UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics and Computer Science

Direct Second Year Admitted Students for the Academic Year 2020-21(Only)

(REV- 2019 'C' Scheme) from the Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering), of University of Mumbai, has taken a lead in incorporating the philosophy of outcome-based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes, understand the depth and approach of the course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process. However, content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum was more focused on providing information and knowledge across various domains of the said program, which led to heavily loading students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self -learning. There-fore in the present curriculum, skill-based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of the curriculum proposed in the present revision is in line with the AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of 'C 'scheme, wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In earlier revisions of the curriculum in the years 2012 and 2016, in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HOD's/ Faculties of all the institutes are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses and on successful completion, they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Program Structure for Second Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 301	Engineering Maths III	3	-	1	3	-	1	4
ECC 302	Electronic Devices	3	-	-	3	-	-	3
ECC 303	Digital Electronics	3	-	-	3	-	-	3
ECC 304	Data Structures and Algorithms	3	-	-	3	-	-	3
ECC 305	Database Management Systems	3	-	-	3	-	-	3
ECL301	Electronic Devices Lab	-	2	-	-	1	-	1
ECL302	Digital Electronics Lab	-	2	-	-	1	-	1
ECL303	Data Structures and Algorithms Lab	-	2	-	-	1	-	1
ECL304	Database Management Systems lab	-	2	-	-	1	-	1
ECL305	Skill-based Lab course: OOPM (C++ and Java)	-	4	-	-	2	-	2
ECM301	Mini-project -1 A	-	4$	-	-	2	-	2
	Total	15	16	1	15	08	1	24

$ indicates workload of learner (Not faculty), for mini-project

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
ECC 301	Engineering Maths III	20	20	20	80	03	25	-	125
ECC 302	Electronic Devices	20	20	20	80	03	-	-	100
ECC 303	Digital Electronics	20	20	20	80	03	-	-	100
ECC 304	Data Structures and Algorithms	20	20	20	80	03	-	-	100
ECC 305	Database Management Systems	20	20	20	80	03	-	-	100
ECL 301	Electronic Devices Lab	-	-	-	-	-	25	25	50
ECL 302	Digital Electronics Lab	-	-	-	-	-	25	25	50
ECL 303	Data Structures and Algorithms Lab	-	-	--	-	-	25	25	50
ECL 304	Database Management systems lab	-	-	-	-	-	25	25	50
ECL 305	Skill-based Lab course: OOPM (C++ and Java)	-	-	-	-	-	50	-	50
ECM 301	Mini Project - 1A						25	25	25
	Total	-	-	100	400	-	200	125	825

Note:

1. Students group and load of faculty per week.

   Mini Project 1 and 2:
   Students can form groups with minimum 3 (Three) and not more than 4(Four).

   Faculty Load:1 hour per week per four groups

   Major Project 1 and2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)

   Faculty Load: In Semester VII– ½ hour per week per project group

   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 301	Engineering Maths III	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg. of Test 1 and Test 2						
ECC 301	Engineering Maths III	20	20	20	80	03	25	--	--	125

Pre-requisite:
Engineering Mathematics-I, Engineering Mathematics-II, Scalar and Vector Product: Scalar and vector product of three and four vectors

Course Objectives:
The course is aimed

1. To learn the Laplace Transform, Inverse Laplace Transform of various functions and its applications.
2. To understand the concept of Fourier Series, its complex form and enhance the problem-solving skills.
3. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in complex plane.
4. To understand the basics of Linear Algebra.
5. To use concepts of vector calculus to analyze and model engineering problems.

Course Outcomes:
After successful completion of the course students will be able to:

1. Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2. Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
5. Use matrix algebra to solve the engineering problems.
6. Apply the concepts of vector calculus in real life problems.

