University of Mumbai

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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.

(डॉ. प्रसाद कारंडे)
कुलसचिव

मुंबई – ४०० ०३२
२७ मे, २०२५

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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.
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AC– 20/5/2025
Item No.– 6.30 (N)

As Per NEP 2020

University of Mumbai

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

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.E. (Electronics and Computer Science)**
2	**Exit Degree**	**U.G. Diploma in Engineering- Electronics and Computer 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-555C** **R. TEU-555D**	**Attached herewith**
6	**Semesters**	**Sem. III & IV**
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. R.N.Awale	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS-Chairman-Electronics Engineering	**Associate Dean**	**Dean**
Faculty of 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 Information Technology 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 Information Technology 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 Electronics and Computer Science based core courses. The technical courses include Open Electives (OE) and Multidisciplinary (MDM)where a pool of subjects is 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 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/-

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BoS-Chairman-Electronics Engineering
Faculty of Technology

Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

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

UnderGraduateDiploma in Engineering- Electronics Engineering

Credit Structure (Sem. III & IV)

	R. TEU-555C								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP,CEP, CC,RP**	**Cum.Cr. / Sem.**	**Degree/Cum.Cr.**
		Mandatory	**Electives**							
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 Diploma45**
	R. TEU-555D									
	IV	PCC401:3 PCC402:3 PCC403:3 PCL401:1 PCL402:1	--	MDM: 4	OE:2	VSEC:2	VEC:2 EEM:2	--	23	
	CumCr.	25	--	4	4	2	*2+2+2+2*	2	45	

Exitoption: AwardofUGDiplomainMajor and MDM with90creditsandadditional4credits 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 compulsorily 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
&
SEM-IV

S.E. (Electronics and Computer Science)

Scheme

Program Structure for Second Year of Electronics and Computer 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
2283111	Signals and Systems (Mathematics-III)	2	--	1	2	1	--	3
2283112	Electronic Devices and Circuits	3	–	--	3	--	--	3
2283113	Computer Organization and Architecture	3	--	--	3	--	--	3
2283114	Data Structures and Algorithms	2	--	--	2	--	--	2
OEC301	Open Elective	2#	--	--	2	--	--	2
2283115	Electronic Devices Lab	--	2	--	--	--	1	1
2283116	Data Structures and Algorithms Lab.	--	2	--	--	--	1	1
2283117	Computer Organization and Architecture Lab	--	2	--	--	--	1	1
2283611	Mini Project (group project)	--	2*+2	--	--	--	2	2
2993511	Entrepreneurship Development	--	2*+2	---	--	--	2	2
2993512	Environmental Science for Engineers	--	2*+2	--	--	--	2	2
Total		**12**	**16**	**01**	**12**	**01**	**09**	**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.

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)					
2283111	Signals and Systems (Mathematics-III)	20	20	40	60	2	25	--	125
2283112	Electronic Devices	20	20	40	60	2	--	--	100
2283113	Computer Organization and Architecture	20	20	40	60	2	--	--	100
2283114	Data Structures and Algorithms	20	20	40	60	2	--	--	100
OEC301	Open Elective	20	20	40	60	2	--	--	100
2283115	Electronic Devices Lab	--	--	--	--	--	25	25	50
2283116	Data Structures and Algorithms Lab.	--	--	--	--	--	25	25	50
2283117	Computer Organization and Architecture Lab						25	25	50
2283611	Mini Project (group project)	--	--	--	--	--	25	25	50
2993511	Entrepreneurship Development	--	--	--	--	--	50	--	50
2993512	Environmental Science for Engineers	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**225**	**100**	**825**

Program Structure for Second Year of Electronics and Computer Science

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER IV

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2284111	Mathematics-IV (Program Specific)	2	--	1	2	1	–	3
2284112	Analog Electronics	3	–	--	3	–	–	3
2284113	Discrete Structure and Automata Theory	3	--	--	3	–	–	3
MDC401	Multidisciplinary minor	3	–	--	3	–	–	3
OEC401	Open Elective	2#	–	--	2	–	–	2
2284114	Analog Electronics lab	–	2	–	–	–	1	1
2284115	Discrete Structure and Automata Theory Lab	–	2	–	–	–	1	1
MDL401	Multidisciplinary minor	–	2	–	–	–	1	1
2284411/2284412	Maintenance of Electronic Appliances and Network Administration/Creative Coding in Python	–	2*+2	–	–	–	2	2
2994511	Business Model Development	–	2*+2	–	–	–	2	2
2994512	Design Thinking	–	2*+2	–	–	–	2	2
Total		**13**	**18**	**01**	**13**	**01**	**09**	**23**

* 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

Students must select 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.

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)					
2284111	Mathematics-IV (Program Specific)	20	20	40	60	2	25	--	125
2284112	Analog Electronics	20	20	40	60	2	--	--	100
2284113	Discrete Structure and Automata Theory	20	20	40	60	2	--	--	100
MDC401	Multidisciplinary minor	20	20	40	60	2	--	--	100
OEC401	Open Elective	20	20	40	60	2	--	--	100
2284114	Analog Electronics lab	--	--	--	--	--	25	25	50
2284115	Discrete Structure and Automata Theory Lab	--	--	--	--	--	25	25	50
MDL401	Multidisciplinary minor	--	--	--	--	--	25	--	25
2284411/2284412	Maintenance of Electronic Appliances and Network Administration/Creative Coding in Python	--	--	--	--	--	25	25	75
2994511	Business Model Development	--	--	--	--	--	50	--	50
2994512	Design Thinking	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**225**	**75**	**825**

Vertical –1
Major

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
2283111	Engineering Mathematics-III	L	T	P	L	T	P	Total
		2	1	--	2	1	-	3
		Examination Scheme						
			IA1	IA2	ESE		Total	
		Theory	20	20	60		100	

Course Objectives:

1. To build a strong foundation in mathematics, provide students with the mathematics fundamentals necessary to formulate, solve and analyze complex engineering problems.
2. To prepare the students to apply reasoning informed by contextual knowledge to engineering practice, and to work as part of teams on multi-disciplinary projects.

Pre-requisite Course Codes	BSC101-Applied Mathematics-I, BSC102-Applied Mathematics-II	
Course Outcomes	After the successful completion, students should be able to	
	CO1	Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
	CO2	Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
	CO3	Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
	CO4	Apply the concept of vector spaces and orthogonalization process in Engineering Problems
	CO5	Apply the concepts Linear transformations in image processing.
	CO6	Apply the concepts of Eigen values and Eigen vectors to concepts of PCA and image processing.

Module No.	Topics	References	No. of Hours
01	**Laplace Transforms:** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform. 1.2 Laplace Transform (L) of Standard Functions like e^{at}, sin(at), cos(at), sinh(at), cosh(at) and t^n, n ≥ 0. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation.	[1], [3]	5
02	**Inverse Laplace Transform:** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof).	[1], [3]	4

03	**Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier Series on interval (c, c+2l). 3.3 Half range Sine and Cosine Series.	[1], [3]	5
04	**Vectors spaces**: 4.1 Vectors spaces in N dimensional, Finite dimensional Vector spaces, Linear Span, Basis, dimension, Subspace, Cauchy Schwartz Inequality 4.2 Inner Product spaces, Norm, Orthogonal Vectors, Orthogonal Projection and Orthogonal Complements, Gram Schmidt Orthogonalization Process	[2], [4]	4
05	**Linear Transformation:** 5.1 Linear Transformation, types of linear operators (Reflection Projection, Rotation, Contraction, Dialtion, shear), Kernel & Range of Linear Transformation, Rank Nullity Theorem (without proof) 5.2	[2], [4]	4
	Matrix of a linear Transformation, Composition of Liner Transformation and Inverse of liner transformation 5.3. Effect of Change of Bases on Linear Operators		
06	**Matrix: Eigen values & Eigen vectors:** 6.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors. (Without Proof). 6.2. Similarity of Matrices, Diagonalization of Matrices and Functions of Square matrices	[2], [4]	4
			26

Reference Books:

1: Integral Transforms and their Applications by Lokenath Debnath and Dambaru Bhatta ,Chapam& Hall/CRC
2: An introduction to Integral Transforms by Baidyanath Patra , CRC Press.
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. Introduction to Linear Algebra by Gilbert Strang, Wellesly Cambridge Press.
8. Linear Algebra, F. Stephen Friedberg, Arnold Insel, Lawrence Spence, Prentice Hall of India.

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write 6 class tutorials on entire syllabus.

Tutorial Guidelines:

Tutorial should be conducted batch wise. Tutorial work will be graded from 20 marks .

