University of Mumbai

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Academic Authorities,
Meetings &Services (AAMS)
Room No. 128, M. G. Road, Fort,
Mumbai – 400 032.
Tel. 022-68320033

Re- accredited with A ++ Grade (CGPA 3.65) by NAAC
Category- I University Status awarded by UGC

No.AAMS_UGS/ICC/2024-25/227 Date: 6th February, 2025

CIRCULAR:-

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments is invited to this office Circular No. UG/47 of 2021 dated 21st January, 2021 relating to the revised syllabus as per (CBCGS) for Bachelor of Engineering (Electrical Engineering).

They are hereby informed that the recommendations made by the **Board of Studies in Electrical Engineering** at its meeting held on 28th November, 2024 and subsequently passed by the Board of Deans at its meeting held on 30th November, 2024 **vide** item No. 6.8 have been accepted by the Academic Council at its meeting held on 4th December, 2024 **vide** item No. 6.38 (R) and in accordance therewith revised Scheme syllabus of B.E. (Electrical & Computer Engineering) (Sem IV) (R-2019) was approved as per appendix from the academic year 2024-25.

(The Circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
06th February, 2025

(Dr. Prasad Karande)
REGISTRAR

To

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments.

AC./6.38(R)/04/12/2024

Copy forwarded with Compliments for information to:-

1) The Chairman, Board of Deans,
2) The Dean, Faculty of Science & Technology,
3) The Chairman, **Board of Studies in Electrical Engineering**
4) The Director, Board of Examinations and Evaluation,
5) The Director, Department of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Director, Centre for Distance and Online Education (CDOE) Vidyanagari,
8) The Deputy Registrar, Admission, Enrolment, Eligibility & Migration Department (AEM),

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentar@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), dlleuniversityofmumbai@gmail.com

Copy for information :-	
1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

To,

1	The Chairman, Board of Deans pvc@fort.mu.ac.in
2	**Faculty of Humanities,** **Dean** 1. Prof.Anil Singh Dranilsingh129@gmail.com **Associate Dean** 2. Dr.Suchitra Naik Naiksuchitra27@gmail.com 3.Prof.Manisha Karne mkarne@economics.mu.ac.in
	Faculty of Commerce & Management, **Dean** 1. Dr.Kavita Laghate kavitalaghate@jbims.mu.ac.in **Associate Dean** 2. Dr.Ravikant Balkrishna Sangurde Ravikant.s.@somaiya.edu 3. Prin.Kishori Bhagat kishoribhagat@rediffmail.com

	Faculty of Science & Technology **Dean** 1. Prof. Shivram Garje ssgarje@chem.mu.ac.in **Associate Dean** 2. Dr. Madhav R. Rajwade Madhavr64@gmail.com 3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies, **Dean** 1.Dr. Anil K. Singh aksingh@trcl.org.in **Associate Dean** 2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
5	The Director, Board of Students Development, dsd@mu.ac.in DSW direcotr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology, director.dict@mu.ac.in

AC – 4/12/2024
Item No. – 6.38

University of Mumbai

Revised Syllabus for
B.E. (Electrical and Computer Engineering)

Syllabus for

Semester – Sem. IV

(Revised – 2019 ‘C’ Scheme)

(with effect from the academic year 2024–2025)

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

University of Mumbai

Sr. No.	Heading	Particulars
1	Title of program O:_____	B.E. (Electrical and Computer Engineering)
2	Eligibility for Admission O: _____	After Passing First Year Engineering as per the University Ordinance
3	Standards of Passing R: _____	40%
4	Semesters	Sem. IV
5	Program Academic Level	U.G.
6	Pattern	Semester
7	Status	Revised 2019 'C' Scheme
8	To be implemented from Academic Year	With effect from Academic Year 2024-25

Sd/-

BoS-Coordinator
Dr. B. R. Patil
Electrical Engineering
Faculty of Science & Technology
University of Mumbai

Offg. Associate Dean
Dr. Deven Shah
Faculty of Science and Technology
University of Mumbai

