University of Mumbai

वेबसाईट – mu.ac.in
ईमेल - आयडी - dr.aams@fort.mu.ac.in
aams3@mu.ac.in

विद्याविषयक प्राधिकरणे
सभा आणि सेवा विभाग(ए.ए.एम.एस)
रूम नं. १२८ एम.जी.रोड, फोर्ट,
मुंबई – ४०० ०३२
टेलिफोन नं. – ०२२ – ६८३२००३३

(नॅक पुनर्मूल्यांकनाद्वारे ३.६५ (सी.जी.पी.ए.) सह अ++ श्रेणी
विद्यापीठ अनुदान आयोगाद्वारे श्रेणी १ विद्यापीठ दर्जा)

क्र.वि.प्रा.स.से./आयसीडी/२०२५-२६/३७ दिनांक : २७ मे, २०२५

परिपत्रक:-

सर्व प्राचार्य/संचालक, संलग्नित महाविद्यालये/संस्था, विद्यापीठ शैक्षणिक विभागांचे संचालक/ विभाग प्रमुख यांना कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण २०२० च्या अमंलबजावणीच्या अनुषंगाने **शैक्षणिक वर्ष २०२५-२६** पासून **पदवी व पदव्युत्तर अभ्यासक्रम** विद्यापरिषदेच्या दिनांक २८ मार्च २०२५ व २० मे, २०२५ च्या बैठकीमध्ये मंजूर झालेले सर्व अभ्यासक्रम मुंबई विद्यापीठाच्या www.mu.ac.in या संकेत स्थळावर NEP २०२० या टॅब वर उपलब्ध करण्यात आलेले आहेत.

मुंबई – ४०० ०३२
२७ मे, २०२५

(डॉ. प्रसाद कारंडे)
कुलसचिव

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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
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11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
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13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
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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

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	Faculty of Science & Technology **Offg. Dean** 1. Prof. Shivram Garje ssgarje@chem.mu.ac.in **Offg. Associate Dean** 2. Dr. Madhav R. Rajwade Madhavr64@gmail.com 3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies, **Offg. Dean** 1.Dr. Anil K. Singh aksingh@trcl.org.in **Offg. Associate Dean** 2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com 3. Dr. Kunal Ingle drkunalingle@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 – 20/5/2025
Item No. –6.39 (N)

As Per NEP 2020

University of Mumbai

Syllabus for Major Vertical – 1, 4, 5 & 6		
Name of the Programme – B.E. (Data Science)		
Faulty of Engineering		
Board of Studies in Computer Science and Engineering (Data Science)		
U.G. Second Year Programme	**Exit Degree**	**U.G. Diploma in Data Science.**
Semester		**III**
From the Academic Year		**2025-26**

University of Mumbai

(As per NEP 2020)

Sr.No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.E. (Data Science)**
2	**Exit Degree**	**U.G. Diploma in Data Science.**
3	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	**Standards of Passing** **R: _____**	**40%**
5	**Credit Structure** **R. TEU-605C** **R. TEU-605D**	**Attached herewith**
6	**Semesters**	**Sem. III**
7	**Program Academic Level**	**5.00**
8	**Pattern**	**Semester**
9	**Status**	**New**
10	**To be implemented from Academic Year**	**2025-26**

Sd/-	**Sd/-**	**Sd/-**
Dr. Subhash K. Shinde	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS Chairman, Computer Engineering	**Associate Dean**	**Dean**
Faculty of Science & Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

Preamble

To meet the challenge of ensuring excellence and NEP 2020 policy in engineering education, the issue of quality needs to be addressed, debated, and taken forward systematically. Accreditation is the principal means of quality assurance in higher education. The major emphasis of the accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of the University of Mumbai has taken the lead in incorporating the philosophy of NEP 2020 education in the process of curriculum development.

The second-year engineering course is a core training program to impart scientific and logical thinking training to learners in general, with a choice of course selection from the program core course, multidisciplinary minor, and vocational skill-enhanced course. Simultaneously, the objectives of NEP 2020 demand nurturing the core program and skills required for the Computer Science and Engineering (Data Science) Branch of engineering in the learner. Keeping this in view, a pool of courses is offered in Core Courses covering fundamentals required to understand core and modern engineering practices and emerging trends in technology. Considering the shift in pedagogy and the convenience of a stress-free learning process, a choice-based subject pool is offered in the coursework under the heads of Computer Science and Engineering (Data Science) in Engineering for open electives and multidisciplinary minor courses in the third and fourth semesters. Essentially, to give a glimpse of trends in the industry under vocational and enhanced skill practices, the pool is offered to nurture and develop creative skills in contemporary industrial practices. Criteria met in the structure is the opportunity for learners to choose the course of their interest in all disciplines.

Program Core Course Cover Computer Science and Engineering (Data Science) core courses. Also, OE and MDM where a pool of subjects are given for selection. Considering the present scenario, diverse choices need to be made available to fulfill the expectation of a learner to aspire for a career in the field of current trends of Technology and interdisciplinary research. Ability enhancement can be achieved in Undergraduate training by giving an objective viewpoint to the learning process and transitioning a learner from a rote learner to a creative professional. for the purpose Design Thinking is introduced in the First Semester to orient a journey learner to become a skilled professional. Considering the NEP-2020 structure of award of Certificate & Diploma at multiple exit-point pools of Vocational skills is arranged for giving exposure to the current Industry practices.

The faculty resolved that course objectives and course outcomes are to be clearly defined for every course so that all faculty members in affiliated higher education institutes understand the depth and approach of the course to be taught, which will enhance the learner's learning process. NEP 2020 grading system enables a much-required shift in focus from teacher-centric to continuous-based 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 a 15-week teaching-learning process for NEP 2020, however, the content of courses is to be taught in 12-13 weeks, and the remaining 2-3 weeks are to be utilized for revision, tutorial, guest lectures, coverage of content beyond the syllabus, etc.

There was a concern that in the present system, the second-year syllabus must not be heavily loaded to the learner and it is of utmost importance that the learner entering into the second year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a learner to get accustomed to the new environment of a college and to create a bond between the teacher and the learner. The present curriculum will be implemented for the Second Year of Engineering from the academic year 2054-26. Subsequently, this system will be carried forward for Third Year and Final Year Engineering in the academic years 2026-27, and 2027-28, respectively.

Sd/-	**Sd/-**	**Sd/-**
Dr. Subhash K. Shinde	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS Chairman, Computer Engineering	**Associate Dean**	**Dean**
Faculty of Science & Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

Under Graduate Diploma in Data Science.