Distribution of Term work Marks

1	Attendance	5
2	Class tutorials	20

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		2	--	--	2	--	1	3
2283112	Electronic Devices and Circuits	Examination Scheme						
			IA1	IA2	ESE		Total	
		Theory	20	20	60		100	

Pre-requisite Course Codes	ESC 102 BEEE, BSC2022-Semiconductor Physics	
Course Outcomes	After the successful completion students should be able to	
	CO1	Demonstrate Semiconductor applications as clipper and clamper
	CO2	Demonstrate simple rectifiers and filters using PN junction diodes
	CO3	Analyze electronic circuits using BJT, its DC and AC analysis
	CO4	Analyze electronic Circuits using MOSFET, its DC and AC analysis
	CO5	Demonstrate power amplifiers
	CO6	Demonstrate different power electronic devices

Module No.	Unit No.	Topics	Reference	Hrs.
Module 1	1	**Clippers & Clampers**		6Hrs
	1.1	Theoretical description of basic structure & construction of p n junction diode, symbol, operation under zero bias, forward bias & reverse bias, avalanche breakdown, V-I characteristics & temperature effects (no mathematical analysis or numerical examples).	1,2	
	1.2	Application of P-N junction diode as clippers & clampers (different types of configurations with input-output waveforms & transfer characteristics; theoretical description & analysis of each circuit; numerical examples)		
Module 2	2	**Rectifiers & Filters**		6Hrs
	2.1	Rectifiers: Working & mathematical analysis of full – wave center tapped rectifier & bridge type rectifier (mathematical analysis include expressions for the DC / average & RMS output voltage, DC / average & RMS output current & ripple factor; numerical examples included)	1,2	
	2.2	Filters: Capacitor (C), Inductor (L), Inductor – Capacitor (LC), C-L-C (π) with circuit diagram, waveforms, working / operation & expression for ripple factor (theoretical description only – no analysis or numerical examples to be included)		

Module 3	**3**	**Bipolar Junction Transistor Based Circuits**	1,2 3, 4	8 Hrs
	3.1	DC Circuit Analysis: DC load line and region of operation, common bipolar transistor configurations, biasing circuits, bias stability and compensation, analysis and design of biasing circuits.		
	3.2	AC Analysis of BJT Amplifiers: AC load line, small signal models (h-parameter model, Hybrid-pi model), graphical analysis, ac equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE, CB and CC amplifiers.		
	3.3	Design of CE Amplifier		
Module 4	**4**	**MOSFET Based Circuits**		8 Hrs
	4.1	DC Circuit Analysis: DC load line and region of operation, common-MOSFETs configurations, analysis and design of biasing circuits	1,2 ,3,4	
	4.2	AC Analysis: AC load line, small-signal model of MOSFET at high and low frequency and its equivalent circuit, small-signal analysis of MOSFET amplifiers, common-source, source follower, common gate.		
	4.3	Design of CS Amplifier using MOSFETS		
Module 5	**5**	**Power Amplifier**		5Hrs
	5.1	Introduction to power amplifiers, difference between voltage and power amplifiers.	2,5,6 ,7	
	5.2	Classification of Class A, Class-B, Class- AB, Class-C power amplifiers, power amplifier using MOSFET		
Module 6	**6**	**Power Electronic Devices**		6Hrs
	6.1	Introduction to power electronic devices and its needs.	9,10	
	6.2	Introduction, scope and application, construction and characteristics of thyristors, power MOSFET, IGBT, IGCT and GTO,		
	6.3	Applications of power electronic devices		
			Total	**39**

Course Assessment:

Theory:

IA1:20 Marks written examination for one hour
IA2:20 Marks written examination for one hour

ESE:60 Marks written examination for two hours

Recommended Books:

[1] Donald A. Neamen, "Electronic Circuit Analysis and Design", TATA McGraw Hill, 2nd Edition
[2] Boylestead," Electronic Devices and Circuit Theory", Pearson Education
[3] James Morris & Krzysztof Iniewski, Nano-electronic Device Applications Handbook by CRC Press
[4] David A. Bell, "Electronic Devices and Circuits", Oxford, Fifth Edition.
[5] Muhammad H. Rashid, "Microelectronics Circuits Analysis and Design", Cengage
[6] S. Salivahanan, N. Suresh Kumar, "Electronic Devices and Circuits", Tata McGraw Hill

[7] Millman and Halkies, “Integrated Electronics”, Tata McGraw Hill.
[8] Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, “Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.
[9] Muhammad H. Rashid, “Power Electronics - circuits, devices and applications”, Prentice Hall of India, 2nd edition.
[10] P. S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi.

Online References:

NPTEL courses on microelectronics: Devices to circuits

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
2284113	Computer Organization and Architecture	L	T	P	L	T	P	Total
		2	--	--	2	--	1	3
		Examination Scheme						
			IA1	IA2	ESE		Total	
		Theory	20	20	60		100	

Pre-requisite Course Codes: PCC201X		
Course Outcomes	After the successful completion students should be able to:	
	CO1	Evaluate the various types of data representation used in Computing systems.
	CO2	Analyse the design considerations in various units of the Processor.
	CO3	Explain concepts related to cache memory and Virtual memory management in Computer systems
	CO4	Contrast different types of I/O data transfers and I/O buses used in Computer systems
	CO5	Evaluate the advantages and limitations of Parallelism in systems.
	CO6	Explain the architectural enhancements in modern processors

Module No.	Unit No.	Topics	References	Hrs.
1	**Introductory Concepts**			6
	1.1.	Basic Building blocks of a Computer, Moore’s law, Evolution of x86 Computers, Von Neumann model, Harvard Model, Performance measures	1,2,4	
	1.2	Number representation: Floating-point representation, Floating point arithmetic, IEEE 754 floating point number representation	1,2,4	
	1.3	Booth’s Multiplier, Restoring and Non-Restoring Division	1	
2	**Processor Organization**			8
	2.1	Instruction format, Instruction cycle, Instruction set types, Addressing Modes	1,2,4	
	2.2	Datapath Organization (including Control sequences)	1,2,4	
	2.3	Control Unit Design: Hardwired and Microprogrammed, Nano-programming	1,2,4	

	2.4	CISC vs RISC: Design philosophy and issues	1,2,4	
3	**Memory Organization**			**8**
	3.1	Types of memories, Performance parameters of a Memory system, Memory Hierarchy, Memory Interleaving	1,2,4	
	3.2	Cache memory concepts: Principles of locality of Reference, Cache mapping techniques, Cache architectures, Cache coherency (Brief Discussion on MESI model)	1,2,4	
	3.3	Virtual management concepts: Paging, Segmentation, Page Replacement policies	1,2,4	
	3.4	Case Study: Virtual Memory management in Pentium processor	1,2,6	
4	**I/O Organization**			**4**
	4.1	I/O interfacing: Handshaking, Interrupt handling, Direct memory Access (DMA)	1	
	4.2	I/O Buses: Protocols, Arbitration	1	
5	**Parallel processing**			**6**
	5.1	Introduction to Parallel processing, Flynn's Classification, Amdahl's Law	3,4	
	5.2	Pipelining, Pipeline Performance metrics, Pipeline Hazards and Solutions	2,3,4	
6	**Enhancements of Advanced Processor Architectures**			**7**
	6.1	Superscalar processors, Branch Prediction logic, GPUs, Clusters, Multi-core processors	1,4,7	
	6.2	NVIDIA GPU Case study and Programming Model	8	
			Total	**39**

Course Assessment:

Theory:

IA1: One hours 20 Marks written examination for one hour
IA2: One hours 20 Marks written examination for one hour

ESE: Two hours 60 Marks written examination for two hours

Recommended Books:

[1] Carl Hamacher, Zvonko Vranesic, Safwat Zaky, "Computer Organization", Tata Mc Graw-Hill, 5 th Edition.

[2] William Stallings," Computer Organization and Architecture: Designing for Performance", Pearson, 8 th Edition.

[3] Andrew S. Tanenbaum," Structured Computer Organization", Pearson, 6 th Edition.

[4] D. A. Patterson and J. L. Hennessy, "Computer Organization and Design – A Quantitative Approach ", Morgan Kaufmann, 6th Edition.

[5] B. Govindarajulu," Computer Architecture and Organization: Design Principles and Applications", McGraw Hill, 2 nd Edition.

[6] Don Anderson, Tom Shanley, "Pentium Processor System Architecture", Addison Wesley Professional, 2nd Edition.

[7] Douglas V Hall," Microprocessor and Interfacing: Programming & Hardware", Tata-Mc Graw Hill, 3 rd Edition.

[8] Jason Sanders, Edward Kandrot**, "**CUDA by Example: An Introduction to General-Purpose GPU Programming", Addison-Wesley, 1st Edition.

Course Code	Course Name	Teaching Scheme (Hrs / week)			Credits Assigned			
		L	T	P	L	T	P	Total
2283114	Data Structures and Algorithms	2	--	2	2	--	1	3
		Examination Scheme						
			IA1	IA2	ESE			Total
		Theory	20	20	60			100

Pre-requisite Course Codes	VSEC102 (C Programming)	
Course Outcomes	At the end of the course student will be able to	
	CO1	Analyze the time and space complexity of algorithms.
	CO2	Apply divide and conquer strategy to solve a problem.
	CO3	Apply greedy strategy to solve optimization problem.
	CO4	Apply dynamic programming strategy to solve optimization problem.
	CO5	Apply backtracking and branch and bound strategies to solve a problem.
	CO6	Apply various string-matching algorithms to solve pattern matching problems

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to Data Structures and Algorithm Complexity:** Introduction to Data Structures, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of array, Static arrays vs Dynamic Arrays, structures. Mathematical preliminaries, time complexity and space complexity, worst-case and average-case analyses, use of order notations.	1,2	4
2	2.1	**Stack and Queues:** , 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.	1,2	4
3	3.1	**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. Variation of LL: Circular Linked List, Doubly Linked List.	1,2	6

4	**4.1**	**Trees and Graphs** Introduction, Tree Terminologies, Binary Tree, Types of Binary Tree, Representation of Binary Trees, Binary Tree Traversals, Binary Search Tree Operations on Binary Search Tree, Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS)	1,2	6
6	**6.1**	**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.	1,2	3
7	**7.1**	**Greedy method and Dynamic Programming** General approach and applications, Knapsack Problem, Job Sequencing with Deadlines Minimum Cost Spanning Trees (Kruskal's and Prim's algorithms), All Pair Shortest Path, Traveling Salesman Problem, Flow Shop Scheduling, MultiStage Graph. Longest Common Subsequence	**1,2**	
Total				**26**

