTHM505            | (A) Economics and Management<br>(B) Business Communication  | (3-0-0) 3              |
| 6              | BTHM706            | Foreign Language Studies  | Audit                  |
| <b>TOTAL</b>   |                    |   | <b>12</b>              |



**d) Professional Core Course**

| <b>Sr. No.</b> | <b>Course Code</b> | <b>Course Name</b>                                    | <b>(L-T-P) Credits</b> |
|----------------|--------------------|---|------------------------|
| 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              |
| <b>TOTAL</b>   |                    |   | <b>44</b>              |

**e) Professional Elective Course**

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

**f) Open Elective Course**

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

**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     |
| <b>TOTAL</b> |             |  | <b>22</b>       |

**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       |
| <b>TOTAL</b> |             |  | <b>22</b>       |

**Category – wise total number of credits**

| <b>Sr. No.</b> | <b>Category of courses</b>   | <b>Minimum credits to be Earned</b> |
|----------------|--|-------------------------------------|
| 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                                  |
| <b>TOTAL</b>   |  | <b>160</b>                          |

## 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  |
|----------------------|---|
| <b>PEO1</b>          | To provide knowledge of sound mathematical principles underlying various programming concepts.  |
| <b>PEO2</b>          | To develop an ability to understand complex issues in the analysis, design, implementation and operation of information systems.              |
| <b>PEO3</b>          | To provide knowledge of mechanisms for building large-scale computer-based systems.   |
| <b>PEO4</b>          | To develop an ability to provide computer-based solutions to the problems from other disciplines of science and engineering.                  |
| <b>PEO5</b>          | To impart skills necessary for adapting rapid changes taking place in the field of information and communication technologies.                |
| <b>PEO6</b>          | 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 –III (Second Year)**

| Course Category | Course Code | Course Title   | Weekly Teaching Hrs |          |          | Evaluation Scheme |            |            |            | Credit    |
|-----------------|-------------|--|---------------------|----------|----------|-------------------|------------|------------|------------|-----------|
|                 |             |  | L                   | T        | P        | CA                | MSE        | ESE        | Total      |           |
|                 | BTBS301     | Engineering Mathematics – III  | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4         |
|                 | BTCOC302    | Discrete Mathematics   | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4         |
|                 | BTCOC303    | Data Structures  | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4         |
|                 | BTCOC304    | Computer Architecture & Organization   | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4         |
|                 | BTCOC305    | Elective –I<br>(a) Object - oriented Programming in C++<br>(b) Object Oriented Programming in Java | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4         |
|                 | BTCOL306    | Data Structures Lab & Object Oriented Programming Lab  | -                   | -        | 4        | 60                | -          | 40         | 100        | 2         |
|                 | BTCOS307    | Seminar – I  | -                   |          | 4        | 60                | -          | 40         | 100        | 2         |
|                 | BTES211P    | Field Training / Internship / Industrial Training Evaluation                                       | -                   | -        | -        | -                 | -          | -          | -          | Audit     |
| <b>TOTAL</b>    |             |  | <b>15</b>           | <b>5</b> | <b>8</b> | <b>220</b>        | <b>100</b> | <b>380</b> | <b>700</b> | <b>24</b> |

## Semester –IV (Second Year)

| Course Category | Course Code | Course Title   | Weekly Teaching Hrs |          |          | Evaluation Scheme |            |            |            | Credit                          |
|-----------------|-------------|--|---------------------|----------|----------|-------------------|------------|------------|------------|---------------------------------|
|                 |             |  | L                   | T        | P        | CA                | MSE        | ESE        | Total      |                                 |
|                 | BTCOC401    | Design & Analysis of Algorithms                              | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4                               |
|                 | BTCOC402    | Operating Systems  | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4                               |
|                 | BTHM403     | Basic Human Rights   | 3                   | -        | -        | 20                | 20         | 60         | 100        | 3                               |
|                 | BTBSC404    | Probability and Statistics                                   | 3                   | -        | -        | 20                | 20         | 60         | 100        | 3                               |
|                 | BTES405     | Digital Logic Design & Microprocessors                       | 3                   | 1        | -        | 20                | 20         | 60         | 100        | 4                               |
|                 | BTCOL406    | Operating Systems & Python Programming Lab                   | 1*                  | -        | 4        | 60                | -          | 40         | 100        | 3                               |
|                 | BTCOS407    | Seminar – II   |                     |          | 4        | 60                | -          | 40         | 100        | 2                               |
|                 | BTCOF408    | Field Training / Internship / Industrial Training Evaluation |                     |          |          |                   |            | -          | -          | Audit to be evaluated in V Sem. |
| <b>TOTAL</b>    |             |  | <b>16</b>           | <b>3</b> | <b>8</b> | <b>220</b>        | <b>100</b> | <b>380</b> | <b>700</b> | <b>23</b>                       |

\*Note: Lecture should be conducted only for Python Programming



## BTBS 301: Engineering Mathematics-III

### Unit 1: Laplace Transform

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by  $t^n$ , scale change property, transforms of functions divided by  $t$ , transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

### Unit 2: Inverse Laplace Transform

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

### Unit 3: Fourier Transform

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

### Unit 4: Partial Differential Equations and Their Applications

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation ( $\partial u/\partial t = C\partial^2 u/\partial x^2$ ), and one dimensional wave equation (i.e.  $\partial^2 y/\partial t^2 = C\partial^2 y/\partial x^2$ ).

### Unit 5: Functions of Complex Variables

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs)

### Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

### Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata McGraw-Hill Publishing Company Ltd.,

New Delhi.

4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy. Knowledge ware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill, New York.