Offg. Dean
Prof. Shivram S. Garje
Faculty of Science and Technology
University of Mumbai

Program Structure for Second Year Electrical and Computer Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2024-25)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELCC401	Engineering Mathematics - IV	3	-	1	3	-	1	4
ELCC402	Data Structures and Algorithms	3	-	-	3	-	-	3
ELCC403	Power Electronic Devices and Circuits	3	-	-	3	-	-	3
ELCC404	Database Management Systems	3	-	-	3	-	-	3
ELCC405	Discrete Structures and Automata Theory	3	-	-	3	-	-	3
ELCL401	Data Structures and Algorithms Lab		2			1		1
ELCL402	Electronics Lab- II	-	2	-	-	1	-	1
ELCL403	Database Management Systems lab	-	2	-	-	1	-	1
ELCL404	Skill-based Lab: *Python programming*	-	4	-	-	2	-	2
ELCM401	Mini-project -1 B	-	4$	-	-	2	-	2
	Total	15	14	1	15	7	1	23

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

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test I	Test II	Avg.					
ELCC401	Engineering Mathematics - IV	20	20	20	80	03	25	-	125
ELCC402	Data Structures andAlgorithms	20	20	20	80	03	-	-	100
ELCC403	Power Electronic Devices and Circuits	20	20	20	80	03	-	-	100
ELCC404	Database Management Systems	20	20	20	80	03	-	-	100
ELCC405	Discrete Structures and Automata Theory	20	20	20	80	03	-	-	100
ELCL401	Data Structures andAlgorithms Lab	-	-	-	-	-	25	25	50
ELCL402	Electronics Lab-II	-	-	-	-	-	25	25	50
ELCL403	Database Management Systems lab	-	-	-	-	-	25	25	50
ELCL404	Skill-based Lab: *Python programming*	-	-	-	-	-	50	-	50
ELCM401	Mini-project -1 B	-	-	-	-	-	25	25	50
	Total	-	-	100	400	-	175	100	775

Note:

<u>Students group and load of faculty per week</u>.

Mini-Project 1A / 1B: Students can form groups with minimum 3 (Three) and not more than 4(Four)

Faculty Load: 1 hour per week per four groups

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Pract.	Tut.	Total
ELCC401	**Engineering Mathematics - IV**	**03**	**--**	**01**	**03**	**--**	**01**	**04**

Examination Scheme								
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**25**	**-**	**-**	**125**

Pre-requisite:
Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mathematics - III, Binomial Distribution.

Course Objectives	**The course is aimed;** 1. To study the line and contour integrals and expansion of complex valued function in a power series. 2. To understand the basic techniques of statistics for data analysis, Machine learning and AI. 3. To study the probability distributions and expectations. 4. To acquaint with the concepts of vector spaces used in the field of machine learning and engineering problems. 5. To familiarize with the concepts of Quadratic forms and Singular value decomposition. 6. To learn the concepts of Calculus of Variations.
Course Outcomes	**On successful completion of course, learner will be able to;** 1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals. 2. Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI. 3. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities. 4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems. 5. Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications. 6. Find the extremals of the functional using the concept of Calculus of variation.

Module	Detailed Contents	Hrs.

1	**Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of *f (z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations, Z- Transform.	7
2	**Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6
3	**Probability Distributions** 3.1. Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
4	**Linear Algebra: Vector Spaces** 4.1 Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**: - Linear combinations, linear Dependence and Independence, QR decomposition.	6
5	**Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value- class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	7

6	**Calculus of Variations:** 6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x,y,y'. 6.2 Isoperimetric problems-Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:**-Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action, Several dependent variables.	6

Total	**39**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. 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.

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

Assessment:

Internal Assessment:

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 second class test (Internal Assessment-II) when additional 40% (approx.) 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 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 number of respective lecture hours as mentioned in the syllabus.

Reference Books:

1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S. Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's Outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication, 43rd edition, 2010.

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total

ELCC402	**Data Structures and Algorithms**	**03**	**-**	**-**	**03**	**-**	**-**	**03**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Prerequisite:

C Programming

Course Objectives	**The course is aimed;** 1. To understand and demonstrate basic data structures (such as Arrays, linked list, stack, queue, binary tree, and 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 nonlinear 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. Analyze the complexity of the given algorithms.