Course Assessment:

Theory:

IA1: One hours 20 Marks written examination for one hour
IA2: One hours 20 Marks written examination for one hour

ESE: Two hours 60 Marks written examination for two hours

Recommended 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.
3 "Algorithm Design Manual" by Steven S. Skiena
4 Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
5 S. K. Basu, "Design Methods and Analysis of Algorithm", PHI

Online resources

1. https://nptel.ac.in/courses/106/106/106106131/
2. https://www.coursera.org/specializations/algorithms
3. https://www.mooc-list.com/tags/algorithms
4. https://www.youtube.com/watch?v=aGjL7YXI31Q&list=PLEbnTDJUr_IeHYw_sfBOJ6gk5pie0yP-0
5. https://www.geeksforgeeks.org/design-and-analysis-of-algorithms/
6. Algorithm visualization tool https://visualgo.net/
7. Electrode/ HackerRank platform to solve challenging problems

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
2283115	Electronic Devices and Circuits Lab	--	--	2	--	--	1	1
		Examination Scheme						
		Term work		Orals			Total	
		25		25			50	

Pre-requisite Course Codes	ESL 102 BEEE Lab, BSL2012 Semiconductor Physics Lab	
Laboratory Objectives	1.	To deliver a hands-on approach for studying electronic devices
	2	To comprehend characteristics of electronic devices; thereby understanding their behavior
	3.	To analyze & calculate inherent parameters of electronic devices through experimental approach
	4.	To introduce modern software simulation tools for modeling & simulation of electronic devices
Laboratory Outcomes	After the successful completion students should be able to	
	LO1	Understand and analyze the operation of clippers and clampers in shaping and modifying waveforms.
	LO2	Simulate basic electronic circuits through software simulation
	LO3	Analyze electronic circuits using BJT and FET (DC & AC analysis)
	LO4	Verify the performance of the designed amplifier through theoretical analysis, simulation, and practical implementation
	LO 5	Study of static characteristic of power devices through software simulation

Laboratory Experiments:

Sr. No.	Title of experiment	Hardware /Software	Module	Reference
1.	To perform Clippers and Clampers.	Hardware	1	1,3
2.	To perform Full wave/Bridge rectifier with LC/pi filter.	Hardware	2	1,3
3.	SPICE simulation of Full wave/Bridge rectifier with LC/pi filter.	Software	2	2
4.	Compare different Biasing Circuits of BJT	Hardware/Software	3	1,3

5.	To perform AC, DC, Transient and frequency response of single stage CE amplifiers.	Hardware/Software	3	1,2,3
6	Design CE amplifier for a given specification	Hardware/Software	3	1,2,3
7	Compare different Biasing Circuits of MOSFETS	Hardware/Software	4	1,2,3
8.	To perform AC, DC, Transient and frequency response of single stage CS MOSFET amplifiers.	Hardware/Software	4	1,2,3
9.	Design of CS Amplifier for a given specification	Hardware/Software	4	1,2,3
10.	Study of Power Amplifier	Software	5	1,2
11.	Study of static characteristics of SCR	Software	6	1,2
12.	Study of static characteristic of Triac and Diac	Software	6	1,2

Laboratory Assessment:

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 examination will be held based on the above syllabus.

Recommended Books:

[1] David A Bell, "Laboratory Manual for Electronic Devices and Circuits", 4th edition, PHI, 2001.

[2] Muhammed H Rashid, "SPICE for circuits and electronics using PSPICE", 2nd edition, PHI, 1995

[3] Mithal. G.K, "Practicals in Basic Electronics", G K Publishers Private Limited, 1997.

Term Work:

At least 10 experiments covering the entire syllabus of PCL 302 (Electronic Devices and circuits Lab) should be set to have well predefined inference and conclusion. This must include **50%** Hardware and **50%** Simulation experiments. The experiments should be student centric and attempts 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.

Note:

Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors 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.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
2283116	Data Structures and Algorithms Laboratory	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
		Term work		Oral			Total	
		25		25			50	

Pre-requisite Course Codes	PCL201X	
Laboratory Outcomes	After the successful completion students should be able to:-	
	LO 1	To Implement and analyze time and space complexity in sorting
	LO 2	To find minimum and maximum element of an array using divide and conquer strategy
	LO 3	To identify and implement an algorithm to be used in the construction of communication networks
	LO4	Identify and implement an algorithm to be used in disaster management

Module. No.	Exp. No	Name of the experiment
1	**1**	**Sorting:** Implement and analyze time and space complexity of Modified bubble, Insertion and Selection sort to display exam result of students based on their total marks scored.
2	2	**Divide and Conquer:** Implement and analyze time and space complexity of Quick and Merge sort to display records of an employee working in any organization based on their work experience.
	3	**Divide and Conquer: (Any one)** I. Implement and Analyze time and space complexity of multiplying long Integers using divide and conquer strategy. I. Implement and Analyze time and space complexity of finding minimum and maximum element of an array using divide and conquer strategy
3	**4** **5**	**Greedy Strategy**: **(Any 2)** I. Identify and implement an algorithm to be used to solve the challenge faced by airline and shipping companies of maximizing revenue while adhering to weight and space constraints when loading cargo onto airplanes or ships.determine the optimal selection and allocation of cargo items based on their values (revenue) and weights, ensuring efficient use of cargo space. I. Identify and implement an algorithm to be used in the construction of communication networks (telephone or internet networks) where a telecommunication company needs to lay down cables to connect several cities to establish a reliable network infrastructure. The company wants to minimize the cost of laying down cables while ensuring that all cities are connected and there is no redundancy in the network. I. Identify and implement an algorithm to be used by vending machines to determine the optimal combination of coins to give as change to customers.

4	6 7	**Dynamic Programming: (Any 2)** I. Identify and implement an algorithm to be used in disaster management and emergency response systems to find the shortest path for emergency vehicles, such as ambulances or fire trucks, to reach affected areas or victims. I. Identify and implement an algorithm to be used to compare DNA /RNA sequences to identify similarities and evolutionary relationships between organisms. I. Identify and implement an algorithm to be used by city planners and urban developers to determine the shortest paths between all pairs of locations, such as residential areas, commercial centers, and public facilities, to improve accessibility, reduce traffic congestion, and enhance urban mobility.
5	**8**	**Backtracking: (Any 1)** I. Implement N queen problem I. Identify and implement an algorithm to be used for coloring regions on a map such that adjacent regions do not have same color.
6	**9**	**String Matching:** Identify and implement an algorithm to be used by search engines to quickly locate documents containing specific keywords or phrases, improving search efficiency and response time.

Laboratory 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 (Experiments) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical/ Oral Exam: An Oral examination will be held based on the above syllabus

Recommended 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.
3. "Algorithm Design Manual" by Steven S. Skiena
4. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
5. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI

Online resources

2. https://nptel.ac.in/courses/106/106/106106131/
3. https://www.coursera.org/specializations/algorithms
4. https://www.mooc-list.com/tags/algorithms
5. https://www.youtube.com/watch?v=aGjL7YXI31Q&list=PLEbnTDJUr_IeHYw_sfBOJ6gk5pie0yP-0
6. https://www.geeksforgeeks.org/design-and-analysis-of-algorithms/
7. Algorithm visualization tool https://visualgo.net/
8. Electrode/ HackerRank platform to solve challenging problems

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
2283117	Computer Organization and Architecture Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		Term work			Oral		Total	
		25			25		50	

Pre-requisite Course Codes: PCL201X		
Laboratory Objectives	To familiarize the learner with the components of a computer	
	To teach the learner the working of the various memory related structures in a computer	
	To familiarize the learner with concepts of pipelining and Branch Prediction	
Laboratory Outcomes	After the successful completion students should be able to: -	
	LO 1	Describe the various parts of a Computer as well as the design considerations
	LO 2	Simulate various memory related concepts like interleaving, cache memory and Virtual memory management like paging
	LO 3	Simulate various pipeline data hazards like RAW, WAR and WAW
	LO4	Simulate the working of architectural enhancements like Branch Prediction Logic

Suggested list of Laboratory Experiments:

Sr. No.	Title of experiment	Module	Reference
1	Study of the various parts of a computer	1	1
2	Booth Multiplication	1	2
3	Implement Restoring and Non-Restoring Division Algorithm	1	2
4	Design a 4-bit parallel adder and 4 bit parallel subtractor (using 7483)	1	3
5	Simulation of Higher and lower order Memory Interleaving	3	2
6	Simulation of the state diagram of MESI Cache consistency model	3	5
7	Implementation of various cache mapping techniques to measure cache hit rate.	3	4
8	Implement various page replacement policies (LRU, FIFO, LFU)	3	4
9	Simulate various data hazards in a pipeline (for a given program segment).	5	4

10	Simulation of a 4-state dynamic Branch prediction logic (for eg. Of the Pentium processor)	**6**	**5**

Laboratory 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 (Experiments) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical/ Oral Exam: An Oral examination will be held based on the above syllabus.

Recommended Books:

[1] B. Govindarajulu, "*Computer Architecture and Organization: Design Principles and Applications*", Second Edition, Tata McGraw-Hill.

[2] C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill, 2002.

[3] John F. Wakerly, "Digital Design Principles and Practice"- Pearson Publications, 4th edition

[4] William Stallings, "*Computer Organization and Architecture: Designing for Performance*", Eighth Edition, Pearson.

[5] Don Anderson, Tom Shanley, "Pentium Processor System Architecture", Second Edition, Mindshare INC.