Credit Structure (Sem. III)

Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC,RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
	R. TEU-605C									
5.0	III	PCC301:3 PCC302:3 PCC303:3 PCC304:3 PCL301: 1 PCL302:1	--	--	OE:2	--	VEC: 2 HSL: 2	CEP: 2	22	**UG Diploma 45**
	R. TEU-605D									
	IV	PCC401:3 PCC402:3 PCC403:3 PCL401:1 PCL402:1	--	MDM: 4	OE:2	VSEC:2	VEC: 2 EEM:2	--	23	
	Cum Cr.	25	--	4	4	2	*2+2+2+2*	2	45	

Exit option: Award of UG Diploma in Major and MDM with 90 credits and additional 4 credits core **one** theory subject with 3 credits and **one** lab with 1 credit from one third year from where they want to take Exit degree. Along with theory and practical course student must compulsory do internship for **one month or 160 hours** which internship is equal to 4 credits.

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project]

Sem. - III

S.E.
(Data Science)
Scheme

Program Structure for Second Year of Data Science

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER III

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2173111	Mathematics for Computer Engineering	2	--	1	2	1	--	3
2173112	Discrete Structures and Graph Theory	3	–	--	3	--	--	3
2173113	Analysis of Algorithm	3	--	--	3	--	--	3
2173114	Computer organization & Architecture	3	--	--	3	--	--	3
2173311	Open Elective	2#	--	--	2	--	--	2
2173115	Analysis of Algorithm Lab	--	2	--	--	--	1	1
2173116	Computer Organization and Architecture Lab	--	2	--	--	--	1	1
2173611	Full Stack Java Programming	--	2*+2	--	--	--	2	2
2993511	Entrepreneurship Development	--	2*+2	---	--	--	2	2
2993512	Environmental Science for Engineers	--	2*+2	--	--	--	2	2
Total		**13**	**16**	**01**	**13**	**01**	**08**	**22**

* Two hours of practical class to be conducted for full class as demo/discussion.

Theory / Tutorial 1 credit for 1 hour and Practical 1 credit for 2 hours

Institute shall offer a course for Open Elective from Science/Commerce/Management stream bucket provided by the University of Mumbai.

#Institute shall offer a course for MDM from other Engineering Boards.

Program Structure for Second Year of Computer Science and Engineering (Data

Science)

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER III

Course Code	Course Description	Examination scheme							
		Internal Assessment Test (IAT)			End Sem. Exam Marks	End Sem. Exam Duration (Hrs)	Term Work (Tw)	Oral & Pract.	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
2173111	Mathematics for Computer Engineering	20	20	40	60	2	25	--	125
2173112	Discrete Structures and Graph Theory	20	20	40	60	2	--	--	100
2173113	Analysis of Algorithm	20	20	40	60	2	--	--	100
2173114	Computer organization & Architecture	20	20	40	60	2	--	--	100
2173311	Open Elective	20	20	40	60	2	--	--	100
2173115	Analysis of Algorithm Lab	--	--	--	--	--	25	25	50
2173116	Computer Organization and Architecture Lab	--	--	--	--	--	25	25	50
2173611	Full Stack Java Programming	--	--	--	--	--	50	25	75
2993511	Entrepreneurship Development	--	--	--	--	--	50	--	50
2993512	Environmental Science for Engineers	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**225**	**75**	**800**

Program Structure for Second Year of Computer Science and Engineering (Data

Vertical – 1
Major

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2173111	Mathematics for Computer Engineering	2	-	1	2	-	1	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2173111	Mathematics for Computer Engineering	20	20	40	60	2	25	--	125

Rationale :

The goal of this course is to achieve conceptual understanding and to retain the best applied mathematics for Computer Science and Engineering (Data Science) and technology. The syllabus is designed to provide the basic tools of mathematics mainly for the purpose of modelling the Computer Science and Engineering (Data Science) problems mathematically and obtaining solutions. This is engineering mathematics course which mainly deals with topics concern to Computer Science and Engineering (Data Science) and technology.

Course Objectives: Six Course Objectives

1. To introduce concepts and fundamentals Matrix algebra for engineering problems
2. To introduce concepts of Linear and Non-linear programming problems of optimization and its applications.
3. To introduce the concept of modular arithmetic.
4. To enhance the skills to expand Fourier series for periodic functions with various period.
5. To develop the proficiency in statistical techniques arising in engineering applications.
6. To familiarize with the concepts of probability distributions with its applications in engineering and science.

Course Outcomes: Six Course outcomes (Based on Blooms Taxonomy)
On successful completion, of course, learner/student will be able to:

1. Apply the concepts of eigenvalues and eigenvectors in engineering problems.
2. Solve Linear and Non-Linear Programming Problems for optimization of engineering problems.
3. Analyze modular arithmetic for security applications.
4. Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.
5. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.
6. Apply the concept of probability distribution to engineering problems, mostly used in varied applications in engineering and science.

DETAILED SYLLABUS:

Sr. No	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Complex Numbers, Probability, Central tendencies and dispersion in Statistical techniques, Baye's theorem, Random variable, Discrete and Continuous random variables.		
I	**Linear Algebra (Theory of Matrices)**	1. Characteristic Equation, Eigenvalues and Eigenvectors, and properties (without proof) 2. Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials 3. Similarity of matrices, diagonalizable and non-diagonalizable matrices **Self-learning Topics**: Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	**5**	**CO1**
II	**Linear and Non-Linear Programming Problems**	1. Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method. 2. NLPP with one and two equality constraint (two or three variables) using the method of Lagrange's multipliers **Self-learning Topics**: Sensitivity Analysis, Big-M method, Artificial variables, Kuhn-Tucker conditions	**5**	**CO2**
III	**Modular Arithmetic**	1. Introduction to Congruence, Linear congruence, reminder theorem, solving polynomials, system of linear congruence 2. Eluer's theorem, Fermat's little theorem, Application of congruence-RSA algorithm. **Self-learning Topics**: Divisiblility, GCD, properties of prime numbers, fundamental theorem of arithmetic.	**4**	**CO3**
IV	**Fourier Series**	1. Dirichlet's conditions, Fourier series of periodic function with period 2π and $2l$. 2. Fourier series of even and odd functions. **Self-learning Topics:** Orthogonal and orthonormal set of functions, Complex form of Fourier Series, Half range Sine and Cosine Series.	**4**	**CO4**
V	**Statistical Techniques**	1. Karl Pearson's coefficient of correlation (r). 2. Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks). 3. Lines of regression, fitting of first-degree curves. **Self-learning Topics:** Covariance, Fitting of second-degree and exponential curve.	**4**	**CO5**
VI	**Probability**	1. Moment generating function, Raw moments. 2. Poisson Distribution, Normal Distribution **Self-learning Topics:** Skewness and Kurtosis of distribution (data), types of distribution and their application.	**4**	**CO6**

Books:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Probability, Statistics and Random Processes, T. Veerarajan, Mc. Graw Hill education.
5. Number theory, M. G. Nadkarni and J. S. Dani, Tata Mc. Graw Hill education.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/111/104/111104085/
2.	https://nptel.ac.in/courses/111/106/111106139/
3.	https://www.youtube.com/watch?v=2CP3m3EgL1Q
4.	https://www.youtube.com/watch?v=Hw8KHNgRaOE
5.	https://nptel.ac.in/courses/111/105/111105041/

Assessment: Note: Tutorial shall be conducted batch wise

Term Work: General Instructions:

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

The tutorials should be conducted batch wise.