Module	Detailed Contents	Hrs.
1	**Introduction to Data Structures** Introduction to Data Structures, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of array, Static arrays vs. Dynamic Arrays, structures. Introduction to Analysis of Algorithms, characteristics of algorithms, Time and Space complexities, Asymptotic notations.	04
2	**Stack and Queues** Introduction, Basic Stack Operations, Representation of a Stack using Array, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation. Queue, Operations on Queue, queue-Round Robin Algorithm.	08
3	**Linked List** 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, reversal of SLL, Print SLL. Implementation of Stack and Queue using Singly Linked List. Introduction to Do Representation of a Queue using array, Circular Queue, concept of priority Queue, Applications of Qubly Linked List and Circular Linked List	08
4	**Trees** Introduction, Tree Terminologies, Binary Tree, Types of Binary Tree, Representation of Binary Trees, Binary Tree Traversals, Binary Search Tree Operations on Binary Search Tree, Applications of Binary Tree – Expression Tree, Huffman Encoding.	08
5	**Graphs** Introduction, Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting.	04
6	**Introduction to Sorting and Searching** Introduction to Searching: Linear search, Binary search, Sorting: Internal VS. External Sorting, Sorting Techniques: Bubble, Insertion, selection, Quick Sort, Merge Sort, Comparison of sorting Techniques based on their complexity. Hashing Techniques, Different Hash functions, Collision & Collision resolution techniques: Linear and Quadratic probing, Double hashing.	07
Total		**39**

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.

Assessment:
Internal Assessment (IA):

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 second class test (Internal Assessment II) when additional 40% (approx..) 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 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 number of respective lecture hours as mentioned in the syllabus.

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
ELCC403	**Power Electronic Devices and Circuits**	**03**	**-**	**-**	**03**	**-**	**-**	**03**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Objectives	**The course is aimed:** 1. To impart knowledge about various power semiconductor devices related to its characteristics, ratings, protection and facilitate selection of semiconductor devices for various applications. 2. To introduce different power conversion topologies such as ac to dc, dc to dc, dc to ac and the underlying principles of converter operation aiding to analyze their performance. 3. To keep abreast with the latest technologies and research going on in different domains related to power electronics.
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Understand the basic operation and characteristics of various semi controllable and fully controllable devices 2. Analyze various single phase and three phase power converter circuits and understand their applications. 3. Analyze dc to dc converter circuits and their applications. 4. Identify and describe various auxiliary circuits and requirements in power electronics applications such as gate driver circuit, snubber circuits and heat sinks. 5. Apply the basic concepts to select devices and converters for various applications

Module	Detailed Content	Hrs.
1	**Thyristors:** Basic operation of silicon controlled rectifier, Static characteristics, two transistor analogy, Dynamic characteristics, Firing circuits (R,RC, Ramp triggering using UJT), Commutation circuits, Protection circuit of SCR. **Self-study topic**: Other devices of Thyristor family	**07**
2	**Power semiconductor devices:** Basic operation and characteristics of power diodes, power BJTs, power MOSFETs, IGBTs, Safe Operation Area (SOA) for each devices, Silicon Carbide (SiC) and GaN devices, Comparison of devices, selection of devices for various applications, Conduction and switching losses.	**06**

3	**Controlled Rectifiers:** Single phase half wave &full wave rectifiers (mid-point and bridge configuration) for R and R-L load, freewheel diode, Rectification and inversion mode of single phase fully controlled rectifier, single phase dual converter, Three phase semi converter and full converter with R load, Applications, calculation of output voltage, single phase PWM rectifier, basic working principle and applications.	**08**
4	**Inverter:** Classification based on source and power level, Single phase bridge Inverters (VSI), Performance parameters, Three phase VSI (120° and 180° conduction mode), Voltage control of single phase inverters- PWM techniques-Single PWM, Multiple PWM, Sinusoidal PWM, Basics of Space vector modulation, Single phase current source inverters (CSI), comparison of VSI and CSI.	**06**
5	**DC to DC Converter**: Introduction, Switching mode regulators – Buck, Boost, Buck-Boost, bidirectional dc to dc converters, all with resistive load and only CCM mode, Applications: Power Factor Correction Circuits, LED lamp driver.	**07**
6	**Auxiliary Circuits**: Types of drivers-level shifters, bootstrap drivers, isolated drivers, Gate Drive circuitry for Power Converters, methods of current and voltage measurement, snubber circuits and heat sinks.	**05**
Total		**39**