Module No.	Unit No.	Contents	Hrs.
1		**Laplace Transform**	06
	1.1	Definition of Laplace transform, Condition of Existence of Laplace transform.	
	1.2	Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$	
	1.3	Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof).	
	1.4	Evaluation of integrals by using Laplace Transformation.	
	Self-learning Topics: Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.		
2		**Inverse Laplace Transform**	06
	2.1	Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives.	
	2.2	Partial fractions method to find inverse Laplace transform.	
	2.3	Inverse Laplace transform using Convolution theorem (without proof).	
	Self-learning Topics: Applications to solve initial and boundary value problems involving ordinary differential equations.		
3		**Fourier Series**	06
	3.1	Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).	
	3.2	Fourier series of periodic function with period 2π and $2l$.	
	3.3	Fourier series of even and odd functions.	
	3.4	Half range Sine and Cosine Series.	
	Self-learning Topics: Complex form of Fourier Series, Orthogonal and Orthonormal set of functions. Fourier Transform.		
4		**Complex Variables**	06
	4.1	Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z)Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof).	
	4.2	Cauchy-Riemann equations in Cartesian coordinates (without proof).	

	4.3	Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given.	
	4.4	Harmonic function, Harmonic conjugate and orthogonal trajectories	
	Self-learning Topics: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations		
5		**Linear Algebra: Matrix Theory**	**06**
	5.1	Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors. (Without Proof).	
	5.2	Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix.	
	5.3	Similarity of matrices, Diagonalization of matrices. Functions of square matrix	
	Self-learning Topics: Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**		
6		**Vector Differentiation and Integral**	**06**
	6.1	Vector differentiation: Basics of Gradient, Divergence and Curl (Without Proof).	
	6.2	Properties of vector field: Solenoidal and irrotational (conservative) vector fields.	
	6.3	Vector integral: Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation.	
	Self-learning Topics: Gauss' divergence Theorem and applications of Vector calculus		
Total			**36**

References:

1. H. K. Das, Advanced Engineering Mathematics, S. Chand Publications, 22nd edition, 2018.
2. B. V. Ramana, Higher Engineering Mathematics, Tata Mc-Graw Hill Publication.1st edition, 2006.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publication, 1st edition, 2006.
4. Wylie and Barret, Advanced Engineering Mathematics, Tata Mc-Graw Hill, 6st edition, 2003.
5. Murray Spiegel, Schaum's Outline of Fourier Analysis with Applications to Boundary Value Problems (Schaum's Outline Series).
6. Murray Spiegel, Schaum's Outline of Vector Analysis (Schaums' Outline Series), Mc-Graw Hill Publication.
7. Seymour Lipschutz, Schaum's Outline of Beginning Linear Algebra (Schaums' Outline Series), Mc-Graw Hill Publication.
8. Dr. B. S. Grewal, Higher Engineering Mathematics, Khanna Publication, 43rd edition, 2010.

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.
4. The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 302	Electronic Devices	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg. of Test 1 and Test 2						
ECC 302	Electronic Devices	20	20	20	80	03	--	--	--	100

Course Objectives:

1. To deliver the knowledge of basic semiconductor devices.
2. To enhance comprehension capabilities of students through understanding of electronic devices.
3. To introduce and motivate students to the use of advanced nano-electronic devices
4. To analyse amplifiers using BJT and FET based devices.

Course Outcomes:

After successful completion of the course students will be able to:

1. Explain the working of semiconductor devices.
2. Interpret the characteristics of semiconductor devices.
3. Analyse Electronics circuits using BJT and FET (DC & AC analysis)
4. Compare various biasing circuits & configurations of BJT and MOSFETs.
5. Select best circuit for the given specifications/application.
6. Describe the working of advanced nano-electronic devices