2. A group of 4-6 students should be assigned a ***self-learning topic*** to 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.

3. The distribution of Term Work marks will be as follows –
   a. Attendance (Theory and Tutorial) : 05 marks
   b. Class Tutorials on entire syllabus : 10 marks
   c. Mini project : 10 marks

Internal Assessment (IA) for 40 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

End Semester Internal Examination for 40 marks:

Question paper format:

1. Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
2. **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
3. A total of **Three questions** needs to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2173112	Discrete Structures and Graph Theory	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract. / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2173112	Discrete Structures and Graph Theory	20	20	40	60	2	--	--	100

Rationale:

Mathematics forms the foundation of computer science and engineering. The study of Discrete Structures and Graph Theory enables students to develop strong logical reasoning, combinatorial techniques, and mathematical structures that are essential in programming, algorithm design, networking, database design, artificial intelligence, and cryptography.

Course Objectives:

1) Cultivate clear thinking and creative problem solving.
2) Thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies.
3) To apply graph theory in solving practical problems.
4) Thoroughly prepare for the mathematical aspects of other Computer Science and Engineering (Data Science) courses.
5) Solve real-world problems using counting principles, recurrence relations.
6) Strengthen mathematical foundations for research and higher studies in Computer Science and Engineering (Data Science).

Course Outcomes:

1) Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving using set theory and logic.
2) Apply properties of Relation sets in real-life problem-solving domains.
3) Apply properties of Function sets in real-life problem-solving domains
4) Apply counting principles, including the Pigeonhole Principle and Inclusion-Exclusion Principle, to solve combinatorial problems.
5) Apply algebraic structure for a given mathematical problem.
6) Apply graph theory in solving computing problems.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basic Set Theory, Logical Operators, Truth Tables, Cartesian product, Types of Functions. Basic Algebra and Number Theory, Fundamental Counting Principle, Permutations, Combinations. Graph Basics.	1	
I	**Crisp Set Theory and Logic**	**Set Theory:** Sets, Subsets, Universal and Empty Sets, Set Operations, Set Representation, Laws of Set theory. **Logic:** Propositional Logic, Predicate Logic, Quantifiers (Universal and Existential). **Types of Mathematical Proof:** Direct proof, Proof by contradiction, Proof by deduction, Proof by cases, Proof by exhaustion, Proof by counterexample, Mathematical induction. **Self-learning Topics:** PROLOG / LISP programming to create expert system using Propositional and Predicate Logic, Other types of logic and sets.	7	CO1
II	**Mathematical Relations**	**Relations:** Definition, Representation of Relations, Properties of Relations, Equivalence Relations, Equivalence Classes, Closures of Relations, Warshall's algorithm. **Posets and Lattice:** Partial Order Relations, Poset, Hasse Diagram, Chain and Anti chains, Lattice, Types of Lattices, Sub lattice. **Self-learning Topics:** Practical applications of relations in real life in the field of Database Management, Economics, Social Network, Sports, Medical Diagnosis, Weather, etc.	8	C02
III	**Functions**	**Functions:** Types: Injective, Surjective, and Bijective Functions. Composition, Inverse Functions. Real life applications of Functions. **Self-learning Topics:** Practical applications of function in Neural Network, Determining risk factors for insurance rates, Taxes and tax brackets, Vending machines, etc.	3	CO3
IV	**Counting**	Pigeonhole Principle, Inclusion-Exclusion Principle. Recurrence relations, Solving recurrence relations **Self-learning Topics:** Applications of Recurrence Relations – Analysis of recursive algorithms in computing. Combinatorial Problem Solving – Using counting techniques in probability and decision-making.	5	CO4
V	**Algebraic Structures**	Algebraic structures with one binary operation: Semi group, Monoid, Groups, Subgroups, Abelian Group, and Cyclic group. Algebraic structures with two binary operations: Ring. **Self-learning Topics:** Error Correcting codes.	7	CO5

VI	**Graph Theory**	Types of graphs, Graph Representation, Sub graphs, Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components, Homomorphism and Isomorphism of Graphs, Euler and Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex, Real life applications of Graph Theory. **Self-learning Topics**: Network Flow Problems – Understanding flow in networks and its optimization. Graph Coloring Applications in Scheduling – Use of graph coloring in timetabling and resource allocation. Optimization Techniques – Application of graphs in shortest path problems, spanning trees, and clustering.	8	CO6

Text Books:

1. Susanna S. Epp, "Discrete Mathematics with Applications", 5th Edition, Cengage Publications.
2. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics", 5th Edition, Pearson Publications.
3. Edgar Goodaire and Michael Parmenter, "Discrete Mathematics and Graph Theory", 3rd Edition, Pearson Publications.

Reference Books:

1. Kenneth A. Ross, "Discrete Mathematics", 5th Edition, Pearson Publications.
2. Swapan Kumar Sarkar, "Textbook of Discrete Mathematics", 9th Edition, S. Chand Publications.
3. Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "Discrete Mathematical Structures", 6th Edition, Pearson Education.
4. T. Veera Rajan, "Discrete mathematics with Graph Theory and Combinatorics", McGraw Hill Publications.
5. C. L. Liu "Elements of Discrete Mathematics", second edition 1985, McGraw-Hill Book Company. Reprinted 2000

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106106094
2.	https://nptel.ac.in/courses/106108227
3.	https://nptel.ac.in/courses/106106183
4.	https://nptel.ac.in/courses/106103205
5.	https://nptel.ac.in/courses/111107058

Assessment:

- Internal Assessment Test (IAT) for 40 Marks:
  - IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I and the remaining 40% to 50% of the syllabus content must be covered in the IAT-II.
- End Semester Theory Examination for 60 Marks:

  Question paper format :
  - Question Paper will comprise a total of six questions each carrying 15 marks Q.1 will be compulsory and should cover the maximum contents of the syllabus.
  - Remaining questions will be mixed in nature (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules).
  - A total of four questions need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2173113	Analysis of Algorithm	2		-	2	-	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	IAT-I + IAT-II (Total)					
2173113	Analysis of Algorithm	20	20	40	60	2	--	--	100

Course Objectives:

1. To provide mathematical approaches for Analysis of Algorithms
2. To understand and solve problems using various algorithmic approaches
3. To analyze algorithms using various methods

Course Outcomes:

1. Evaluate the time and space complexity of algorithms.
2. Implement the Divide and Conquer strategy and assess its complexity.
3. Utilize the Greedy algorithm approach and determine its efficiency.
4. Develop solutions using Dynamic Programming and examine its complexity.
5. Employ Backtracking and Branch and Bound techniques.
6. Apply String Matching algorithms for pattern searching

Prerequisite: Data structure concepts

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction**	Performance analysis- Master Method, space, and time complexity Growth of function, Big-Oh, Omega Theta notation Mathematical background for algorithm analysis. Analysis of selection sort, insertion sort. **Self-learning Topics:** Complexity class: Definition of P, NP, NP-Hard, NP-Complete	**4**	CO1
II	**Divide and Conquer Approach**	General method, Merge sort, Quick sort, Analysis of Binary search. **Self-learning Topics:** Finding minimum and maximum algorithms and their Analysis, Strassen's Algorithm, real life applications of all algorithms	**5**	CO2
III	**Greedy Method Approach**	General Method, Single source shortest path: Dijkstra AlgorithmFractional Knapsack problem, Minimum cost spanning trees: Kruskal and Prim's algorithms **Self-learning Topics:** Job sequencing with deadlines, real life applications of all algorithms	**5**	CO3

IV	**Dynamic Programming Approach**	General Method, Multistage graphs, All pair shortest path: Floyd Warshall Algorithm, 0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence. **Self-learning Topics:** Bellman Ford Algorithm, real life applications of all algorithms	**8**	CO4
V	**Backtracking and Branch and bound**	General Method, Backtracking: N-queen problem, Sum of subsets,Graph coloring. Branch and Bound: Travelling Salesperson Problem, 15 Puzzle problem **Self-learning Topics:** Real life applications of all algorithms	**7**	CO1
VI	**String Matching Algorithms**	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm **Self-learning Topics:** Real life applications of all algorithms	**3**	CO2

Text Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005

2. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106/106/106106131/
2.	https://swayam.gov.in/nd1_noc19_cs47/preview
3.	https://www.coursera.org/specializations/algorithms
4.	https://www.mooc-list.com/tags/algorithms

Assessment:

- **Internal Assessment (IA) for 40 marks:**

  IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

End Semester Examination for 60 Marks:

Question paper format:

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Three questions** needs to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2173114	Computer Organization & Architecture	3	-	-	3	-	-	3

Course Code	Course Name	Evaluation Scheme (Theory)					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
2173114	Computer Organization & Architecture	20	20	40	60	2	-	-	100

Pre-requisite.	Fundamental of Mathematics
Course Objective: To study the fundamentals of number system and arithmetic operations. To equip students with the foundational knowledge of computer organization and architecture, fostering an understanding of how hardware and software components collaborate to execute tasks, and preparing them to design and optimize computing systems for real-world applications.	
Course Outcomes (CO): At the End of the course students will be able to	
CO.1	Conceptualize basic computer structure with its models.
CO.2	Design algorithms to solve ALU operations
CO.3	Comprehend processor organization with various control signal design methods of CPU with comparative analysis.
CO.4	Design memory systems with analysis of mapping techniques for cache memory.
CO.5	Explore different types of I/O buses, examine data transfer methods, and assess arbitration techniques for optimized system performance.
CO.6	Analyze different parallel organizations that includes pipelined and parallel processors

DETAIL SYLLABUS:

Sr. No.	Name of the Module	Topics	Hrs	CO Mapping
1	**Computer Fundamentals**	**Number Systems:** Binary. Octal and Hexadecimals. **Binary Number representation:** Sign Magnitude, 1's and 2's Compliment representation. **Logic Gates:** AND, OR, NOT, NAND, NOR, EX-OR. Basic Organization of Computer, Von Neumann model.	**4**	CO 1
2	**ALU Operations**	**ALU Operation:** Addition and Subtraction on Binary, Octal, Hexadecimal number. Booth's Algorithms, Restoring and Non restoring division algorithm. IEEE 754 Floating point representation and conversation.	**8**	CO 2
3	**Processor Organization and Control Unit Design**	**8086 Processor**: Architecture of 8086 processor, Register Organization, Instruction formats, instruction cycle, addressing modes. **Control Unit:** Instruction interpretation and sequencing, Micro-programmed and hardwired control unit design methods. Microinstruction sequencing and execution, Micro programs. **RISC and CISC:** Introduction to RISC and CISC architectures and design issues.	**8**	CO 3

4	**Memory Systems Organization**	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Memory hierarchy and characteristics, Virtual Memory: Segmentation and Paging Cache memory: Concept, hierarchy (L1, L2, L3), mapping techniques. Cache Coherency and technique to resolve it. Interleaved and Associative memory. **Self-Study** : Case study of Pentium Processor Cache Memory Model (MESI Protocol)	**7**	CO 4
5	**I/O Organization**	Buses: Types of Buses, Bus Arbitration, Bus standards and its comparative study I/O Interface, I/O channels, I/O modules and IO processor, Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA.	**4**	CO 5
6	**Parallel Processing**	Advanced Processor Models(80386DX): Real Model, Protected Model, Virtual Model Pipelined Architecture: Pipeline Stages, Superscalar architecture Pipeline Hazards, Mitigation of Hazards with branch prediction and data forwarding techniques, Amdahl's Law Introduction to parallel processing concepts, Flynn's classifications. **Self-Study:** Superscalar Architecture: Case study of Pentium processor and GPGPU architecture.	**8**	CO 6

Text Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Modern Digital Electronics	4th	R P Jain	Tata McGraw-Hill	2009
2	Computer Organization	5th	Carl Hamacher, Zvonko Vranesic	Tata McGraw-Hill	2002
3	Computer Architecture and Organization	3rd	John P. Hayes	Tata McGraw-Hill	2012
4	Computer Organization and Architecture: Designing for Performance	8th	William Stallings	Pearson	2010
5	Microprocessors and Interfacing	3rd	Douglas V Hall	Tata McGraw-Hill	2017
6	The 80386, 80486, and Pentium Microprocessor: Hardware, Software, and Interfacing	3rd	Walter Triebel	Pearson	1997
7	Pentium Pro Processor System Architecture	3rd	Tom Shanely	Addison Wesley	1996

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Structured Computer Organization	6th	Andrew S. Tanenbaum	Pearson	2012
2	Computer Architecture and Organization: Design Principles and Applications	2nd	B. Govindarajulu	McGraw Hill	Paperback-2017
3	Advance Computer Architecture: Parallelism, Scalability, Programmability	3rd	Kai Hwang	Tata-McGraw Hill	2017

4	Microcomputer System The 8086/8088 family	2nd	Liu and Gibson	Pearson	2015
5	Programmer's reference Manual for IBM Personal Computers	1st	Steven Armburst	Tata-McGraw Hill	

Online References:

Sr. No.	Website Name
1.	https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2.	https://nptel.ac.in/courses/106/103/106103068/
3.	https://www.coursera.org/learn/comparch
4.	https://www.edx.org/learn/computer-architecture

Assessment:

- **Internal Assessment (IA) for 40 marks:**

  IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **End Semester Examination for 60 Marks:**

  Question paper format:

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
  - A total of **Three questions** needs to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2173115	Analysis of Algorithm Lab	--	2	-	--	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
2173115	Analysis of Algorithm Lab	--	--	--	--	25	25	50

Lab Objectives:

1. To introduce the methods of designing and analyzing algorithms
2. Design and implement efficient algorithms for a specified application
3. Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4. Analyze worst-case running time of algorithms and understand fundamental algorithmic problems

Lab Outcomes: At the end of the course, the students will be able to

1. Implement the algorithms using different approaches.
2. Analyze the complexities of various algorithms.
3. Compare the complexity of the algorithms for specific problem.