Course Code	**Course Name**	**Teaching Scheme (Hrs./week)**			**Credits Assigned**			
2284111	**Engineering Mathematics-IV**	L	T	P	L	T	P	Total
		2	1	--	2	1	-	3
		Examination Scheme						
			IA1	**IA2**	**ESE**		**Total**	
		Theory	20	20	60		100	

Course Objectives:

1. To build a strong foundation in mathematics, provide students with the mathematics fundamentals necessary to formulate, solve and analyze complex engineering problems.
2. To prepare the students to apply reasoning informed by contextual knowledge to engineering practice, and to work as part of teams on multi-disciplinary projects.

Pre-requisite Course Codes	BSC101-Applied Mathematics-I, BSC102-Applied Mathematics-II	
Course Outcomes	After the successful completion, students should be able to	
	CO1	Find eigenvalues and eigenvectors of the matrix, apply Caley Hamilton theorem, find a matrix function, and distinguish derogatory and diagonalizable matrices.
	CO2	Reduce a quadratic form to canonical forms using congruent and orthogonal transformations and characterize it based on rank, index and class value.

Module No.	**Topics**	**No. of Hours**	**References**

	CO3	Identify vector spaces and their bases, calculate the norm and inner products, prove the associated properties, and find an orthogonal and orthonormal basis using the Gram-Schmidt process.
	CO4	Compute probability using probability distribution of discrete and continuous random variables, Binomial, Poisson, and Normal distributions.
	CO5	Apply testing of the hypothesis associated with the Sampling distribution of large samples, small samples and chi-square distribution.
	CO6	Apply the concept of correlation and regression, fitting the curve to estimate the parameters for a given data set.

01	**Linear Algebra (Theory of Matrices):** 1.1 Eigenvalues and eigenvectors and properties. 1.2 Cayley-Hamilton Theorem (without proof), Functions of Square Matrix. 1.3 Derogatory and non-derogatory matrices. 1.4 Similarity of matrices, diagonalizable and non-diagonalizable matrices.	4	[1], [3]
02	**Linear Algebra (Quadratic Forms):** 2.1 Quadratic forms over the real field, the linear transformation of quadratic form, reduction of quadratic form to canonical forms (diagonal and normal) using a congruent transformation. 2.2 Rank, index and signature of a quadratic form, Sylvester's law of inertia, value-class of a quadratic form-Definite, Semi-definite and Indefinite. 2.3 Reduction of quadratic form to canonical forms (diagonal and normal) using an orthogonal transformation.	4	[1], [3]
03	**Linear Algebra (Vector Space, Basis and Orthonormal Basis):** 2.1 Vector spaces over real field, subspaces. 2.2 Vectors in n-dimensional vector space, linear combinations, linear dependence and independence set of vectors, basis of a vector space. 2.3 Norm, inner product, distance between two vectors, angle between two vectors, orthogonal vectors, triangular and Cauchy-Schwarz inequality. 2.4 Orthogonal and orthonormal bases, Gram-Schmidt process to construct an orthonormal basis.	4	[1], [3]
04	**Probability:** 4.1 Discrete and continuous random variable with a probability distribution and density function. 4.2 Expectation, variance, moment generating function, raw and central moments, covariance, correlation coefficient and their properties. 4.4 Probability distribution: Binomial, Poisson and Normal distributions.	5	[2], [4]
05	**Probability Distribution and Sampling Theory:** 5.1 Sampling distribution, test of hypothesis, level of significance, critical region, one-tailed and two-tailed test, test of significance of mean and difference between the means of two samples for large samples. 5.2 Degree of freedom, Student's t-distribution, test of significance of mean and difference between the means of two samples for small	5	[2], [4]

	samples. 5.3 Chi-Square Test: Test of goodness of fit, contingency table and test of independence of attributes, Yate's correction.		
06	**Statistical Techniques:** 6.1 Karl Pearson's coefficient of correlation. 6.2 Spearman's rank correlation coefficient (with repeated and non-repeated ranks). 6.3 Fitting of first- and second-degree curves. 6.4 Linear regression.	4	[2], [4]
	Total	**26**	

Course Assessment:

Theory:

IA1:20 Marks written one-hour examination should be conducted when approximately 40% of the syllabus is completed.
IA2:20 Marks written one-hour examination should be conducted when approximately 80% of the syllabus is completed.

ESE:60 Marks written two-hour examination should be conducted based on 100% of the syllabus.

End Semester Theory Examination:
1 Question paper will be worth 60 marks.
2 Question paper will have a total of five questions.
3 All questions have equal weightage and carry 20 marks each.
4 Any three questions out of five need to be solved.

Recommended Books:

Text Books:
[1] D. C. Lay, Linear Algebra and its Applications, Pearson.
[2] Gupta and Kapoor, Fundamental of Mathematical Statistics, S Chand.

References:
[3 Howard Anton and Chris Rorres, Elementary Linear Algebra with Supplemental Applications, Wiley.
[4] T. Veerarajan, Probability, Statistics and Random Processes, McGraw-Hill.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		3	--	--	3	--	1	4
2284112	**Analog Electronics**	**Examination Scheme**						
			IA1	**IA2**	**ESE**		**Total**	
		Theory	20	20	60		100	

Pre-requisite Course Codes	PC 302 Electronic Devices	
Course Outcomes	After the successful completion students should be able to	
	CO1	To evaluate performance of single or multi-stage MOSFET

		amplifier using frequency response.
	CO2	To analyze various performance parameters of op-amp.
	CO3	To apply the concepts of feedback while selecting amplifiers for the given specifications/ applications.
	CO4	To design Oscillators using op-amp.
	CO5	To examine the operation of OPAMP for different application.
	CO6	To select and use the suitable integrated circuit for a specific application.

Module No.	Unit No.	Topics	Reference	Hrs.
1		**Frequency Response of MOSFET Amplifiers**		7
	1.1	Low frequency response & analysis, effect of the coupling, bypass & load capacitances on single stage MOSFET amplifier for common source (CS) configuration (mathematical analysis & Numerical examples included)	R1, R3	
	1.2	High frequency response & analysis, effect of parasitic capacitances on MOSFET amplifier, high frequency equivalent circuit of MOSFET, Miller's theorem, effect of Miller's capacitance, unity gain bandwidth (mathematical analysis & numerical examples included).	R1, R3	
	1.3	Introduction to multi-stage amplifiers – need & necessity, different types of couplings (DC, R-C & transformer) with advantages & disadvantages, the MOSFET Cascode amplifier (theoretical description only)	R1, R3	
2		**Differential Amplifier and Op-amp**		9
	2.1	Basic MOSFET differential amplifier, DC characteristics, transfer characteristics, small signal (AC) analysis of only dual input balanced output (DIBO) for differential mode gain & common mode gain, Common mode rejection ratio (CMRR) & input resistance / impedance.	R1	
	2.2	MOSFET differential amplifier with an active load (theoretical description & only mathematical analysis (no numerical examples).	R1	
	2.3	The ideal operational amplifier (op-amp), internal block diagram of op-amp, characteristics of op-amp, ideal & practical op-amp parameters / specifications (no detailed description or any Analysis), mathematical model of op-amp, IC 741 op-amp with pin diagram & description.	R1, R7	
3		**Op-amp and Feedback**		5
	3.1	Open loop & closed loop configurations (theoretical description only), the concept of virtual ground & virtual short.	R1, R2	
	3.2	Basic concepts of feedback, Types of feedback – positive and negative and its effect on gain (block diagram and derivation of gain expected).	R2, R3	
	3.3	Types of negative feedback – voltage series, voltage shunt, current series & current shunt (block diagram and derivation expected), the op-amp inverting amplifier & op-amp noninverting amplifier (mathematical analysis for derivation of output voltage only, numerical examples & designing)	R2, R3, R7	
4		**Oscillators and Waveform Generator**		6

	4.1	Oscillators: Barkhausen's criteria for sustained oscillations, RC phase shift oscillator, Wien bridge oscillator & the crystal oscillator (theoretical description only–no mathematical analysis), numerical example & design problem on RC phase shift oscillator & Wien bridge oscillator.	R2, R4	
	4.2	Waveform Generator: Square wave generator & triangular wave generator (only theoretical description – no mathematical analysis or designing examples).	R2, R4, R7	
5		**Applications of Op-amp**		6
	5.1	Adder, summing amplifier, averaging circuit, subtractor, integrator (ideal), differentiator (ideal), difference amplifier, current amplifier & 3 op-amp instrumentation amplifier (only mathematical analysis for derivation of output voltage with numerical examples & designing included).	R2, R7	
	5.2	Current to voltage converters (I to V) & voltage to current converters (V to I) – floating load & grounded load (mathematical analysis only – no numerical).	R2, R7	
6		**Non-Linear Integrated Circuits**		6
	6.1	Comparators: Inverting comparator, non-inverting comparator, zero crossing detectors, window detector.	R2, R4, R7	
	6.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger	R2, R4, R7	
	6.3	IC 555 Timer: pin configuration and block diagram, Operation in astable and monostable multivibrator with mathematical analysis & numerical examples, applications in astable and monostable configurations.	R2, R7	
Total				**39**

Course Assessment:

Theory:

IA1: One hours 20 Marks written examination for one hour
IA2: One hours 20 Marks written examination for one hour

ESE: Two hours 60 Marks written examination for two hours

Recommended Books:

[1] Donald A. Neamen, "Electronic Circuit Analysis and Design", TATA McGraw Hill, 2nd Edition
[2] Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Pearson Prentice Hall, 4th Edition.
[3] Robert Boylestad," Electronic Devices and Circuit Theory", Pearson.
[4] David A. Bell,"Electronic Devices and Circuits", Oxford, Fifth Edition.
[5] Muhammad H. Rashid, "Microelectronics Circuits Analysis and Design", Cengage.
[6] S. Salivahanan, N. Suresh Kumar, "Electronic Devices and Circuits", Tata McGraw Hill.
[7] D. Roy Choudhury and S. B. Jain, "Linear Integrated Circuits", New Age International Publishers, 4th Edition.
[8] Sergio Franco, "Design with operational amplifiers &analog integrated circuits", Tata McGraw Hill, 3rd edition
[9] William D. Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson,

4th Edition.