Assessment:

Internal Assessment (IA):

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 second class test (Internal Assessment II) when additional 40% (approx.) 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 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 number of respective lecture hours as mentioned in the syllabus.

Books Recommended:

Text Books:

1. M. H. Rashid, *Power Electronics: Circuits, Devices, and Applications*, Pearson Education, 2009.
2. N. Mohan and T. M. Undeland, *Power Electronics: Converters, Applications and Design*, John Wiley & Sons, 2007.
3. R.W. Erickson and D. Maksimovic, *Fundamentals of Power Electronics*, Springer Science & Business Media, 2007.
4. L. Umanand, *Power Electronics: Essentials and Applications*, Wiley India, 2009.

5. P.C Sen., *Modern Power Electronics*, Wheeler publishing Company, 1st Edition, 2005
6. Alok Jain, *Power Electronics: Devices, Circuits and Matlab Simulations*, Penram Int. 2010

Reference Books:

1. C.W. Landers, *Power Electronics*, McGraw Hill, 1993
2. Ashfaq Ahmed, *Power Electronics for Technology*, Pearson, 1998
3. Joseph Vithayathil, *Power Electronics*, Tata McGraw hill, 1995.
4. P. Friedrichs, T. Kimoto, L. Ley and G. Pensl, *Silicon Carbide, Volume 2: Power Devices and Sensors*, Wiley Publications, 2011.
5. Dokić, Branko L. and Blanuša, Branko, *Power Electronics Converters and Regulators* Springer International Publishing, 2015

NPTEL/ Swayam Course:

1. **Course: Advance Power Electronics And Control** – Prof. Avik Bhattacharya (IIT Roorkee)
https://nptel.ac.in/courses/108/107/108107128/

2.**Course: Power Electronics** - Prof. G. Bhuvaneshwari (IIT Delhi)
https://swayam.gov.in/nd1_noc20_ee97/preview

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELCC404	**Database Management Systems**	**03**	**--**	**--**	**03**	**--**	**--**	**03**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Objectives	**The course is aimed:** 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		Detailed Content	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**	07
	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	
	2.4	Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	
3		**Relational Model and Relational Algebra**	06
	3.1	Introduction to the Relational Model	
	3.2	Relational schema and concept of keys	
	3.3	Mapping the ER and EER Model to the Relational Model	
	3.4	Relational Algebra – operators, Relational Algebra Queries.	
4		**Structured Query Language (SQL)**	06
	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	
	4.6	Views in SQL, joins, Nested and complex queries, Triggers	
5		**Relational–Database Design**	07
	5.1	Pitfalls in Relational-Database designs	

	5.2	Concept of normalization	
	5.3	Function Dependencies	
	5.4	First Normal Form, 2NF, 3NF, BCNF.	
6		**Transactions Management and Concurrency and Recovery**	10
	6.1	Transaction Concept, Transaction states	
	6.2	ACID properties	
	6.3	Transaction Control Commands	
	6.4	Concurrent Executions	
	6.5	Serializability: Conflict and View	
	6.6	Concurrency Control: Lock-based, Timestamp-based protocols	
	6.7	Recovery System: Log based recovery	
	6.8	Deadlock handling	
	Total		**39**

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

Assessment:
Internal Assessment (IA):

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 second class test (Internal Assessment II) when additional 40% (approx.) 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 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 number of respective lecture hours as mentioned in the syllabus.