Module No.	Unit No.	Contents	Hrs.
1		**P-N Junction Diode & Applications**	06
	1.1	Theoretical description of basic structure & construction, symbol, operation under zero bias, forward bias & reverse bias, avalanche breakdown, V-I characteristics & temperature effects (no mathematical analysis or numerical examples)	
	1.2	Application of P-N junction diode as clippers & clampers (different types of configurations with input-output waveforms & transfer characteristics; theoretical description & analysis of each circuit; numerical examples)	
2		**Special Semiconductor Devices**	04
	2.1	Zener diode as the voltage regulator (theoretical description only which includes construction of circuit diagram, operation / working for varying DC input voltage & varying load resistance, concept of line regulation & load regulation – no numerical examples)	
	2.2	Construction, structure, symbol, operating principle, working & V-I characteristics of special semiconductor devices such as Varactor diode, Schottky diode, Photo diode, Light emitting diode (LED) & Solar cells	
3		**Bipolar Junction Transistor (BJT)**	03
	3.1	BJT construction & structure, symbol, operation, voltages & currents, V-I characteristics of common emitter (CE), common base (CB) & common collector (CC) configuration, Early effect & concept of leakage current	
4		**Field Effect Devices (FET)**	03
	4.1	JFET: Construction, symbol, operation, V-I & transfer characteristics MOSFET: Construction, operation, symbol, V-I & transfer characteristics of the D-MOSFET & E-MOSFET (theoretical description only for JFET & MOSFET)	
5		**Rectifiers &Filters**	04
	5.1	Rectifiers: Working & mathematical analysis of full – wave centre tapped rectifier & bridge type rectifier (mathematical analysis include expressions for the DC / average & RMS output voltage, DC / average & RMS output current & ripple factor; numerical examples included)	
	5.2	Filters: Capacitor (C), Inductor (L), Inductor – Capacitor (LC), C-L-C (π) with circuit diagram, waveforms, working / operation & expression for ripple factor (theoretical description only – no analysis or numerical examples to be included)	
		Total	20

Text Books:

1. Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, “Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.
3. James Morris & Krzysztof Iniewski, Nano-electronic Device Applications Handbook by CRC Press

Reference Books:

1. Boylestead," Electronic Devices and Circuit Theory", Pearson Education
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar, “Electronic Devices and Circuits”, Tata McGraw Hill.
5. Millman and Halkies, “Integrated Electronics”, Tata McGraw Hill.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and oral	Tutorial	Theory	Practical and oral	Tutorial	Total
ECC 303	Digital Electronics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 303	Digital Electronics	20	20	20	80	03	--	--	100

Course Pre-requisites:
Basic Electrical & Electronics Engineering

Course Objectives:
1. To understand various number systems & codes and to introduce students to various logic gates, SOP, POS form and their minimization techniques.
2. To teach the working of combinational circuits, their applications and implementation of combinational logic circuits using MSI chips.
3. To teach the elements of sequential logic design, analysis and design of sequential circuits.
4. To understand various counters and shift registers and its design using MSI chips.
5. To explain and describe various logic families and Programmable Logic Devices.
6. To train students in writing programs with Verilog hardware description languages.

Course Outcomes:
After successful completion of the course students will be able to
1. Perform code conversion and able to apply Boolean algebra for the implementation and minimisation of logic functions.
2. Analyse, design and implement Combinational logic circuits.
3. Analyse, design and implement Sequential logic circuits.
4. Design and implement various counter using flip flops and MSI chips.
5. Understand TTL & CMOS logic families, PLDs, CPLD and FPGA.
6. Understand basics of Verilog Hardware Description Language and its programming with combinational and sequential logic circuits.

Module No.	Unit No	Contents	Hrs.
1		**Fundamentals of Digital Design**	02
	1.1	**Number Systems and Codes:** Review of Number System, Weighted code, Parity Code: Hamming Code	
		Combinational Circuits using basic gates as well as MSI devices	02
2	2.1	**Arithmetic Circuits:** Ripple carry adder, Carry Look ahead adder	
	2.2	**MSI devices:** IC 7483, IC 74151, IC 74138, IC 7485.	
		Sequential Logic Design	07
3	3.1	**Sequential Logic Design:** Mealy and Moore Machines, Clocked synchronous state machine analysis, State reduction techniques (inspection, partition and implication chart method) and state assignment, sequence detector, Clocked synchronous state machine design.	
	3.2	**Sequential logic design practices:** MSI counters (7490, 7492, 7493,74163, 74169) and applications, MSI Shift registers (74194) and their applications.	
		Logic Families and Programmable Logic Devices	04
4	4.1	**CMOS Logic**: CMOS inverter, CMOS NAND and CMOS NOR, Interfacing CMOS to TTL and TTL to CMOS.	
	4.2	**Programmable Logic Devices**: Concepts of PAL and PLA. Simple logic implementation using PAL and PLA, Introduction to CPLD and FPGA architectures, Numericals based on PLA and PAL	
		Introduction to Verilog HDL	05
5	5.1	**Basics**: Introduction to Hardware Description Language and its core features, synthesis in digital design, logic value system, data types, constants, parameters, wires and registers. **Verilog Constructs:** Continuous & procedural assignment statements, logical, arithmetic, relational, shift operator, always, if, case, loop statements, Gate level modelling, Module instantiation statements.	
	5.2	**Modelling Examples:** Combinational logic eg. Arithmetic circuits, Multiplexer, Demultiplexer, decoder, Sequential logic eg. flip flop, counters.	
		Total	20