### General Instructions:

1. The tutorial classes in Engineering Mathematics-III are to be conducted batch wise. Each class should be divided into three batches for the purpose.
2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

## BTCOC302: Discrete Mathematics

### [UNIT 1] Fundamental Structures and Basic Logic [7 Hours]

Sets, Venn diagram, Cartesian product, Power sets, Cardinality and countability, Propositional logic, Logical connectives, Truth tables, Normal forms, Validity, Predicate logic, Limitations of predicate logic, Universal and existential quantification, First order logic, Principles of Mathematical Induction: The Well-Ordering Principle, Recursive definition, The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

### [UNIT 2] Functions and Relations [7 Hours]

Subjective, Injective, Bijective and inverse functions, Composition of function, Reflexivity, Symmetry, Transitivity and equivalence relations.

**Combinatorics:** Counting, Recurrence relations, generating functions.

### [UNIT 3] Graph [7 Hours]

Basic terminology, Multi graphs and weighted graphs, Paths and circuits, Shortest path problems, Euler and Hamiltonian paths, Representation of graph, Isomorphic graphs, Planar graphs, Connectivity, Matching Colouring.

### [UNIT 4] Trees [7 Hours]

Trees: Rooted trees, Path length in rooted tree, Binary search trees, Spanning trees and cut set, Minimal spanning trees, Kruskal's and Prim's algorithms for minimal spanning tree.

### [UNIT 5] Algebraic Structures and Morphism [7 Hours]

Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Substructures, Normal Subgroups, Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields, Boolean Algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form.

#### Text Books:

1. C. L. Liu, Elements of Discrete Mathematics, McGraw-Hill Publication, 3rd Edition, 2008.

#### Reference Books:

1. Lipschutz, Discrete Mathematics, McGraw-Hill Publication, 3rd Edition, 2009.
2. V. K. Balakrishnan, Schaum's Outline of Graph Theory, McGraw-Hill Publication, 1st Edition, 1997.
3. Eric Gossett, Discrete Mathematics with Proof, Wiley Publication, 2nd Edition, 2009.
4. Kenneth H. Rosen, Discrete Mathematics and its Applications, McGraw-Hill Publication, 6th Edition, 2010. Y. N. Singh, Discrete Mathematical Structures, Wiley Publication, 1st Edition, 2010.
5. Dr. Sukhendu Dey, Graph Theory with Applications, SPD Publication, 1st Edition, 2012.

## **BTCOC303: Data Structures**

### **[UNIT 1] Introduction**

**[7 Hours]**

Data, Data types, Data structure, Abstract Data Type (ADT), representation of Information, characteristics of algorithm, program, analyzing programs. Arrays and Hash Tables Concept of sequential organization, linear and non-linear data structure, storage representation, array processing sparse matrices, transpose of sparse matrices, Hash Tables, Direct address tables, Hash tables, Hash functions, Open addressing, Perfect hashing.

### **[UNIT 2] Stacks and Queues**

**[7 Hours]**

Introduction, stack and queue as ADT, representation and implementation of stack and queue using sequential and linked allocation, Circular queue and its implementation, Application of stack for expression evaluation and expression conversion, recursion, priority queue.

### **[UNIT 3] Linked list**

**[7 Hours]**

Concept of linked organization, singly and doubly linked list and dynamic storage management, circular linked list, operations such as insertion, deletion, concatenation, traversal of linked list, dynamic memory management, garbage collection.

### **[UNIT 4] Trees and Graphs**

**[7 Hours]**

Basic terminology, binary trees and its representation, insertion and deletion of nodes in binary tree, binary search tree and its traversal, threaded binary tree, Heap, Balanced Trees, Terminology and representation of graphs using adjacency matrix, Warshall's algorithm.

### **[UNIT 5] Searching and Sorting**

**[7 Hours]**

Sequential, binary searching, skip lists – dictionaries, linear list representation, skip list representation, operations– insertion, deletion and searching. Insertion sort, selection sort, radix sort, File handling.

### **Text Book:**

1. Weiss, Data structures and algorithms analysis in C++, Pearson Education, 4th Edition,2013

### **Reference Books:**

1. S. Lipschutz, Data Structures, McGraw-Hill Publication, Revised 1st Edition, 2014.
2. Y.Langsm, M. Augenstin, A. Tanenbaum , Data Structure using C and C++, Prentice Hall India Learning Private Limited,2<sup>nd</sup> edition,1998.
3. Horowitz and Sahani, Fundamentals of Data Structures, Universities Press, 2nd Edition,2008.
4. Thomas Cormen, Introduction to Algorithms, PHI Publication, 2nd Edition,2002.
5. Venkatesan& Rose, Data Structures, Wiley Publication, 1st Edition,2015.
6. Goodrich & Tamassia, Data Structure & Algorithm in C++, Wiley Publication, 2nd Edition,2011.
7. R. G. Dromey, How to Solve it by Computer, 2nd Impression, Pearson Education.
8. Kyle Loudon, Mastering Algorithms with C: Useful Techniques from Sorting to Encryption, O'Reilly Media, 1st Edition,1999.

## **BTCOC 304: Computer Architecture and Organization**

### **[UNIT 1] Introduction**

**[7 Hours]**

Concept of computer organization and architecture, Fundamental unit, Computer function and interconnection, CPU structure and function

### **[Unit 2] Instruction Sets**

**[7 Hours]**

Characteristics, Types of operands, Types of operations, Assembly language, Addressing modes, Instruction format, Types of instruction, Instruction execution, Machine state and processor status, Structure of program, Introduction to RISC and CISC architecture.