Prerequisite: Basic knowledge of programming and data structure

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic knowledge of programming and data structure		
I	Introduction	Performance analysis- Master Method, space, and time complexity Growth of function, Big-Oh, Omega Theta notation Mathematical background for algorithm analysis. Analysis of selection sort, insertion sort.	2	**LO1, LO2, LO3**
II	Divide and Conquer Approach	General method, Merge sort, Quick sort, Analysis of Binary search. **Self-learning Topics:** Finding minimum and maximum algorithms and their Analysis, Strassen's Algorithm	2	**LO1, LO2, LO3**
III	Greedy Method Approach	General Method, Single source shortest path: Dijkstra AlgorithmFractional Knapsack problem, Minimum cost spanning trees: Kruskal and Prim's algorithms **Self-learning Topics:** Job sequencing with deadlines	2	**LO1, LO2, LO3**

IV	Dynamic Programming Approach	General Method, Multistage graphs All pair shortest path: Floyd Warshall Algorithm, 0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence **Self-learning Topics:** Bellman Ford Algorithm	2	**LO1, LO2, LO3**
V	Backtracking and Branch and bound	General Method, Backtracking: N-queen problem, Sum of subsets,Graph coloring Branch and Bound: Travelling Salesperson Problem, 15 Puzzle problem	2	**LO1, LO2, LO3**
VI	String Matching Algorithms	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	2	**LO1, LO2, LO3**

Text Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI

Online Resources:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106/106/106106131/
2.	https://swayam.gov.in/nd1_noc19_cs47/preview
3.	https://www.coursera.org/specializations/algorithms
4.	https://www.mooc-list.com/tags/algorithms

Sr No	List of Assignments / Tutorials	Hrs
01	Assignment covers the topics from first three units limited to three Questions	2
02	Assignment covers the topics from Last three units limited to three Questions	2

Suggested list of Experiments.

Sr No	Title of Experiments	Hrs
01	Experiment based on common mathematical functions.(Selection sort, Insertion sort)	2
02	Experiment based on divide and conquers approach. (Merge sort, Quick sort, Binary search)	2
03	Experiment based on greedy approach.(Single source shortest path- Dijkstra Fractional Knapsack problem, Minimum cost spanning trees-Kruskal and Prim's algorithm)	2
04	Experiment using dynamic programming approach (All pair shortest path- Floyd Warshall, 0/1 knapsack)	2
05	Travelling salesperson problem Longest common subsequence	2
06	Experiment based on graph Algorithms (BFS, DFS , etc)	2
07	Experiment using Backtracking strategy. (N-queen problem, Sum of subsets, Graph coloring)	2
08	Experiment using branch and bound strategy.	2
09	Experiment based on string matching/amortized analysis (The Naïve string-matching Algorithms , The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm.	2
10	Implementation Min-Max Algorithm	2
11	Implementation of Job Sequencing with deadlines.	2
12	Implementation of Bellman Ford Algorithm using Dynamic programming	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2173116	Computer Organization & Architecture Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
2173116	Computer Organization & Architecture Lab	--	--	--	--	25	25	50

Prerequisite: C/C++ Programming Language.	
Lab Objectives:	
1	To study and learn assembler and using its utilities.(MASM)
2	To write assembly language programs.
3	To perform various ALU operations using assembly language programs.
4	To enable and use graphical mode in assembly language programs.
5	To implement arithmetics operations using algorithms.
6	To implement cache memory mapping techniques.

Lab Outcomes: At the end of the course, student will be able to	
1	To install the MASM.
2	Write assembly language programs.
3	Utilised various utility of INT 21H interrupts.
4	Utilised various utility of INT 10H interrupts.
5	Simulate various algorithms.
6	Simulate varus cache memory mapping techniques.

Suggested List of Experiments:

Sr. No	Title of Experiments	LO
1	Installation and configure: DOS, MASM, Debug and X86 Mode	1
2	Implementation of various ALU operations (ADD, SUB, MUL, DIV, AND, OR, XOR, NOT) through assembly language programming for 8086 using MASM and Debug.	2
3	Implementation of number conversion (HEX to BCD, ASCII to BCD, BCD to ASCII) using MASM.	2
4	Implementation of two 8-bit BCD addition with accepting input from keyboard and displaying output on monitor using INT 21H interrupts.	3
5	Implement various String Operations in 8086 through the utilities provided by DOS and BIOS interrupts (MASM)	2
6	Block Transfer and Block Exchange using Index Registers.	2
7	Drawing basic shapes like rectangle, triangle, etc. using BIOS services [Use C/MASM]	4

8	Design Password Detection Application using BIOS and DOS interrupts along with 8086 instructions.	2
9	Implement file operations [DOS Interrupts in C/MASM]	2
10	Implement I/O interfacing using inbuilt speakers of IBM PC	2
11	Implementation of cursor activity like hiding cursor and changing it to box size using INT 10H interrupts.	4
12	Implement Booth's Multiplication Algorithm	5
13	Implement Division Algorithm (Non-Restoring and/or Restoring)	5
14	Implementation of Mapping techniques of Cache memory	6
15	Displaying 8086 processor's Flag register content on monitor.	2
16	Designing 4X4 memory using 1X1 memory chips. Use COA virtual lab by IIT Kharagpur.	