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELCC405	**Discrete Structures and Automata Theory**	**03**	**-**	**--**	**03**	**-**	**--**	**03**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Prerequisite:

Engineering Mathematics - I, II & III

Course Objectives	**The course is aimed:** 1. To cultivate clear thinking for Creative Problem Solving. 2. To train students to understand and construct Mathematical Proofs. 3. To introduce the notions of Sets, Relations, Functions, Graphs and their applications. 4. To build concepts of theoretical design of Basic machines, Deterministic and Non Deterministic Finite state machines and Pushdown Machines. 5. To gain the conceptual understanding of fundamentals of Grammars. 6. To prepare students with the mathematical aspects in other courses such as Formal Specification, Verification, Artificial Intelligence etc.
Course Outcomes	**After successful completion of the course students will be able to:** 1. Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving. 2. Reason Logically. 3. Perform operations with Sets, Relations, Functions, Graphs and their applications. 4. Design Deterministic Finite Automata (DFA) and Non-deterministic Finite Automata (NFA) and Pushdown Automata with understanding of power and limitations 5. Design Context Free Grammar and perform the operations like simplification and normal forms 6. Apply Discrete Structures and Automata Theory concepts into solving real world computing problems in the domain of Formal

Module		Detailed Contents	Hrs
1		**Set Theory and Logic**	06
	1.1	Set Theory: Fundamentals - Sets and Subsets, Venn Diagrams, Operations on sets, Laws of Set Theory, Power Set,	
	1.2	Principle of Inclusion and Exclusion, Mathematical Induction.	
	1.3	Propositions and Logical operations, Truth tables, Equivalence, Implications	
	1.4	Laws of Logic, Normal Forms, Inference	
	1.5	Predicates and Quantifiers	
2		**Relations and Functions**	07
	2.1	Relations- Definition, Properties of Relations	
	2.2	Types of binary relations (Equivalence and partial ordered relations),	
	2.3	Closures, Poset, Hasse diagram and Lattice	
	2.4	Functions-Definition, Types of Functions (Injective, Surjective and Bijective)	
	2.5	Identity and Inverse Functions	
	2.6	Pigeonhole Principle, Extended Pigeonhole Principle	
3		**Graph Theory**	07
	3.1	Graphs and their basic properties - degree, path, cycle, subgraphs, Types of graphs.	
	3.2	Definitions, Paths and circuits: Eulerian and Hamiltonian, Planner Graph.	
	3.3	Isomorphism of graphs, Dijkstra Shortest Path Algorithm	
	3.4	Trees, Types of Trees	
4		**Finite Automata**	07
	4.1	Introduction of Automata and its applications	
	4.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, NFA to DFA Conversion.	
	4.3	Eliminating epsilon-transitions from NFA.	
	4.4	FSM with output: Moore and Mealy machines.	
5		**Regular Expression (RE) and Regular Grammar (RG)**	05
	5.1	Regular Grammar and Regular Expression (RE): Definition, Equivalence and Conversion from RE to RG and RG to RE.	
	5.2	Equivalence of RE and FA, Converting RE to FA and FA to RE.	
6		**Context Free Grammar (CFG) and Push Down Automata(PDA)**	07
	6.1	Grammars: Chomsky hierarchy, CFG- Definition, Sentential forms, Leftmost and Rightmost derivations.	
	6.2	Context Free languages (CFL): Parsing and Ambiguity. CFLs: Simplification and Applications.	
	6.3	Normal Forms: Chomsky Normal Form	
	6.4	PDA- Definition, Transitions (Diagrams, Functions and Tables), Design of PDA with Graphical Notation and Instantaneous Descriptions.	
Total			**39**

Text Books:

1. BernadKolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "DiscreteMathematical Structures", Pearson Education.
2. C.L.Liu, "Elements of Discrete Mathematics", Second edition 1985, McGraw-HillBook Company, Reprinted 2000.
3. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, "Introduction to Automata Theory, Languages andComputation‖", Pearson Education.
4. Vivek Kulkarni, "Theory of Computation", Oxford University Press, India.