Text Books:

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2. Morris Mano, Digital Design, Pearson Education, Asia 2002.
3. J. Bhaskar, A Verilog HDL Primer, Third Edition, Star Galaxy Publishing, 2018.

Reference Books:

1. Digital Logic Applications and Design – John M. Yarbrough, Thomson Publications, 2006
2. John F. Warkerly, Digital Design Principles and Practices, Pearson Education, Fourth Edition, 2008.
3. Stephen Brown and Zvonko Vranesic, Fundamentals of digital logic design with Verilog design, McGraw Hill, 3rd Edition.
4. Digital Circuits and Logic Design – Samuel C. Lee, PHI
5. William I.Fletcher, "An Engineering Approach to Digital Design", Prentice Hall of India.
6. Parag K Lala, "Digital System design using PLD", BS Publications, 2003.
7. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 2004.

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and the second class test (Internal Assessment II) when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 304	Data Structures and Algorithms	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 304	Data Structures and Algorithms	20	20	20	80	03	--	-- --	100

Course Prerequisite:
C Programming

Course Objectives:

1. To understand and demonstrate basic data structures (such as Arrays, linked list, stack, queue, binary tree, graph).
2. To implement various operations on data structures.
3. To study different sorting and searching techniques.
4. To choose efficient data structures and apply them to solve real world problems.

Course Outcomes:
After successful completion of the course students will be able to

1. Implement various linear data structures.
2. Implement various non-linear data structures.
3. Select appropriate sorting and searching techniques for a given problem and use it.
4. Develop solutions for real world problems by selecting appropriate data structure and algorithms.
5. Analyse the complexity of the given algorithms.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Data Structures**	**02**
		Introduction to Data Structures, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of array, Static arrays vs Dynamic Arrays, structures.	
2		**Stack and Queues**	**04**
		Introduction, Basic Stack Operations, Representation of a Stack using Array, Applications of Stack – Infix to Postfix Conversion and Postfix Evaluation. Queue, Operations on Queue	
3		**Linked List**	**04**
		Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List (SLL), Operations on Singly Linked List: Insertion, Deletion, Print SLL. Implementation of Stack and Queue using Singly Linked List.	
4		**Trees**	**04**
		Introduction, Tree Terminologies, Binary Tree, Representation of Binary Trees, Binary Tree Traversals, Binary Search Tree Operations on Binary Search Tree,	
5		**Graphs**	**03**
		Introduction, Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS)	
6		**Introduction to Sorting and Searching**	**03**
		Introduction to Searching: Linear search, Binary search, Sorting: Internal VS. External Sorting, Sorting Techniques: Bubble, Insertion, selection, Quick Sort, Merge Sort	
		Total	**20**

Text Books:

1. Data Structures Using C, Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, Pearson Education
2. Introduction to Data Structure and its Applications Jean-Paul Tremblay, P. G.Sorenson
3. Data Structures using C, Reema Thareja, Oxford
4. C and Data structures, Prof. P.S.Deshpande, Prof. O.G.Kakde, Dreamtech Press.
5. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, Second Edition, CENGAGE Learning

Reference Books:

1. Data Structure Using C, Balagurusamy.
2. Data Structures using C and C++, Rajesh K Shukla, Wiley - India
3. ALGORITHMS Design and Analysis, Bhasin, OXFORD.
4. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill.
5. Computer Algorithms by Ellis Horowitz and Sartaj Sahni, Universities Press.
6. Data Structures, Adapted by: GAV PAI, Schaum's Outlines.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as the final IA marks.