Text Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Computer Organization	5th	Carl Hamacher, Zvonko Vranesic and Safwat Zaky	Tata McGraw-Hill	2002
2	Computer Architecture and Organization	3rd	John P. Hayes	Tata McGraw-Hill	2012
3	Computer Organization and Architecture: Designing for Performance	8th	William Stallings	Pearson	2010
4	Microprocessor and Interfacing: Programming & Hardware	3rd	Douglas V Hall	Tata-McGraw Hill	2017

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Structured Computer Organization	6th	Andrew S. Tanenbaum	Pearson	2012
2	Microcomputer System The 8086/8088 family	2nd	Liu and Gibson	Pearson	2015
3	Computer Architecture and Organization: Design Principles and Applications	2nd	B. Govindarajulu	McGraw Hill	Paperback-2017
4	Advance Computer Architecture: Parallelism, Scalability, Programmability	3rd	Kai Hwang	Tata-McGraw Hill	2017
5	Programmer's reference Manual for IBM Personal Computers	1st	Steven Armburst	Tata-McGraw Hill	

Online References:

Sr. No.	Website Name
1.	https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2.	https://nptel.ac.in/courses/106/103/106103068/
3.	https://www.coursera.org/learn/comparch

4	https://www.edx.org/learn/computer-architecture
5	http://cse10-iitkgp.virtual-labs.ac.in/

Sr No	Suggested List of Assignments
1.	Number conversion from one base to another and addition and subtraction on converted numbers.
2.	Numerical on Booth's Algorithm and on Restoring and Non restoring algorithm. IEEE 754 conversion.
3.	Numerical on Cache memory mapping. Cache coherency and resolution methods.
4.	Different techniques for designing control unit of computer.
5.	Different data transfer techniques and bus arbitration.
6.	Pipeline and pipeline hazards.
7.	Flynn's classification scheme.
8.	Memory interleaving and associative memory.

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the theory and practical syllabus.

Vertical – 5

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2993511	Entrepreneurship Development	--	2*+2	-	-	2*+2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	IAT-I + IAT-II				
2993511	Entrepreneurship Development	--	--	--	--	50	--	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Lab Objectives:

1. To introduce students to entrepreneurship concepts and startup development.
2. To develop business idea generation, validation, and business model preparation.
3. To provide hands-on experience in market research, financial planning, and business pitching.
4. To enhance problem-solving and decision-making skills in entrepreneurial ventures.
5. To familiarize students with government schemes and support systems for entrepreneurs.
6. To develop communication and presentation skills required for business pitching.

Lab Outcomes:

Upon successful completion of this course, students will be able to:

1. Understand the fundamental concepts of entrepreneurship and business models.
2. Conduct market research and develop business plans.
3. Utilize financial planning and cost analysis for startups.
4. Apply entrepreneurial skills to identify and solve business challenges.
5. Develop prototypes using open-source software for business operations.
6. Pitch business ideas effectively with structured presentations.

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Fundamentals of communication and leadership skills.	01	--
I	**Introduction to Entrepreneurship**	Definition, Characteristics, and Types of Entrepreneurs. Entrepreneurial Motivation and Traits. Start-up Ecosystem in India. Challenges in Entrepreneurship	02	LO1
II	**Business Idea Generation & Validation**	Ideation Techniques: Design Thinking, Brainstorming, Mind Mapping. Business Model Canvas (BMC). Market Research & Customer	04	LO2

		Validation. Minimum Viable Product (MVP) Concept.		
III	**Business Planning & Strategy**	Writing a Business Plan. SWOT Analysis and Competitive Analysis. Financial Planning and Budgeting. Risk Assessment and Management	04	LO3
IV	**Funding and Legal Framework**	Sources of Funding: Bootstrapping, Angel Investors, Venture Capital Government Schemes & Start-up India Initiatives. Business Registration & Legal Formalities. Intellectual Property Rights (IPR) & Patents	05	LO4
V	**Marketing & Digital Presence**	Branding and Digital Marketing. Social Media Marketing & SEO. Customer Relationship Management (CRM). E-commerce & Online Business Models	05	LO5
VI	**Business Pitching & Prototype Development**	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch. Case Studies of Successful Start-ups	05	LO6

Text Books:

1. "Entrepreneurship Development and Small Business Enterprises" – Poornima M. Charantimath, Pearson, 3rd Edition, 2021.
2. "Innovation and Entrepreneurship" – Peter F. Drucker, Harper Business, Reprint Edition, 2019.
3. "Startup and Entrepreneurship: A Practical Guide" – Rajeev Roy, Oxford University Press, 2022.
4. "Essentials of Entrepreneurship and Small Business Management" – Norman Scarborough, Pearson, 9th Edition, 2021.
5. "The Lean Startup" – Eric Ries, Crown Publishing, 2018.

References:

1. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" – Bill Aulet, MIT Press, 2017.
2. "Zero to One: Notes on Startups, or How to Build the Future" – Peter Thiel, 2014.
3. "The $100 Startup" – Chris Guillebeau, Crown Business, 2019.
4. "Business Model Generation" – Alexander Osterwalder & Yves Pigneur, Wiley, 2020.
5. "Blue Ocean Strategy" – W. Chan Kim & Renée Mauborgne, Harvard Business Review Press, 2019.

Online Resources:

Website Name
1. **Startup India Portal** – https://www.startupindia.gov.in 2. **MIT OpenCourseWare – Entrepreneurship** – https://ocw.mit.edu/courses/sloan-school-of-management/ 3. **Coursera – Entrepreneurship Specialization** – https://www.coursera.org/specializations/entrepreneurship 4. **Harvard Business Review – Entrepreneurship Articles** – https://hbr.org/topic/entrepreneurship 5. **Udemy – Startup & Business Courses** – https://www.udemy.com/courses/business/entrepreneurship/

List of Experiments.

Sr No	List of Experiments	Hrs
01	Business Idea Generation using Mind Mapping.	02
02	Conducting Market Research & Customer Validation.	02
03	Preparing a Business Model Canvas for a Startup Idea.	02
04	Developing a Financial Plan & Break-even Analysis.	02
05	Creating a Website using WordPress/Wix.	02
06	Social Media Marketing Campaign using Open-source Tools.	02
07	Digital Prototyping using Figma/Inkscape.	02
08	Business Pitch Deck Preparation & Presentation.	02
09	Exploring Government Schemes for Startups.	02
10	Legal Compliance & IPR Basics (Case Study).	02

Sr No	List of Assignments / Tutorials	Hrs
01	a. Write a report on any successful entrepreneur and their startup journey. b. Conduct SWOT analysis for a real-life startup.	02
02	Develop a business idea and create a one-page business plan.	02
03	Conduct market research using surveys & present findings.	02
04	Design a simple logo and branding strategy for a startup.	02
05	Create a financial model and cost estimation for a startup.	02
06	Make a case study report on startup failure analysis.	02

List of Open-Source Software
1. Canva – Designing pitch decks, social media posts, and branding materials. 2. Trello / Asana – Project management for startups. 3. GIMP / Inkscape – Graphic design and logo creation. 4. WordPress / Wix – Website development for startups. 5. OpenCart / PrestaShop – E-commerce website setup. 6. Figma – UI/UX design and prototyping. 7. LibreOffice Calc – Financial planning and budgeting. 8. Google Suite (Docs, Sheets, Slides) – Documentation and presentations. 9. Python (Pandas, Flask, Django) – Data analytics and web application development. 10. MailChimp – Email marketing and customer engagement.