Reference Books:

1. K.H.Rosen, "Discrete Mathematics and applications", fifth edition 2003, Tata McGraw Hill publishing Company.
2. Y N Singh, "Discrete Mathematical Structures", Wiley-India.
3. J .L.Mott, A.Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, second edition 1986, Prentice Hall of India.
4. J. P. Trembley, R. Manohar "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill.
5. Seymour Lipschutz, Marc Lars Lipson," Discrete Mathematics" Schaum's Outline, McGraw Hill Education.
6. Daniel I. A. Cohen," Introduction to Computer Theory", Wiley Publication.
7. Michael Sipser, "Theory of Computation", Cengage learning.
8. J. C. Martin, "Introduction to Languages and the Theory of Computation", Tata McGraw Hill.
9. Krishnamurthy E. V., "Introductory Theory of Computer Science", East-West Press.
10. Kavi Mahesh, "Theory of Computation: A Problem Solving Approach", Wiley-India.

Assessment:
Internal Assessment (IA):

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 second class test (Internal Assessment II) when additional 40% (approx.) 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 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 number of respective lecture hours as mentioned in the syllabus.

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELCL401	**Data Structures and Algorithms Lab**	**--**	**02**	**--**	**--**	**01**	**--**	**01**

Examination Scheme							
Theory							**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Practical & Oral	
Test-I	Test-II	Average					
--	**--**	**--**	**-**	**--**	**25**	**25**	**50**

Prerequisite:
C Programming Language
Lab Objectives:
1.To implement basic data structure such as arrays, linked lists, stacks and queues
2 Solve problem involving graphs and trees
3.To develop application using data structure algorithms

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

- **Term Work:**

At least 10 experiments and 2 assignments covering entire syllabus of **Data Structures and Algorithms (ELCC402)** 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.

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

- **Oral & Practical exam:** Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	*Implement Stack ADT using array
2	*Convert an Infix expression to Postfix expression using stack ADT
3	Evaluate Postfix Expression using Stack ADT
4	Check whether parentheses are balanced or not.
5	*Implement Linear Queue ADT using array
6	Implement Circular Queue ADT using array
7	Implement Priority Queue ADT using array
8	*Implement Singly Linked List ADT
9	Implement Doubly Linked List ADT
10	*Implement Stack ADT using Linked List
11	*Implement Linear Queue ADT using Linked List
12	*Implement Binary Search Tree ADT using Linked List
13	*Implement Depth First Search and Breadth First Search Graph Traversal technique
14	*Implement searching algorithms -Linear search, Binary search
15	*Implement sorting algorithms (any 2)- bubble, selection, insertion, merge, quick

(*) marked experiments are compulsory.

Useful Links:

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

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	**Practical**	**Tutorial**	**Theory**	**Pract.**	**Tutorial**	**Total**
ELCL402	**Electronics Lab II**	**--**	**02**	**--**	**--**	**01**	**--**	**01**

Examination Scheme							
Theory Marks					Term Work	Practical & Oral	Total
Internal Assessment			End Sem. Exam	Exam duration Hours			
Test 1	Test 2	Average					
--	**-**	**--**	**--**	**--**	**25**	**25**	**50**

Course Objectives	**The course is aimed:** 1. To impart knowledge about various power semiconductor devices related to its characteristics, ratings, protection and to select semiconductor devices for various applications. 2. To introduce different methods of power conversion such as ac to dc, dc to dc, dc to ac the underlying principles of converter operation and hence to analyze different converter circuits for power conversion. 3. To keep abreast with the latest technologies and research going on in different areas related to power electronics
Course Outcomes	**Upon successful completion of this course, the learner will be able to** 1. Student will be able to o Draw V-I characteristics of power electronic devices. 2. Simulate the performance of power electronic conversion systems. . 3. Analyze various single phase and three phase power converter circuits and understand their applications. . 4. Apply the basic concepts of power electronics to design the circuits in the fields of AC and DC drives, power generation and transmission and energy conversion, industrial applications. , 5. Identify and describe various auxiliary circuits and requirements in power electronics applications such as Gate driver circuit, and snubber circuits along with electrical isolation and heat sinks

Syllabus: Same as that of Course ELCC403-**Power Electronics Devices and Circuits.**

Suggested List of Laboratory Experiments.