### **[Unit 3] Computer Arithmetic**

**[7 Hours]**

The arithmetic and logic Unit, Integer representation, Integer arithmetic, Floating point representation, Floating point arithmetic, Introduction of arithmetic co-processor.

### **[Unit 4] Memory Organization**

**[7 Hours]**

Internal Memory: Semiconductor main memory, Error correction, Advanced DRAM organization, Virtual memory systems and cache memory systems. External Memory: Organization and characteristics of magnetic disk, Magnetic tape, Optical memory, RAID, Memory controllers.

### **[Unit 5] Control Unit and Input / Output Organization**

**[7 Hours]**

Control unit operation: Micro-operations, Control of the processor, Hardwired implementation, Micro-programmed Control Unit, Basic concepts, Micro-instruction sequencing, Micro-instruction execution, Applications of micro-programming. **Input/output Organization:** External devices, I/O module, Programmed I/O, Interrupt driven I/O, Direct memory access, I/O channels and processors, External interface. Instruction pipe-lining: Concepts. Parallel processing: Multiple processor organization, Symmetric multiprocessor, Cache coherence and the MESI protocol.

### **Text Book:**

1. William Stalling, Computer Organization and Architecture: Designing for Performance, Prentice Hall Publication, 8th Edition, 2009.

### **Reference Books:**

1. Hayes, Computer Architecture and Organization, McGraw-Hill Publication, 3rd Edition, 2012.
2. Zaky, Computer Organization, McGraw-Hill Publication, 5th Edition, 2011.
3. Hennessy and Patterson, Computer Architecture: A Quantitative Approach, Morgan and Kaufman Publication, 4th Edition, 2007.
4. Morris Mano, Computer System Architecture, Pearson Education India, 3rd Edition, 2007.
5. Mostafa Abd-El-Barr, Hesham El-Rewini, Fundamentals of Computer Organization and Architecture, Wiley Publication, 1st Edition, 2004.
6. Miles J. Murdocca, Vincent P. Heuring, Computer Architecture and Organization: An Integrated Approach, Wiley Publication, 1st Edition, 2007.
7. Sajjan G. Shiva, Computer Organization: Design, and Architecture, CRC Press, 5th Edition, 2013.

**Elective –I**

**(A) BTCOC 305: Object Oriented Programming in C++**

**[Unit 1] Introduction to Object Oriented Programming and Objects and Classes [7 Hours]**

Need of object oriented programming, The object oriented approach, Characteristics of object oriented languages, class, Objects as data types, Constructors, Objects as function arguments, Returning objects.

**[Unit 2] Operator Overloading, Inheritance and Polymorphism [7 Hours]**

Overloading unary and binary operators, Data conversion. Derived and base class, Public and private inheritance, Levels of inheritance, **multiple** inheritance Examples.

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

Virtual functions, Dynamic binding, Abstract classes and pure virtual functions, Friend functions, this pointer.

**[Unit 4] Streams and Files [7 Hours]**

Streams, Stream output and input, Stream manipulators, Files and streams, Creating, Reading, Updating sequential and random files.

**[Unit 5] Templates, Exception Handling and STL [7 Hours]**

Function templates, Overloading function templates, Class templates, Exception handling overview, Need of exceptions, An exception example, Multiple exceptions, Exception specifications. Standard Template Library (STL) Introduction to STL-Containers, Iterators, Algorithms, Sequence containers, Associative containers, Container adapters.

**Text Book:**

1. E. Balagurusamy, Object Oriented Programming with C++, McGraw-Hill Publication, 6th Edition, 2013.

**Reference Books:**

1. Robert Lafore, Object Oriented Programming in C++, Sams Publishing, 4th Edition, 2001.
2. Dr. B. B. Meshram, Object Oriented Paradigms with C++ Beginners Guide for C and C++, SPD Publication, 1st Edition, 2016.
3. Rajesh R. Shukla, Object-Oriented Programming in C++, Wiley India Publication, 1<sup>st</sup> Edition, 2008
4. Bjarne Stroustrup, The C++ Programming Language, Addison-Wesley Publication, 4th Edition, 2013.
5. P.J. Deitel, H. M. Deitel, C++ How to Program, PHI Publication, 9th Edition, 2012.
6. John Hubbard, Programming with C++, Schaum's Outlines, McGraw-Hill Publication, 2nd Edition, 2000.
7. Nicolai M. Josuttis, Object-Oriented Programming in C++, Wiley Publication, 1st Edition, 2002.

**Elective –I**

**(B) BTCOC 305: Object Oriented Programming in JAVA**

**[Unit 1] Introduction to Java Applications**

**[7 Hours]**

Introduction, Java Class Libraries, Typical Java Development Environment, Memory Concepts, Arithmetic. Introduction to Classes and Objects: Introduction, Classes, Objects, Methods and Instance Variables, Declaring a Class with a Method and Instantiating an Object of a Class, Declaring a Method, Instance variables, *set* Methods and *get* Methods, Primitive Types vs. Reference type double Types, Initializing Objects with Constructors, floating point numbers.

**[Unit 2] Control Statements**

**[7 Hours]**

Control structures *if* single-selection statement, *if....else* double-selection statement, *while* repetition statement, *do....while* repetition statement, *switch* multi-selection statement, *break* and *continue* statements, logical operators. Methods :Introduction, Program modules in Java, *static* methods, *static* Fields and *Class Math*, declaring methods with multiple parameters, scope of declaration, method overloading and Java API packages.

**[Unit3]Arrays**

**[7 Hours]**

Arrays, declaring and creating arrays in java, examples using arrays, passing arrays to methods, multidimensional arrays, variable-length argument lists, using command-line arguments.