Assessment :

Term Work: Term Work shall consist of at least 08 to 10 practicals' based on the above list. Also, Term work Journal must include at least 6 assignments.

Term Work Marks: 50 Marks (Total marks) = 20 Marks (Experiment) + 15 Marks (Assignments) + 5 Marks (Attendance)+ 10 Marks (Report)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2993512	Environmental Science for Engineers	--	2*+2	-	--	2*+2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I+IAT-II					
2993512	Environmental Science for Engineers	--	--	--	--	--	50	--	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Rationale:

Most of the engineering branches are offspring of applied sciences, and their practices have a significant impact on the environment. Understanding environmental studies is essential for engineers to develop sustainable solutions, minimize ecological footprints, and promote responsible resource management. This course equips students with the knowledge of ecosystems, biodiversity, pollution control, and environmental laws, enabling them to integrate sustainability into engineering practices.

Lab Objectives:

1. To understand the scope, importance, and role of environmental studies in public awareness and health.
2. To study different natural resources, their issues, and sustainable conservation.
3. To understand ecosystem types, structures, and functions.
4. To explore biodiversity, its importance, threats, and conservation.
5. To learn about pollution types, causes, effects, and control measures.
6. To understand environmental challenges, sustainability, and ethics.

Lab Outcomes:

1. Explain the significance of environmental studies and the role of IT in environment and health.
2. Describe resource types, associated problems, and conservation methods.
3. Classify ecosystems and explain their role in ecological balance
4. Analyze biodiversity levels and conservation strategies, especially in India.
5. Explain pollution impacts and suggest preventive measures.
6. Discuss environmental issues and propose sustainable solutions.

DETAILED SYLLABUS:

Unit Name	Topic Name	Topic Description	Hours	LO Mapping
I	**The Multidisciplinary Nature of Environmental Studies**	Definition, scope and importance. Need for public awareness, Role of information technology in environment and human health. Human population and the environment: Population growth, variation among nations. Population Explosion- family welfare program. Environment and human health Women and child welfare	**03**	LO1

II	**Natural Resources**	Renewable and non-renewable resources. Natural resources & associated problems: a) Forest resources: b) Water resources: Natural resources & associated problems c) Mineral resources: d) Food resources: e) Energy resources: Role of an individual in conservation of natural resources: f) Equitable use of resources for sustainable lifestyles.	**04**	LO2
III	**Ecosystems**	Concepts of an ecosystem. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries). Case study on various ecosystems in India.	**05**	LO3
IV	**Biodiversity and its Conservation**	Introduction, Definition, genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity, Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation, Case study on Bio diversity in India.	**05**	LO4
V	**Environmental Pollution Definition**	Causes, effects and control measures of: a) Air pollution b) Water pollution b) Soil pollution. Solid waste management: Causes, effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Case study on Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention.	**05**	LO5
VI	**Social Issues and Environment**	From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solution. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Consumerism and waste products. Environment protection act. Public awareness Case study on Environmental Ethics	**04**	LO6

Textbooks

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd Edition, PHI Learning, Publication Year: 2016
3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann, Springer 2008

4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009
5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

Reference Books

1. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, 2nd Edition, Oxford University Press 2018
2. The International Handbook of Environmental Laws, David Freestone and Jonathon L. Rubin, Edward Elgar Publishing 2000
3. E-Waste Management: Challenges and Opportunities in Developing Countries, Ruediger Kuehr and Ram K. Jain, Springer 2008
4. The E-Waste Handbook: Managing Electronic Waste, Klaus Hieronymi, Ruediger Kuehr, and Ram K. Jain, Earthscan 2009
5. Environmental Ethics: An Introduction, J. Baird Callicott, University of Georgia Press1999

Online References:

Sr. No.	Website Name
1.	Centre for Science and Environment (CSE), Website: cseindia.org
2.	Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India
3.	CSIR-National Environmental Engineering Research Institute (NEERI)

List of Experiments.

Sr No	List of Experiments	Hrs
01	Study of Environmental Components and Ecosystems.	2
02	Visit and Report on Solid Waste Management Plant.	2
03	Study of Renewable Energy Sources (Solar, Wind, Biogas).	2
04	Analysis of Air and Water Quality Parameters.	2
05	Study of Local Biodiversity and Conservation Methods.	2
06	Awareness Activity on Environmental Issues.	2
07	Rainwater Harvesting System Design	2
08	Case Study on Environmental Pollution & Control Measures.	2
09	Report on Climate Change Impact and Adaptation.	2
10	Study of Environmental Laws and Acts.	2
11	Study of Disaster Management Techniques.	2
12	Report on Role of IT in Environmental Protection.	2

Sr No	List of Assignments / Tutorials	Hrs
01	Prepare a report on Renewable and Non-Renewable Resources.	2
02	Write a case study on Ecosystem Types in India	2
03	Write a report on Biodiversity in India.	2
04	Prepare a report on Pollution Types and Control Measures.	2
05	Prepare a report on Environmental Ethics and Sustainability.	2
06	Prepare a case study report on Global Warming and Climate Change.	2
07	Report on Role of an Individual in Environmental Protection.	2
08	Write a report on Disaster Management Techniques.	2

09	Prepare a report on Environmental Laws and Acts in India.	2
10	Case Study on E-waste Management and Recycling Techniques.	2

Assessment :

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term work Journal must include at least 8 to 10 assignments.

Term Work Marks: 50 Marks (Total marks) = 20 Marks (Experiment) + 15 Marks (Assignments) + 5 Marks (Attendance)+ 10 Marks (Report)

Vertical – 6

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2173611	Full Stack Java Programming	-	2*+2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
2173611	Full Stack Java Programming	--	--	--	--	50	25	75

Lab Objectives: This subject seeks to give students an understanding of full stack development in Java. The main aim of this course is to:

1. Familiarize with Basic OOP concepts in Java,
2. Understand the concepts of inheritance and exceptions in java,
3. Design and implement programs involving Client and Server Side Programming,
4. Describe and utilize the functioning of DOM and Java script,
5. Study different design patterns in web programming and understand the working of react framework,
6. To describe the Spring Framework and implement the related case studies.