End Semester Examination:
1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 305	Database Management Systems	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 305	Database Management Systems	20	20	20	80	03	--	--	100

Course Objectives:

1. Develop entity relationship data model and its mapping to relational model
2. Learn relational algebra and formulate SQL queries
3. Apply normalization techniques to normalize the database
4. Understand concepts of transaction, concurrency control and recovery techniques

Course Outcomes:

After successful completion of the course students will be able to:

1. Recognize the need of database management system
2. Design ER and EER diagram for real life applications
3. Construct relational model and write relational algebra queries.
4. Formulate SQL queries
5. Apply the concept of normalization to relational database design.
6. Describe the concepts of transaction, concurrency and recovery.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Database Concepts**	**03**
	1.1	Introduction, Characteristics of databases	
	1.2	File systems v/s Database systems	
	1.3	Data abstraction and Data Independence	
	1.4	DBMS system architecture	
	1.5	Database Administrator	
2		**Entity–Relationship Data Model**	**03**
	2.1	The Entity-Relationship (ER) Model	
	2.2	Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys	
	2.3	Relationship constraints: Cardinality and Participation	
3		**Relational Model and Relational Algebra**	**03**
	3.1	Relational schema and concept of keys	
	3.2	Relational Algebra – operators, Relational Algebra Queries.	
4		**Structured Query Language (SQL)**	**05**
	4.1	Overview of SQL	
	4.2	Data Definition Commands	
	4.3	Integrity constraints: Key constraints, Domain Constraints, Referential integrity, Check constraints	
	4.4	Data Manipulation commands, Data Control commands	
	4.5	Set and string operations, aggregate function - group by, having	
5		**Relational–Database Design**	**03**
	5.1	Concept of normalization	
	5.2	Function Dependencies	
	5.3	First Normal Form, 2NF, 3NF	
6		**Transactions Management and Concurrency and Recovery**	**03**
	6.1	Transaction Concept, Transaction states	

	6.2	ACID properties	
	6.3	Transaction Control Commands	
	6.4	Serializability: Conflict and View	
		Total	**20**

Text Books:

1. Korth, Slberchatz,Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 5th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

Reference Books:

1. Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management‖, Thomson Learning, 5th Edition.
2. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3. G. K. Gupta, Database Management Systems, McGraw Hill., 2012

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Total
ECL 301	Electronic Devices Lab	--	02	--	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 301	Electronic Devices Lab	--	--	--	--	--	25	25	50

Laboratory Objectives:

1. To deliver a hands-on approach for studying electronic devices
2. To comprehend characteristics of electronic devices; thereby understanding their behaviour
3. To analyse & calculate inherent parameters of electronic devices through experimental approach
4. To introduce modern software simulation tools for modelling & simulation of electronic devices

Laboratory Outcomes:

After successful completion of the laboratory students will be able to

1. Explain the working of semiconductor devices.
2. Interpret the characteristics of semiconductor devices.
3. Analyse electronics circuits using BJT and FET (DC & AC analysis)
4. Simulate basic circuits using electronic devices through software simulation

Term Work:

At least 6 experiments covering entire syllabus of ECC 302 (Electronic Devices) should be set to have well predefined inference and conclusion. **This must include 60% Hardware and 40% Simulation experiments.** The experiments should be student centric and attempt should be made to make the experiments meaningful and interesting. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments is given below. 70% of the experiments performed should be from this list. For the rest 30%, the course instructor has the option to set innovative experiments, from within the curriculum.