**[Unit 4] Inheritance and Polymorphism in Java**

**[7 Hours]**

Inheritance: Super classes and Subclasses, protected members, relationship between super classes and subclasses, constructors in subclasses, objectclass. Polymorphism: Abstract classes and methods, final methods and classes, polymorphism examples and Interfaces.

**[Unit 5] Exception-handling and Java script**

**[7 Hours]**

Exception-handling overview, handling *Arithmetic Exceptions* and *Input Mismatch Exceptions*, when to use exception handling, java exception hierarchy, *finally* block. Introduction to Java Applets. Java script: Introduction to client side scripting, Syntax basics, Operators, Comparisons, Statements, Loops, Events, Objects, and User defined functions, Validations using object functions, Validations using regular expressions, JS document object model, popovers, windows

**Text Book:**

1. Paul Deitel and Harvey Detail, *Java: How to Program*, Pearson's Publication, 9th Edition.

**Reference Books:**

1. Joel Murach and Michael Urban, *Murach's Beginning Java with Eclipse*, Murach's Publication, 1st Edition, 2016. Doug Lowe, *Java All-in-One For Dummies*, Wiley Publication, 4th Edition, 2014.
2. Herbert Schildt, *Java The Complete Reference*, McGraw-Hill Publication, 9th Edition.
3. Patrick Niemeyer, Daniel Leuck, *Learning Java*, O'Reilly Media, 4th Edition, 2013.
4. "JavaScript: The Good Parts", Douglas Crockford, O'Reilly, ISBN: 9782744055973. "Microsoft® .NET: Architecting Applications for the Enterprise", Microsoft Press; 1st edition, ISBN:978-0735626096

## **BTCOL306: Data Structure Laboratory**

### **List of Experiments:**

1. Write a program to implement stack using arrays.
2. Write a program to evaluate a given postfix expression using stacks.
3. Write a program to convert a given infix expression to postfix form using stacks.
4. Write a program to implement circular queue using arrays.
5. Write a program to implement double ended queue (dequeue) using arrays.
6. Write a program to implement a stack using two queues such that the push operation runs in constant time and the pop operation runs in linear time.
7. Write a program to implement a stack using two queues such that the push operation runs in linear time and the pop operation runs in constant time.
8. Write a program to implement a queue using two stacks such that dequeue operation runs in constant time and enqueue operation runs in linear time.
9. Write programs to implement the following data structures: (a) Single linked list (b) Double linked list.
10. Write a program to implement a stack using a linked list such that the push and pop operations of stack still take  $O(1)$  time.
11. Write a program to create a binary search tree (BST) by considering the keys in given order and perform the following operations on it. (a) Minimum key (b) Maximum key (c) Search for a given key (d) Find predecessor of a node (e) Find successor of a node (f) delete a node with given key.
12. Write a program to construct an AVL tree for the given set of keys. Also write function for deleting a key from the given AVL tree.
13. Write a program to implement hashing with (a) Separate Chaining and (b) Open addressing methods.
14. Implement the following sorting algorithms: (a) Insertion sort (b) Merge sort (c) Quick sort (d) Heap sort.
15. Write programs for implementation of graph traversals by applying: (a) BFS (b) DFS.

**Elective –I**

**BTCOL306: Object Oriented Programming Lab**

**(a) Object Oriented Programming in C++**

**List of Experiments:**

1. Programs on Operators, Arithmetic Promotion, Method Calling.
2. Programs on dealing with Arrays.
3. Programs on Classes: String and Math.
4. Programs on Inheritance and Polymorphism.
5. Programs on Garbage collection, packaging, access Modifiers, as well as static and abstract modifiers.
6. Programs on Interfaces block initializers, final Modifier, as well as static and dynamic binding.
7. Programs on file handling and stream manipulation.
8. Programs on Dynamic Polymorphism.
9. Programs on Dynamic Memory Management.
10. Programs on Exception Handling.
11. Programs on generic programming using templates.
12. Programs on STL-containers and iterators

**(b) Object Oriented Programming in JAVA**

**List of Experiments:**

1. Programs on Operators, Arithmetic Promotion, Method Calling.
2. Programs on Classes: String and Math.
3. Write a program to demonstrate following Function concepts
  - i) Function overloading
  - ii) Constructors of all types
  - iii) Default parameters, returning by reference
4. Programs on dealing with Arrays.
5. Programs on Classes: String and Math.
6. Programs on Inheritance and Polymorphism.
7. Programs on Garbage collection, packaging, access Modifiers, as well as static and abstract modifiers.
8. Programs on Interfaces, block initializers, final Modifier, as well as static and dynamic binding.
9. Programs on Exception Handling.
10. Write a Java program that illustrates the following
  - a) Creation of simple package.
  - b) Accessing a package.
  - c) Implementing interfaces.
11. Programs on Java script client side scripting.
12. Programs on Java script Operators, Comparisons, Statements, Loops, Events, Objects.
13. Programs on Java script User defined functions.
14. Programs on Java script Validations using object functions.
15. Programs on Java script Validations using regular expressions.
16. Programs on Java script JS document object model, Popovers, Windows.



## **BTCOC401: Design and Analysis of Algorithms**

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

**[7 Hours]**

Definition, Properties of Algorithms, Expressing Algorithm, Flowchart, Algorithm Design Techniques, Performance Analysis of Algorithms, Types of Algorithm's Analysis, Order of Growth, Asymptotic Notations, Recursion, Recurrences Relation, Substitution Method, Iterative Method, Recursion Tree, Master Theorem, Changing Variable, Heap Sort.