Lab Outcomes: At the end of the course, the students should be able to:

1. Understand and apply the fundamentals of Java Programming and Object-Oriented Programming,
2. Analyze and Illustrate Inheritance and Exception Handling Mechanisms,
3. Elaborate and design applications using Client and Server Side Programming,
4. Understand the concepts in JavaScript for interactive Web Development,
5. Implement the real-world application development in web programming using React,
6. Design and Develop Enterprise-Level Applications Using the Spring Framework.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Programming constructs in C & Python.		
I	**Introduction to OOP in Java**	**OOP concepts:** Objects, class, Encapsulation, Abstraction, Inheritance, Polymorphism, message passing. Branching and looping. Class, object, data members, member functions Constructors, types, static members and functions Method overloading Input and output functions in Java, Buffered reader class, scanner class, Packages in java, types, user defined packages. **Self-learning Topics:** Array and Vectors in Java	4	LO 1
II	**Inheritance & Exception Handling**	**Inheritance:** Types of inheritance, Method overriding, super, abstract class and abstract method, final, Multiple inheritances using interface, extends keyword. **Exception Handling:** try, catch, finally, throw and throws, Multiple try and catch blocks, user	3	LO 2

		defined exception. **Self-learning Topics:** Multithreading in Java		
III	**Client and Server Side Programming**	**Java Database Connectivity (JDBC):** JDBC architecture and drivers Connecting to databases (MySQL, Oracle, etc.) Executing SQL queries using Java Statements. **Client Side Scripting: HTML:** Elements, Attributes, Head, Body, Hyperlink, Formatting, Images, Tables, List, Frames, Forms. **CSS3:**Syntax, Inclusion, Color, Background, Fonts, Tables, lists,CSS3 selectors. **Server side programming in Java:** Introduction of Servlet, Servlet lifecycle, Servlet Request, Servlet Response, Servlet Context, HTTP Sessions, Handling forms and user inputs, Session management. Introduction to Java Server Pages, JSP architecture and page directives, Components of a JSP, Scripting elements and Standard actions, Method Definitions, JSTL. **Self-learning Topics:** Database Connectivity in Servlets and Implement JSP with JDBC to fetch data from a database	5	LO 3
IV	**Fundamentals of Java Script**	**Java Script:** Introduction to JavaScript: Conditionals Statements, Loops, Functions, Arrays, Objects, Control Flow, Math Function, Browser Object Model, Document Object Model. **DOM Manipulation:** Introduction to the DOM, Defining the DOM, Defining DOM, Dom Tree, Language-Specific DOMs, Accessing relative nodes, Checking the node type, Dealing with attributes, Creating and manipulating nodes, DOM HTML Features, Attributes as properties, Table methods, DOM Traversal, NodeIterator, TreeWalker, Selector methods, Detecting DOM Conformance, DOM style methods, Custom tooltips, Collapsible sections, Accessing style sheets Events, Fetch & Callbacks: Event Flow, Event Handlers/Listeners, The Event Object, Types of Events, Cross-Browser Events, HTTP Responses, Working with JSON data. **Self-learning Topics:** AJAX	5	LO 4
V	**Web Programming using React**	**Design Pattern:** Understanding MVC architecture Implementing MVC with servlets and JSP Developing a complete web application Solving company's use cases. **React Framework:** Introduction to React JS, Components and Elements of React, Rendering Components, React State and Props, Events, Hooks, Routing Conditional Rendering, Lists and Keys, Forms, create a single page application using React. **Self-learning Topics:** Flux and Redux	5	LO 5
VI	**Applications of Spring Framework**	**Spring Framework:** Introduction to Microservices, Basics Dependency injection and inversion of control (IoC), Spring annotations, Database integration and Aspect-oriented programming (AOP) with spring, creating spring boot applications, Building RESTful APIs with spring boot.	4	LO 6

		Self-learning Topics: Real-time Applications on Spring Framework		

Text Books:

1. Herbert Schildt, "Java The Complete Reference" Ninth Edition, Oracle Press
2. Christopher Schmitt and Kyle Simpson, "HTML5 Cookbook",O'Really Press
3.Nicholas C. Zakas,"Professional JavaScript™ for Web Developers", Wiley Publishing
4. Amuthan G., "Spring MVC, Beginners Guide" Pakt Publication
5. Chris Minnick,"BEGINNING ReactJS Foundations Building User Interfaces with ReactJS", Wrox publication
6.Iuliana Cosmina, Rob Harrop, "Pro Spring 5 An In-Depth Guide to the Spring Framework and Its Tools",Fifth Edition,APress

Reference Books:

1. Laura Lemay, Charles L. Perkins","Teach Yourself JAVA in 21 Days",Sams.net Publishing
2. Eureka, Ribbon, Zuul and Cucumber Moises Macero,"Learn Microservices with Spring Boot A Practical Approach to RESTful Services using RabbitMQ", APress
3.Alex Banks & Eve Porcello," React FUNCTIONAL WEB DEVELOPMENT WITH REACT AND REDUX", O'Really Press

Online Resources:

Sr. No.	Website Name
1.	https://www.javatpoint.com/html5-tutorial
2.	https://www.w3schools.com/js/
3.	https://www.tutorialspoint.com/spring_boot/index.htm
4.	https://www.w3schools.com/REACT/DEFAULT.ASP

Suggested list of Experiments		
Sr No	**Title of Experiments**	**Hrs**
01	Programs on classes and objects	2
02	Programs on method and constructor overloading.	2
03	Programs on various types of inheritance and Exception handling	2
04	Program on Implementing Generic and HTTP servlet.	2
05	Design a login webpage in JSP that makes validation through Database using JDBC and call the servlet for various operations	2
06	Program on Implicit and Explicit objects in JSP	2
07	Program to create a website using HTML CSS and JavaScript	2
08	Program using Java Script to validate the email address entered by the user (check the presence of "@" & "." character. If this character is missing, the script should display an alert box reporting the error and ask the user to re-enter it again).	2
09	Program based on Document Object Model to change the background color of the web page automatically after every 5 seconds.	2
10	Program for making use of React Hooks that displays four buttons namely, "Red", "Blue", "Green", "Yellow". On clicking any of these buttons, the code displays the message that you have selected that particular color.	2
11	Creating a Single Page website using the concepts in React like Hooks, Router, Props and States.	2
12	Program to create a Monolithic Application using SpringBoot	2
13	Program for Building RESTful APIs with spring boot	2

Sr No	Suggested List of Assignments / Tutorials	Hrs
1.	Theory Assignment based on Introduction to OOP in Java, Inheritance, Exception Handling and Client/Server Side Programming (Chapter 1 to 3)	4
2.	Theory Assignment based on Fundamentals of Java Script, Web Programming using React and Applications of Spring Framework (Chapter 4 to 6)	4

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments. Mini Project based on the content of the syllabus (Group of 2-3 students), The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Term Work Marks: Total 50-Marks (Experiments: 15-marks, Attendance: 05-marks, Assignments: 05-marks, Mini Project: 20-marks, MCQ as a part of lab assignments: 5-marks)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	**% of Marks**	**Alpha-Sign/ Letter Grade Result**	**Grading Point**
9.00 - 10.00	90.0 – 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	----	Ab (Absent)	0

Sd/-

Dr. Subhash K. Shinde
BoS Chairman, Computer Engineering
Faculty of Science & Technology

Sd/-

Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

Sd/-

Prof. Shivram S. Garje
Dean
Faculty of Science & Technology