1. Study of I-V characteristics of Thyristors (SCR/Triac)
2. Study of switching characteristics of Power BJT/ Power MOSFET/ IGBT
3. Implementation of Single phase Half wave and Full wave rectifiers
4. Study of single phase PWM rectifier
5. Implementation and testing of SPWM VSI.
6. Design of IGBT gate drivers circuit
8. Design and Implementation of DC-DC Buck converter Design and Implementation of DC-DC Boost converter
9. Implementation and testing of LED driver circuit
10. Study of current and voltage measurement circuits in switching converters
11. Study of Analog to Digital Converter

Any other experiments based on syllabus which will help students to understand topic/concept.

Note:

Students and teachers are encouraged to use the 'Virtual Labs' (an MHRD Govt. of India Initiative) whose links are as given below. The remote-access to Labs in various disciplines of Science and Engineering is available. Students can conduct experiments which would help them in learning basic and advanced concepts through remote experimentation.

Virtual Lab Website Reference

1. http://vlab.co.in/broad-area-electrical-engineering
2. http://vlab.co.in/broad-area-electronics-and-communications

Term work:

Term work shall consist of minimum six experiments and at least four simulations. The distribution of marks for term work shall be as follows:

Laboratory Performance : 10 marks
Journal : 10 marks
Attendance : 05 marks

The final certification and acceptance of term work ensures the minimum passing in the term work.

Practical and Oral Examination:

Practical will be based on all the laboratory experiments carried out and Oral examination will be based on entire syllabus of ELCC403 - Power Electronics Devices and Circuits

The distribution of marks for practical examination shall be as follows:

Practical Exam : 15 marks
Oral Exam : 10 marks

Electrical and Computer Engineering-Semester-IV								
Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical		Total
ELCL403	**Database Management Systems Lab**	**--**	**02**	**--**	**--**	**01**	**--**	**01**

Examination Scheme							
Theory Marks					**Term Work**	**Practical and Oral**	**Total**
Internal assessment			**End Sem. Exam**	**Exam duration Hours**			
Test 1	**Test 2**	**Average**					
--	**--**	**--**	**--**	**--**	**25**	**25**	**50**

Lab Objectives:

1. To explore design and develop of relational model
2. To present SQL and procedural interfaces to SQL comprehensively
3. introduce the concepts of transactions and transaction processing

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 real world application.
2. Apply DDL, DML, DCL and TCL commands.
3. Write simple and complex queries
4. Use PL/SQL Constructs.

- **Term Work:**

At least 10 experiments covering the entire syllabus of Database Management Systems **(ELCC404)** 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.

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

- **Oral & Practical exam**: Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement various Join operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands
9	Implement procedure and functions
10	Implementation of Views and Triggers.
11	Demonstrate Database connectivity
12	Implementation and demonstration of Transaction and Concurrency control techniques using locks.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Electrical and Computer Engineering-Semester-IV								
Course Code	**Course Name**	**Teaching Scheme**			**Credits Assigned**			
	Skill Base Lab: *Python Programming*	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ELCL 404		**--**	**01[$] + 03**	**--**	**--**	**02**	**--**	**02**
$ One-hour theory per week for the complete class. (For simplifying its implementation, 2hrs. theory on alternate weeks can be conducted)								

Examination Scheme							
Theory Marks					**Term Work**	**Practical and Oral**	**Total**
Internal Assessment			**End Sem. Exam**	**Exam duration Hours**			
Test 1	**Test 2**	**Average**					
--	**--**	**--**	**--**	**--**	**50**	**--**	**50**

Prerequisite: Basic Programming syntax of Java/C.

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes:

After successful completion of the course student will be able to;

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object-oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python.

Module No.		**Content**	**Hrs.**
1		**Introduction to Python**	06
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python.	