### **[Unit 2] Divide and Conquer**

**[7 Hours]**

Introduction, Binary Search, Merge Sort, Quick Sort, Strassen's Matrix Multiplication.

### **[Unit 3] Backtracking**

**[7 Hours]**

Backtracking Concept, N-Queens Problem, Four-Queens Problem, Eight-Queen Problem, Hamiltonian Cycle, Sum of Subsets Problem, Graph Colouring Problem, Branch and Bound: Introduction, Travelling Salesperson Problem, 15-Puzzle Problem, Comparisons between Backtracking and Branch and Bound.

### **[Unit 4] Greedy Algorithms**

**[7 Hours]**

Introduction to Greedy Technique, Greedy Method, Optimal Merge Patterns, Huffman Coding, Knapsack Problem, Activity Selection Problem, Job Sequencing with Deadline, Minimum Spanning Tree, Single-Source Shortest Path Algorithm

### **[Unit 5] Dynamic Programming**

**[7 Hours]**

Introduction, Characteristics of Dynamic Programming, Component of Dynamic Programming, Comparison of Divide-and-Conquer and Dynamic Programming Techniques, Longest Common Sub-sequence, matrix multiplication, shortest paths: Bellman Ford, Floyd Warshall, Application of Dynamic Programming. NP Completeness: Introduction, the Complexity Class P, the Complexity Class NP, Polynomial-Time Reduction, the Complexity Class NP-Complete.

### **Text Book:**

1. T. Cormen, Introduction to Algorithms, PHI Publication, 2nd Edition, 2002.

### **Reference Books:**

1. Aho, Ullman, Data Structure and Algorithms, Addison-Wesley Publication, 1st Edition, 1983.
2. Michel Goodrich, Roberto Tamassia, Algorithm Design – Foundation, Analysis & Internet Examples, Wiley Publication, 2nd Edition, 2006.
3. George T. Heineman, Gary Pollice, Stanley Selkow, Algorithms in a Nutshell, A Practical Guide, O'Reilly Media, 2nd Edition, 2016.
4. Ellise Horowitz, Sartaj Sahni, S. Rajasekaran, Fundamentals of Computer Algorithms, University Press (India) Private Ltd, 2nd Edition, 2008.
5. Sara Base, Computer algorithms: Introduction to Design and Analysis, Addison-Wesley Publication, 2nd Edition, 1988

## BTCOC402: Operating Systems

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

Introduction and Operating system structures: Definition, Types of Operating system, Real-Time operating system, System Components: System Services, Systems Calls, System Programs, System structure, Virtual Machines, System Design and Implementation, System Generations.

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

Processes and CPU Scheduling: Process Concept, Process Scheduling, Operation on process, Inter-process Communication, Cooperating processes, Threads, Multithreading model, Scheduling criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Scheduling Algorithms evaluation.

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

Process Synchronization: The critical-section problem, Critical regions, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of synchronization, and Monitors Deadlocks: Systems Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock, Combined approach to deadlock Handling.

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

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Continuous Memory Allocation, Fixed and variable partition, Internal and external fragmentation and compaction, Paging: Principle of operation, Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging; Segmentation. Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page / Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

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

File Management: File Concept, Access methods, File types, File operation, Directory and disk structure, File System Structure, File System Implementation, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance. Mass-Storage Structure: Disk Structure, Disk attachment, Disk scheduling, Disk management, Swap Space Management.

**Text Book:**

1. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, Wiley Publication, 8th Edition, 2008.

**Reference Books:**

1. Andrew S. Tanenbaum, Modern Operating System, PHI Publication, 4th Edition, 2015.
2. D. M. Dhamdhere, Systems Programming and Operating Systems, McGraw-Hill, 2<sup>nd</sup> Edition, 1996.
3. Garry Nutt, Operating Systems Concepts, Pearson Publication, 3rd Edition, 2003.
4. Harvey M. Deitel, An Introduction to Operating Systems, Addison Wesley Publication, 2<sup>nd</sup> Edition, 1990.
5. Thomas W. Doepfner, Operating System in Depth: Design and Programming, Wiley Publication, 2011.

## **BTHM403: Basic Human Rights**

### **[Unit 1]**

**[6 Hours]**

The Basic Concepts: - Individual, group, civil society, state, equality, justice, Human Values, Human rights and Human Duties: - Origin, Contribution of American bill of rights, French revolution, Declaration of independence, Rights of citizen, Rights of working and exploited people.

### **[Unit 2]**

**[6 Hours]**

Fundamental rights and economic programme, Society, religion, culture, and their inter relationship, Impact of social structure on human behavior, Social Structure and Social Problems: - Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labor.

### **[Unit 3]**

**[6 Hours]**

Migrant workers and human rights violations, human rights of mentally and physically challenged, State, Individual liberty, Freedom and democracy, NGOs and human rights in India: - Land, Water, Forest issues.

### **[Unit 4]**

**[6 Hours]**

Human rights in Indian constitution and law: - i) the constitution of India: Preamble ii) Fundamental rights iii) Directive principles of state policy vi) Fundamental duties v) some other provisions.

### **[Unit 5]**

**[6 Hours]**

Universal declaration of human rights and provisions of India, Constitution and law, National human rights commission and state human rights commission.

### **Text Book:**

1. Shastry, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd.), 2005.

### **Reference books:**

1. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India

## **BTBSC404: Probability and Statistics**

### **[Unit 1] Probability Theory**

**[7 Hours]**

Definition of probability: classical, empirical and axiomatic approach of probability, Addition theorem of probability, Multiplication theorem of probability, Bayes' theorem of inverse probability, Properties of probabilities with proofs, Examples.