Online References:

https://nptel.ac.in/courses/108107142
https://nptel.ac.in/courses/108102112
https://nptel.ac.in/courses/108105158

Course Code	Course Name	Teaching Scheme (Hrs./week)			Credits Assigned			
2284113	Discrete Structures and Automata Theory	L	T	P	L	T	P	Total
		3	--	--	3	--	1	4
		Examination Scheme						
			IA1	IA2	ESE		Total	
		Theory	20	20	60		100	

Pre-requisite Course Codes: PC 303 Data Structure and Algorithms

Course Outcomes	After the successful completion students should be able to	
	CO1	Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
	CO2	Reason Logically.
	CO3	Perform operations with Sets, Relations, Functions, Graphs and their applications.
	CO4	Design Deterministic Finite Automata (DFA) and Non-deterministic Finite Automata (NFA) and Pushdown Automata with understanding of power and limitations.
	CO5	Design Context Free Grammar and perform the operations like simplification and normal forms.
	CO6	Apply Discrete Structures and Automata Theory concepts into solving real world computing problems in the domain of Formal Specification, Verification, Artificial Intelligence etc.

Module No.	Unit No.	Topics	Reference	Hrs.
1	**Set Theory and Logic**		T1,2 R1,2,5	7
	1.1	Set Theory: Fundamentals - Sets and Subsets, Venn Diagrams, Operations onsets, Laws of Set Theory, Power Set, Principle of Inclusion and Exclusion, Mathematical Induction.		
	1.2	Propositions and Logical operations, Truth tables, Equivalence, Implications		
	1.3	Laws of Logic, Normal Forms, Inference, Predicates and Quantifiers		
2	**Relations and Functions**		T 1,2 R 1,2, ,4,6	9
	2.1	Relations- Definition, Properties of Relations, Types of binary relations (Equivalence and partial ordered relations),		
	2.2	Closures, Poset, Hasse diagram and Lattice Functions-Definition, Types of Functions (Injective, Surjective and Bijective)		
	2.3	Identity and Inverse Functions, Pigeonhole Principle,		

		Extended Pigeonhole Principle		
3	**Graph Theory**		T-3,4 R 6,7,8,9	5
	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, Trees, Types of Trees		
4	**Finite Automata**		T-3,4 R 6,7,8,10	6
	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. FSM with output: Moore and Mealy machines.		
5	**Regular Expression (RE) and Regular Grammar (RG)**		T-3,4 R 6,7,8,10	6
	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. Applications of RE and RG.		
6	**Context Free Grammar (CFG) and Push Down Automata (PDA)**		T-3,4 R 6,7,8,10	6
	6.1	Grammars: Chomsky hierarchy, CFG-Definition, Sententia lforms, Leftmost and Rightmost derivations.		
	6.2	Context Free languages(CFL): Parsing and Ambiguity. CFLs: Simplification and Applications.		
	6.3	Normal Forms: Chomsky Normal Form (CNF)		
	6.4	PDA-Definition, Transitions (Diagrams, Functions and Tables), Design of PDA with Graphical Notation and Instantaneous Descriptions.		
Total				**39**

Course Assessment:

Theory:

IA1: One hours 20 Marks written examination for one hour
IA2: One hours 20 Marks written examination for one hour

ESE: Two hours 60 Marks written examination for two hours

Recommended Books:

Text Books:

1. Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "Discrete Mathematical Structures", Pearson Education.
2. C.L.Liu, , "Elements of Discrete Mathematics", second edition 1985, McGraw-Hill Book Company. Reprinted 2000.

3. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, “Introduction to Automata Theory, Languages and Computation”, 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.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
2284114	**Analog Electronics Lab**	**Examination Scheme**						
		Term work		**Orals**			**Total**	
		25		25			75	

Pre-requisite Course Codes	**Electronic Devices Laboratory**	
Laboratory Objectives	1.	To practically analyze& compute performance parameters of various electronic circuits
	2	To familiarize with principles of designing of practical electronic circuits as per given specifications
	3.	To develop overall approach for students from selection of integrated circuit, specification, functionality and applications
Laboratory Outcomes	After the successful completion students should be able to	
	LO 1	Experimentally evaluate performance of amplifiers through frequency response

	LO 2	Analyze differential amplifiers for various performance parameters
	LO 3	Implement practically various applications and circuits based on operational amplifiers.

Laboratory Experiments:

Sr. No.	Title of experiment	Module	Reference
1.	To implement single stage MOSFET CS amplifier and study its frequency response	1	R1, R3
2.	To implement CS-CG MOSFET Cascode amplifier and study its frequency response.	1	R1, R3
3.	To determine input and output impedance of CS amplifier with and without feedback.	1	R1, R3
4.	To study Op-amp as Differential amplifier.	2	R1, R7
5.	To measure parameters of Op-amp.	2	R1, R7
6.	To study Inverting and Non-inverting configuration of Op-amp.	3	R7
7.	To study and calculate frequency of oscillations of Wien bridge oscillator	4	R2, R4
8.	To study and calculate frequency of oscillations of RC Phase shift oscillator	4	R2, R4
9.	To study voltage gain of three Op-amp instrumentation amplifier	5	R2, R7
10.	To study the operational amplifier as summing amplifier.	5	R2, R7
11.	To determine upper and lower threshold voltage in Schmitt trigger using IC 741.	6	R2, R4, R7
12.	To study and implement Astable multi-vibrator using 555 timer IC.	6	R2, R7
13.	To study Op-amp as comparator and zero crossing detector	6	R2, R4, R7

Laboratory Assessment:

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 examination will be held based on the above syllabus.

Recommended Books:

[1] Donald A. Neamen, "Electronic Circuit Analysis and Design", TATA McGraw Hill, 2nd Edition
[2] Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Pearson Prentice

Hall, 4th Edition.
[3] Robert Boylestad," Electronic Devices and Circuit Theory", Pearson.
[4] David A. Bell,"Electronic Devices and Circuits", Oxford, Fifth Edition.
[5] Muhammad H. Rashid, "Microelectronics Circuits Analysis and Design", Cengage.
[6] S. Salivahanan, N. Suresh Kumar,"Electronic Devices and Circuits", Tata McGraw Hill.
[7] D. Roy Choudhury and S. B. Jain, "Linear Integrated Circuits", New Age International Publishers, 4th Edition.
[8] Sergio Franco, "Design with operational amplifiers &analog integrated circuits", Tata McGraw Hill, 3rd edition
[9] William D. Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson, 4th Edition

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
2284115	Discrete Structures and Automata Theory Tutorials	L	T	P	L	T	P	Total
		--	1	--	--	1	--	1
		Examination Scheme						
		Term work		Orals/Presentation			Total	
		25		25			50	

Pre-requisite Course Codes: PC 303 Data Structure and Algorithms		
After the successful completion students should be able to		
Laboratory Outcomes	1.	To cultivate clear thinking for Creative Problem Solving.
	2.	To introduce the notions of Sets, Relations, Functions, Graphs and their applications.
		To build concepts of theoretical design of Basic machines, Deterministic and Non-Deterministic Finite state machines and Pushdown Machines.
	LO 1	Train students to understand and construct Mathematical Proofs.
	LO 2	Analyze differential amplifiers for various performance parameters
	LO 3	Implement practically various applications and circuits based on operational amplifiers.

Tutorial Assessment:

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 tutorials based on the above list.

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

Seminar Presentation: Presentation on applications based on concepts at above syllabus. Report making 10 marks and Presentation: 15 marks

Vertical - 4

Detail Syllabus

VSC

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
VSEC 2284411	Maintenance of Electronic Instruments/ Network Administration	--	--	4	--	--	2	2
		Examination Scheme						
		Term work			Orals		Total	
		25			25		50	

Pre-requisite Course Codes	Basics of measurements and Network	
Course Outcomes	After the successful completion students should be able to	
	CO1	Have a working knowledge about the measurement process, units of measurements, static and dynamic characteristics of instrument.
	CO2	Identify and classify types of test & measuring instruments that are available in the laboratory
	CO3	Understand the networking, OSI Concepts and Recognize the Network technologies.
	CO4	Recognize the Linux features, basic commands Installing and configuring the networking, servers and storage systems
	CO5	To understand the method of installing, configuring, outlook and concepts of anti-virus.