	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements.	
2		**Functions and File I/O Handling**	06
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, with keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3		**Object Oriented Programming**	08
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4		**Graphical User Interface and Image processing**	08
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqilite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Data frame, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	
6		**Python Applications**	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor	
	6.5	Support Vector Machines	
Total			**48**

Text Books:

1. Yashvant Kanetkar, "Let us Python: Python is Future, Embrace it fast", BPB Publications; 1st edition (8 July 2019).
2. Dusty Phillips, "Python 3 object-oriented Programming", Second Edition PACKT Publisher, August 2015.
3. John Grayson, "Python and Tkinter Programming", Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python, E Balagurusamy, McGraw Hill Education

Reference books:

1. Eric Matthes, “Python Crash Course A hands-on, Project Based Introduction to programming” No Starch Press; 1st edition (8 December 2015).
2. Paul Barry, “Head First Python” O′Reilly; 2nd edition (16 December 2016)
3. Zed A. Shaw, “Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly
4. Beautiful World of Computers and Code”, Addison Wesley; 3rd edition (1 October 2013).
5. Andreas C. Mueller, “Introduction to Machine Learning with Python”, O’Reilly; 1st edition (7 October 2016)
6. David Beazley, Brian K. Jones, “Python Cookbook: Recipes for Mastering Python 3”, O'Reilly Media; 3rd edition (10 May 2013).
7. Bhaskar Chaudhary, “Tkinter GUI Application Development Blueprints: Master GUI
8. Programming in Tkinter as you design, implement, and deliver 10 real world application”, Packt Publishing (November 30, 2015)

Software Tools:

- Python IDE: https://www.python.org/downloads/
- Anaconda Environnent: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/
3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation: https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

Sr. No.	Problem Statement	Module No.
1	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures. 4. Assume a suitable value for distance between two cities (in km). 5. Write a program to convert and print this distance in meters, feet, inches and centimeter. 6. Write a program to carry out the following operations on the given set 7. s = {10, 2, -3, 4, 5, 88} a) Number of items in sets s b) Maximum element in sets s c) Minimum element in sets s	Module 1

	d) Sum of all elements in sets s e) Obtain a new sorted set from s, set s remaining unchanged f) Report whether 100 is an element of sets s g) Report whether -3 is not an element of sets	
2	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. 3. Generate and print a list of tuples containing name, age and salary from the 3 lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center- justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number entered through the keyboard 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write a recursive function to calculate sum of digits of 5-digit number.	Module 3
4	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain a. individual histograms. 4. Write Python program for histogram equalization 5. Write Python Program for edge detection 6. Write Python Program for image segmentation 7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	Module 4
5	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: a) Find and print the name of the country with the highest GDP b) Find and print the name of the country with the lowest GDP c) Print text and input values iteratively d) Print the entire list of the countries with their GDPs e) Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a) View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, fatal flag b) Clean the dataset and replace the fatal flag NaN with “No”. c) Find the aircraft types and their occurrences in the dataset d) Remove all the observations where aircraft names are not available e) Display the observations where fatal flag is “Yes”	Module 5

	5. Analyze the "auto mpg data" and draw a pair plot using seaborn library for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 6. Write python program to use SciPy to solve a linear algebra problem. 7. There is a test with 30 questions worth 150 marks. The test has two types of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions	
6	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server	Module 6

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

Note:

Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:

At least 12 experiments and 1 course project should be performed. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Electrical and Computer Engineering-Semester-IV		
Course Code	**Course Name**	**Credits**
ELCM 401	**Mini Project - 1B**	**02**

Examination Scheme							
Theory Marks					Term Work	Practical/ Oral	Total
Internal Assessment			End Sem. Exam	Exam duration Hours			
Test 1	Test 2	Average					
--	--	--	--	--	25	25	50

Course 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.
Course 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. Analyze 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.

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.

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 finalization of problem
    - Second shall be on finalization of proposed solution of problem.
- In second semester expected work shall be procurement of components/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 finalization 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.

<u>Guidelines for Assessment of Mini Project Practical/Oral Examination:</u>

- 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 organizations 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 the 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.

Sd/-
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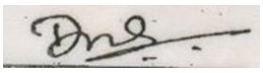

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