### **[Unit 2] Random Variable and Mathematical Expectation**

**[7 Hours]**

Random variables, Probability distributions, Probability mass function, Probability density function, Mathematical expectation, Joint and marginal probability distributions, Properties of expectation and variance with proofs. Theoretical Probability Distributions : Binomial distribution, Poisson distribution, Normal distribution, Fitting of binomial distributions, Properties of binomial, Poisson and normal distributions, Relation between binomial and normal distributions, Relation between Poisson and normal distributions, Importance of normal distribution, Examples.

### **[Unit 3] Correlation**

**[7 Hours]**

Introduction, Types of correlation, Correlation and causation, Methods of studying correlation, Karl Pearson's correlation coefficient, Spearman's rank correlation, Coefficient, Properties of Karl Pearson's correlation coefficient and Spearman's rank correlation coefficient, Probable errors.

### **[Unit 4] Linear Regression Analysis**

**[7 Hours]**

Introduction, Linear and non-linear regression, Lines of regression, Derivation of regression lines of  $y$  on  $x$  and  $x$  on  $y$ , Angle between the regression lines, Coefficients of regression, Theorems on regression coefficient, Properties of regression coefficient.

### **[Unit 5] Estimation and Hypothesis**

**[7 Hours]**

Estimation, Large Sample Estimation of a Population Mean, Small Sample Estimation of a Population Mean, Large Sample Estimation of a Population Proportion, Sample Size Considerations, Testing Hypotheses, The Elements of Hypothesis Testing, Large Sample Tests for a Population Mean, The Observed Significance of a Test, Small Sample Tests for a Population Mean, Large Sample Tests for a Population Proportion.

### **Text Book:**

1. S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House, 7th Revised and Enlarged Edition, 2016.

### **Reference Books:**

1. G. V. Kumbhojkar, Probability and Random Processes, C. Jamnadas and Co., 14th Edition, 2010.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.
4. G. Haribaskaran, Probability, Queuing Theory and Reliability Engineering, Laxmi Publications, 2nd Edition, 2009.
5. Murray Spiegel, John Schiller, R. ALU Srinivasan, Probability and Statistics, Schaum's Outlines, 4th Edition, 2013.
6. Kishor S. Trivedi, Probability, Statistics with Reliability, Queuing and Computer Science Applications, Wiley India Pvt. Ltd, 2nd Edition, 2001.
7. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Wiley

Publication, 2nd Edition, 2001.

8. Roxy Peck, Chris Olsen, Jay Devore, Introduction to Statistics and Data Analysis, Third Edition, Thomson Books/Cole.
9. Ronald Walpole; Raymond Myers; Sharon Myers; Keying Ye, Probability & statistics for engineers & scientists, 9th edition, Prentice Hall.

## **BTES405: Digital Logic Design & Microprocessor**

### **[Unit1] Introduction**

**[7 Hours]**

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, Number Systems: binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes.

### **[Unit 2] Combinational Digital Circuits**

**[7 Hours]**

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions, Don't care conditions, Multiplexer, De-Multiplexer / Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, parity checker / generator.

### **[Unit 3] Sequential circuits and systems**

**[7 Hours]**

1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J-K-T and D-types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple(Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

### **[Unit 4] Fundamentals of Microprocessors**

**[7 Hours]**

Fundamentals of Microprocessor, Comparison of 8-bit, (8085) 16-bit (8086), and 32-bit microprocessors (80386), The 8086 Architecture: Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

### **[Unit 5] 8086 Instruction Set and Programming**

**[7 Hours]**

Memory Interfacing, I/O Interfacing, Direct Memory Access (DMA), Interrupts in 8086, 8086 Instruction Set and Programming: Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing, Instruction timings, Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction, Assembly language programs, C language programs, Assemblers and compilers, Programming and debugging tools.

### **Text Book:**

1. R. P. Jain, Modern Digital Electronics, McGraw Hill Education, 2009.

### **Reference Books:**

1. M. M. Mano, Digital logic and Computer design, Pearson Education India, 2016.
2. Kumar, Fundamentals of Digital Circuits, Prentice Hall India, 2016.
3. Douglas Hall, Microprocessors and Interfacing, McGraw-Hill Publication, Revised 2nd Edition, 2006.

## BTCOL406: Python Programming

**One hour per week is for program demonstration and instruction which can be conducted as a classroom session or lab session.**

**[Unit 1] [2 Hours]**

Informal introduction to programming, algorithms and data structures, downloading and installing Python, run a simple program on Python interpreter.

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

Variables, operations, control flow – assignments, conditionals, loops, functions: optional arguments, default values, passing functions as arguments.

**[Unit 3] [2 Hours]**

Statements, Expressions, Strings: String processing. Exception handling, Basic input/output, handling files.

**[Unit 4] [2 Hours]**

Class and Object, Data Structure: List, Tuple and Sequences, Set, Dictionaries.

**[Unit 5] [4 Hours]**

Using Database and Structured Query Languages (SQL): SQLite manager, Spidering Twitter using a Database, Programming with multiple tables, JOIN to retrieve data.

\*Programming assignments are mandatory.

### **Text Book:**

1. Michael Urban and Joel Murach, Murach's Python Programming, Murach's Publication, 2016.

### **Reference Books:**

1. Charles Severance, Python for Informatics: Exploring Information, University of Michigan, Version 2.7.0, 2014.
2. Dr. R. Nageswara Rao, Core Python Programming, Dreamtech Press, 1st Edition, 2016.
3. Mark Lutz, Learning Python, O'Reilly Media, 5th Edition, 2013.
4. Mark Pilgrim, Dive into Python 3, A press Publication, 2nd Edition, 2009.
5. Allen B. Downey, Think Python, O'Reilly Media, 2nd Edition, 2012.
6. Jon Kleinberg and Eva Tardos, Algorithm Design, Pearson Education, 1st Edition, 2006.