Module No.	Unit No.	Topics	Reference	Hrs.
1. Introduction to Basic Concepts of Measurements and Standards	**1.1**	Introduction to the measurement process & its aim, functional elements of an instrumentation system, Need of Inspection, Go-No Go Gauges. Difference between measuring instrument and Comparator.	1	8
	1.2	Introduction to Standards such as IS/ BIS, NABL standards. Errors in measurement, types, classification, Calibration & its importance, Calibration method.	2	
2. Static and Dynamic Characteristics of Transducer and Instruments	**2.1**	Difference between sensor and transducer, classification of Types of electrical, electronic, and mechanical sensors	1	9
		Performance characteristics of instruments – static characteristics & dynamic characteristics, List of Manufacturers/ vendors dealing with sale, service, and repair of measuring and test instruments.	2, 3	
3. Hardware and Network Essentials	**3.1**	Different component of computer, Assembly of system troubleshooting of the system, Layout, Components and from factors of mother broad, form factors, slot types and different memory types, Storage and to recognize the methods of storage and different hardware components used for storage.	4	9
	3.2	Hardware components in the computer, the methods of troubleshooting storage, power supplies. Different types of printers and scanner, Installing and configuring of operating system and it drives. Safety consideration.		
	3.3	Networking, OSI Concepts, recognize the Network technologies, types of application functionality, the colour coding for the Ethernet cable to be crimping & Punching, Recognize network adaptor configuration, the network design structure, the different configuration methods of device		
4 .Windows Essentials and Server	**4.1**	Features of windows client, performance information, tool configuration, Installation, upgrading and its features, Configuring, maintaining, backup and recovery	5	9
	4.2	Directory services and different functional levels, installing configuring Directory services, the methods of disaster recovery and		

		backup, the method of implementing secure domain, administrating and creation of user, maintaining group policies, e goals set, improving the reading skills		
5. Linux Server	**5.1**	The Linux features, basic commands, the methods of installing, configuring server and services, the method of fault analysis, filesystem corruption.	4,5	9
	5.2	Installing, configuring network adaptor, basic services, managing of storage.		
6. IT Security fundamentals	**6.1**	The method of installing, configuring, outlook and concepts of anti-virus, Methods of identifying types and indication of virus, worms, Trojan etc. , understand the compatibility		8
			Total	**52**

Recommended Books:

1 Electronic Instrumentation By W. D. Cooper
2. Instrumentation By A. K. Shawney
3. Sensors and Transducers, Second Edition, D. Patranabis, PHI publications, 2003
4. The Linux Command Line by William Shotts for beginners, or "How Linux Works" by Brian Ward
5. Windows Operating System Fundamentals, by Crystal Panek ,Released November 2019
Publisher(s): Sybex

Course Code	**Course Name**	**Teaching Scheme (Hrs/week)**			**Credits Assigned**			
VSEC 2284412	**Creative Coding in Python**	L	T	P	L	T	P	Total
		--	--	4	--	--	2	2
		Examination Scheme						
		Term work		**Orals**			**Total**	
		25		25			50	

Pre-requisite Course Codes: Python programming		
Laboratory Objectives	1.	To familiarize learners with Python's basic syntax, variables, data types, operators, and input/output functions.
	2	To introduce learners with file handling, exception management, and Python packaging.
	3.	To reinforce the understanding and application of GUI.
	4	To explore advanced libraries such as Numpy, Pandas, Matplotlib, Seaborn, Scipy.
	5	To explore data visualization tools.
	6	To introduce and demonstrate the use of DJANGO for web applications.

Laboratory Outcomes	After the successful completion students should be able to	
	LO 1	Identify the fundamental Python programming to design object- oriented programs with Python classes
	LO 2	Demonstrate the file handling operations like reading, writing to create the programs
	LO 3	Express proficiency in the handling Python libraries to Design GUI Applications
	LO 4	Design interactive visualizations that allow users to explore data creatively
	LO 5	Develop interactive projects with the help of Machine learning libraries to develop different applications
	LO 6	Create the web development applications with the help of DJANGO.

DETAILED SYLLABUS:

Module No. 1	**Unit No.**	**Introduction to Creative Coding with Python**	**Reference**	**Hrs.**
1		**Python Programming Basics**	R1	**04**
	1.1	Basic Syntax and Data Types - Variables and data types, Operators, Input and output, Data Structures- list, tuple, set and dictionary Understanding the Syntax Transition: From C to Python		
	1.2	Conditional Statements: if, else, elif , Loops: for and while loop Functions- Defining functions, Parameters and return values, Scope and lifetime of variables.		
2		**Functions, File I/O Handling and Classes**	R1, R2	**04**
	2.1	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		
	2.2	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes. Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.		
3		**Graphical User Interface and Image processing**	R3	**06**
	3.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.		
	3.2	Database: Sqilite database connection, Create, append, update, delete records from database using GUI.		
	3.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.		
4		**Numpy, Pandas, Matplotlib, Seaborn, Scipy and Data Science**	R3, R4	**08**
	4.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy		

	4.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.		
	4.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn		
	4.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.		
	4.5	Dataframes, Data analysis commands, Data visualization: Line chart, Bar Diagram, Histogram, Pie chart		
5		**Web Development**	R3, R4, R5	**04**
	5.1	Introduction to web development application, Web Architecture and applications.		
	5.2	Introduction to DJANGO Framework: History of DJANGO, DJANGO-Design philosophies, DJANGO features and Environment set up.		
			Total	**26**

Recommended 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

Online Resources:

- Python Tutorial: http://docs.python.org/release/3.0.1/tutorial/
- Python for everybody specialization: https://www.coursera.org/specializations/python.
- Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
- https://nptel.ac.in/courses/106/106/106106182/

Laboratory Experiments:

The following experiments serve as samples to illustrate the application of concepts covered in each unit. Instructors are encouraged to modify and adapt these experiments to meet the specific needs of the course and the learning objectives. It is essential to ensure that the fundamental concepts and skills outlined in each unit are adequately covered, even with modifications

Sr. No.	Title of experiment	Module	Reference
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 a 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,	Module 1	R1

	inches and centimeter.		
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. 4. Write Python program to implement classes, object, Static method and inner class 5. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 6. 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. 7. Write a program to find the factorial value of any number entered through the keyboard.	Module 2	R2
3.	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 3	R3
4.	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: • Find and print the name of the country with the highest GDP • Find and print the name of the country with the lowest GDP • Print text and input values iteratively • Print the entire list of the countries with their GDPs • 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: • View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, fatal flag • Clean the dataset and replace the fatal flag NaN with “No”. • Find the aircraft types and their occurrences in the dataset • Remove all the observations where aircraft names are not available • Display the observations where fatal flag is “Yes” 5. Analyze the “auto mpg data” and draw a pair plot using seaborn	Module 4	R4,5,6

	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.		
5.	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 5	R4,5,6

Laboratory Assessment:

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 examination will be held based on the above syllabus.

SEC

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
2283611	Mini- Project	L	T	P	L	T	P	Total
		--	--	4	--	--	2	2
		Examination Scheme						
		Term work		Orals			Total	
		25		25			50	

Pre-requisite Course Codes		
Course Outcomes	After the successful completion students should be able to	
	CO1	Identify and address community needs and challenges which help learners to develop problem-solving skills and creativity in finding innovative solutions.
	CO2	Enhance their cultural competence and ability to work effectively in multicultural settings
	CO3	Critically think on complex issues considering multiple view points
	CO4	Demonstrate collaboration, team work, civic engagement, empathy, and compassion while engaging directly with community
	CO5	Develop a lifelong commitment to social justice and making a positive impact in the world

This course requires students to participate in field-based learning/projects generally under the supervision of faculty. The curricular component of 'community engagement and service' involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems. At the end of the course, it is expected that students will have valuable learnings in terms of enhanced communication skills, increased cultural competence, improved critical thinking, leadership skills, collaboration skills, empathy & compassion, civic engagement, problem-solving skills, self-reflection & personal growth, and long-term commitment to social justice. It is expected that 26-30 hours of contact time per credit in a semester (52 to 60 hours in a semester for 2 credits) along with 13-15 hours of activities such as preparation for community engagement and service, preparation of reports, etc., and independent reading and study.

Other Guidelines to students for successful Community Engagement:

Community engagement is the process of working collaboratively with and through groups of people affiliated by geographic proximity, special interest, or similar situations to address issues affecting the well-being of those people It is a powerful vehicle for bringing about environmental and behavioural changes that will improve the health of the community and its members. It often involves partnerships and coalitions that help mobilize resources and influence systems, change relationships among partners, and serve as catalysts for changing policies, programs, and practices. Community engagement project is different as compared to traditional consultation. It is a regular engagement of community for achieving an identified goal or vision. It recognizes the role of community engagement in its broadest sense in the development of local democracy, while noting that the focus of the report is on the practice of community engagement as it relates to local authority activity. Communication, diplomacy, patience, and flexibility are essential to engage with a community. For successful engagement conditions include: Shared and defined purpose. Willingness to collaborate. Commitment to contributing. Participation of the right people. Open and credible process. Involvement of a champion with credibility and clout. Ensure that the engagement process is complex but

manageable. Initially the team will: Discuss and define the initiative and its potential impact. Set the purpose and goals for community engagement. Define the community. Know and respect the community's characteristics. Develop a relationship with the community, build trust, work with formal and informal leadership, find the community gatekeeper, identify the project champion, meet with the local organizations, and learn the assets and challenges for that community keeping in mind the 17 sustainable development goals. Find the common interests. The following four phases provide broad outline for the community engagement process:

Phase-I: **Outreach**

Go to the community instead of having the community come to you. Invite the stakeholders to a conversation. Create a constructive environment for dialogue allowing time to get to know the participants remembering that the community's time is valuable and must be respected. Identify the person or the organization that has convened the group and will provide initial leadership and organizational management. Outline the purpose and process for the conversation. Use a facilitator when appropriate. Define the issue and why it is important. Outline what is broken and focus on what is working. Is the issue a people problem or a situation problem? Can the problem be solved with technical expertise or will it require something else? Determine the interest and merit in hosting future discussions.

Phase-II: **Gather Facts, Brainstorm and Select**

Create an environment for discussion where people are comfortable asking questions, expressing doubts, and brainstorming new ideas. Gather the facts related to the issue and its impact. Use a SWOT, appreciative inquire, asset mapping, and other tools during the factfinding stage. Clarify the issue's alignment with the community's values and ethics. Establish the common ground on which conversations will be based. Brainstorm and gather alternative solutions. Ask the "what if" questions. Spend time discussing the options and the potential impact. Allow the process to equip the participants to see the change, feel the change, and then be prepared to change. Select the best practice/solution. If required use decision-making tools to reduce the number of options.

Phase-III: **Plan and Review**

Write the implementation action plan. Include the evaluation procedure that will answer the question "What will it look like when the change has happened?". Discuss the proposal with the appropriate stakeholders searching for insight and response. Use the feedback to assess and revise the plan. Stay focused on the solution.

Phase-IV: **Implement and Evaluate**

Implement the plan. Remember, groups want a rapid success. Identify an action that will provide a "meaningful win" within the "immediate reach." Evaluate the impact. Report the status to the community and gather feedback. Revise the plan and evaluate again. Keep the participants informed through discussion agendas, written summaries of previous discussions, goals/assignments for the next discussion, and progress reports providing accountability for delivering what was promised.

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

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 Validation. Minimum Viable Product (MVP) Concept.	**04**	**LO2**
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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2993512	**Environmental Science**	**1**	**-**	**-**	**1**	**-**	**-**	**3**

Assessment :

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

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

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
2993512	**Environmental Science**	-	-	-	-	-	25	25	50

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.

Course 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.

Course 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	No of Lecture
Module-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	2
Module-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.	2
Module-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.	2
Module-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.	3

Module-V	Environmental Pollution Definition	Causes, effects and control measures of: a) Air pollution b) Water pollution c) 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	3
Module-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	3

Textbooks

1. Environmental Science: Towardsa Sustainable Future, G.Tyler Millerand 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 Downand Greening Up YourIT Infrastructure, DavidF. Linthicum, IBM Press 2009
5. Environmental Modelling:Finding Solutions to Environmental Problems, DavidL. 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, Pearson2012

Reference Books

1. Environmental Law and Policy in India, Shyam Divan and ArminRosencranz,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. TheE-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)

Assessment:
Internal Assessment (IA) for 20 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

➢ **Question paper format**

- 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**
- **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
2994511	**Business Model Development**	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				
2994511	**Business Model Development**	--	--	--	--	25	25	50

Lab Objectives:

1. To introduce a learner to the entrepreneurship and its role in economic development
2. To familiarize a learner with the start-up ecosystem and government initiatives in India
3. To explain the process of starting a business
4. To familiarize a learner to the building blocks of a business
5. To teach a learner to plan their own business with the help of Business Model Canvas

Lab Outcomes:

The learner will be able to:

1. discuss the role of entrepreneurship in the economic development of a nation and describe the process of starting a business
2. describe start-up ecosystems in Indian and global context
3. identify different types of business models
4. identify customer segments, channels and customer relationship components for a particular business
5. identify key activities, key partners and key resources for a particular business
6. develop a financial plan for a business with the help of cost structure and revenue model
7. prepare a complete Business Model Canvas for their own business / busine

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Design Thinking principles	1	L2
I	1	Introduction to entrepreneurship: Definition, the role of entrepreneurship in the economic development, the entrepreneurial process, Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset **Self-learning Topics:** Case studies: Henry Ford https://www.thehenryford.org/docs/default-source/default-document-library/default-document-library/henryfordandinnovation.pdf?sfvrsn=0 The Tatas: How a Family Built a Business and a Nation by Girish Kuber, April 2019, Harper Business	**4**	**L2, L3**
II	2	Entrepreneurship Development: Types of business ownerships: Proprietorship, Public and Private Companies, Co-operative businesses, Micro, Small and Medium Enterprises (MSME): Definition and role of MSMEs in economic development	5	L2, L3
III	3	**Start-up financing:** Cost and revenue models, Sources of start-up fundings: Angel investors, Venture capitalists, Crowd funding, Government schemes for start-up funding **Self-learning Topics:** Successful business pitching	4	L2, L3
IV	4	**Intellectual Property Rights (IPR):** Types of IPR: Patents, trademarks and copyrights, Patent search and analysis, Strategies for IPR protection, Ethics in technology and innovation	**4**	**L2,L3**
V	**5**	**Business Model Development:** Types of business models, Value proposition, Customer segments, Customer relationships, Channels, Key partners, Key activities, Key resources, Prototyping and MVP **Self-learning Topics:**	**4**	**L5, L6**

		The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything by Guy Kawasaki		
VI	**6**	**Digital Business Management:** Digital Business models (Subscription, Freemium *etc*), Digital marketing: Search Engine Optimization (SEO), Search Engine Marketing (SEM), Social media and influencer marketing, Disruption and innovation in digital business **Self-learning Topics:** Case study: Airbnb https://www.prismetric.com/airbnb-business-m		**L2, L3**

Textbooks:

1. Entrepreneurship: David A. Kirby, McGraw Hill, 2002
2. Harvard Business Review: Entrepreneurs Handbook, HBR Press, 2018
3. Business Model Generation; Alexander Ostlewalder and Yves Pigneur, Strategyzer, 2010
4. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Reference books:

1. Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
2. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Online Resources:

Sr. No.	Website Name
3.	Entrepreneurship by Prof. C Bhaktavatsala Rao https://onlinecourses.nptel.ac.in/noc20_mg35/preview
4.	Innovation, Business Models and Entrepreneurship by Prof. Rajat Agrawal, Prof. Vinay Sharma https://onlinecourses.nptel.ac.in/noc21_mg63/preview
3.	Sarasvathy's principles for effectuation https://innovationenglish.sites.ku.dk/model/sarasvathy-effectuation/

List of Experiments.

The lab activities are to be conducted in a group. One group can be formed with 4-5 students. A group has to develop a Business Model Canvas and a digital prototype (Web App/ mobile app). Weekly activities are to be conducted as follows:

Sr No	Lab activities	Hrs
01	Problem identification (Pain points, Market survey)	2
02	Design a digital solution for the problem (Ideation techniques)	2
03	Preparing a business model canvas: Value proposition, Key partners, Key resources, Key activities	2
04	Preparing a business model canvas: Customer segment, Customer relationships and channels	2
05	Preparing a business model canvas: Cost and Revenue structure	2
06	Prototype development: Low fidelity	2

07	Prototype development: Customer feedback	2
08	Prototype development: High fidelity	2
09	Presentation of high-fidelity prototype	2
10		2

Sr No	List of Assignments / Tutorials	Hrs
01	Presentation on case study of a failed business model	2
02	Presentation on case study of a woman entrepreneur	2

Assessment:
Term Work: Term Work shall consist of 10 lab activities based on the above list. Also, Term work journal must include any 2 assignments from the above list.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)
Oral Exam: An oral 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
2994512	**Design Thinking**	**-**	2*+2 Hours Batch-Wise	**-**	**-**	**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				
2994512	**Design Thinking**	--	--	--	--	25	25	50

Lab Objectives:
1. To introduce a learner to the principles of Design Thinking
2. To familiarize a learner with the process (stages) of Design Thinking
3. To expose a learner to various case studies of Design Thinking

Lab Outcomes:
Students will be able to …

1. compare traditional approach to problem solving with the Design Thinking approach and discuss the principles of Design Thinking
2. define a user persona using empathy techniques
3. frame a problem statement using various Design Thinking tools
4. use ideation techniques to generate a pool of solutions for a problem
5. create prototypes using different techniques
6. test the prototypes and gather feedback for refining the prototype

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	No perquisites	-	-
I	1	**Introduction to Design Thinking:** Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test) **Self-learning Topics:** Design thinking case studies from various domains https://www.design-thinking-association.org/explore-design-thinking-topics/external-links/design-thinking-case-study-index	5	**L1, L2**
II	**2**	**Empathy:** Foundation of empathy, Purpose of empathy, Observation for empathy, User observation technique, Creation of empathy map **Self-learning Topics:** Creation of empathy maps https://www.interaction-design.org/literature/topics/empathy-mapping	5	**L2, L3**
III	3	**Define:** Significance of defining a problem, Rules of prioritizing problem solving, Conditions for robust problem framing, Problem statement and POV **Self-learning Topics:** Creating a Persona – A step-by-step guide with tips and examples https://uxpressia.com/blog/how-to-create-persona-guide-examples	**5**	**L2, L3**
IV	4	**Ideate:** What is ideation? Need for ideation, Ideation techniques, Guidelines for ideation: Multi-disciplinary approach, Imitating with grace, Breaking patterns, Challenging assumptions,	**5**	**L3, L7**

		Looking across value chain, Looking beyond recommendation, Techniques for ideation: Brainstorming, Mind mapping **Self-learning Topics:** How To Run an Effective Ideation Workshop: A Step-By-Step Guide https://uxplanet.org/how-to-run-an-effective-ideation-workshop-a-step-by-step-guide-d520e41b1b96		
V	5	**Prototype:** Low and high-fidelity prototypes, Paper prototype, Story board prototype, Scenario prototype	**3**	**L6**
VI	6	**Test:** 5 guidelines of conducting test, The end goals of test: Desirability, Feasibility and Viability, Usability testing	**3**	**L4, L5**

Textbooks:

1. Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Pavan Soni, Penguin Random House India Private Limited
2. Design Thinking: Methodology Book, Emrah Yayichi, 2016
3. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

Reference books:

1. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, Wiley, 2013
2. Change by Design, Tim Brown, Harper Business, 2009

Online Resources:

Sr. No.	Website Name
5.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
6.	Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr. Deepali Raheja, Dr. Mansi Kapoor https://onlinecourses.swayam2.ac.in/imb24_mg37/preview
3.	Usability Testing https://www.interaction-design.org/literature/topics/usability-testing

List of Experiments.

The experiments are to be performed in groups. A practical batch may be divided into groups of 4-5 students.

Sr No	List of Experiments	Hrs
01	Customer Journey Mapping: Visualize the steps users take to interact with a product or service. Map out the customer journey from discovering a product to making a purchase and using the product. Identify pain points and opportunities for improvement.	2
02	Stakeholder mapping: Identify all relevant stakeholders in a project. Create a stakeholder map, categorizing stakeholders based on their influence and interest. Include management of relationships with key stakeholders.	2
03	"How Might We" Problem Framing: Transform user insights into actionable problem statements. After empathizing with users, turn challenges into "How Might We" statements that define the problem without prescribing a solution.	2

04	Brainstorming Session: Generate a pool of ideas in a creative, non-judgmental environment. Using ideation techniques like mind mapping and brainwriting, students brainstorm as many solutions as possible to their "How Might We" problem statements.	2
05	Affinity Diagramming: Organize group ideas to find patterns and insights. After brainstorming, students will categorize their ideas into themes by placing sticky notes on a wall and moving them into groups based on similarities.	2
06	Rapid Prototyping: Create quick, low-fidelity versions of solutions. Use materials like paper, cardboard, and markers to build a prototype of their solution within 30 minutes. The focus is on speed and functionality, not aesthetics.	2
07	Wireframing: Create a visual guide for digital interfaces for mobile app / web app for the problems identified in earlier lab sessions. Students will sketch wireframes of the user interface for their product or service. Use tools like Balsamiq or paper and pen for low-fidelity wireframes.	2
08	Role-Playing: Walk through a prototype from the user's perspective. Students act as both users and designers, role-playing scenarios where they interact with their prototype (Developed in earlier lab sessions). Gather feedback from participants on how to improve the experience.	2
09	Usability Testing: Evaluation of the effectiveness and user-friendliness of a prototype (developed in earlier lab sessions). Students will have peers or target users test their prototypes, observe how they interact with it, and collect feedback on any issues or improvements needed.	2
10	Feedback Loop and Iteration: Refine solutions based on user feedback. After usability testing, students will refine their prototypes. Document changes made based on feedback and discuss how continuous iteration improves the design.	2

Sr No	List of Assignments (Any two)	Hrs
01	Create an empathy map for a target user group. Break them into four sections: *Says, Thinks, Feels, and Does*. Interview users or research their experiences to fill in the map.	3
02	Based on research, students will create user personas including demographic details, motivations, pain points, and goals. Each group will present their persona to the class.	3
03	Consider 3 examples of real-life products which have good design and bad design. Write down reasons why do you think they are good or bad designs. May take user survey to support your work.	3
04	Study any open-source design thinking tool and write a brief report about it.	3

Assessment:

Term Work: Term Work shall consist of 10 lab activities based on the above list. Also, Term work journal must include any 2 assignments from the above list.

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

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

Vertical – 6

(Open Electives and MDM Courses)

Detailed Syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE301	Introduction to IoT and Applications	2	--	--	2	--	--	2
		Examination Scheme						
			IA1	IA2	ESE		Total	
		Theory	20	20	60		100	

Course Objectives:

1. Define the Internet of Things (IoT) and its key characteristics.
2. Explore the conceptual framework and architectural views of IoT systems.
3. Identify the technologies and components that enable IoT implementations.
4. Understand communication protocols and design principles for connected devices.
5. Examine various sensor and actuator technologies used in IoT applications.
6. Apply IoT design methodologies through case studies in smart living and connected commerce.

Course Outcomes	After the successful completion students should be able to	
	CO1	Articulate the fundamental concepts and significance of IoT.
	CO2	Analyze and differentiate between various IoT technologies and protocols.
	CO3	Design and implement basic IoT applications using appropriate sensors and actuators.
	CO4	Evaluate the effectiveness of IoT solutions in real-world scenarios.
	CO5	Conduct case studies to assess the impact of IoT on smart living and commerce.
	CO6	Collaborate on innovative IoT projects, demonstrating practical application of learned concepts.

Module No.	Unit No.	Topics	Reference	Hrs.
1	**Introduction to Internet of Things**		1,2	6
	1.1	Definition and characteristics, IoT conceptual framework		
	1.2	IoT architectural View		
	1.3	Technology behind IoT – server end technology, Major components of IoT system, Development too, ls and Open-source Framework for IoT implementation, APIs and device Interfacing Components, platforms, and Integration tools, M2M		
2	**Design Principles for Connected Devices and Web Connectivity**		1,2	6
	2.1	Overview of NFC, RFID, Bluetooth, Bluetooth LE, Zigbee, Wi-Fi, GSM		
	2.2	Constrained RESTful Environment (CoRE), CoAP, REST, HTTP, HTTPS, and web-sockets		
	2.3	Internet connectivity		
3	**Sensors and Actuators**		1,2	4
	3.1	Sensor technology – Analog and digital sensors, temperature sensor, humidity sensor, distance sensor, light sensor, acceleration sensor		
	3.2	Participatory sensing, Industrial IoT		
	3.3	Actuators – LED, Piezoelectric vibrator , piezoelectric speaker, motor, relay switch		
4	**IoT Platforms Design Methodology**		1,2	4
	4.1	10 step IoT design Methodology		
	4.2	Case study: IoT system for Weather Monitoring		
5	**Case Studies Based on Smart Living**		1,2	4
	5.1	Smart lighting, gas/smoke detection		

	5.2	Smart parking, emergency response		
	5.3	Smart irrigation, wearable electronics for health and fitness monitoring		
6	**Case studies based on Connected Commerce**		1,2	4
	6.1	Inventory management, smart payment		
	6.2	Fleet tracking		
Total				**26**

Course Assessment:

Theory: **IA1:** One hours 20 Marks written examination for one hour

IA2: One hours 20 Marks written examination for one hour

ESE: Two hours 60 Marks written examination for two hours

Reference text books:

1. Internet of Things – Architecture and Design Principles – Raj Kamal
2. Internet of Things – A Hands on Approach – Arshdeep Bahga and ViajyMadisetti

Course Code	**Course Name**	**Teaching Scheme (Hrs/week)**			**Credits Assigned**			
OE401	**Robotics and Its Applications**	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			IA1	**IA2**	**ESE**		**Total**	
		Theory	20	20	60		100	

Course Objectives:

1. To introduce Robotics and discuss the Functional concepts of Robots
2. To explore and learn Configurations of Robots and their Kinematics
3. To introduce path planning techniques for Robotics
4. To explore sensors and understand the concepts of drives and grippers
5. To understand the applications of Robotics
6. To learn about Humanoid Robotics Technology and Social Robots

Course Outcomes	After the successful completion students should be able to	
	CO1	Understand the significance, social impact and future prospects of robotics and automation in various engineering applications.
	CO2	Understand the various configurations and kinematics of robots
	CO3	Know about various path planning techniques
	CO4	Learnt about sensors used in robots along with concepts of drives and grippers
	CO5	Explored the domains of applications for robotics
	CO6	Know about the Humanoid Robotics Technology and Social Robots.

Module No.	**Topics**	**Reference**	**Hrs.**
1	**Introduction:**	T1	4

	Introduction to Robotics, Laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market, and the future prospects, advantages and disadvantages of robots.	T3 R6	
2	**Configuration and Kinematics** Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Wok volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix.	T1 T3 R3	4
3	**Sensors** Characteristics of sensing devices, Criterion for selections of sensors, Classification, & applications of sensors. Internal sensors: Position sensors, & Velocity sensors, External sensors Internal sensors: Position sensors, & Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors	T3 T5 R3	5
4	**Drives and Grippers:** Drives – Basic types of drives. Advantages and Disadvantages of each type. Selection / suitability of drives for Robotic application. Controllers, Types of Controllers, and introduction to close loop controller Grippers – Mechanisms for actuation, Magnetic gripper vacuum cup	T1 T5 R5	5
5	**Robotics Applications:** Material Handling: pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, Ariel and underwater applications, robotic for computer integrated manufacturing. Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Robots, Autonomous robots, and Swarm robots	T1 T3 R6	5
6	**Humanoid Robotics Technology and Social Robots:** Sensors in Humanoid Robot, Control of Humanoid Robot, actuation types for humanoid Robot, System Integration in Humanoid Robot, Social Robot, Need of Social Robots, Assistive and Social Robots in the Healthcare Sector and other, Case study On Humanoid Robot.	T4 T5 R5	5
Total			**26**

Course Assessment:

Theory:

IA1: One hours 20 Marks written examination for one hour
IA2: One hours 20 Marks written examination for one hour

ESE: Two hours 60 Marks written examination for two hours

Reference Books:

1. S. K. Saha, Introduction to Robotics, TATA McGraw Hills Education, 2014.
2. S. B. Nikku, Introduction to Robotics – Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., 2020.
3. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt. Ltd., 2012
4. Ganesh S Hegde, "A textbook on Industrial Robotics", University science press,

3rdedition, 2017.
5. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009.

Text Books:

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005.
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press, 2006.
3. Elmer P. Dadios, “Humanoid Robot: Design and Fuzzy Logic Control Technique for Its Intelligent Behaviors”, 2012.
4. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.

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. R.N.Awale
BoS-Chairman-Electronics Engineering
Faculty of Technology

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Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

Sd/-

Prof. Shivram S. Garje
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