List of Hardware Experiments

Sr. No.	Experiment Name
1	To study passive (R, L, C) and active (BJT, MOSFET) components.
2	To study equipment (CRO, Function Generator, Power supply).
3	To perform characteristics of PN junction diode.
4	To perform Clippers and Clampers.
5	To perform Full wave/Bridge rectifier with LC/pi filter.
6	To perform Zener as a shunt voltage regulator.
7	To simulate VI characteristics of MEMRISTOR using nanohub.org

List of Simulation Experiments

Sr. No.	Experiment Name
1	SPICE simulation of and implementation for junction analysis
2	SPICE simulation of and implementation for BJT characteristics
3	SPICE simulation of and implementation for JFET characteristics
4	SPICE simulation of for MOSFET characteristics
5	SPICE simulation of Full wave/Bridge rectifier with LC/pi filter.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Total
ECL 302	Digital Electronics Lab	--	02	--	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 302	Digital Electronics Lab	-	-	-	-	-	25	25	50

Laboratory Objectives:

1. To learn the functionality of basic logic gates.
2. To construct combinational circuits and verify their functionalities.
3. To learn the functionality of flip flops and their conversion.
4. To design and implement synchronous and asynchronous counters, Shift registers using MSI
5. To simulate various combinational and sequential circuits and analyze the results using Verilog HDL.

Term Work:

At least 6 experiments covering the entire syllabus of ECC 303 (Digital Logic Circuits) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments meaningful and interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments is given below. 70% of the experiments performed should be from this list. For the rest 30%, the course instructor has the option to set innovative experiments, from within the curriculum.

List of Hardware Experiments

Sr. No.	Experiment Title
1	To verify different logic gates and implement basic gates using universal gates
2	To implement Boolean function in SOP and POS form
3	To implement half adder, full adder, half Subtractor, full Subtractor
4	To implement BCD adder using binary adder IC 7483
5	To implement logic equations using Multiplexer IC 74151
6	To verify truth table of SR, JK, T and D flip flops
7	To perform Flip flop conversion JK to D, JK to T and D to T flip flop
8	To implement MOD N counter using IC 7490/7492/7493
9	To implement Synchronous counter using IC 74163/74169 **OR** To implement universal shift register using IC 74194

List of Simulation/Software Experiments

Sr. No.	Experiment Title
1	To design and simulate Full adder/full subtractor using Verilog HDL
2	To design and simulate Multiplexer/Demultiplexer using Verilog HDL
3	To design and simulate decoder 74138 using Verilog HDL
4	To simulate basic flip flops using Verilog HDL
5	To design and simulate 4 bit counter / up-down counter using Verilog HDL
6	To design and simulate Shift register using Verilog HDL

Additional/ Suggested experiments (optional) - Implementation of any of above using **FPGA/CPLD**

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Total
ECL 303	Data Structures and Algorithms Lab	--	02	--	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 303	Data Structures and Algorithms Lab	--	--	--	--	--	25	25	50

Prerequisite:
C Programming Language

Laboratory Outcomes:
1. Students will be able to implement linear data structures & will be able to handle operations like insertion, deletion, searching and traversing on them.
2. Students will be able to implement nonlinear data structures & will be able to handle operations like insertion, deletion, searching and traversing on them.
3. Students will be able to choose appropriate data structure and apply it in various problem domains.
4. Students will be able to select appropriate searching techniques for given problems.

Term Work:
At least 6 experiments and 2 assignments covering entire syllabus of **Data Structures and Algorithms (ECC 304)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments meaningful and interesting. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Total 25 Marks = (Experiments-15 mark + Attendance -5 mark + Assignments-05 mark)

Suggested List of Experiments

(*) marked experiments are compulsory.

Sr. No	Experiment Name
1	*Implement Stack ADT using array
2	*Convert an Infix expression to Postfix expression using stack ADT
3	*Implement Linear Queue ADT using array
4	*Implement Singly Linked List ADT
5	*Implement Binary Search Tree ADT using Linked List
6	*Implement searching algorithms -Linear search, Binary search
7	*Implement sorting algorithms (any 2)- bubble, selection, insertion, merge,quick

Useful Links:

1. www.leetcode.com
2. www.hackerrank.com
3. www.cs.usfca.edu/~galles/visualization/Algorithms.html
4. www.codechef.com

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical		Total
ECL 304	Database Management Systems lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg, of Test 1 and Test 2					
ECL 304	Database Management Systems lab	--	--	--	--	--	25	25	50

Laboratory Outcomes:
At the end of the course the student should be able to
1. Design ER /EER diagram and convert to relational model for the realworld application.
2. Apply DDL, DML, DCL and TCL commands.
3. Write simple and complex queries
4. Use PL/SQL Constructs.
5. Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Term Work:
At least 6 experiments covering the entire syllabus of Database Management Systems (ECC 305) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make the experiments meaningful and interesting. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments is given below. 70% of the experiments performed should be from this list. For the rest 30%, the course instructor has the option to set innovative experiments, from within the curriculum.