## **BTCOL406: Python Programming**

### **List of Experiments:**

- 1 Program to calculate area of triangle, rectangle, circle
- 2 Program to find the union of two lists.
- 3 Program to find the intersection of two lists.
- 4 Program to remove the “i” th occurrence of the given word in a list where words repeat.
- 5 Program to count the occurrences of each word in a given string sentence.
- 6 Program to check if a substring is present in a given string.
- 7 Program to map two lists into a dictionary.
- 8 Program to count the frequency of words appearing in a string using a dictionary.
- 9 Program to create a dictionary with key as first character and value as words starting with that character.
- 10 Program to find the length of a list using recursion.
- 11 compute the diameter, circumference, and volume of a sphere using class
- 12 Program to read a file and capitalize the first letter of every word in the file.

## **BTCOL406: Operating Systems Laboratory**

### **List of Experiments:**

1. Hands on Unix Commands
2. Shell programming for file handling.
3. Shell Script programming using the commands grep, awk, and sed.
4. Implementation of various CPU scheduling algorithms (FCFS, SJF, Priority).
5. Implementation of various page replacement algorithms (FIFO, Optimal, LRU).
6. Concurrent programming; use of threads and processes, system calls (fork and v-fork).
7. Study pthreads and implement the following: Write a program which shows the performance.
8. Improvement in using threads as compared with process.(Examples like Matrix Multiplication.
9. Hyper Quick Sort, Merge sort, Traveling Sales Person problem).
10. Implementation of Synchronization primitives – Semaphore, Locks and Conditional Variables.
11. Implementation of Producer-Consumer problem, Bankers algorithm.
12. Implementation of various memory allocation algorithms, (First fit, Best fit and Worst fit), Disk.
13. Scheduling algorithms (FCFS, SCAN, SSTF, C-SCAN).
14. Kernel reconfiguration, device drivers and systems administration of different operating systems.

Writing utilities and OS performance tuning



## BTCOS407: Seminar – II

### [Unit 1]

Web Site development Essentials: Overview of Web Design Concepts, Web Project Management Fundamentals, Web Site Development Process, HTML and the Evolution of Markup languages, HTML basic tags, Web Page Layout and Elements, Create Hyperlinks, Create Tables, Create Web Forms, Image Inserting Techniques, Create Frames, GUI HTML Editors, Site Content and Metadata.

### [Unit 2]

Cascading Style Sheets: Cascading Style Sheets for Web page design, Creating CSS rules, Format Text with CSS, Use of CSS Selectors, Embed Style Sheets, and Attach External Style Sheets. Using CSS with Tables: Insert and Styling Tables, Import Table Data, Style Tables with CSS, Sort Data in Table.

### [Unit 3]

Introduction to JavaScript, Variables, Basic in JavaScript — Numbers and operators, Handling text — Strings in JavaScript, Useful string methods, Arrays, Troubleshooting JavaScript;  
Programming fundamentals: If...Else Statements, Else...If Statements, For Loops, While Loops, Breaking Out Of Loops, Switch Statements, Functions; JavaScript Events, Selecting HTML elements using get Element ById().

### [Unit 4]

PHP: Basic Syntax, Defining variable and constant, PHP Data type, Operator and Expression, Handling Html Form with PHP: Capturing Form Data, Dealing with Multi-value filed, redirecting a form after submission, PHP Session.

### [Unit 5]

JQuery: Introduction to JQuery, Validation using JQuery, JQuery Forms, JQuery Examples  
AJAX: Introduction to AJAX, PHP with AJAX Introduction to RDBMS: Connection with MySQL Database, Performing basic database operation (DML)(Insert, Delete, Update, Select)

### Suggestive List of Experiments:

1. Design an html form for displaying information using interactive css including images, tables.
2. Create a webpage with HTML describing your department with following specification:
  - a. Change the background color of the page. At the bottom create a link to take user to the top of the page.
  - b. Insert an image and create a link such that clicking on image takes user to other page.
  - c. Also apply font styling like italics, underline and two other fonts to words you find appropriate. Also use header tags.
3. Write a JavaScript to design a simple calculator to perform the following operations: sum, product, difference and quotient.
4. Write a JavaScript to validate the following fields of employee on html form: email, name, mobile no., address, salary.
5. Develop and demonstrate a HTML file that includes JavaScript script that uses functions for the following problems:
  - a. Parameter: A string  
Output: Length of the String
  - b. Parameter: A number  
Output: The number with its digits in the reverse order
6. Develop and demonstrate a HTML file that includes JavaScript for the following problems:
  - a. Input: A starting and ending number
  - b. Output: find all the prime numbers between starting and ending number.
7. Write a PHP program to display a digital clock which displays the current time of the server.

8. Write a PHP program to implement sign-In and Sign-out functionality.
9. Write a PHP program to keep track of the number of visitors visiting the Web page and to display this count of visitors, with proper headings.
10. Write a PHP code to implement AJAX functionality.
11. Write a PHP program to perform search operation on the student records using AJAX.
12. Write a PHP program to sort the student records which are stored in the database using ascending/descending order.

**Text Book:**

1. HTML 5 Black Book, Covers CSS 3, JavaScript, XML, XHTML, Ajax, PHP and jQuery, 2ed (English, Paperback, DT Editorial Services).

**Reference Books:**

1. Robin Nixon, Learning PHP, MySQL & JavaScript with j Query, CSS & HTML5 Paperback by Orielly Pub.
2. E. Robson, E. Freeman, Head First HTML & CSS, O'Reilly Media, 2nd Edition, 2012.

**Guidelines for Seminar:**

1. Each candidate shall deliver a seminar as per the Scheme of Teaching and Examination for a minimum 35 minutes including questions and answers.
2. Students can choose/propose any topic for web application development.
3. Students can use HTML, CSS, Java Script, AJAX, PHP or any other front-end tool for web application development.
4. Applications developed must be demonstrated on desktop/laptop as a web based application in the seminar.
5. A seminar report must be submitted at the end of semester on the base of application developed and technology used.

## 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>   | IIT, Madras                       | 85                          | 8 Weeks                |                                |
|         |                                      |             |          | <a href="https://nptel.ac.in/courses/111/106/111106051/">https://nptel.ac.in/courses/111/106/111106051/</a>   |                                   | 90                          | 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>   | IIT, Madras                       | 90                          | 8 Weeks                |                                |
|         |                                      |             |          | <a href="https://nptel.ac.in/courses/111/107/111107058/">https://nptel.ac.in/courses/111/107/111107058/</a>   |                                   | 90                          |                        |                                |
| 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>   | IIT, Madras                       | 85                          | 12 weeks               |                                |
|         |                                      |             |          | <a href="https://nptel.ac.in/courses/106/103/106103180/">https://nptel.ac.in/courses/106/103/106103180/</a>   |                                   | 75                          |                        |                                |
|         |                                      |             |          | <a href="https://nptel.ac.in/courses/106/106/106106166/">https://nptel.ac.in/courses/106/106/106106166/</a>   |                                   | IIT, Guwahati               |                        | 70                             |
|         |                                      |             |          | <a href="https://nptel.ac.in/courses/106/105/106105163/">https://nptel.ac.in/courses/106/105/106105163/</a>   |                                   | IIT, Madras ,IIT, Kharagpur |                        | 85                             |
|         |                                      |             |          | <a href="https://swayam.gov.in/nd1_noc20_cs64/preview">https://swayam.gov.in/nd1_noc20_cs64/preview</a>       | IIT, Kharagpur                    | 85                          |                        |                                |
| 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>   | IIT, Kharagpur IIT, Madras        | 40                          | 12 weeks               |                                |
|         |                                      |             |          | <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>       |                                   |                             |                        | Chennai Mathematical Institute |
| 8       | Probability & Statistics             | BTBS402     | IV       | <a href="https://nptel.ac.in/courses/111/106/111106112/#">https://nptel.ac.in/courses/111/106/111106112/#</a> | IIT, Madras                       | 80                          | 4 weeks                |                                |
|         |                                      |             |          | <a href="https://nptel.ac.in/courses/111/105/111105090/">https://nptel.ac.in/courses/111/105/111105090/</a>   |                                   | IIT, Kharagpur              | 90                     | 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>   | IIT, Madras                       | 1.85<br>2.80                | 1.8 Weeks<br>2.8 Weeks |                                |
|         |                                      |             |          | <a href="https://nptel.ac.in/courses/106/106/106106144/">https://nptel.ac.in/courses/106/106/106106144/</a>   |                                   |                             |                        | IIT, Madras                    |
| 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><br><a href="https://nptel.ac.in/courses/108/103/108103157/">https://nptel.ac.in/courses/108/103/108103157/</a> | IIT, Kharagpur<br>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/106106093/">http://nptel.ac.in/courses/106106093/</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><br><a href="https://nptel.ac.in/courses/106/106/106106049/">https://nptel.ac.in/courses/106/106/106106049/</a> | IIT, Kharagpur<br>IIT, Madras   | 92       | 45 Hrs<br>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><br><a href="https://nptel.ac.in/courses/106/104/106104123/">https://nptel.ac.in/courses/106/104/106104123/</a> | IISc, Bangalore<br>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><br><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><br><a href="https://nptel.ac.in/courses/109/104/109104074/">https://nptel.ac.in/courses/109/104/109104074/</a> | IIT, Guwahati<br>IIT, Kanpur    | 30<br>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><br><a href="https://nptel.ac.in/courses/106/105/106105078/">https://nptel.ac.in/courses/106/105/106105078/</a> | IIT, Madras<br>IIT, Kharagpur         | 70       | 48 Hrs<br>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><br><a href="https://nptel.ac.in/courses/106/105/106105167/">https://nptel.ac.in/courses/106/105/106105167/</a> | IIT, PATNA<br>IIT, Kharagpur          | 30<br>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><br>2) <a href="https://www.coursera.org/specializations/discrete-mathematics">https://www.coursera.org/specializations/discrete-mathematics</a> | 1) Shanghai Jiao Tong University<br>2) University of California San Diego National Research University Higher School of Economics | 1) 75<br>2) 90 | 8 Weeks                  |
| 2       | Data Structures                       | BTCOC303     | III      | 1) Data Structures<br>2) Data Structures & Algorithms  | 1) UC San Diego<br>2) UC San Diego  | 1) 90<br>2) 80 | 1) 6 Weeks<br>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<br>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  | 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><br><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<br>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<br>2) Algorithms and Data Structures  | 1) IIT Bombay<br>2) UCSanDiego                    | 1) 90<br>2) 70 | 1) 6 Weeks<br>2) 4 Weeks |
| 3       | Computer Architecture & Organization  | BTCOC304     | III      | 1. Computer Organization<br>2. Computer Architecture  | 1. MITx<br>2. MITx                                | 1. 20<br>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  | <a href="https://www.edx.org/course/software-engineering-essentials">Software Engineering Essentials</a><br><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<br>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  |