Sr. No.	Experiment Name
1	Identify the case study and detailed statement of problem. Design an Entity-Relationship (ER)
2	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
3	Apply DML Commands for the specified system
4	Perform Simple queries, string manipulation operations and aggregate functions.
5	Implement various Join operations.
6	Perform Nested and Complex queries
7	Perform DCL and TCL commands
8	Demonstrate Database connectivity

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 305	Skill-based Lab OOPM	--	02* + 02	--	--	02	--	02
* Theory class to be conducted for full class								

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 305	Skill-based Lab OOPM	--	--	--	--	--	50	--	50

Course Pre-requisites:

- Fundamentals of C-Programming
- Control Structures
- Arrays and String

Course Objectives:

1. To understand Object Oriented Programming basics and its features.
2. To understand and apply Object Oriented Programming (OOP) principles
3. Able to implement Methods, Constructors, Arrays, Multithreading and Applet in java
4. Able to use a programming language to resolve problems.

Course Outcomes:

After successful completion of the course student will be able to

1. Use different control structures.
2. Understand fundamental features of an object-oriented language: object classes and interfaces, exceptions and libraries of object collections.
3. Understand Java Programming.
4. To develop a program that efficiently implements the features and packaging concept of java in laboratory.
5. To implement Exception Handling and Applets using Java.

Module No	Unit No.	Contents	Hrs.
1		**Introduction to Java**	**06**
	1.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based. Difference between C++ and Java.	
	1.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
2		**Inheritance, Polymorphism, Encapsulation using Java**	**12**
	2.1	**Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize () method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java.	
	2.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
3		**Exception Handling and Applets in Java**	**06**
	3.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception subclasses).	
	3.2	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	**24**

Textbooks:

1. Bjarne Stroustrup, “The C++ Programming language”, Third edition, Pearson Education, 2000.
2. Deitel, “C++ How to Program”, 4th Edition, Pearson Education, 2005.
3. D. T. Editorial Services, “Java 8 Programming Black Book”, Dreamtech Press, Edition, 2015.
4. Yashwant Kanitkar, “Let Us Java”, BPB Publications, 4nd Edition, 2019.

Reference Books:

1. Herbert Schidt, "The Complete Reference", Tata McGraw-Hill Publishing Company Limited, 10th Edition, 2017.
2. Harvey M. Deitel, Paul J. Deitel, Java: How to Program, 8th Edition, PHI, 2009.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, "The Unified Modeling Languageser Guide", Pearson Education.
4. Sachin Malhotra, Saurabh Chaudhary "Programming in Java", Oxford University Press, 2010

Software Tools:

1. Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/
2. Eclipse: https://eclipse.org/
3. Netbeans:https://netbeans.org/downloads/
4. CodeBlock:http://www.codeblocks.org/
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Suggested list of Experiments

Sr. No.	JAVA Programs
1	Display addition of number
2	Accept marks from user, if Marks greater than 40, declare the student as "Pass" else "Fail""
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor

13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Term Work:

At least 8 experiments covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.
The experiments should be students centric and attempt should be made to make experiments meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student, with experiments graded from time to time.

The grades will be converted to marks as per "**Choice Based Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on the entire syllabus. Students are encouraged to share their experiment codes on online repository. Practical exam slip should cover all 16 experiments for examination.

Course code	Course Name	Credits
ECM 301	Mini Project 1 A	02

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM 301	Mini Project- 1A	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.
- **Students must take up a project spanning Semester 3 and Semester 4. It is expected that in Semester 3, Literature Survey and Problem formulation is completed and a concise report of the same is submitted. In Semester 4, Implementation of the project followed by report is expected.**

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing

- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication