K J Somaiya Institute of Engineering and Information Technology, Sion, Mumbai

An Autonomous Institute affiliated to University of Mumbai

Autonomy Syllabus Scheme-I (2021-22)

Bachelor of Technology

in

Electronics and Telecommunication Engineering

(Second/Third/Last Year)

(with Effect from AY 2021-22)

From the Principal's Desk:

The academic reforms recently recommended by the AICTE and UGC have effectually strengthened the higher education system in India. To adhere to the status quo and enhance the academic standards and quality of engineering education further, it is essential to assimilate innovation and recurrent revision in curriculum, teaching-learning methodology, examination, and assessment system.

In congruence with it, the University of Mumbai has adapted Outcome-Based Education (OBE) system and has revised the engineering curriculum thrice in the last decade — as Rev 2012, Rev 2016, and the recent Rev 2019, 'C' scheme focusing on cutting-edge technology courses.

K. J. Somaiya Institute of Engineering and Information Technology, being an autonomous institute possesses more flexibility in adapting newer approaches to reach higher levels of excellence in engineering education. This first syllabus scheme under the autonomy comprises state-of-the-art courses and laboratory sessions on emerging areas of technology. The syllabus is designed with an objective to foster the students for developing innovative solutions to real-world issues of the society and/or industry through the acquired knowledge. The induction program for the students is deliberated as per guidelines of AICTE and shall be executed over the entire First Year.

With an ideology that the root of innovation is 'interest', the curriculum offers a wide range of elective courses - grouped into core and inter-disciplinary domains. At par with international engineering education, the students can choose to study courses concerning areas of their interests.

The curriculum introduces Skill-Based Learning (SBL), Activity-Based Learning (ABL), and Technology-Based Learning (TBL) as eXposure (SAT) courses - that assure X factor in all the students of the institute. The SAT courses shall be practiced across the first three years of engineering, focusing on graduate attributes like work ethics, responsibilities towards society, problem-solving ability, communication skills, motivation for life-long learning, leadership and teamwork, etc. that may not be copiously imbibed through regular engineering courses. The proficiencies acquired herein shall open huge employment and entrepreneurial opportunities for the students.

Students of the institute are already provided exposure to the work culture and trends in industries through live / collaborative projects / product developments, etc. Under autonomy too, through the component of Project-Based Learning included in the syllabus, the students shall develop Mini, Minor, and Major projects in Second, Third, and Last Year respectively concerning healthcare, agriculture, societal / industrial need-based problems, etc. as well as pursue internships at the end of each semester / year - making them industry-ready engineers. The blend of all these learning components in the curriculum shall strengthen the research and innovation ecosystem in the institute — for best benefits of the students.

This first syllabus shall be effective from Academic Year 2021-22 to all four years at once. It comprises 165 credits, follows the AICTE model curriculum, focuses on learner-centric approach as well as continuous evaluation, and shall offer the ideal learning experience for the students of the institute.

In the coming years, the institute shall also offer an Honours degree for students who are desirous of pursuing their special interest areas in industry-relevant tracks like Artificial Intelligence, Internet of Things, Cyber Security, etc. Through joint efforts of all stakeholders, strategic planning, and efficient execution of neoteric educational practices with hi-tech wizardry, we shall strive to become a role model for all autonomous institutes across the nation.

Dr. Suresh Ukarande
Principal and Chairman - Academic Council

Member Secretary, Academic Council's Preamble

We, Board of Studies in Computer Engineering (CE), Information Technology (IT), Artificial Intelligence and Data Science (AI-DS), Electronics and Telecommunication (EX) and Electronics Engineering (ET) are very happy to present 4 years of undergraduate and 2 years of post-graduation in Artificial Intelligence (AI), Engineering technology syllabus effective from the Academic Year 2021-22 under the autonomy status granted to our institute, K J Somaiya Institute of Engineering and Information Technology (KJSIEIT). We are sure you will find this syllabus interesting, challenging and meeting the needs of Industry 4.0.
UGC states the benefits of granting academic autonomy to higher education institutes as 'the freedom to modernize curricula, making it globally competent, locally relevant and skill oriented to promote employability'. Thus exercising academic freedom by eligible and capable institutes is the need for developing the intellectual climate of our country and bringing and promoting academic excellence in higher education system. KJSIEIT under its first autonomous syllabus scheme (KJSIEIT-Scheme I) is keen in providing globally required exposure to its learners focusing sound theoretical background supported by practical experiences in the relevant areas of engineering and technology.

Besides engineering and technology foundation, Industry 4.0 demands modern, industry-oriented education, up-to-date knowledge of analysis, interpretation, designing, implementation, validation, and documentation of not only computer software and systems but also electronics and communication systems, hardware devices and tools, trained professional, ability to work in teams on multidisciplinary projects, etc. Thus KJSIEITs autonomy Scheme-I syllabus has been designed for the learners to successfully acquaint with the demands of the industry worldwide, life-long experiential learning, professional ethics with universal human values and training for needed skillsets and in line with the objectives of higher and technical education, AICTE, UGC and various accreditation and ranking agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of KJSIEITs autonomy Scheme-I syllabus are:

1. Total 165 credits ensuring extra time for students' experiential learning through extracurricular activities, innovations, and research.
2. Introduction of Skill Based, Activity Based, Technology based and Project Based learning to showcase learners' creativity, interest and talent by developing additional skillsets, social involvement and contributions through activities, case studies, field visits, internships, creative learning, innovative mini, minor and major project developments, strengthen their profile and increasing the chances of employability.
3. Value addition learning through MOOCs platforms such as IBM-ICE, Coursera, NPTEL, SWAYAM, Spoken Tutorial etc.
4. Emerging areas of technology learning in Artificial Intelligence, Machine learning, Data Science, Internet of things, Cyber Security, Block chain, augmented and Virtual reality.

We would like to place on record our gratefulness to the faculty, alumni, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Dr. Sunita R Patil

Member Secretary, Academic Council and Vice Principal, KJSIEIT, Sion

From ET BoS Chairman's Desk:-

Preface

In today's world, lot of technological developments are taking place in the field of Electronics & Telecommunication Engineering in order to meet the current requirements. Hence, there is always a requirement for continuous enrichment of course content in the field of education on regular basis to maintain a good quality of education by the regular revision of curriculum. This will help our students with the upgraded knowledge, help in achieving better employability, opportunities to work with start -ups, chances for good internships at premier organizations/industries and other avenues of higher studies.

The newly designed curriculum of Electronics and Telecommunication Engineering under the autonomy has focussed on all these above mentioned factors and aims to provide strong foundation along with required analytical concepts in the field of electronics & telecommunication. The curriculum is designed keeping in mind the modern curriculum of AICTE. Some of the salient features of the syllabus are as mentioned below.

1. The curriculum is designed with a total of number of 165 credits along with the inclusion of Skill, Activity, Technology and Project based learning.

2. The skill based courses are introduced in the second and third year in which students are exposed to hard as well as soft skills. The second year students are also exposed activity based learning. Students are also introduced with the mini projects in the second year in the specified selected technologies

3. Third year students are introduced with technology based learning along with skill based courses. The minor projects are introduced to the third year students in the specialized core fields

4. The curriculum is designed with department and institute level electives covering the thrust areas that will provide more focussed approach for the students in problem solving and also to be at par with the current industry requirements.

5. The contents of the curriculum is designed taking into consideration the current IT developments into account and at the same time keeping the focus on core specialization of the program intact,

The Board of Studies would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analysing the contents.

Dr. Jayashree V. Khanapuri
HOD and Chairperson,
Electronics and Telecommunication Engineering, KJSIEIT, Sion

Program Structure for Second Year UG Technology (ET)

Semester-III - Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		Course Category
		TH – P – TUT	Total (Hrs.)	TH – P – TUT	Credits	
1UEXC301	Applications of Mathematics in Engineering-I	3– 0 – 1	04	3 – 0 – 1	04	BS
1UEXC302	Digital Logic Design	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC303	Electronic Devices & Circuits	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC304	Electronic Instrumentation and Control System	3 – 0 – 0	03	3 – 0 – 0	03	PC
1UEXC305	Electrical Network Theory	2 – 0 – 0	02	2 – 0 – 0	02	PC
1UEXL302	Digital Logic Design Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL303	Electronic Devices & Circuits Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL304	Electronic Instrumentation and Control System Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXPR31	Project Based Learning- Mini Project Lab-I	0 – 2 – 0	02*	0 – 1 – 0	01	PBL
1UEXXS33	Skill Based Learning-III	0 – 2*– 0	02	0 – 1 – 0	01	SAT
1UEXXA34	Activity Based Learning-IV	0 – 2*– 0	02	0 – 1 – 0	01	SAT
Total		**14– 12– 01**	**28**	**14 - 06 - 01**	**21**	

***Load of learner, not the faculty / *SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.**

Semester-III - Examination Scheme

Course Code	Course Name	Marks								
		CA			ESE	TW	O	P	P&O	Total
		T1	T2	IA						
1UEXC301	Applications of Mathematics in Engineering-I	15	15	10	60	25	-	-	-	125
1UEXC302	Digital Logic Design	15	15	10	60	-	-	-	-	100
1UEXC303	Electronic Devices & Circuits	15	15	10	60	-	-	-	-	100
1UEXC304	Electronic Instrumentation and Control System	15	15	10	60	-	-	-	-	100
1UEXC305	Electrical Network Theory	10	10	10	45	-	-	-	-	75
1UEXL302	Digital Logic Design Laboratory	-	-	-	-	25	-	25		50
1UEXL303	Electronic Devices & Circuits Laboratory	-	-	-	-	25	25	-	-	50
1UEXL304	Electronic Instrumentation and Control System Laboratory	-	-	-	-	25	-	-	-	25
1UEXPR31	Project Based Learning- Mini Project Lab-I	-	-	-	-	25	-	25	-	50
1UEXXS33	Skill Based Learning-III	-	-	-	-	25	-	-	-	25
1UEXXA34	Activity Based Learning-IV	-	-	-	-	25	-	-	-	25
Total		**70**	**70**	**100**	**285**	**175**	**25**	**50**	**-**	**725**

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC301	**Applications of Mathematics in Engineering-I**	**3 + 0 + 1**
Prerequisite:	1. Engineering Mathematics-I 2. Engineering Mathematics-II 3. Scalar and Vector Product: Scalar and vector product of three and four vectors	
Course Objectives:	1. To learn the Laplace Transform, Inverse Laplace Transform of various functions and its applications. 2. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill. 3. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in the complex plane. 4. To understand the basics of Linear Algebra. 5. To use concepts of vector calculus to analyze and model engineering problems	
Course Outcomes:	Upon completion of the course, the learners will be able to: 1. Solve the real integrals in engineering problems using the concept of Laplace Transform. 2. Analyze engineering problems through the application of inverse Laplace transform of various functions. 3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems. 4. Solve the problems of obtaining orthogonal trajectories and analytic functions by means of complex variable theory and application of harmonic conjugate. 5. Use matrix algebra to solve the engineering problems. 6. Apply the concepts of vector calculus in real life problems.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Laplace Transform	1.1 Definition of Laplace transform, Condition of Existence of Laplace transform. Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and t^n, $n \geq 0$.	1	02	06
	1.2 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof).		02	
	1.3 Evaluation of integrals by using Laplace Transformation.		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. 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	02	07
	2.2 Partial fractions method to find inverse Laplace transform.		03	
	2.3 Inverse Laplace transform using Convolution theorem (without proof).		02	
3. Fourier Series	3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).	3	01	06
	3.2 Fourier series of periodic function with period 2π and $2l$.		02	
	3.3 Fourier series of even and odd functions.		01	
	3.4 Fourier Transform-Fourier sine transform and Fourier cosine transform.		02	
4. Complex Variables	4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof).	4	03	07
	4.2 Cauchy-Riemann equations in Cartesian coordinates (without proof).		01	
	4.3 Milne-Thomson method to determine analytic function $f(z)$when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given		02	
	4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories.		01	
5. Linear Algebra: Matrix Theory	5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors. (Without Proof).	5	02	06
	5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix.		02	
	5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix		02	
6. Vector Differentiation and Integral	6.1 Vector differentiation: Basics of Gradient, Divergence and Curl (Without Proof).	6	02	07
	6.2 Properties of vector field: Solenoidal and irrotational (conservative) vector fields.		02	
	6.3 Vector integral: Line Integral, Green's		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation.			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Advanced engineering mathematics, H.K. Das, S . Chand, Publications 2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication 3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication 4. Advanced Engineering Mathematics, Wylie and Barrett, Tata Mc-Graw Hill.
Reference Books	1. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series 2. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication 3. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication 4. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Useful links:

1. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=25
2. https://nptel.ac.in/noc/courses/111/
3. https://www.coursera.org/courses?query=mathematics
4. https://ndl.iitkgp.ac.in/

Continuous Assessment:

General Instructions:

1. Each Student has to write at least 6 class tutorials on the entire syllabus.

2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered a mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 Marks
2.	Class Tutorials on entire syllabus	10 Marks
3.	Mini Project Presentation	10 Marks

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC302	Digital Logic Design	3+0+0
Prerequisite:	1. Basics of Electrical Engineering(1UBSC105) 2. Engineering Physics(1UBSC102)	
Course Objectives:	1. To understand number system representations and their inter-conversions used in digital electronic circuits. 2. To analyse digital logic processes and to implement logical operations using various combinational logic circuits. 3. To analyse, design and implement logical operations using various sequential logic circuits. 4. To study the characteristics of memory and their classification. 5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.	
Course Outcomes:	1. Develop a digital logic and apply it to solve real life problems. 2. Analyse, design and implement combinational logic circuits. 3. Classify different semiconductor memories. 4. Analyse, design and implement sequential logic circuits. 5. Analyse digital system design using PLD. 6. Simulate and implement combinational and sequential circuits using VHDL.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Number Systems and Codes	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Binary code, Gray code and BCD code, Binary Arithmetic, Addition, Subtraction using 1’s and 2’s Complement.	1	--	04
2. Logic Family and Logic Gates	2.1 Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics.	1	02	05
	2.2 Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan’s Theorem.		03	
3. Combinational Logic Circuits	3.1 SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions.	2	04	12
	3.2 Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder,		04	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Magnitude Comparator.			
	3.3 Multiplexer and De-Multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder.		04	
4. Sequential Logic Circuits	4.1 Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO and Universal Shift Register.	4	04	12
	4.2 Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD N, BCD Counter.		04	
	4.3 Applications of Sequential Circuits: Frequency division, Ring counter, Johnson counter, Introduction to design of Moore and Mealy circuits.		04	
5.Different Types of Memories and Programmable Logic Devices	5.1 Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	3	01	04
	5.2 Introduction: Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL).	5	03	
6. Introduction to VHDL	Basics of VHDL/Verilog Programming, Design and implementation of Adder, Subtractor, multiplexer and flip flop using VHDL/Verilog.	6	--	02
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. John F. Warkerly, "Digital Design Principles and Practices", Pearson Education, Fifth Edition (2018). 2. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education, Fifth Edition (2013). 3. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill Education, Fourth Edition (2010). 4. A. Anand Kumar, "Fundamentals of Digital Circuits", PHI, Fourth Edition (2016). 5. Volnei A. Pedroni, "Digital Electronics and Design with VHDL" Morgan Kaufmann Publisher, First Edition (2008). 6. Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Third Edition, MGH (2014). Stochastic Processes", Tata McGraw Hill Education
Reference Books	1. Thomas L. Floyd, "Digital Fundamentals", Pearson Prentice Hall, Eleventh Global Edition (2015). 2. Mandal, "Digital Electronics Principles and Applications", McGraw Hill Education, First Edition (2010). 3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss "Digital Systems Principles and Applications", Ninth Edition, PHI (2009). 4. Donald P. Leach / Albert Paul Malvino/Gautam Saha, "Digital Principles and Applications", The McGraw Hill, Eight Edition (2015). 5. Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic Design with VHDL", Second Edition, TMH (2009). 6. J. Bhasker, "A Verilog HDL Primer", Star Galaxy Press, Third Edition (1997)
Useful Links:	1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee70/preview

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC303	Electronic Devices and Circuits	3+0+0
Prerequisite:	Basic Electrical Circuits	
Course Objectives:	1. To explain the physics of semiconductor devices. 2. To explain the working Principle of Devices and circuits. 3. To demonstrate analysis of Devices and Circuits. 4. To introduce Modelling of Electronic Devices.	
Course Outcomes:	After successful completion of the course, student will be able to 1. Evaluate Electrical/physical parameters from energy band diagram of devices. 2. Define Various parameter, specifications of Electronics circuits 3. Compare Model of semiconductor devices 4. Analyse Electronic amplifier Circuits 5. Design Amplifier circuits for given specification. 6. Compare various types of amplifiers.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Introduction of Electronic Devices	1.1 Review of Energy Band Diagram, Carrier statistics and Thermal Equilibrium, Carrier transport: drift diffusion , Generation and Recombination	1	02	04
	1.2 PN Junction diodes , current equation, Zener diode, Voltage regulator, BJT and MOSFET construction, Band diagram of these devices	1, 2	02	
2. Biasing Circuits of BJTs and MOSFETs	2.1 Concept of DC load line, DC models, Q point and regions of operations, Analysis and design of biasing circuits for BJT (Fixed bias & Voltage divider Bias) DC load line and region of operation for MOSFETs.	2, 3	02	06
	2.2 Analysis and design of biasing circuits for JFET (self-bias and voltage divider bias), E-MOSFET (Drain to Gate bias & voltage divider bias).	3, 4	04	
3. Small Signal Amplifiers	3.1 Concept of AC load line and Amplification, Small signal analysis (Zi, Zo, Av and Ai) of CE amplifier using hybrid pi model	3	03	09

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	3.2 Small signal analysis (Zi, Zo, Av) of CS (for EMOSFET) amplifiers. Introduction to multistage amplifiers. (Concept, advantages & disadvantages).	3, 4, 6	06	
4. Frequency response of Small signal Amplifiers	4.1 Effects of coupling, bypass capacitors and parasitic capacitors on frequency response of single stage amplifier, Miller effect and Miller capacitance	4	05	09
	4.2 High and low frequency analysis of CS, CE amplifier.	3, 4, 6	04	
5. Large Signal Amplifiers	5.1 Classification and working of Power amplifier	6	02	05
	5.2 Analysis of Class A power amplifier (Series fed and transformer coupled).	4	01	
	5.3 Transformerless Amplifier: Class B power amplifier. Class AB output stage with diode biasing	6	02	
6. MOSFET amplifiers	6.1 Introduction of Differential Amplifier and its configurations(EMOSFET), Small signal Analysis	4	02	06
	6.2 Differential and common mode gain, CMRR, differential and common mode Input impedance, Current sources using 2 transistor	2	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. D. A. Neamen, “Electronic Circuit Analysis and Design,” Tata McGraw Hill, 2nd Edition. 2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, “Microelectronic Circuits Theory and Applications,” International Version, OXFORD International Students, 6th Edition
Reference Books	1. Boylestad and Nashelesky, “Electronic Devices and Circuits Theory,” Pearson Education, 11th Edition. 2. A. K. Maini, “Electronic Devices and Circuits,” Wiley. 3. T. L. Floyd, “Electronic Devices, ”Prentice Hall, 9th Edition, 2012
Useful Links:	
1. https://www.falstad.com/circuit/ 2. https://youtu.be/sKmSqjNvGH8	

Term Work:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC304	**Electronic Instrumentation & Control Systems**	**3+0+0**

Prerequisite:	1. Basic Electrical Engineering 2. Applied Physics
Course Objectives:	1. To provide basic knowledge about the various sensors and transducers 2. To provide fundamental concepts of control system such as mathematical modelling, time response and Frequency response 3. To develop concepts of stability and its assessment criteria.
Course Outcomes:	1. Identify various sensors, transducers and their brief performance specification 2. Understand the principle of working of various transducer used to measure temperature, displacement, level, pressure and their application in industry 3. Determine the models of physical systems in forms suitable for use in the analysis and design of control systems 4. Obtain the transfer functions for a given Control system 5. Understand the analysis of systems in the time domain and frequency domain. 6. Predict stability of a given system using appropriate criteria.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Principle of Measurement, Testing and Measuring instruments	1.1 Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration	1	02	04
	1.2 Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Megohm bridge. Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge		02	
2. Sensors and Transducers	2.1 Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers	2	02	06
	2.2 Displacement and pressure- Potentiometers, pressure gauges, Linear Variable Differential Transformers (LVDT) for		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	measurement of pressure and displacement strain gauges			
	2.3 Temperature Transducers- Resistance Temperature Detectors (RTD). Thermistors and thermocouples, their ranges and applications		02	
3. Introduction to control system Analysis	3.1 Introduction: Open and closed loop systems, example of control systems, Introduction of Adaptive Control System	3	01	08
	3.2 Modelling: Modelling OF Electrical System, Transfer function model		02	
	3.3 Block diagram reduction techniques and Signal flow graph		05	
4. Response of control system	4.1 Dynamic Response: Standard test signals, transient and steady state behaviour of first and second order systems, steady state errors in feedback control systems and their types.	4	02	04
	4.2 Concept of lag and lead compensator		02	
5. Stability Analysis in Time Domain	5.1 Concept of stability: Routh and Hurwitz stability criterion.	5	02	08
	5.2 Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system		06	
6. Stability Analysis in frequency domain	6.1 Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	6	03	09
	6.2 Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using bode plot. Frequency response analysis of RC, RL, RLC circuits		04	
	6.3 Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion, gain and phase margin		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation"* – DRS. India 2. B.C Nakra, K.K. Chaudhary, Instrumentation Measurement and Analysis, Tata Mc Graw Hill. 3. W.D. Cooper, "*Electronic Instrumentation and Measuring Techniques"* –PHI 4. Nagrath, M. Gopal, "*Control System Engineering*", Tata McGraw-Hill
Reference Books	1. Helfrick & Cooper, "*Modern Electronic Instrumentation & Measuring Techniques"* – PHI 2. M.M.S. Anand, "*Electronic Instruments and Instrumentation Technology".* 3. Gopal M., "*Control Systems Principles and Design*", Tata McGraw Hill Publishing Co. Ltd. New Delhi, 1998 4. Benjamin C. Kuo, "*Automatic Control Systems*, Pearson Education", VIIth edition
Useful Links:	
NPTEL/ Swayam Course: Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras); https://swayam.gov.in/nd1_noc20_ee90/preview	

Continuous Assessment (CA) :

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC305	**Electrical Network Theory**	**2+0+0**
Prerequisite:	1. Basic Electrical Engineering 2. Matrix (Engineering Mathematics-I), Solutions to Differential Equation, Integration (Engineering Mathematics- II), Laplace Transform (Applications of Mathematics in Engineering -I)	
Course Objectives:	1. To explain the basic concepts and Theorems of electrical networks with Dependent Source and solve them using mesh and nodal analysis techniques 2. To introduce students with the fundamental concepts in graph theory 3. To analyse the Circuits in Time and Frequency domain 4. To introduce open circuit, short circuit, transmission, hybrid parameters. 5. To study concepts of driving point and transfer functions, poles and zeros, Hurwitz polynomial of Network Functions. 6. To study positive real functions from given functions.	
Course Outcomes:	After successful completion of the course, student will be able to 1. Articulate knowledge in analysing Circuits by using Network theorems with Dependent source. 2. Illustrate the complex electric circuits by converting them into Graph Theory. 3. Apply Time domain and frequency domain analysis of RLC Circuits 4. Synthesize the various parameters of two port network 5. Recognize Hurwitz polynomials from a given function. 6. Integrate positive real function from given function	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	01	01
1. Analysis of DC circuits	1.1 Analysis of DC circuits: Analysis of circuits with dependent sources using generalized Mesh, Node, Super mesh, Super node analysis.	1	02	07
	1.2 Circuit Theorems: Superposition Theorem, Thevenin Theorem, Norton Theorem, Maximum Power transfer Theorem. (Use only DC source).	1	04	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	1.3 Magnetic Circuits: Concept of Self and mutual inductances, Coefficient of Coupling, dot convention, equivalent circuit.	1	01	
2. Graph Theory	2.1 Concept of Node and Loop, Tree, Co-tree, Incidence matrix: Complete Incidence matrix, Reduced Incidence matrix, number of possible trees of graph	2	02	04
	2.2 Cut Set Matrix and Tie Set Matrix	2	02	
3. Time domain and frequency domain analysis of R-L-C Circuits	3.1 Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values. Solution using first order and second order differential equations with step signals.	3	03	06
	3.2 Frequency domain analysis of R-L-C Circuits: Forced and natural response, Solution using second order equation for step signal (One Loop or Node), Effect of damping factor (No Numerical)	3	03	
4. Two port Networks	4.1 Open Circuit, Short Circuit, and Transmission and Hybrid parameters.	4	03	04
	4.2 Relationships among parameters (No Derivations), reciprocity and symmetry conditions	4	01	
5. Network Function	Driving point and Transfer function, Poles and Zeros of Network functions, Properties of Hurwitz Polynomials, Testing for Hurwitz polynomials.	5	--	03
6. Positive Real Functions	Properties of Positive Real Functions, Necessary and sufficient conditions for positive real functions. Testing for positive real functions.	6	--	02
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	--	01	01
			Total:	**28**

Books:	
Text Books	1. Franklin F Kuo, "Network Analysis and Synthesis", Wiley Toppan, 2^{nd} edition, 1966. 2. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 26^{th} Indian Reprint, 2000
Reference Books	1. A. Sudhakar, Shyam mohan S. Palli "Circuits and Networks", Tata McGraw-Hill education, 2010 2. Smarajit Ghosh "Network Theory Analysis & Synthesis", PHI learning 3. K.S. Suresh Kumar, "Electric Circuit Analysis" Pearson, 2013. 4. D. Roy Choudhury, "Networks and Systems" , New Age International, 1998 5. C. K. Alexander and M. N. O. Sadiku," Fundamental of Electric Circuit" McGraw Hill Education, India, 2013
Useful Links:	
1. Analog signals, Network and measurement Virtual Laboratory: vlabs.iitkgp.ac.in/asnm/#	

Continuous Assessment (CA) :

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	10 marks
2.	Class Test 2	10 marks
3.	Internal Assessment	10 marks

Class Tests (20-Marks): Test-1 and Test-2 consists of two class tests of 10 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be – 45 Minutes.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 45 Marks with Two hour duration.

Lab Code	Lab Name	Credits (P+TUT)
1UEXL302	**Digital Logic Design Laboratory**	**1+0**

Lab Prerequisite:	1. Basics of Electrical Engineering(1UBSC105) 2. Engineering Physics(1UBSC102)
Lab Objectives:	1. To understand number system representations and their inter-conversions used in digital electronic circuits. 2. To analyse digital logic processes and to implement logical operations using various combinational logic circuits. 3. To analyse, design and implement logical operations using various sequential logic circuits. 4. To study the characteristics of memory and their classification. 5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.
Lab Outcomes:	1. Verify logic gates. 2. Implement combinational logic circuits. 3. Implement sequential logic circuits. 4. Simulate basic logic gates using VHDL. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1.	Verify operations of logic gates and Boolean function.	1, 5, 6	02
2.	Verify operations of universal gates NAND and NOR.	1, 5, 6	02
3.	Implement and design Binary to Gray and Gray to Binary.	1, 5, 6	02
4.	Implement and design half adder & subtractor and full adder & subtractor circuits.	2, 5, 6	02
5.	Implement and design BCD Adder.	2, 5, 6	02
6.	Design and Implement logic equation using multiplexer.	2, 5, 6	02
7.	Implement and Design digital Encoder circuit.	1, 5, 6	02
8.	Design and verify the truth table of various flip flops (FF) like SR, JK, D and T flip-flops.	3, 5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
9.	Simulate AND, OR and NAND logic gate operation using Verilog Hardware Description Language.	4, 5, 6	02
10.	Simulate Decoder using VHDL code.	5, 6	02
11.	Simulate positive edge triggered D flip flop with asynchronous active low preset and clear using VHDL code.	5, 6	02
12.	Simulate the counter using VHDL code.	5, 6	02
13.	Case Study / Mini Project	1 to 6	02
		Total	**28**

Useful Links:
1. http://vlabs.iitkgp.ac.in/dec/#

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Practical examination will be based on the experiment list and content of the entire theory syllabus.

Lab Code	Lab Name	Credits (P+TUT)
1UEXL303	**Electronic Devices & Circuits Laboratory**	**1+0**

Hardware Requirements:	PC With following Configuration 1. Intel Dual core Processor or higher 2. Minimum 4 GB RAM 3. Minimum 40 GB Hard disk
Software Requirements:	1. Windows / Linux Desktop OS 2. NGSpice Software 3. LTspice Circuit Simulation Software
Lab Prerequisite:	1. Basic Electrical Engineering Lab
Lab Objectives:	1. To physical Implementation of given circuit 2. To introduce simulation of Electronic circuits 3. To troubleshoot the Electronic circuit 4. To create new circuits for given application
Lab Outcomes :	Student Will be able to 1. Assemble components and measuring devices using bread board as per the circuit diagram for experiment to be performed. 2. Perform experiment to gather appropriate data 3. Analyse data obtained from experiment to relate theory with experiment results 4. Explain functionality of various equipments, electronics devices and components and instruments used to perform laboratory work 5. Write accurate documentation for experiments performed. **6.** Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1.	Introduction to Lab equipment and Simulation tools	1, 5, 6	02
2.	To study P-N junction diode characteristics. Simulation experiment on multistage amplifier.	2, 3, 4, 5, 6	02
3.	To study Zener as a voltage regulator	2, 3, 4, 5, 6	02
4.	To study characteristics of CE configuration	2, 3, 4, 5, 6	02
5.	To study BJT biasing circuits	2, 3, 4, 5, 6	02
6.	To study BJT as CE amplifier	2, 3, 4, 5, 6	02
7.	To study frequency response of CE amplifier	2, 3, 4, 5, 6	02
8.	To study E-MOSFET biasing circuits	2, 3, 4, 5, 6	02
9.	Simulation experiment on study of CS amplifier	2, 3, 4, 5, 6	02
10.	Simulation experiment on study frequency response of CS amplifier	2, 3, 4, 5, 6	02
11.	Simulation experiment on study of differential amplifier	2, 3, 4, 5, 6	02
12.	Implementation of application based on BJT	2, 3, 4, 5, 6	02
13.	Implementation of application on MOSFET	2, 3, 4, 5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
		Total:	**28**

Useful Links:

1. http://vlabs.iitkgp.ernet.in/be/
2. https://www.falstad.com/circuit/

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Oral examination will be based on the experiment list and content of the entire theory syllabus.

Lab Code	Lab Name	Credits (P+TUT)
1UEXL304	**Electronic Instrumentation and Control System Lab**	**1+0**

Lab Prerequisite:	1. Basic Electrical Engineering 2. Applied Physics
Lab Objectives:	1. To experimentally verify the principle and characteristics of various transducers and measurement of resistance and inductance 2. To make students understand the construction and the working principle of various transducers used for Displacement measurement, Temperature measurement and Level measurement. 3. To examine steady-state and frequency response of the Type 0, 1, and 2 systems 4. To examine steady-state and frequency response of first and second order electrical systems. 5. To inspect stability analysis of a system using Root locus, Bode plot, polar plot and Nyquist plot.
Lab Outcomes:	1. Analyse Plot and validate the performance characteristics of transducers. 2. Validate the characteristics of various temperature, pressure and level transducers. 3. Analyse Plot frequency response of first-order electrical system. 4. Analyse Plot time response of second-order electrical systems and calculate the steady-state error. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1.	Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)	1, 5, 6	02
2.	Designing AC bridge Circuit for capacitance measurement.	1, 5, 6	02
3.	Study and characteristics of Resistive Temperature Detector (RTD).	2, 5, 6	02
4.	Study of Linear Variable Differential Transformer (LVDT)	2, 5, 6	02
5.	To plot the effect of time constant on first-order systems response.	3, 5, 6	02
6.	To plot the frequency response of first-order System	3, 5, 6	02
7.	To plot the time response of second-order systems	3, 5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
8.	To plot the frequency response of second-order System	3, 5, 6	02
9.	To Examine Steady State Error for Type 0, 1, 2 System	4, 5, 6	02
10.	To study the performance of Lead and Lag Compensator	4, 5, 6	02
11.	To inspect the relative stability of systems by Root-Locus using Simulation Software	3, 5, 6	02
12.	To determine the frequency specification from Polar plot of system	4, 5, 6	02
13.	To inspect the stability of system by Nyquist plot using Simulation software	4, 5, 6	02
14.	To inspect the stability of the system by Bode plot using Simulation software.	3, 5, 6	02
15.	Any other experiment based on syllabus which will help students to understand the topic/concept.		02
		Total	**32***
***Minimum 28 Hrs. Lab / Mini Project to be conducted**			

Useful Links:

1. http://slcoep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering
2. http://vlabs.iitkgp.ernet.in/asnm/#

Term work:

1. Term work should consist of a minimum of 8 experiments.

2. Journal must include assignments on content of theory and practical of the course.

3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Course code	Project Based Learning	Credits (TH+P+TUT)
1UEXPR31	**Mini Project Lab-I**	**0+1+0**

Objectives:
1. To acquaint yourself with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.
Outcomes:
Learner will be able to… 1. Identify problems based on societal /research needs. 2. Design solutions or system components or processes that meet the specified needs 3. Select appropriate tools to implement the project 4. Develop interpersonal skills to work as a member of a group or leader. 5. Excel in written and oral communication. 6. Demonstrate project management principles during project work 7. Demonstrate capabilities of investigation and self-learning by oneself or as a team gaining life skills

General Guidelines for Mini Project I and II:	
1	Students shall form a group of 2 to 3 students, while forming a group shall not be allowed less than two or more than four students, as it is a group activity.
2	Students should do surveys and identify needs, which shall be converted into problem statements for mini projects in consultation with faculty supervisor/internal committee of faculties.
3	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
4	A logbook to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.
7	Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of the college.

General Guidelines for Mini Project I and II:	
9	With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project ideas in even semester. This policy can be adopted on a case by case basis.

One-year project:	
1	In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group. ▪ First shall be for finalization of problem ▪ Second shall be on finalization of the proposed solution of the problem.
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ▪ First review is based on readiness of building working prototypes to be conducted. ▪ Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.
Half-year project:	
1	In this case in one semester students' group shall complete project in all aspects including, ▪ Identification of need/problem ▪ Proposed final solution ▪ Procurement of components/systems ▪ Building prototype and testing
2	Continuous assessment will be weekly based on a logbook. Two presentations will be conducted for review before a panel. ▪ First shall be for finalization of problem and proposed solution ▪ Second shall be for implementation and testing of solutions.

Assessment criteria of Mini Project – I and II Term Work:	
Mini Project shall be assessed based on following criteria;	
1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness
8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements
10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individual's as member or leader
13	Clarity in written and oral communication
In **one year, project**, first semester evaluation may be based on the first six criterias and the remaining may be used for the second semester evaluation of performance of students in the mini project.	
In the case of a half **year project** all criteria in generic may be considered for evaluation of performance of students in a mini project.	
Guidelines for Assessment of Mini Project – I and II Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the Head of Institution.
3	Students shall be motivated to participate in poster, project competition on the work in students' competitions.
Mini Project shall be assessed based on following points:	
1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication

Project Based Learning Code	Project Based Learning Course Name	Credits (TH+P+TUT)
1UEXPR31	**Mini Project Lab-I**	**0+1+0**
Mini Project Prerequisite:	1. Basics of Electrical Engineering (1UBSC105)	
Mini Project Objectives:	1. To make students familiar with the basics of electronic devices and circuits, electrical circuits and digital systems 2. To familiarize the students with the designing and making of Printed circuit boards(PCB) 3. To improve the knowledge of electronics hardware among students	
Mini Project Outcomes:	After successful completion of the course student will be able to: 1. Create the electronics circuit for a particular application/experiment. 2. Design and simulate the circuits by putting together the analog and digital components 3. Learn the technique of soldering and circuit implementation on general purpose printed circuit board (GPP). 4. Realize the PCB design process and gain up-to-date knowledge of PCB design software. 5. Utilize the basic electronic tools and equipment (like DMM, CRO, DSO etc.) 6. Analysis of hardware fault (Fault detection and correction	

Module No. &Name	Sub Topic	PRO Mapped	Hrs/ Sub Topic	Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Identification and Designing of Circuit	1.1 Identification of a particular application with understanding of its detailed operation. Study of necessary components and devices required to implement the application.	1	02	04
	1.2 Designing the circuit for particular application (either analog, digital, electrical, analog and digital, etc.)		02	
2. Software simulation and Implementation on GPP	2.1 Simulation of circuit for particular application using software's to verify the expected results	2	02	06
	2.2 Implementation of verified circuit on general purpose printed circuit board(GPP). Now Verify the hardware results by using electronic tools and equipment like millimeter, CRO, DSO etc.		04	

Module No. &Name	Sub Topic	PRO Mapped	Hrs/ Sub Topic	Hrs/ Module
3. PCB design and optimization	3.1 Design the circuit by placing components using PCB design software.	3	02	04
	3.2 Reduce the size of PCB by varying the position of components or devices for optimize use of copper clad material		02	
4. Implementation of PCB	4.1 Transfer the designed PCB on Copper clad either by using a dark room or taking printout on glossy paper, etc. (use available suitable method).	4	02	04
	4.2 Perform Etching and then Soldering.		02	
5. Detection of Hardware faults and Result verification	5.1 Identify the hardware faults in designed circuit and subsequently rectify it	5	02	04
	5.2 Now again verify the hardware results by using electronic tools and equipments like millimeter, CRO, DSO etc.		02	
6. Understanding the Troubleshooting	6.1 Understand the trouble shooting by removing some wired connection.	6	02	04
	6.2 Understand the trouble shooting of track. Troubleshoot the faulty components or devices		02	
			Total:	**28**

NOTE:

During 1st week or within 1-month of the beginning of the semester, following topics should be covered as theoretical concepts.

a. Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.

b. Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.

c. Components selection and material related to PCB

d. Understanding about the PCB fabrication steps in Industrial Application

Useful learning Links:

Suggested Software tools:

1. LTspice:https://www.analog.com/en/design-center/design-tools-andcalculators/ltspice-simulator.html#
2. Eagle : https://www.autodesk.in/products/eagle/overview
3. OrCAD: https://www.orcad.com/
4. Multisim : https://www.multisim.com/
5. Webbench:http://www.ti.com/design-resources/design-tools-simulation/webenchpower-designer.html
6. Tinkercad : https://www.tinkercad.com/

Online Repository:
1. https://www.electronicsforu.com
2. https://circuitdigest.com
3. https://www.electronicshub.org

Term Work (25 Marks):

The review/ progress monitoring committee shall be constituted by senior faculty members. The progress of the mini project to be evaluated on a continuous basis, minimum two reviews in each semester. Assessment also considers peer review and ethics observed by faculties and participation involvement.

In continuous assessment focus shall also be on each individual student, log book maintained and weekly meeting based on the same.

Distribution of Term work marks for both semesters shall be as below:		**Practical Marks**
1	Marks awarded by guide/supervisor based on implementation	10
2	Peer assessment by team members	05
3	Marks awarded by review committee	05
4	Quality of Project report	05

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

Skill Based Learning Code	Skill Based Learning - III	Credits (TH+P+TUT)
1UEXXS33	**C++ and Java Programming**	**0+1+0**
Skill Prerequisite:	1. C-Programming (Structured Programming Approach)	
Skill Objectives:	1. To describe the principles of Object Oriented Programming (OOP) 2. To describe and understand decision making, looping structure for effective programming 3. To understand and apply concept of classes and objects, inheritance and interfaces 4. To understand and develop program using multithreading and Applet	
Skill Outcomes:	1. Apply the basic principles of OOP. 2. Apply decision making, looping structure for effective programming. 3. Implement the concept of classes and objects, inheritance and interfaces 4. Apply the concept of multithreading in object oriented programming and Using Applet solve real world problems. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Module No.	Module Title	SO Mapped	Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
Write C++ Program to			
1.	Print Number Entered by User	1	02
2.	Swap Two Numbers	1	02
3.	Check Whether Number is Even or Odd	2	02
4.	Find Largest Number Among Three Numbers	2	02
5.	Create a Simple class and Object	3	02
6.	Create an object of a class and access class attributes	3	02
7.	Create class methods	3	02
8.	Create a class to read and add two distance	3	02
9.	Create a class for student to get and print details of a student	3	02
10.	Demonstrate an example of friend function with class.	3	02
11.	Implement inheritance.	3	02
Write JAVA Program to			
1.	Display addition of number using command line	1	02

Module No.	Module Title	SO Mapped	Hrs/ Module
	Argument		
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail”	1	02
3	Write a program to demonstrate call by value and call by reference.	3	02
4	Display sum of first 10 even numbers using do-while loop.	2	02
5	Display Multiplication table of 15 using while loop	2	02
6	Display basic calculator using Switch Statement.	2	02
7	Write a program to find the factorial of a number, using a recursive function.	3	02
8	Illustrate method of overloading	3	02
9	Demonstrate Parameterized Constructor	3	02
10	Write a program to find the area of a circle using Single Inheritance such that the base class method accepts the radius and the derived class method calculates and displays area.	3	02
11	Create thread by implementing 'runnable' interface or creating 'Thread Class	4	02
12	Write an applet to draw different shapes using colors (Applet)	4	02
		Total	**48***

***Minimum 28 Hrs. Lab / Mini Project to be conducted**

Text Books:

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

Reference Books:

1. Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, Ninth Edition.
2. Java: How to Program, 8/e, Dietal, PHI
3. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Languageser Guide”, Pearson Education
4. Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010.

Useful Links:

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

Term Work (25 Marks):

Term Work shall be awarded based on Assessment Rubrics.

Activity Based Learning Code	Activity Based Learning - IV	Credits (TH+P+TUT)
1UEXXA34	1. Innovation and Creativity/ 2. Study of World's top 2 problems/ 3. How Does the Government Work? [Study of one department of the Central/ State Government]	**0+1+0**
Prerequisite:	Knowledge of Problems and Issues of the National, Global, Societal and Environmental Issus that need attention.	
ABL Objectives:	1. To identify and describe various social, Environmental, Economic, Political, educational, Agricultural, Governance related issues and problems. 2. To plan and prepare a structured or unstructured survey or study methodology to have an in-depth analysis of the issues and problems to carry out the activity. 3. To compare and contrast social, ethical, environmental and legal issues surrounding the subject of study. 4. To analyse and suggest solutions to the existing issues, modify and improve the existing problems.	
ABL Outcomes:	1. Define the areas of problems and issues by forming specific statements. 2. Analyse the collected data to propose solutions to solve the issues. 3. Demonstrate critical and innovative thinking. 4. Display competence in oral and visual communication. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Guidelines for Activity Based Learning:

1. Students shall form a group of 2 to 3 students, while forming a group shall not be allowed less than 2 or more than 3 students, as it is a group activity.
2. Students can select any One activity/Topic from the given activity list.
3. Students should do surveys and collect information on the given problems/topics in the activity head.
4. Faculty supervisor is allotted to a group of 20 to 25 students (based on number of students enrolled for one activity) and supervisor may give inputs to students during activity; however, focus shall be on self-learning.
5. The faculty supervisor will monitor the activities and documentation of the students assigned to them.
6. Students in a group shall discuss the problems effectively and propose multiple solution for selected problem.
7. Professional Committee will arrange Two to Three Guest lecture based on the problem/Topic in the activity head so that student will get more idea about the Topic selected.
8. The marks will be assigned by the faculty supervisor according to the Assessment Rubrics.
   The marks are to be submitted to the respective Departments and the Departments will submit them to the Exam Section.

Activity No	Activity Title	Activity Outcome Mapped	Hrs
1	Guest lecture to introduce Topic selected in Activity-Based learning	1	2
2	Guest Lecture	1	2
3	Selection of any Two Problems	2,6	2
4	Group Discussion with other students	2,4,6	2
5	Presentation	2,4,6	2
6	Presentation	2,4,6	2
7	Presentation	3,6	2
8	Find out solution for selected problem	3,6	2
9	Group Discussion with other students	2,4,6	2
10	Presentation	3,4,6	2
11	Presentation	3,4,6	2
12	Presentation	3,4,6	2
13	Report submission	5,6	2
14	Course recap, Outcomes, Summarization	-	2
		Total	**28**

Term Work (25 Marks):
Marks will be awarded based on designed Assessment Rubrics which includes the following; 1 Identification of problem and solution 2 Attendance of Seminars/relevant sessions 3 Submission of Report/demo/act etc. 4 Presentation of Surveys/Case study

Program Structure for Second Year UG Technology (ET)

Semester-IV-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
1UEXC401	Applications of Mathematics in Engineering-II	3– 0 –1	04	3 – 0 – 1	04	BS
1UEXC402	Microcontrollers	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC403	Linear Integrated Circuits	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC404	Principles of Communication Engineering	3 – 0 – 0	03	3 – 0 – 0	03	PC
1UEXC405	Signals and Systems	3 – 0 – 0	03	3 – 0 – 0	03	PC
1UEXL402	Microcontrollers Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL403	Linear Integrated Circuits Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL404	Principles of Communication Engineering Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXPR42	Project Based Learning-Mini Project Lab-II	0 – 2 – 0	02*	0 – 1 – 0	01	PBL
1UEXXS45	Skill Based Learning – V	0 – 2* - 0	02	0 – 1 – 0	01	SAT
1UEXXA46	Activity Based Learning - VI	0 – 2* - 0	02	0 – 1 – 0	01	SAT
Total		**15– 12– 01**	**28**	**15 - 06 - 01**	**22**	

$Class-wise tutorials ***Load of learner, not the faculty** ***SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.**

Semester-IV Examination Scheme

Course Code	Course Name	Examination Scheme								
		Marks								
		CA			ESE	TW	O*	P	P&O	Total
		T1	T2	IA						
1UEXC401	Applications of Mathematics in Engineering-II	15	15	10	60	25	-	-	-	125
1UEXC402	Microcontrollers	15	15	10	60	-	-	-	-	100
1UEXC403	Linear Integrated Circuits	15	15	10	60	-	-	-	-	100
1UEXC404	Principles of Communication Engineering	15	15	10	60	-	-	-	-	100
1UEXC405	Signals and Systems	15	15	10	60	-	-	-	-	100
1UEXL402	Microcontroller Laboratory	-	-	-	-	25	25	-	-	50
1UEXL403	Linear Integrated Circuits Laboratory	-	-	-	-	25	-	25	-	50
1UEXL404	Principles of Communication Engineering Laboratory	-	-	-	-	25	-	25	-	50
1UEXPR42	Project Based Learning-Mini Project Lab-II	-	-	-	-	25	-	25	-	50
1UEXXS45	Skill Based Learning- V	-	-	-	-	25	-	-	-	25
1UEXXA46	Activity Based Learning -VI	-	-	-	-	25	-	-	-	25
Total		**75**	**75**	**50**	**300**	**125**	**25**	**75**	**-**	**775**

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC401	**Applications of Mathematics in Engineering -II**	**3+0+1**
Prerequisite:	1. Engineering Mathematics-I 2. Engineering Mathematics-II 3. Applications of Mathematics in Engineering-I & Binomial Distribution	
Course Objectives:	1. To understand line and contour integrals and expansion of complex valued functions in a power series. 2. To understand the basic techniques of statistics for data analysis, Machine learning and AI. 3. To understand probability distributions and expectations. 4. To understand the concepts of vector spaces used in the field of machine learning and engineering problems. 5. To understand the concepts of Quadratic forms and Singular value decomposition. 6. To understand the concepts of Calculus of Variations.	
Course Outcomes:	1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals. 2. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI. 3. Apply the concepts of probability and expectation for getting the spread of the data and distribution of probabilities. 4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems. 5. Use the concept of Quadratic forms and Singular value decomposition which are very useful tools in various Engineering applications. 6. Find the externals of the functional using the concept of Calculus of variation	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Complex Integration	1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof)	1	03	07
	1.2 Taylor's and Laurent's series (without proof).		02	
	1.3 Definition of Singularity, Zeroes, poles of f(z), Residues, Cauchy's Residue Theorem (without proof).		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Statistical Techniques	2.1 Cla Karl Pearson's Coefficient of correlation (r)	2	01	06
	2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks)		01	
	2.3 Lines of regression		02	
	2.4 Fitting of first and second degree curves		02	
3. Probability Distributions	3.1 Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function	3	02	07
	3.2 Expectation, mean and variance		02	
	3.3 Probability distribution: Poisson & normal distribution		03	
4. Linear Algebra: Vector Spaces	4.1 Vectors in n-dimensional vector space, norm, dot product, The Cauchy-Schwarz inequality (with proof), Unit vector	4	02	06
	4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors		02	
	4.3 Vector spaces over real field, Subspaces.		02	
5. Linear Algebra: Quadratic Forms	5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation.	5	01	07
	5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value class of a quadratic form-Definite, Semi definite and Indefinite		02	
	5.3 Reduction of Quadratic form to a canonical form using congruent transformations		02	
	5.4 Singular Value Decomposition		02	
6. Calculus of Variations	6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'	6	02	06
	6.2 Isoperimetric problems- Lagrange Method		02	
	6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method		02	
ii. Course	Recap of Modules, Outcomes, Applications,	-	01	01

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Conclusion	and Summarization			
			Total:	**42**

Books:	
Text Books	1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication 2. Advanced engineering mathematics H.K. Das, S. Chand, Publications. 3. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication.
Reference Books	1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education. 2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education. 3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication 4. Advanced Engineering Mathematics Wylie and Barret, Tata McGraw Hill. 5. Beginning Linear Algebra Seymour Lipschutz Schaum's outline series, Mc-Graw Hill Publication
Useful Links:	1. https://nptel.ac.in/courses/111/108/111108066/ 2. https://nptel.ac.in/courses/111/103/111103070/ 4. https://nptel.ac.in/courses/111/105/111105041/ 5. https://www.coursera.org/learn/complex-analysis

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment (IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)

1UEXC402	Microcontrollers	3+0+0
Prerequisite:	Digital System Design	
Course Objectives:	1. To develop background knowledge of Computers and its memory System. 2. To understand the architecture of 8051 and ARM7 core. 3. To write programs for 8051 microcontrollers. 4. To understand the design of Microcontroller and ARM Applications.	
Course Outcomes:	1. Outline Microcomputer system and various microcomputers architecture model 2. Outline Memory System concept of microcomputer 3. Outline the detailed architecture of 8051. 4. Write programs for 8051 microcontrollers and Interface various peripheral devices to the microcontrollers. 5. Outline the detailed architecture of ARM7 Core. 6. Write Assembly language and Embedded C program for microcontrollers.	

Module No. & Name		Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline		Prerequisite Concepts and Course Introduction.	-	02	02
1. Overview of Microcomputer based System	1.1	Overview of microcomputer systems and their building blocks, Memory	1	01	05
	1.2	Interfacing, Steps taken by the microprocessor to fetch and executes an instruction from the memory		01	
	1.3	Concepts of Program counter register, Reset, Stack and stack pointer , Subroutine, Interrupts and Direct Memory Access		01	
	1.4	Concept of RISC & CISC Architecture		01	
	1.5	Harvard & Von Neumann Architecture		01	
	1.6	Comparison between Microprocessor and Microcontroller, Applications of microcontrollers			
2. The Memory Systems	2.1	Classification of Memory : Primary and Secondary	2	01	04
	2.2	Types of Semiconductor memories		01	

Module No. & Name	Sub Topics		CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.3	Cache Memory		01	
	2.4	Virtual Memory Concept with Memory Management Unit with Segmentation and Paging (Address Translation Mechanism)		01	
3. 8051 Microcontroller	3.1	Features, architecture and pin configuration	3	02	08
	3.2	CPU timing and machine cycle		01	
	3.3	Input / Output ports		01	
	3.4	Memory organization		01	
	3.5	Counters and timers		01	
	3.6	Interrupts		01	
	3.7	Serial data input and output		01	
4. 8051 Assembly Language Programming and Interfacing	4.1	Addressing modes	4	01	10
	4.2	Instruction set		01	
	4.3	Need of Assembler & Cross Assemble, Assembler Directives		01	
	4.4	Programs related to: arithmetic, logical, delay subroutine , input, output, timer, counters, port, serial communication, and interrupts		04	
	4.5	Interfacing with LEDs, Relay and Keys, LCD and Seven Segment Display		03	
5. ARM7	5.1	Introduction & Features of ARM 7	5	01	08
	5.2	Concept of Cortex-A, Cortex-R and Cortex-M		01	
	5.3	Architectural inheritance, Pipelining		02	
	5.4	Programmer’s model		01	
	5.5	Brief introduction to exceptions and interrupts handling		01	

Module No. & Name	Sub Topics		CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	5.6	Instruction set: Data processing, Data Transfer, Control flow		02	
6. ARM Programming with Embedded C	6.1	General Purpose Input Output	6	01	04
	6.2	Timer Mode		01	
	6.3	Pulse–Width Modulator Configuration		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization		-	01	01
				Total:	**42**

Books:	
Text Books	1. C. Kenneth J. Ayala and D. V. Gadre, "The 8051 Microcontroller & Embedded system using assembly & 'C' ", Cengage Learning, Edition 2010. 2. Douglas V Hall, SSSP Rao "Microprocessors & Interfacing", McGraw Hill 3. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006. 4. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand & Sons Inc., Edition 2014 5. Lyla Das, Embedded Systems: An Integrated Approach‖, Pearson Publication, First Edition 2013 6. Steve Furber, "ARM System on chip Architecture", Pearson, 2nd edition. 7. Shibu K. V "Introduction to embedded systems" McGraw Hill.
Reference Books	1. "MCS@51 Microcontroller, Family User's Manual" Intel 2. P89V51RB2/RC2/RD2 8-bit 80C51 5 V low power 16/32/64 kB flash microcontroller, Data Sheet NXP founded by Philips 3. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, Tata McGraw-Hill
Useful Links:	Course: Microprocessors and Microcontrollers by Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee42/preview

Continuous Assessment(CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment (IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC403	**Linear Integrated Circuits**	**3+0+0**
Prerequisite:	1. Basic Electrical Engineering 2. Electronic Devices & Circuits	
Course Objectives:	1. To understand the concepts, working principles and key applications of linear integrated circuits 2. To perform analysis of circuits based on linear integrated circuits. 3. To design circuits and systems for particular applications using linear integrated circuits.	
Course Outcomes:	1. Outline and classify all types of integrated circuits 2. Explain the fundamentals and areas of applications for the integrated circuits. 3. Design practical circuits that perform the desired operations 4. Compare theoretical & practical results in integrated circuits. 5. Identify the appropriate integrated circuit modules for designing engineering application 6. Select and use an appropriate integrated circuit to build a given application.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Introduction to Operational Amplifier	1.1 Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.	1	02	07
	1.2 Configurations of Op-Amp: Open loop and closed loop configurations of Op-amp, Inverting and Non-inverting configuration of Op-amp and buffer.		02	
	1.3 Summing amplifier, difference amplifiers and Instrumentation amplifier using Op-amp. (using 2 opamp & 3 op amp)		03	
2. Linear Applications of Operational Amplifier	2.1 Voltage to current and current to voltage converter	2	03	08
	2.2 Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters. Filter approximation		03	
	2.3 Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Non-Linear Applications of Operational Amplifier	3.1 Comparators: Inverting comparator, non-inverting comparator zero crossing detectors, window, detector, level detector	3	02	07
	3.2 Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger		03	
	3.3 Waveform Generators: Square wave generator and triangular wave generator. Basics of Precision Rectifiers: Half wave and full wave precision rectifiers. Peak detector		02	
4. Timer IC 555 and its applications	4.1 Functional block diagram and working of IC 555	4	02	07
	4.2 Design of Astable and Monostable multivibrator using IC 555		03	
	4.3 Applications of Astable and Monostable multivibrator as Pulse width modulator and Pulse Position Modulator		02	
5. Voltage Regulators	5.1 Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series). Introduction of LM317, LM 337	5	02	06
	5.2 Functional block diagram, working and design of general-purpose IC 723 (HVLC and HVHC).		02	
	5.3 Introduction and block diagram of switching regulator		02	
6. Special Purpose Integrated Circuits	6.1 Functional block diagram and working of VCO IC 566 and application as frequency modulator	6	02	04
	6.2 Functional block diagram and working of PLL IC 565 and application as FSK Demodulator		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	-	01	01
			Total:	**42**

Books:	
Text Books	1. Ramakant A. Gaikwad, "Op-Amps and Linear Integrated Circuits", Pearson 2. D. Roy Choudhury and S. B. Jain, "Linear Integrated Circuits", New Age International Publishers, 4th Edition
Reference Books	1. K. R. Botkar, "Integrated Circuits", Khanna Publishers (2004) 2. Sergio Franco, "Design with operational amplifiers and analog integrated circuits",Tata McGraw Hill, 3rd Edition. 3. David A. Bell, "Operational Amplifiers and Linear Integrated Circuits", Oxford University Press, Indian Edition. 4. R. F. Coughlin and F. F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Prentice Hall, 6th Edition. 5. J. Millman, Christos CHalkias, and Satyabrata Jit, Millman's, "Electronic Devices and Circuits," McGrawHill, 3rd Edition.

Useful Links:	NPTEL/ Swayam Course: Course: ICs MOSFETs Op-Amps & Their Applications By Prof. Hardik Jeetendra Pandya (IISc Bangalore); https://swayam.gov.in/nd1_noc20_ee13/preview

Continuous Assessment(CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment (IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC404	**Principles of Communication Engineering**	**3 + 0 + 0**
Prerequisite:	1. Applications of Mathematics in Engineering-I 2. Electronics Devices & Circuits	
Course Objectives:	1. To illustrate the fundamentals of basic communication systems. 2. To understand various analog modulation and demodulation techniques. 3. To focus on applications of analog modulation and demodulation techniques. 4. To explain the key concepts of analog and digital pulse modulation and demodulation.	
Course Outcomes:	1. Explain the basic components and types of noises in the communication system. 2. Analyse the concepts of amplitude modulation and demodulation. 3. Analyse the concepts of angle modulation and demodulation. 4. Compare the performance of AM and FM receivers. 5. Describe analog and digital pulse modulation techniques. 6. Illustrate the principles of multiplexing and de-multiplexing techniques.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Basics of Communication System	1.1 Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels	1	02	03
	1.2 Types of noise, signal to noise ratio, noise figure, and noise temperature		01	
2. Amplitude Modulation and Demodulation	2.1 Basic concept, mathematical analysis, signal representation (time domain and frequency domain), need for modulation, modulation index, bandwidth, voltage distribution, and power calculation	2	02	10
	2.2 Analyse the concepts of amplitude modulation and demodulation DSBFC: Principles, modulating circuits, low level and high-level transmitters DSB suppressed carrier: - Balanced modulators with diode (Ring modulator and FET) Single Side Band (SSB): -Principle,		06	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Filter method, phase shift method and third method Independent sideband (ISB) and Vestigial Side Band (VSB) transmitters			
	2.3 Amplitude demodulation: Diode detector, practical diode detector. Advantages, disadvantages and applications of AM, Comparison of different types of AM		02	
3. Angle Modulation and Demodulation	3.1 Frequency and Phase modulation (FM and PM): Basic concepts, mathematical analysis, FM wave (time and frequency domain), sensitivity, phase and frequency deviation, modulation index, deviation ratio, bandwidth requirement of angle modulated waves, narrowband FM and wideband FM	3	02	10
	3.2 Varactor diode modulator, FET reactance modulator, stabilized reactance modulator- AFC, Direct FM transmitter, indirect FM Transmitter		04	
	3.3 FM demodulation: Balanced slope detector, Foster-Seely discriminator, ratio detector, Phase lock loop (PLL) FM demodulator. Noise triangle in FM, pre-emphasis and de-emphasis. amplitude limiting and thresholding in FM, Advantages, disadvantages and applications of FM and PM, Comparison of AM, FM, PM		04	
4. Radio Receivers	4.1 TRF, Super-heterodyne receiver, receiver parameters, and choice of IF.	4	01	04
	4.2 AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC, and communication receiver		02	
	4.3 FM receiver circuits, Comparison of AM, FM receiver		01	
5. Pulse Modulation and Demodulation Techniques	5.1 Theorem for low pass and band pass signals, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing error, and aperture effect	5	03	10
	5.2 Generation and Detection of PAM, PWM, PPM, advantages, disadvantages and applications of pulse		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	communication			
	5.3 Pulse Code Modulation, DPCM, Delta modulation, adaptive delta modulation, Advantages, Disadvantages and Application of Pulse transmission techniques		04	
6. Multiplexing & De-multiplexing	6.1 FDM transmitter & receiver block diagram, Hierarchical FDM, FDM in Telephone System, Advantages, disadvantages and applications of FDM.	6	01	02
	6.2 TDM transmitter & receiver block diagram, signalling rate, Crosstalk and guard time Advantages, disadvantages and applications of TDM.		01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	-	01	01
			Total:	**42**

Books:	
Text Books	1. Kennedy and Davis, "Electronics Communication System", Tata McGraw Hill, Fourth edition. 2. B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication system", Oxford University Press, Fourth edition. 3. Wayne Tomasi, "Electronics Communication Systems", Pearson education, Fifth edition.
Reference Books	1. Taub, Schilling and Saha, "Taub's Principles of Communication systems", Tata McGraw Hill, Third edition. 2. P. Sing and S.D. Sapre, "Communication Systems: Analog and Digital", Tata McGraw Hill, Third edition. 3. Simon Haykin, Michel Moher, "Introduction to Analog and Digital Communication", Wiley, Second edition. 4. Dennis Roddy and John Coolen, Electronic Communication, Pearson, 4/e, 2011. 5. Louis Frenzel, "Communication Electronics", Tata McGraw Hill, Third Edition.
Useful Links:	NPTEL/ Swayam Course: 1. Course: Analog Communication by Prof. Goutam Das (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee69/preview 2. https://nptel.ac.in/courses/106/103/106103068/

Continuous Assessment(CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment (IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC405	**Signals and Systems**	**3+0+0**
Prerequisite:	Engineering Mathematics III	
Course Objectives:	1. To introduce students to the idea of signal and system analysis and characterization in time and frequency domain. 2. To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.	
Course Outcomes:	1. Describe different types of signals and systems 2. Analyse continuous time and discrete time systems in time domain 3. Analyse continues time and discrete time signals and systems using Fourier Series and Fourier Transform 4. Analyse continuous time LTI systems using Laplace transform 5. Analyse discrete time LTI systems using Z- transform	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Introduction to signals and systems	1.1 Introduction to Signals: Definition, Basic Elementary signals -exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. Classification of Signals: Analog and discrete time signals, even and odd signals, periodic and non-periodic signals, deterministic and non-deterministic signals, energy and power signals.	1	04	08
	1.2 Systems and Classification of systems: System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system.		04	
2. Time domain analysis of Continuous	2.1 Linear Time Invariant (LTI) systems: Impulse, step and exponential response, System Stability and Causality.	2	02	10

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Time and Discrete Time systems	2.2 Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems.		04	
	2.3 Correlation and spectral Density: auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD and PSD with auto-correlation.		04	
3. Review of Fourier series	3.1 Trigonometric and exponential Fourier series representation of signals, Gibb's phenomenon, Discrete Time Fourier Series, properties, analogy between Continuous Time Fourier Series (CTFS) and Discrete Time Fourier Series (DTFS).	2, 3	03	03
4. Fourier Analysis of Continuous and Discrete Time Signals and Systems	4.1 Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform (No proof required), Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform.	3	06	06
5. Laplace Transform and Continuous time LTI systems	5.1 Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform (No proof required), Relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform, inverse Laplace Transform.	4	04	06
	5.2 Analysis of continuous time LTI systems using Laplace Transform: Causality and stability of systems in *s*-domain, Total response of a system.		02	
6. z-Transform and Discrete time LTI systems	6.1 Need of z-Transform, z-Transform of finite and infinite duration sequences, Concept of Region of Convergence, z-Transform properties (No proof required), Standard z-transform pairs, relation between z-transform and discrete time Fourier Transform, one sided z-Transform. Inverse z-Transform: Partial Fraction method only.	5	03	06
	6.2 Analysis of discrete time LTI systems using z-Transform: Systems characterized by		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Linear constant coefficient difference equation, Transfer Function, plotting Poles and Zeros of a transfer function, causality and stability of systems, Total response of a system.			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	-	01	01
			Total:	**42**

Books:	
Text Books	1. Signals and Systems, Third Edition, Nagoor Kani, Tata McGraw Hill, 2011. 2. Signals and Systems, Fourth Edition, Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Pearson Education,2009. 3. Signals and Systems, Second Edition, Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Prentice-Hall of India, 2002. 4. Signals and Systems, Fourth Edition, Ramesh Babu, Scitech
Reference Books	1. Signals and Systems, Third edition, Hwei. P Hsu, Tata McGraw Hill, 2010 2. Signals and Systems, Second Edition, Simon Haykin and Barry Van Veen, John Wiley and Sons, 2004 3. Signals and Systems, First Edition, V. Krishnaveni and A. Rajeshwari Wiley-India, 2012
Useful Links:	1. Course: Principles of Signals & Systems By Prof. Aditya K. Jagannatham (IIT Kanpur); https://swayam.gov.in/nd1_noc20_ee15/preview 2. Signals and Systems Laboratory: Virtual Laboratory http://ssl-iitg.vlabs.ac.in/

Continuous Assessment(CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment (IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (P+TUT)
1UEXL402	**Microcontrollers Laboratory**	**1+0**

Lab Prerequisite:	Digital System Design
Lab Objectives:	1. To understand development tools of microcontroller based systems. 2. To learn programming for different microcontroller operation & interface to I/O devices. 3. To develop microcontroller based applications.
Lab Outcomes:	1. Outline different development tools required to develop microcontroller based systems 2. Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations for 8051 and ARM7 3. Write assembly language programs for general purpose I/O, Timers & Interrupts. 4. Programs for 8051 microcontrollers and Interface various peripheral devices to the microcontrollers and develop microcontroller based applications 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1	Study of development tools like Editor, Assembler-cross Assembler, Compiler-Cross compiler, Linker, Simulator, emulator etc.	1, 5, 6	02
2	Perform Arithmetic and Logical Operations (Using Immediate, Direct and Indirect addressing) 8051 and ARM 7	2, 5, 6	02
3	Code Conversion	2, 5, 6	02
4	Transfer of data bytes between Internal and External Memory	2, 5, 6	02
5	Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay for 8051	3, 5, 6	02
6	Interfacing of Matrix Keyboard, LED, 7 Segment display, LCD, Stepper Motor, UART	4, 5, 6	02
7	Perform Arithmetic (Using Immediate, Direct and Indirect addressing) ARM 7	2, 5, 6	02
8	Perform Logical Operations (Using Immediate, Direct and Indirect addressing) ARM 7	2, 5, 6	02
9	Case Study/ Mini Project	1 to 6	10
		Total	**28**

Term work: 1. Term work should consist of a minimum of 8 experiments. 2. Journal must include assignments on content of theory and practical of the course. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)
Oral/Practical/P&O : Oral examination will be based on the experiment list and content of the entire theory syllabus.

Course Code	Course Name	Credits (P+TUT)
1UEXL403	Linear Integrated Circuits Laboratory	1+0

Lab Prerequisite:	1. Basic Electrical Engineering 2. Electronic Devices & Circuits
Lab Objectives:	1. To teach fundamental principles of standard linear integrated circuits. 2. To develop an overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications
Lab Outcomes:	1. Demonstrate an understanding of fundamentals of integrated circuits. 2. Analyse the various applications and circuits based on particular linear integrated circuits. 3. Explain the differences between theoretical, practical and simulated results in integrated circuits. 4. Apply the knowledge to do simple mathematical operations. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1	Design inverting, non-inverting amplifiers and buffers using IC 741.	1, 5, 6	02
2	Design the summing and difference amplifiers using op-amp.	1, 5, 6	02
3	Design voltage to current converter with grounded load.	1, 5, 6	02
4	Design and analyse Integrator	1, 5, 6	02
5	Design and analyse Differentiator	1, 5, 6	02
6	Design Schmitt trigger using Op-amp.	2, 5, 6	02
7	Design Wein bridge and RC phase shift Oscillator.	2, 5, 6	02
8	Design and analyse second order High pass and Low pass filter	2, 5, 6	02
9	Design and analyse Band pass and Band reject filter.	2, 5, 6	02
10	Design Astable Multivibrator using IC 555 for fixed frequency and variable duty cycle.	2, 5, 6	02
11	Design Monostable Multivibrator using IC 555.	2, 5, 6	02
12	Design High voltage Low current voltage regulator using IC 723.	3, 5, 6	02
13	Design High voltage High current voltage regulator using IC 723.	3, 5, 6	02
14	Design Frequency Modulator using IC 566	3, 5, 6	02
15	Design FSK Demodulator using IC 565	4, 5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
16	Design Instrumentation amplifier using 3 Op-Amp.	4, 5, 6	02
17	Design Precision rectifier (HWR & FWR)	4, 5, 6	02
18	Design Square & Triangular wave generator USING OP AMP	4, 5, 6	02
		Total	**38***
***Minimum 28 Hrs. Lab / Mini Project to be conducted**			

Useful Links:

1. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/electronerds/experiments/inverting-amplifier-pvg/
2. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/electronerds/experiments/adder-pvg/
3. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/electronerds/experiments/integrator-pvg/
4. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/electronerds/experiments/differentiator-pvg/
5. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/electronerds/experiments/schmitt-trigger-pvg/
6. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/electronerds/experiments/instrumentation-amplifier-pvg/index.html

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Practical examination will be based on the experiment list and content of the entire theory syllabus.

Course Code	Course Name	Credits (P+TUT)
1UEXL404	**Principles of Communication Engineering Laboratory**	**1+0**

Lab Prerequisite:	1. Usage of basic electronic instruments and components. 2. Fundamentals of Electronic Devices and circuits
Lab Objectives:	1. To understand the Time and Frequency domain representation of signals. 2. To demonstrate continuous wave modulation and demodulation. 3. To demonstrate analog and digital pulse communication. 4. To use simulation software to build communication circuits.
Lab Outcomes:	1. Demonstrate and compare analog modulation and demodulation techniques and sketch the appropriate waveform 2. Demonstrate and compare analog pulse modulation and demodulation techniques. 3. Demonstrate and compare digital pulse modulation and demodulation techniques. 4. Simulate analog and pulse modulation and demodulation techniques using MATLAB 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1	Generation & Detection of AM (DSBFC/DSB/SSB) signal	1, 5, 6	02
2	Generation & Detection of FM/PM signal	1, 5, 6	02
3	Analyse the output waveforms of each block of AM/FM transmitter /receiver	1, 5, 6	02
4	Verification of sampling theorem.	2, 5, 6	02
5	Generation of PAM modulation and demodulation.	2, 5, 6	02
6	Generation of PWM and PPM modulation and demodulation.	2, 5, 6	02
7	Demonstrate Digital pulse transmission technique (PCM)	3, 5, 6	02

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
8	Demonstrate Digital pulse transmission technique (DM, ADM)	3, 5, 6	02
9	Observation of TDM/FDM multiplexing and de-multiplexing signals.	1, 5, 6	02
10	Simulate any modulation techniques using MATLAB 1. Simulate AM/FM/PM using MATLAB 2. Simulate Pre-emphasis and De-emphasis circuit 3. Simulate PAM/PWM/PPM using MATLAB 4. Simulate PCM/DM/ADM using MATLAB	4, 5, 6	02
11	Write program in MATLAB to find Gain, Noise Figure and Noise Temperature of multistage amplifier	4, 5.6	02
12	Subject Simulation Project	1 to 6	04
		Total	**28**

References:

[1] Lab manuals [2] www.mathworks.com [3] www.scilab.org [4] www.ni.com/labview

Useful Links:

1. http://ssl-iitg.vlabs.ac.in/Sampling%20and%20signal%20reconstruction%20(objective).html
2. https://www.vlab.co.in/broad-area-electronics-and-communications

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Practical examination will be based on the experiment list and content of the entire theory syllabus.

Project Based Learning Code	Project Based Learning	Credits (TH+P+TUT)
1UEXPR42	**Mini Project Lab-II**	**0+1+0**

Mini project Prerequisite:	1. Mini-Project 1- PBL 2. C++ and Java Programming 3. Electronic Devices and Circuit
Mini project Objectives:	1. To make students familiar with the basics of Electronics, Microcontroller, Arduino board, Raspberry Pi, Arduino IDE (Integrated Development Environment) and Python programming. 2. To familiarize the students with the programming and interfacing of different devices with Arduino and Raspberry Pi Board 3. To increase students' critical thinking ability and provide solutions to some real time problems.
Mini project Outcomes:	1. Write basic codes for the Arduino board using the IDE for utilizing the on-board resources. 2. Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task. 3. Design Arduino based projects for a given problem. 4. Write code using python language using IDE for utilizing the onboard resources. 5. Apply the knowledge of interfacing different devices to Raspberry-Pi board to accomplish a given task. 6. Design Raspberry Pi based projects for a given problem.

Section A: Arduino Board

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Arduino Board	1.1. Introduction to Arduino Uno board and Integrated Development Environment (IDE)	1	01	02
	1.2. Write the code for blinking the on board led with a specified delay Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software.		01	
2. GPIO (along with Analog pin) Programming	2.1 Introduction to programming GPIO, Analog and PWM PINS.	2	01	04
	2.2. Interface any Digital Sensors to the Arduino board and display sensor values on serial Monitor.		01	
	2.3. Interface any Analog sensor to the Arduino board and display sensor values on serial Monitor.		01	
	2.4. Generate varying duty cycle PWM using Arduino.		01	
3. Controlling output devices /Displaying	3.1. Introduction to different sensor (Analog and Digital), Relays, Motors and display.	3	01	04
	3.2. Interface an Analog Sensors to the Arduino board and display sensor values on LCD/TFT/Seven segment Display.		01	
	3.3. Interface a temperature sensor to Arduino and switch on a relay to operate a fan if temperature exceeds given threshold. Also display the temperature on any of the display device		02	
4. Interfacing Communication Devices and Cloud Networking	4.1. Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods**.**	4	02	04
	4.2 Interface WIFI/ Bluetooth/ GSM/ Zigbee/ RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
	the above-mentioned modules need to be interfaced			
5. Sample Projects	1. Waste Management System	1, 2, 3, 4	01	10
	2. Smart City Solutions		01	
	3. Energy Monitoring Systems		01	
	4. Smart Classrooms and learning Solutions		01	
	5. Home security systems		01	
	6.Smart Agriculture solutions		01	
	7. Healthcare solutions.		01	
	8. Industrial Applications		01	
	9. IoT Applications		01	
	10. Robotics		01	
ii. Project Conclusion	Recap of project outcomes, applications and summarisation		02	02
			Total:	**28**

Section B: Raspberry Pi

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
1. Introduction to Raspberry PI	1.1 What is Raspberry PI? Downloading and Installation of NOOBS, First Power- Up & Having a Look around, Introduction to the Shell and Staying updated.	5	01	02
	1.2 Familiarization with Raspberry PI and perform necessary software installation. Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.		01	
2. Interfacing with Input / Output Devices using Python	2.1 Introduction to Python, Connecting to the outside World with GPIO.	5	01	04
	2.2 To Interface LED/Buzzer with Raspberry PI and write a program to turn ON LED for 1 sec after every 2 sec. Apparatus Requirement: Raspberry PI with inbuilt Python Package, LED, Buzzer.		01	
	2.3 To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI and write a program to turn ON LED when Push button is pressed or at sensor detection.		01	

<table>
<tr><th>Module No & Name</th><th>Sub Topics</th><th>CO Mapped</th><th>Hrs/ Sub Topic</th><th>Hrs/ Topic</th></tr>
<tr><td rowspan="2"></td><td>Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR).</td><td rowspan="2"></td><td></td><td rowspan="2"></td></tr>
<tr><td>2.4 To interface an analog sensor using MCP 3008 analog to digital converter chip.
Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip</td><td>01</td></tr>
<tr><td rowspan="4">3. Interfacing Temperature Sensor, Motors, Display Devices</td><td>3.1 Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits.</td><td rowspan="4">6</td><td rowspan="2">01</td><td rowspan="4">03</td></tr>
<tr><td>3.2 To interface the DHT11 sensor with Raspberry PI and write a program to print temperature and humidity readings.
Apparatus Requirement: Raspberry PI with inbuilt Python Package, DTH11 Sensor</td></tr>
<tr><td>3.3 To interface the motor using a relay with Raspberry PI and write a program to turn ON the motor when push button is pressed.
Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors.</td><td rowspan="2">02</td></tr>
<tr><td>3.4 To interface OLED with Raspberry PI and write a program to print temperature and humidity readings on it.
Apparatus Requirement: Raspberry PI with inbuilt Python Package, OLED display device.</td></tr>
<tr><td rowspan="4">4. Interfacing Communication Devices and Cloud Networking</td><td>4.1 Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.</td><td rowspan="4">4</td><td>01</td><td rowspan="4">05</td></tr>
<tr><td>4.2 Interface Bluetooth/Zigbee/RFID/Wi-Fi with Raspberry PI and write a program to send sensor data to a smartphone using Bluetooth/Zigbee/RFID/WIFI. (Anyone can be used for performing)
Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/ Zigbee/ RFID/ WIFI.</td><td>01</td></tr>
<tr><td>4.3 Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry PI</td><td>01</td></tr>
<tr><td>4.4 Write a program on Raspberry PI to upload temperature and humidity data from</td><td>02</td></tr>
</table>

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
	thing speak cloud. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thing speak (open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.			
5. Understanding of Communication Protocols	5.1 Introduction to MQTT, IFTTT protocols and configuration steps	6	01	04
	5.2 Write a program on Raspberry PI to publish temperature data to MQTT broker		01	
	5.3 Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.		01	
	5.4 Configuration of Web Server using Raspberry PI.		01	
6. Sample Projects	1. MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud	4 ,5, 6	02	10
	2. License Plate Recognition using Raspberry Pi and OpenCV			
	3. Real Time Face Recognition with Raspberry Pi and OpenCV			
	4. Smart Garage Door Opener using Raspberry Pi			
	5. Remote Controlled Car Using Raspberry Pi and Bluetooth			
	6. Fingerprint Sensor based door locking system using Raspberry Pi		02	
	7. Raspberry Pi Ball Tracking Robot using Processing			
	8. Web Controlled Home Automation using Raspberry Pi			
	9. Line Follower Robot using Raspberry Pi			
	10.Raspberry Pi based Smart Phone Controlled Home Automation			
	11.Web Controlled Raspberry Pi Surveillance Robotic Car		02	
	12.Raspberry Pi Based Weight Sensing Automatic Gate			
	13.Raspberry Pi Emergency Light with Darkness and AC Power Line Off Detector			
	14.Detecting Colors using Raspberry Pi and			

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
	Color Sensor TCS3200			
	15.Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor			
	16.Call and Text using Raspberry Pi and GSM Module		02	
	17.Raspberry Pi Home Security System with Email Alert			
	18.Raspberry Pi Based Obstacle Avoiding Robot using Ultrasonic Sensor			
	19.Web Controlled Notice Board using Raspberry Pi			
	20.RF Remote Controlled LEDs Using Raspberry Pi			
	21.RFID and Raspberry Pi Based Attendance System		02	
	22.Raspberry Pi Interactive Led-Mirror			
	23.Garage Door monitor using Raspberry Pi			
	24.Raspberry Pi Digital Code Lock on Breadboard			
	25.Electronic Voting Machine using Raspberry Pi			
			Total:	**28**
Note: Student can do project based on Arduino **OR** Raspberry Pi				

Reference Books:	1. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2 edition (September 28, 2017) 2. Simon Monk, "Raspberry PI Cookbook Software and Hardware Problems and Solutions" O'Reilly 2nd Edition 3. Simon Monk, Programming the Raspberry Pi, 2nd Edition: Getting Started with Python" The McGraw Hill 4. "DK Workbooks: Raspberry Pi Project Workbook", DK Children; Workbook edition (March 7, 2017) 5. Donald Norris, "Raspberry Pi Electronic Projects for Evil Genius", McGraw-Hill Education TAB; 1 edition (May 20, 2016)
Useful Links:	Software Tools: Raspbian OS: https://www.raspberrypi.org/downloads/ Win32 Disk Imager: https://sourceforge.net/projects/win32diskimager/ SD Card Formatter: https://www.sdcard.org/downloads/formatter/ Arduino IDE: https://www.arduino.cc/en/main/software
Online Repository:	1. GitHub 2. NPTEL Videos on Raspberry Pi and Arduino Programming 3. https://www.electronicsforu.com/raspberry-pi-projects

	4. https://circuitdigest.com/simple-raspberry-pi-projects-for-beginners 5. https://www.electronicshub.org/raspberry-pi-projects/ 6. Spoken Tutorial Project-IIT Bombay: https://spoken-tutorial.org/tutorialsearch/?searchFoss=Arduino&search_language=English Teachers are recommended to use a free online simulation platform “Tinker cad” for the simulation of Arduino based circuits before the students implement it in the hardware: ht://www.tinkercad.com/

Note: General Guidelines and assessment criteria will remain same as Mini project-I

Skill Based Learning Code	Skill Based Learning - V	Credits (TH+P+TUT)
1UEXXS45	**Python Programming**	**0+1+0**
Skill Prerequisite:	1. Knowledge of some programming language like C++ 2. Knowledge of some programming language like Java	
Skill Objectives:	1. To study List, tuple, set, dictionary, string, array and functions in python programming language. 2. To study List, tuple, set, dictionary, string, array and functions in python programming language. 3. To study data structures and Object-Oriented Programming using Python. 4. To explain concepts of modules, packages and exception handling. 5. To study File handling, django framework and regular expression. 6. To study data visualization using Matplotlib, data analysis using Pandas and Web programming using Flask.	
Skill Outcomes:	1. Apply the structure, syntax, and semantics of the Python language. 2. Implement the concept of advanced data types and functions in python 3. Illustrate data structures the concepts of object-oriented programming as used in Python 4. Create Python applications using modules, packages, exception handling, File Handling programs, Matplotlib, data analysis using Pandas and Web programming using Flask. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Module No	Module Title	SO Mapped	Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1	Write python programs to understand 1.1 Basic data types, Operators, expressions and Input Output Statements 1.2 Control flow statements: Conditional statements (if, if…else, nested if) 1.3 Looping in Python (while loop, for loop, nested loops) 1.4 Decorators, Iterators and Generators. Concepts: 1.1 Introduction, Features, Python building blocks – Identifiers, Keywords, Indention, Variables and Comments. 1.2 Basic data types (Numeric, Boolean, Compound) Operators: Arithmetic, comparison, relational,	1, 5, 6	04

Module No	Module Title	SO Mapped	Hrs/ Module
	assignment, logical, bitwise, membership, identity operators and operator precedence. 1.3 Control flow statements: Conditional statements (if, if…else, nested if) Looping in Python (while loop, for loop, nested loops) Loop manipulation using continue, pass, break. Input/output Functions, Decorators, Iterators and Generators.		
2	Write python programs to understand 2.1 Different List and Tuple operations using Built-in functions 2.2 Built-in Set and String functions 2.3 Basic Array operations on 1-D and Multidimensional arrays using Numpy 2.4 Implementing User defined and Anonymous Functions Concepts: 2.1 Lists: a) Defining lists, accessing values in list, deleting values in list, updating lists b) Basic list operations c) Built-in list functions 2.2 Tuples: a) Accessing values in Tuples, deleting values in Tuples, and updating Tuples b) Basic Tuple operations c) Built-in Tuple functions 2.3 Dictionaries: a) Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary b) Basic Dictionary operations c) Built-in Dictionary functions 2.4 Sets: a) Accessing values in Set, deleting values in Set, updating Sets b) Basic Set operations, c) Built-in Set functions 2.5 Strings: a) String initialization, Indexing, Slicing, Concatenation, Membership & Immutability b) Built-in String functions 2.6 Arrays: a) Working with Single dimensional Arrays: Creating, importing, Indexing, Slicing, copying and processing array arrays. b) Working with Multi-dimensional Arrays using Numpy: Mathematical operations, Matrix operations, aggregate and other Built-in functions. 2.7 Functions: a) Built -in functions in python b) Defining function, calling function, returning values, passing parameters c) Nested and Recursive functions d) Anonymous Functions (Lambda, Map, Reduce, Filter.	2, 5, 6	06
3	Write python programs to understand 3.1 Classes, Objects, Constructors, Inner class and Static	3, 5, 6	03

Module No	Module Title	SO Mapped	Hrs/ Module
	method 3.2 Different types of Inheritance 3.3 Polymorphism using Operator overloading, Method overloading, Method overriding, Abstract class, Abstract method and Interfaces in Python. Concepts: 3.1 Overview of Object-oriented programming, Creating Classes and Objects, Self-Variable, Constructors, Inner class, Static method, Namespaces. 3.2 Inheritance: Types of Inheritance (Single, Multiple, Multi-level, Hierarchical), Super() method, Constructors in inheritance, operator overloading, Method overloading, Method overriding, Abstract class, Abstract method, Interfaces in Python		
4	Write python programs to understand 4.1 Creating User-defined modules/packages and import them in a program 4.2 Creating user defined multithreaded application with thread synchronization and deadlocks 4.3 Creating a menu driven application which should cover all the built-in exceptions in python Concepts: 4.1 Modules: Writing modules, importing objects from modules, Python built -in modules (e.g. Numeric and Mathematical module, Functional Programming module, Regular Expression module), Namespace and Scoping. 4.2 Packages: creating user defined packages and importing packages. Exception handling: Compile time errors, Runtime errors, exceptions, types of exception, try statement, except block, raise statement, Assert statement, User -Defined Exceptions 4.3 Creating a menu driven application which should cover all the built-in exceptions in python	4, 5, 6	03
5	Write python programs to implement 5.1 Different types of plots using Matplotlob 5.2 Basic operations using pandas like series, data frames, indexing, filtering, combining and merging data frames 5.3 Different Linear algebra functions using Scipy Concepts: 5.1 Visualization using Matplotlib: Matplotlib with Numpy, working with plots (line plot, bar graph, histogram, scatter plot, area plot, pie chart etc.),	4, 5, 6	05

Module No	Module Title	SO Mapped	Hrs/ Module
	working with multiple figures. 5.2 Data manipulation and analysis using Pandas: Introduction to Pandas, importing data into Python, series, data frames, indexing data frames, basic operations with data frame, filtering, combining and merging data frames, Removing Duplicates. SciPy: Linear algebra functions using Numpy and Scipy.		
6	Write python programs to understand 6.1 Different File Handling operations in Python 6.2 Creating web application using flask web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression) 6.3 Server side deployment of flask applications:- mod wsgi Concepts: 6.1 File Handling: Opening file in different modes, closing a file, writing to a file, accessing file contents using standard library functions, reading from a file – read (), readline (), readlines (), Renaming and Deleting a file, File Exceptions, Pickle in Python. 6.2 Flask framework and Regular Expressions using python	4, 5, 6	05

Books:	
Text Books	1. Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press 2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication 3. Anurag Gupta, G. P. Biswas, "Python Programming", McGraw-Hill 4. E. Balagurusamy, "Introduction to computing and problem-solving using python", McGraw Hill Education
Reference Books	1. Eric Matthes, "Python Crash Course A hands-on, Project Based Introduction to programming" No Starch Press; 1 edition (8 December 2015). 2. Paul Barry, "Head First Python" O′Reilly; 2 edition (16 December 2016) 3. Online resources for Flask

Useful Links:

1. https://python-iitk.vlabs.ac.in/
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/python-basics/index.html
3. www.nptelvideos.in
4. www.w3schools.com
5. www.tutorialspoint.com
6. https://starcertification.org/Certifications/Certificate/securejava

Term Work (25 Marks):
Term Work shall be awarded on the basis of 1. Student’s active participation in skill based learning. 2. Presenting/showcasing learned skills through Social /outreach/ extension activities/Events/ Competitions/Trainings/Internships etc. 3. Submission of Report/act/demonstrations/specific participation / Idea creation / scope / creativity / Case study etc. 4. Assessment Rubrics.

Activity Based Learning Code	Activity Based Learning - VI	Credits (TH+P+TUT)
1UEXXA46	1. Waste Segregation Surveys (Residential, hospital, Educational institute……) 2. Mentoring of School Children/ NSS activities and camp	**0+1+0**

Prerequisite:	Knowledge of Problems and Issues of the National, Global, Societal and Environmental Issues that need attention.
ABL Objectives:	1. Identify and describe various social, Environmental, Economic, Political, educational, Agricultural, Governance related issues and problems. 2. To plan and prepare a structured or unstructured survey or study methodology to have an in-depth analysis of the issues and problems to carry out the activity. 3. To compare and contrast social, ethical, environmental and legal issues surrounding the subject of study. 4. To analyse and suggest solutions to the existing issues, modify and improve the existing problems.
ABL Outcomes:	1. Define the areas of problems and issues by forming specific statements. 2. Decision on instruments and methodology to study the problem. 3. Analyse the collected data to propose solutions to solve the issues. 4. Document the learning and experiences from the activities.

Guidelines for Activity Based Learning:

1. Students shall form a group of 2 to 3 students, while forming a group shall not be allowed less than 2 or more than 3 students, as it is a group activity.
2. Students can select any One activity/Topic from the given activity list.
3. Students should do surveys and collect information on the given problems/topics in the activity head.
4. Faculty supervisor is allotted to a group of 20 to 25 students (based on number of students enrolled for one activity) and supervisor may give inputs to students during activity; however, focus shall be on self-learning.
5. The faculty supervisor will monitor the activities and documentation of the students assigned to them.
6. Students in a group shall discuss the problems effectively and propose multiple solutions for selected problem.
7. Professional Committee will arrange Two to Three Guest lecture based on the problem/Topic in the activity head so that student will get more idea about the Topic selected.
8. The marks will be assigned by the faculty supervisor according to the Assessment Rubrics.
9. The marks are to be submitted to the respective Departments and the Departments will submit them to the Exam Section.

Activity No	Activity Title	Activity Outcome Mapped	Hrs
1	Guest lecture to introduce Topic selected in Activity-Based learning	1	02
2	Guest Lecture	1	02
3	Selection of any Two Problems	2,6	02
4	Group Discussion with other students	2,4,6	02
5	Presentation	2,4,6	02
6	Presentation	2,4,6	02
7	Presentation	3,6	02
8	Find out solution for selected problem	3,6	02
9	Group Discussion with other students	2,4,6	02
10	Presentation	3,4,6	02
11	Presentation	3,4,6	02
12	Presentation	3,4,6	02
13	Report submission	5,6	02
14	Recap of learning, Outcome and summarization		02
		Total	**28**

Term Work (25 Marks):
Marks will be awarded based on designed Assessment Rubrics which includes the following; 1 Identification of problem and solution 2 Attendance of Seminars/relevant sessions 3 Submission of Report/demo/act etc. 4 Presentation of Surveys/Case study

Program Structure for Third Year UG Technology (ET)

Semester-V - Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
1UEXC501	Digital Communication	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC502	Digital VLSI Design	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC503	Discrete Time Signal Processing	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC504	Random Signal Analysis	3 – 0 – 0	03	3 – 0 – 0	03	PC
1UEXDLC505	Department Level Elective Course - I	3 – 0 – 0	03	3 – 0 – 0	03	DLE
1UEXL501	Digital Communication Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL502	Digital VLSI Design Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL503	Discrete Time Signal Processing Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXDLL505	Department Level Elective Course Laboratory- I	0 – 2 – 0	02	0 – 1 – 0	01	DLE
1UEXL506	Business Communication & Ethics Laboratory	0 – 4** – 0	04	0 – 2 – 0	02	BS
1UEXPR53	Project Based Learning – Minor Project Lab - I	0 – 2 – 0	02*	0 – 1 – 0	01	PBL
1UEXXS57	Skill Based Learning -VII	0 – 2*- 0	02	0 – 1 – 0	01	SAT
1UEXXT58	Technology Based Learning - VIII	0 – 2*- 0	02	0 – 1 – 0	01	SAT
Total		**15 – 18 – 00**	**33**	**15- 09- 00**	**24**	

***Load of learner, not the faculty / *SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need. / Minor Project Lab - I:**

- Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- Faculty Load : 1 hour per week per four groups

****2 Hours class wise and 2 Hours batch wise**

Semester-V- Examination Scheme

Course Code	Course Name	Examination Scheme								
		Marks								
		CA			ESE	TW	O*	P	P & O	Total
		T1	T2	IA						
1UEXC501	Digital Communication	15	15	10	60	-	-	-	-	100
1UEXC502	Digital VLSI Design	15	15	10	60	-	-	-	-	100
1UEXC503	Discrete Time Signal Processing	15	15	10	60	-	-	-	-	100
1UEXC504	Random Signal Analysis	15	15	10	60	-	-	-	-	100
1UEXDLC505	Department Level Elective Course - I	15	15	10	60	-	-	-	-	100
1UEXL501	Digital Communication Laboratory	-	-	-	-	25	25	-	-	50
1UEXL502	Digital VLSI Design Laboratory	-	-	-	-	25	-	25	-	50
1UEXL503	Discrete Time Signal Processing Laboratory	-	-	-	-	25	-	-	-	25
1UEXDLL505	Department Level Elective Course Laboratory- I	-	-	-	-	25	-	-	-	25
1UEXL506	Business Communication & Ethics	-	-	-	-	25	25	-	-	50
1UEXPR53	Project Based Learning – Minor Project Lab – I	-	-	-	-	25	-	25	-	50
1UEXXS57	Skill Based Learning –VII	-	-	-	-	25	-	-	-	25
1UEXXT58	Technology Based Learning -VIII	-	-	-	-	25	-	-	-	25
Total		**75**	**75**	**50**	**300**	**200**	**50**	**50**	**-**	**800**

Department Level Elective Course - I	Course Code	Course Title and Group^
	1UEXDLC5051	Group A: Data Compression & Encryption
	1UEXDLC5052	Group B: Sensor Technology
	1UEXDLC5053	Group C: Microelectronics Devices and Circuit
	1UEXDLC5054	Group D: Data Structures and Algorithms

^ Student have freedom to select any course from Group A / B / C / D from Semester V to VIII

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC501	Digital Communication	3+0+0

Prerequisite:	1. Applications of Mathematics in Engineering-II 2. Signals and Systems 3. Principles of Communication Engineering
Course Objectives:	1. To describe the basics of information theory and source coding 2. To illustrate various error control codes 3. To describe baseband system 4. To learn different digital modulation and demodulation techniques
Course Outcomes:	1. Apply the concepts of information theory in source coding 2. Apply different error control systems and various error detection codes 3. Analyse different error correction codes 4. Compare various baseband transmission methods for digital signals 5. Evaluate the performance of optimum baseband detection in the presence of white noise 6. Compare the performances of different digital modulation techniques

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Information Theory and Source Codes	1.1 Block diagram of digital communication system, Information content of a source symbol, Source entropy, Average information rate, AWGN channel, and Shannon-Hartley channel capacity theorem	1	03	05
	1.2 Introduction of source code, Huffman code, Shannon-Fano code		02	
2. Error Control System and Error Detection Codes	2.1 Introduction of error control system, Automatic Retransmission Query (ARQ) system, Types of ARQ systems and comparison, Forward error correction (FEC) system. Comparison between FEC and ARQ	2	01	03
	2.2 Error detection codes: Vertical Redundancy Check (VRC) code, Longitudinal Redundancy Check (VRC) code, Cyclic Redundancy Check (CRC) code and Checksum code		02	
3. Error Correction	3.1 Linear block code: Code generation,	3	03	10

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Codes	calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder			
	3.2 Cyclic code: Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder		03	
	3.3 Convolutional code: Generation, path responses, encoder, state transition table, state diagram, tree diagram, trellis diagram, decoding using Viterbi's algorithm		04	
4. Baseband Transmission	4.1 Block diagram of baseband transmitter-receiver system, Line codes (RZ and NRZ Uni Polar formats, RZ and NRZ Polar formats, NRZ Bipolar format (AMI format), NRZ Manchester format, and Quaternary Polar format). Comparison of line codes with respect to bandwidth, power requirement, synchronization capability, DC level, polarity inversion error and complexity. Power spectral density and spectrum of NRZ Unipolar and Polar formats	4	03	05
	4.2 Inter Symbol Interference (ISI), Inter Channel Interference (ICI). Nyquist criterion for distortion less baseband binary transmission, Nyquist bandwidth and practical bandwidth		02	
5. Optimum Detection of Baseband Signal	5.1 Matched filter, Output SNR, Transfer function, Impulse response and Error probability. Integrate and dump receiver, Correlator receiver	5	04	04
6. Digital Modulations	6.1 Generation, Detection, Error probability (using signal space representation and Euclidean distance), Bandwidth (using PSD and spectrum except for MSK) and applications of the following	6	12	12

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	modulations: Binary ASK, Binary PSK, Quadrature PSK, Off-Set QPSK, M-ary PSK, Binary FSK, M-ary FSK, 16-ary QASK and MSK			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Principles of Communication Systems, Third Edition, H.Taub, D.Schlling and G.Saha, Tata Mc-Graw Hill, New Delhi, 2012 2. Modern Digital and Analog Communication Systems, Fourth Edition, Lathi BP and Ding Z, Oxford University Press, 2009 3. Digital Communication System, Fourth Edition, Haykin Simon John Wiley and Sons, New Delhi 2014 4. Digital Communications, Fourth Edition, John G. Proakis, McGraw-Hill
Reference Books	1. Digital Communication: Fundamentals and applications, Second Edition 2. Sklar B, and Ray P. K. Pearson, Dorling Kindersley (India), Delhi, 2009 3. Analog and Digital Communication, First Edition, T L Singal, Tata Mc-Graw Hill, New Delhi, 2012 4. Digital Communication, First Edition, P Ramakrishna Rao, Tata Mc-Graw Hill, New Delhi, 2011

Useful Links:

1. https://nptel.ac.in/courses/117/101/117101051/
2. https://nptel.ac.in/courses/117/105/117105077/
3. https://nptel.ac.in/courses/108/101/108101113/
4. https://nptel.ac.in/courses/108/102/108102096/
5. https://nptel.ac.in/courses/108/102/108102120/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC502	Digital VLSI Design	3+0+0

Prerequisite:	1. Electronics Devices & Circuits 2. Digital Logic Design
Course Objectives:	1. To introduce process flow of VLSI Design 2. To understand MOSFET operation from VLSI design perspective 3. To learn VLSI design performance metric and trade-offs 4. To design, implement and verify combinational and sequential logic circuits using various MOS design styles 5. To provide an exposure to RTL design
Course Outcomes:	1. Explain various tools and processes used in VLSI Design 2. Derive expressions for performance parameters of basic building blocks like CMOS inverter 3. Design and realize various combinational and sequential circuits for given specifications 4. Explain working of building blocks of semiconductor memory 5. Illustrate various data path circuits and the issues related to the design of the VLSI system 6. Design digital systems using RTL design technique

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Review of MOSFET operation and Fabrication	1.1 MOSFET structure and operation, IV characteristics, MOSFET Capacitances, MOSFET scaling	1	02	05
	1.2 Overview of VLSI Design Flow, Fabrication process flow of NMOS and CMOS, Lambda based design rules, Stick diagram and mask layout		03	
2. Combinational CMOS Logic Circuits	2.1 CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins, Propagation Delay, Power Dissipation, Design of CMOS Inverter, Layout of CMOS Inverter	2	03	06
	2.2 Realization of CMOS NAND gate, NOR gate, Complex CMOS Logic Circuits, Layout of CMOS NAND, NOR and complex CMOS circuits		03	
3. MOS Design	3.1 Static CMOS, Pass Transistor Logic,	3	04	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Logic Styles	Transmission Gate, Pseudo NMOS, Dynamic CMOS Logic, Domino Logic, NORA, Zipper, C^2MOS			
	3.2 Combinational circuit design: MUX, Decoder using above design styles ,1-bit full adder Concepts of Setup time, Hold time, clocked CMOS SR Latch, CMOS JK Latch, MS – JK Flip Flop, Edge triggered D-Flip Flop, Realization of Shift Register using design styles		04	
4. Semiconductor Memories	4.1 ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM	4	04	07
	4.2 Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory		03	
5. Data path and system design issues	5.1 Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder, Array Multiplier, Barrel shifter	5	03	09
	5.2 On chip clock generation and distribution, Interconnect delay model, interconnect scaling and crosstalk		02	
	5.3 Design for testability: Fault Types and models, Controllability and observability, Ad hoc testable design techniques, Scan based techniques, Built-in-self-test, Current monitoring test		04	
6. RTL Design	6.1 High Level state machines, RTL design process RTL design of Soda dispenser machine, Laser Based Distance Measurer, FIR Filter	6	04	04
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. CMOS Digital Integrated Circuits Analysis and Design, Third edition, Sung-Mo Kang and Yusuf Leblebici, McGraw Hill, 2012 2. Digital Integrated Circuits: A Design Perspective, Second edition, Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, Pearson Education, 2013 3. Digital Design with RTL design, VHDL and VERILOG, Second edition, Frank Vahid, John Wiley and Sons Publisher, 2010
Reference Books	1. VLSI Design: A Circuits and Systems Perspective, Third Edition, Neil H. E. Weste, David Harris and Ayan Banerjee, Pearson Education, 2012 2. Introduction to VLSI Circuits and Systems, Student Edition, John P. Uyemura, Wiley, 2013 3. CMOS Circuit Design, Layout and Simulation, Second Edition, R. Jacob Baker, Willey, 2002

Useful Links:

1. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee25/
2. https://nptel.ac.in/courses/108/103/108103108/
3. http://cmosedu.com/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC503	Discrete Time Signal Processing	3+0+0
Prerequisite:	Signals & Systems	
Course Objectives:	1. To develop a thorough understanding of Discrete Fourier transform and its use in frequency domain filter designing 2. To design and realize IIR filters and FIR filters, gain an appreciation for the trade-offs necessary in the filter design and to evaluate the effects of finite word lengths on the filters. 3. To introduce applications of digital signal processing in the field of biomedical and speech signal processing	
Course Outcomes:	1. Identify different types of filters based on pass band of given transfer function 2. Illustrate the concepts of Discrete Fourier transform, Fast Fourier transform and apply in system analysis 3. Design digital IIR and FIR filters to satisfy the given specifications and evaluate the frequency response 4. Apply Digital FIR and IIR filter to realize structures 5. Interpret Finite word length Effect in Digital filter 6. Apply signal processing concepts, algorithms in applications related to the field of biomedical and speech signal processing	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Transform Analysis of Linear Time Invariant System	1.1 LTI systems as frequency-selective filters like low pass, high pass, band pass, Notch, comb, all-Pass filters	1	03	05
	1.2 Invertibility of LTI systems, minimum-phase, maximum-phase, mixed-phase system		02	
2. The Discrete Fourier Transform and Efficient Computation	2.1 Relation between DTFT and DFT, Definition and Properties of Discrete Fourier transform (DFT), Inverse DFT, Circular convolution of sequences using DFT and IDFT	2	04	10
	2.2 Linear filtering Technique based on DFT: Evaluation of Linear filtering using DFT, Linear filtering of long data sequences: overlap add and overlap save method		02	
	2.3 Fast Fourier Transform: Radix-2 Decimation in time and Decimation in frequency FFT algorithm and its Inverse, Introduction to Composite -Radix Fast Fourier Transform (FFT)		04	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Design of Digital Filters and Implementation	3.1 Concepts of Infinite Impulse Response (IIR) filter, Mapping of S-plane to Z-plane, Design of Infinite Impulse Response (IIR) filters using Impulse Invariant Method and Bilinear transformation Method from analog filter with examples, Design of Digital Low pass and high pass Butterworth and Chebyshev-I filter from analog filter with examples	3	06	10
	3.2 Concepts of Finite Impulse Response (FIR) filter, Symmetric and Anti-symmetric FIR filter, Design Techniques of FIR filter using various window: Rectangular window, Hamming window, Gibb's phenomenon, Comparison of IIR and FIR filter		04	
4. Digital filter structure	4.1 Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure, Computational complexities for N length filter	4	03	05
	4.2 Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter	5	02	
5. Finite word length Effect in Digital filter	5.1 Quantization Noise, Truncation and Rounding, Effect due to Truncation and Rounding, Coefficient quantization error	5	02	04
	5.2 Dead band, Zero input Limit cycle oscillations and Overflow Limit cycle oscillations		02	
6. Applications of Digital Signal Processing	6.1 Voice Processing, Digital Representation of speech signal, Short Time Spectral Analysis of Speech signal, channel Vocoder, Sub-band Coding, Voice privacy system.	6	03	05
	6.2 Applications of DSP for ECG signal analysis		01	
	6.3 Applications of DSP for Dual Tone Multi-Frequency Signal Detection		01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education 2. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education 3. A Nagoor Kani "Digital Signal Processing", 2nd Edition. Tata Mc Graw Hill Education Private Limited
Reference Books	1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", 4th Edition McGraw Hill Education (India) Private Limited, 2013 2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010 3. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", PrenticeHall of India, 2006 4. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited, 4th Edition, 2015 5. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011 6. Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach", Wiley 2002

Useful Links:

1. Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi
   http://www.nptelvideos.in/2012/12/digital-signal-processing.html
2. Course: Digital Signal Processing By Prof. V. M. Gadre , IIT Bombay
   https://nptel.ac.in/courses/108/101/108101174/
3. Course: Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur
   https://nptel.ac.in/courses/108/105/108105055/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC504	Random Signal Analysis	3+0+0

Prerequisite:	1. Applications of Mathematics in Engineering-II 2. Signals and Systems
Course Objectives:	1. To strengthen the foundations of probability 2. To teach continuous and discrete random variables 3. To explain statistical behaviour of one dimensional and two-dimensional random variables 4. To describe the concept of random process which is essential for random signals and systems encountered in Communications 5. To develop problem solving skills and explain how to make the transition from a real-world problem to a probabilistic model
Course Outcomes:	1. Apply theory of probability in identifying and solving relevant problems 2. Elucidate and Differentiate Random Variables and Vector through the use of cumulative distribution function (CDF), Probability density function (PDF), probability Mass function (PMF) as well as Joint, Marginal and Conditional CDF, PDF and PMF. 3. Articulate expectation and variance of random variables using special distributions 4. Apply concepts to multiple random variables and investigate significance of Central Limit Theorem 5. Illustrate and specify Random processes and determine whether given process is stationary or wide sense stationary 6. Describe basic concept of Markov chain related to real world applications

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Basic Concept in Probability	1.1 Definitions of Probability, Joint, Conditional and Total Probability, Bayes' Theorem, Independence of events.	1	03	04
	1.2 Binary symmetric communication channel analysis using Bayes' Theorem.		01	
2. Introduction to Random variables	2.1 Continuous & Discrete Random Variables, Probability Density Function, Probability Distribution Function, and Probability Mass Function, Properties of PDF and CDF.	2	04	08
	2.2 Special distributions- Binomial, Poisson, Uniform, Gaussian and Rayleigh		04	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Distributions and its Mean, variance and moments of random variables			
3. Operations on One Random Variable	3.1 Function of a random variable and their distribution and density functions	3	04	08
	3.2 Expectation, Variance, Moments, and Characteristic function of random variable.		04	
4. Multiple random variables	4.1 Pairs of random variables, Joint CDF and Joint PDF	4	02	08
	4.2 One function of two random variables, Joint moments, covariance and correlation independent, uncorrelated and orthogonal random variables		05	
	4.3 Central limit theorem and its significance.		01	
5. Random Processes	5.1 Definitions, statistics of stochastic processes, n^{th} order distribution, second-order properties: mean and autocorrelation, SSS, WSS	5	04	06
	5.2 Mean and Correlation Ergodic Processes, Power Spectral Density Functions and its properties		02	
6. Markov Chains	6.1 Markov process, Discrete Markov chains	6	01	05
	6.2 The n–step Transition Probabilities, Chapman-Kolmogorov equations (for discrete Markov Chain), Steady State probabilities, Classification of States of Markov Chain		04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. T. Veerarajan, “Probability, Statistics and Random Process”, Tata McGraw Hill Education, Third Edition (2018). 2. Athanasios Papoulis and S. Unnikrishnan Pillai, “Probability, Random Variables, and Stochastic Processes”, Tata McGraw Hill Education 3. Henry Stark & John Woods, “Probability, Statistics, and Random Processes for Engineers,4th Edition, Pearson Education, 2012
Reference Books	1. Scott Miller and Donald Childers, “Probability and Random Processes with Applications to Signal Processing and Communications”, Elsevier Publication Hwei Hsu, “Theory and Problems of Probability, Random Variables, and Random Processes”, Schaum’s Outline Series, McGraw Hill, 1997 2. P. Ramesh Babu, “Probability Theory and Random Process”, Tata McGraw Hill Education 3. Alberto Leon Garcia, “Probability and Random Processes for Electrical Engineering”, second edition, Pearson education 4. Ronald Walpole, et. al., “Probability and Statistics for Engineers and Scientists”, 8^{th} edition, Pearson Education 5. P. Kousalya, “Probability, Statistics, and Random Processes”, Pearson Education

Useful Links:

1. Introduction to probability and Statistics, Prof. G. Srinivasan (IIT Madras): https://onlinecourses.nptel.ac.in/noc21_ma01/preview
2. Probability and Probability Distributions By Dr. P.Nagesh:\ https://onlinecourses.swayam2.ac.in/cec21_ma02/preview

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course - I	Credits (TH+P+TUT)
1UEXDLC5051	**Data Compression and Encryption**	**3+0+0**
Prerequisite:	Applications of Mathematics in Engineering-I	
Course Objectives:	1. To understand data compression methods for text, images, video and audio. 2. To study different source coding techniques of data compression. 3. To understand the concepts of cryptography and different algorithms to provide system security 4. To learn to apply different cryptographic techniques	
Course Outcomes:	1. Apply different compression techniques on text 2. Explain different data compression methods and standards 3. Explain symmetric and asymmetric cryptography techniques and standards 4. Apply different ciphers and number theory concepts and algorithms to solve the cryptographic problems 5. Describe methods that provide integrity, confidentiality and authentication 6. Describe system security facilities designed to protect the system from security threats	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Data Compression	1.1 Data compression, modelling and coding, Lossless and Lossy Compression, Arithmetic Coding – Decoding, Dictionary Based Compression, Sliding Window Compression: LZ-77, LZ-78, LZW	1	05	08
	1.2 Image Compression: DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards	2	03	
2. Video and Audio Compression	2.1 Video compression: Motion compensation, temporal and spatial prediction, MPEG-4, H.264 encoder and decoder.	2	03	06
	2.2 Sound, Digital Audio, μ-Law and A-Law Companding, MPEG –4 Audio Layer, Advanced Audio Coding (AAC) standard		03	
3. Data Security	3.1 Security Goals, Cryptographic Attacks and Techniques	3	02	09
	3.2 Symmetric Key: Substitution Cipher,		05	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Transposition Cipher , Stream and Block Cipher			
	3.3 DES, double DES and triple DES, AES		02	
4. Number Theory	4.1 Prime Numbers, Fermat's and Euler's Theorem	4	02	04
	4.2 Chinese Remainder Theorem		02	
5. Asymmetric Key Cryptography	5.1 Principles of Public Key Crypto System, RSA, Key Management, Deffie-Hellman Key Exchange	5	04	08
	5.2 Message Integrity, Message Authentication and Hash Functions, SHA, HMAC, Digital Signature Standards		04	
6. System Security	6.1 Intrusion Detection System, Secure Electronic Transactions	6	02	04
	6.2 Firewall Design, Digital Immune systems, Biometric Authentication, Ethical Hacking		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Khalid Sayood, 3rd Edition, Introduction to Data Compression, Morgan Kauffman 2. Mark Nelson, Jean-Loup Gailly, The Data Compression Book, 2nd edition, BPB Publications 3. William Stallings, Cryptography and Network Security Principles and Practices 5th Edition, Pearson Education. 4. Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw-Hill.
Reference Books	1. David Salomon, Data Compression: The Complete Reference, Springer 2. Matt Bishop, Computer Security Art and Science, Addison-Wesley 3. Bernard Menesez, Network Security and Cryptography, Delmar Cengage Learning, 7th Edition
Useful Links:	
1. http://www.nptelvideos.com/video.php?id=989 2. https://www.coursera.org/lecture/algorithms-part2/introduction-to-data-compression-OtmHU 3. https://nptel.ac.in/courses/106102064/19 4. 4.https://www.coursera.org/learn/crypto?_escaped_fragment_=&trk=profile_certification_title 5. https://onlinecourses.nptel.ac.in/noc21_cs16/preview/	

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course - I	Credits (TH+P+TUT)
1UEXDLC5052	**Sensor Technology**	**3+0+0**

Prerequisite:	1. Electronics Devices and Circuits 2. Linear Integrated Circuits
Course Objectives:	1. To explain basics of sensing techniques and parameters 2. To familiarize about MEMS sensors and Actuators 3. To provide exposure to wireless sensing technologies using sensors and signal conditioning. 4. To provide insight into various sensor applications
Course Outcomes:	1. Describe the transduction principle of various sensors. 2. Select sensors suitable for required application 3. Analyse wireless sensing techniques 4. Identify signal conditioning method for particular application 5. Design the data acquisition system 6. Implement applications using various sensor technologies

Module No.	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Classification of Sensors: The sensors are classified with criteria like primary physical quantity to be sensed, transduction principle, material and technology used and application	1	01	03
	1.2 Criteria to choose a Sensor: Accuracy, Precision, Resolution, Environmental condition, Range, Calibration, and Cost		01	
	1.3 Smart Sensors: Low-power, Self – diagnostic and Self- calibration		01	
2. Types of Sensors	2.1 Temperature Sensors: RTD, Thermocouple and Thermistors sensor	2	02	09
	2.2 Proximity Sensors: Inductive (LVDT), Capacitive, Photoelectric and Ultrasonic sensors		02	
	2.3 Chemical Sensors: Gas, Smoke, Conductivity and pH sensor		02	
	2.4 Other Sensors: Optical, Infrared (IR), Sound, Motion, Pressure, Level, Moisture, Humidity, Laser, UV sensors, Ac, IR and		03	

Module No.	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Segmented Sensors.			
3. MEMS Sensors and Actuators	3.1 MEMS Sensors: General design methodology, techniques for sensing, Pressure sensor , Acceleration sensor, Accelerometers, Angular Rate sensor and Gyroscopes, Micro machined microphones, Chemical sensors	2	03	06
	3.2 MEMS Actuators: Techniques for actuation, Digital Micro mirror Device, Micro Machined Valves, Microfluid Devices, IEEE P1451 standard		03	
4. Wireless Sensing Technologies	4.1 Bluetooth: Concepts of Pico net, Scatter net, Link types. Application of Blue tooth with Sensors. IEEE P1451standard	3	02	05
	4.2 ZigBee: components, architecture PLE, Self-Organizing networks and Applications with Sensors		01	
	4.3 Near Field Communication (NFC) and RFID: technical requirements, components and characteristics and their applications with Sensors		02	
5. Data Acquisition and Signal Conditioning	5.1 Signal Conditioning: Block Diagram of Signal Conditioning System, ADC, R2R DAC, Instrumentation Amplifier, Supervisory System (SCADA)	4	02	08
	5.2 Fundamentals of Data Acquisition: Analog and Digital data acquisition system with different configurations, Data loggers, Noise and interference	5	03	
	5.3 Utilization of Signal conditioning circuits for Temperature, Pressure, Optical, Strain gauges, Displacement and Piezoelectric Transducers		03	
6. Sensor Applications	6.1 On-board Automobile sensing system, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring, Biomedical Sensing Applications.	6	04	08
	6.2 Radio sensors for industrial applications, Remote Sensing, Ground Penetrating Radars, Underwater sensing, Agricultural Sensor applications.		04	
ii. Course	Recap of Modules, Outcomes, Applications and	-	01	01

Module No.	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Conclusion	Summarization.			
			Total:	**42**

Books:	
Text Books	1. An Introduction to Micro electromechanical Systems Engineering, 1st Edition, Nadim Maluf, Kirt Williams, Artech House 2004 2. Micro Electro Mechanical System Design, 2nd Edition, James J. Allen, Taylor and Francis, 2005 3. A Course in Electrical and Electronic Measurements and Instrumentation, 19th Edition, A K Swahney, Dhanpatrai & Co., 2011 4. Instrumentation Devices and System, 2nd Edition, Rangan, Mani and Sharma, Tata McGraw-Hill Publications, 1997
Reference Books	1. Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction, 3rd Edition, Nathan Ida Wiley, 2010 2. Handbook of Modern Sensors Physics, Designs, and Applications, 4th Edition, Jacob Fraden Springer, 2010
Useful Links:	
1. https://nptel.ac.in/courses/108/108/108108147/ 2. https://www.youtube.com/watch?v=vjhp0zTXEsc 3. http://nptel.ac.in/courses/112103174/3	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course - I	Credits (TH+P+TUT)
1UEXDLC5053	Microelectronics Devices and Circuits	3+0+0

Prerequisite:	1. Electronic Devices and Circuits 2. Electrical Networks
Course Objectives:	1. To give exposure to MOSFET devices and issues related to it. 2. To introduce Analog integrated circuits based on MOSFET 3. To give exposure to Analog IC design issues 4. To introduce Novel devices and circuits
Course Outcomes:	1. Explain Model of FET devices 2. Analyze advanced amplifier circuit 3. Evaluate circuit parameter of given circuit 4. Design amplifier circuit for given overheads. 5. Explain working Novel devices and circuit 6. Evaluate capacitance and other physical parameter from Layout of simple integrated circuits

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. MOSFET and scaling	1.1 MOS capacitor CV characteristic and concept of accumulation, depletion and inversion; MOSFET characteristics and SPICE models, Long channel and short channel MOSFET , Short channel effects	1	03	06
	1.2 Transistors along with mask layout diagram, Multi finger transistor, Scaling of MOSFET, CMOS technology	1,6	03	
2. Current Mirror and DC analysis	2.1 Current Mirror, cascade current source, Wilson current source, bias independent current source using MOSFET	2,3	02	06
	2.2 DC analysis and small signal analysis of MOS active load, Differential pair, DC analysis and small signal analysis of MOS advanced active load amplifier, Differential pair	3,4	04	
3. Amplifier with Active loads	3.1 CS amplifier with current source load, CS amplifier with diode connected load, CS amplifier with current source load, Common gate circuit	2,4	03	07

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	3.2 Differential pair, Cascode amplifier, Double Cascoding, Folded Cascod	2,3	04	
4. Frequency Response	4.1 Poles and Zeros of CS amplifier, Miller's Theorem, Direct analysis technique, impedance vs frequency	2	04	07
	4.2 Frequency response of single stage (CS, CG) amplifier. cascode stage, differential stage	2, 4,6	03	
5. Feedback in Circuits	5.1 Loop gain, feedback characteristic, Positive feedback, oscillator Barkhausen's criteria and oscillator example	5	02	07
	5.2 Negative feedback topology: voltage-voltage, voltage-current, current-current, current-voltage fed	3	03	
	5.3 Problem of instability in circuit, Stability analysis of Cascode circuit, Frequency Compensation, miller compensation	3,4	02	
6. Introduction of Novel Devices and circuit Design	6.1 Introduction to FinFet, GAA FETS, double gate, SOI multigate Mosfet	1, 5,6	02	06
	6.2 Analog Design: Device figure of merit, technology issue in circuit design, Flicker noise, matching behaviour and techniques, Layout rules for transistor matching		04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. D. A. Neamen, "Electronic Circuit Analysis and Design," Tata McGraw Hill, 2nd Edition 2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, "Microelectronic Circuits Theory and Applications," International Version, OXFORD International Students, 6th Edition 3. Behzad Razavi, Microelectronics, 2nd Edition
Reference Books	1. Behzad Razavi, Analog Circuit Design, 2nd Edition 2. J.P. Coligne Finfet and other Multi-Gate Transistors
Useful Links:	
1. https://www.semiconductors.org/semiconductors-101/what-is-a-semiconductor/ 2. https://onlinecourses.nptel.ac.in/noc21_ee51/ 3. http://cmosedu.com/	

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – I	Credits (TH+P+TUT)
1UEXDLC5054	**Data Structures and Algorithms**	**3+0+0**
Prerequisite:	Computer Programming	
Course Objectives:	1. To teach efficient storage mechanisms of data for an easy access. 2. To design and implementation of various basic and advanced data structures. 3. To introduce various techniques for representation of the data in the real world and to improve the logical ability 4. To understand the concept of protection and management of data and to develop application using data structures 5. To understand various problem solving strategies. 6. To apply mathematical background for algorithm analysis and implementation of various strategies like divide and conquer, Dynamic programming	
Course Outcomes:	1. To choose appropriate data structure as applied to specified problem definition. 2. To use linear and non-linear data structures like stacks, queues, linked list etc. 3. To select appropriate problem solving strategies. 4. To calculate time complexity and space complexity of an algorithm. 5. To analyze different divide and conquer problems. 6. Ability to analyze different dynamic programming problems.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Data Structures and Stack	1.1 Introduction to Data Structures Types of Data Structures, Arrays, Strings, Recursion, ADT (Abstract Data type), Concept of Files, Operations with files, types of files	1	02	05
	1.2 Stack : The Stack as an ADT, Stack operation, Array Representation of Stack, Link Representation of Stack, Application of stack – Recursion, Polish Notation	2	03	
2. Queues and Linked List	2.1 Queues The Queue as an ADT, Queue operation, Array Representation of Queue, Linked Representation of Queue, Circular Queue,	2	02	07

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Priority Queue, & Dequeue, Application of Queues – Johnsons Algorithm, Simulation			
	2.2 Linked List Linked List as an ADT, Linked List Vs. Arrays, Memory Allocation & De-allocation for a Linked List, Linked List operations, Types of Linked List, Implementation of Linked List, Application of Linked List polynomial, sparse matrix.		05	
3. Trees and Graphs	3.1 Trees Basic trees concept, Binary tree representation, Binary tree operation, Binary tree traversal, Binary search tree implementation, Thread Binary tree, The Huffman Algorithm, Expression tree, Introduction to Multiway search tree and its creation(AVL, B-tree, B+ tree)	2, 3	05	07
	3.2 Graphs Basic concepts, Graph Representation, Graph traversal (DFS & BFS)		02	
4. Introduction to analysis of algorithm	Decision and analysis fundamentals, Performance analysis , space and time complexity; Growth of function – Big –Oh, Omega, Theta notation; Mathematical background for algorithm analysis, Analysis of selection sort, insertion sort , Randomized algorithms, Recursive algorithms, The substitution method, Recursion tree method, Master method	3, 4	06	06
5. Feedback in Circuits	General method , Binary search , Finding minimum and maximum, Merge sort analysis, Quick sort analysis, Strassen’s matrix multiplication, The problem of multiplying long integers	5	06	06
6. Dynamic Programming	General Method, Multistage graphs, all pair shortest path, single source shortest path, Optimal binary search tree, 0/1 knapsack, Travelling salesman problem, Flow shop scheduling	6	07	07
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Data Structures A Psedocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, Second edition, CENGAGE Learning 2. Data Structures using C, Reema Thareja, Oxford University press 3. Introduction to Data Structure and its Applications Jean-Paul Tremblay, P. G. Sorenson 4. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. “Fundamentals of computer algorithms” University Press 5. T.H.Coreman , C.E. Leiserson, R.L. Rivest, and C. Stein, “Introduction to algorithms”, 2nd edition , PHI publication 2005. 6. Alfred v. Aho, John E. Hopcroft , Jeffrey D. Ullman , “Data structures and Algorithm” Pearson education, Fourth impression 2009
Reference Books	1. Data Structures Using C & C++, Rajesh K. Shukla, Wiley- India 2. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill 3. Data Structure Using C, Balagurusamy 4. C & Data Structures, Prof. P.S. Deshpande, Prof. O.G. Kakde, Dreamtech press 5. Data Structures, Adapted by: GAV PAI, Schaum’s Outlines 6. Michael Gooddrich & Roberto Tammassia, “Algorithm design foundation analysis and internet examples”, Second edition , Wiley student edition

Useful Links:

1. https://learndsa.kjsieit.in/
2. https://nptel.ac.in/courses/106/102/106102064/
3. https://www.coursera.org/specializations/data-structures-algorithms
4. https://www.edx.org/course/data-structures-fundamentals
5. https://swayam.gov.in/nd1_noc19_cs67/preview

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (P+TUT)
1UEXL501	**Digital Communication Laboratory**	**1+0**
Lab Prerequisite:	1. Analog communication 2. Electronic devices and circuits	
Lab Objectives:	1. To learn source coding and error control coding techniques 2. To compare different line coding methods 3. To distinguish various digital modulations 4. To use different simulation tools for digital communication applications	
Lab Outcomes:	1. Compare various source coding schemes 2. Design and implement different error detection codes 3. Illustrate the impulse response of a matched filter for optimum detection 4. Demonstrate various digital modulation techniques 5. Write accurate documentation for experiments performed 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Huffman code generation	1,5,6	02
2	Shannon-Fano code generation	1,5,6	02
3	Vertical redundancy Check (VRC) code generation and error detection	2,5,6	02
4	Horizontal Redundancy Check (HRC) code generation and error detection	2,5,6	02
5	Cyclic redundancy Check (CRC) code generation and error detection	2,5,6	02
6	Checksum code generation and error detection	2,5,6	02
7	Compare the performances of HRC and Checksum	2,5,6	02
8	Linear block code generation and error detection	2,5,6	02
9	Error detection and correction using Hamming code (virtual lab http://vlabs.iitb.ac.in/vlabsev/labs/mit_bootcamp/comp_networks_sm/labs/exp1/index.php)	2,5,6	02
10	Cyclic code generation and error detection	2,5,6	02
11	Convolutional code generation	2,5,6	02
12	Line Codes generation and performance comparison	1,5,6	02
13	Spectrum of line codes (NRZ unipolar and polar)	1,5,6	02
14	Impulse responses of ideal (Nyquist filter) and practical (Raised cosine filter) solution for zero ISI	3,5,6	02
15	Matched filter impulse response for a given input	3,5,6	02
16	Generation (and detection) of Binary ASK	4,5,6	02
17	Generation (and detection) of Binary PSK	4,5,6	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
18	Generation (and detection) of Binary FSK	4,5,6	02
19	Generation (and detection) of QPSK	4,5,6	02
20	Generation (and detection) of M-ary PSK	4,5,6	02
21	Generation (and detection) of M-ary FSK	4,5,6	02
22	Generation (and detection) of 16-ary QASK	4,5,6	02
23	Generation (and detection) of MSK	4,5,6	02
		Total	**48***

***Minimum 28 Hrs. Lab / Mini Project to be conducted**

Suggested list of experiments is given as 23 experiments. One can add / subtract then this according to the syllabus and time. Term work should consist of minimum 8 experiments.

Virtual Lab Links:

http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks_sm/labs/exp1/index.php)

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Oral examination will be based on the experiment list and content of the entire theory syllabus.

Course Code	Course Name	Credits (P+TUT)
1UEXL502	**Digital VLSI Digital Laboratory**	**1 + 0**

Lab Prerequisite:	Digital Logic Design
Lab Objectives:	1. To simulate the various phenomenon related to CMOS circuits 2. To analyse simple CMOS circuits using SPICE tools 3. To simulate the logic circuits using various design style 4. To draw mask layout of various circuits
Lab Outcomes:	1. Implement SPICE model for given combinational and sequential CMOS circuits. 2. Perform various analysis like operating point, dc, transient etc. of given CMOS circuits. 3. Design, simulate, and verify CMOS circuit for given specification and Evaluate performance of the same. 4. Draw layout of given CMOS circuit and also able extract various parasitic using open source layout tool like Magic. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Constant Voltage and Constant field MOSFET scaling	2,5,6	02
2	Layout of MOSFET and extraction of parasitic capacitances	4,5,6	02
3	Voltage transfer characteristics of CMOS inverter and calculation of Noise Margin and static power	2,5,6	02
4	Transient Analysis of CMOS inverter and calculation of t_{pHL}, t_{pLH}, t_r, t_f and average power	3,5,6	02
5	Design of CMOS inverter for given specifications	3,5,6	02
6	Layout of CMOS inverter and comparison of pre layout and post layout performance	4,5,6	02
7	Voltage transfer characteristics of 2 input NAND/NOR gate and calculation of noise margins and validation using equivalent inverter approach	2,5,6	02
8	Transient Analysis of 2 input NAND/NOR CMOS gate and calculation of t_{pHL}, t_{pLH}, t_r, t_f, average power and validation using equivalent inverter approach	3,5,6	02
9	Layout of 2 input CMOS NAND/NOR gate and comparison of pre layout and post layout performance	4,5,6	02
10	Static and transient analysis of Complex CMOS gate	3,5,6	02
11	Layout of complex CMOS gate using Euler path	4,5,6	02
12	Implementation of various combinational and sequential circuits	1,5,6	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
	using different design styles		
13	Design and implementation of NAND based and NOR based ROM array	3,5,6	02
14	Performance analysis of 6T-SRAM Cell	3,5,6	02
15	Design of 6T SRAM cell robust read and write operation	3,5,6	02
16	Performance analysis of 1T and 3T DRAM Cell	3,5,6	02
17	RTL design of Soda dispenser machine	1,5,6	02
18	RTL design of FIR Filter	1,5,6	02
		Total	**38***

***Minimum 28 Hrs. Lab / Mini Project to be conducted**

Virtual Lab Links:
https://vlsi-iitg.vlabs.ac.in/

Term work:
1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :
Practical examination will be based on the experiment list and content of the entire theory syllabus.

Course Code	Course Name	Credits (P+TUT)
1UEXL503	**Discrete Time Signal Processing Laboratory**	**1+0**
Lab Prerequisite:	Signals and Systems	
Lab Objectives:	1. To carry out basic discrete time signal processing operations 2. To implement and design FIR filters and IIR filters 3. To implement applications related to the field of biomedical signal processing and audio signal processing	
Lab Outcomes:	1. Demonstrate their ability to perform frequency analysis of different discrete time sequences. 2. Perform basic signal processing operations such as circular convolution of discrete time sequences. 3. Design and implement IIR & FIR Filters for given specifications. 4. Analyse and Implement applications related to the field of biomedical signal processing and audio signal processing 5. Write accurate Documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Impulse response of Discrete Time System	1,5,6	02
2	4-point DFT of Discrete Time Sequence	1,5 ,6	02
3	Circular Convolution of Discrete Time Sequence	1,2,5,6	02
4	8- point DFT of Discrete Time Sequence	1,5,6	02
5	Butterworth IIR filter using Impulse Invariance Transformation	3,5,6	02
6	Butterworth IIR filter using Bilinear Transformation Technique	3,5,6	02
7	Chebyshev filter using Bilinear Transformation Technique	3,5,6	02
8	Impulse response of FIR band pass filter	3,5,6	02
9	Impulse FIR filter using Rectangular Window	3,5,6	02
10	Case study on different applications of Digital Signal Processing	4,5,6	08
		Total	**28**

Virtual Lab Links:
vlabs.iitkgp.ernet.in/dsp/#

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Course Code	Department Level Elective Course – I Laboratory	Credits (P+TUT)
1UEXDLL5051	**Data Compression and Encryption Laboratory**	**1+0**

Lab Prerequisite:	Any suitable programming skills
Lab Objectives:	1. To apply statistical and dictionary methods for text compression 2. To understand on how to apply the concept of quantization and audio/image compression 3. To understand the concepts of Encryption and techniques of Encryption 4. To understand on how to apply the cryptographic algorithm
Lab Outcomes:	1. Implement Text compression Techniques 2. Implement Image compression techniques 3. Implement data Encryption technique 4. Implement public key cryptography algorithms 5. Write accurate documentation for experiments performed 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Write a program to encode and decode message and find code efficiency using Arithmetic Coding	1,5,6	02
2	Write a program to encode and decode the text using Dictionary methods	1,5,6	02
3	Write a program to Discrete Cosine Transform for image compression	2,5,6	02
4	To study DPCM Audio Compression Method	2,5,6	02
5	To study the effect of Uniform and Non uniform Quantization on speech signal	2,5,6	02
6	Write a program to apply Affine Cipher Encoding and decoding for data encryption	3,5,6	02
7	Write a program to apply Caesar Cipher Encoding and decoding for data encryption	3,5,6	02
8	Write a program to implement Diffie-Hellman Public Key Cryptography	4,5,6	02
9	To study RSA Public Key Encryption and Decryption Algorithm	4,5,6	02
10	To study the Message Authentication algorithm	4,5,6	02
11	Case Study / Mini Project	1,2,3,4,5,6	06
		Total	**28**

Virtual Lab Links:

1/cse29-iiith.vlabs.ac.in/

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Course Code	Department Level Elective Course – I Laboratory	Credits (P+TUT)
1UEXDLL5052	Sensor Technology Laboratory	1+0

Lab Prerequisite:	1. Knowledge of implementing Electronic Circuits 2. Interfacing devices for processing such as Arduino, Raspberry Pi, Microprocessors and Microcontrollers. 3. Signal Conditioning Circuits
Lab Objectives:	1. To implement basic applications using different types of Sensors. 2. To apply the knowledge of MEMS and Smart sensors by implementing applications 3. To implement signal conditioning circuits to shape the input signals. 4. To interface sensors with various communication Technologies
Lab Outcomes:	1. Develop basic sensor application circuit using sensors like temperature, smoke, humidity, moisture sensors. 2. Apply the smart sensors and connect them to different platforms like wired and wireless. 3. Design suitable signal conditioning to different types of sensor outputs for further processing. 4. Implement applications based on A to D convertors and D to A convertors and connect them to sensor circuits through different case studies. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Study of different types of sensors by observing them in the lab and study the important parameters like accuracy, Precision, Resolution, Range, tolerance limits etc.	1,5,6	02
2	Implement a circuit to detect smoke.	1,5,6	02
3	Design bimorph cantilever which acts as a pressure sensor.	2,5,6	02
4	Model and simulate Electro-mechanical actuator. Do dc and transient analysis	2,5,6	02
5	Simulate the harvested electrical power from mechanical vibrations using piezoelectric cantilever beam.	2,5,6	02
6	Model and simulate accelerometer	2,5,6	02
7	Implement A to D conversion	3,5,6	02
8	Implement R2R D to A convertors	3,5,6	02
9	Interfacing the Zigbee with humidity sensors.	4,5,6	02
10	Interfacing RFID with proximity sensors	4,5,6	02
11	Study of NFC and suitable sensors for interfacing.	4,5,6	02
12	Case Study / Mini Project	1 to 6	04
		Total	**28**

Virtual Lab Links: https://ssp-iitb.vlabs.ac.in/
Term work: 1. Term work should consist of a minimum of 8 experiments. 2. Journal must include assignments on content of theory and practical of the course. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Course Code	Department Level Elective Course – I Laboratory	Credits (P+TUT)
1UEXDLL5053	**Microelectronics Devices and Circuits Laboratory**	**1 + 0**

Lab Prerequisite:	Electronic Devices & Circuits
Lab Objectives:	1. To provide insight into Analog circuit design using CAD tools 2. To gain proficiency in integrated circuit analysis using LTspice 3. To provide exposure to Layout IC design 4. To provide insight into Analog design flow process
Lab Outcomes:	1. Design amplifier circuits in LTspice simulation environment. 2. Design layout of amplifier inverter in Electric 3. Analyse from the data available from simulation in LTspice 4. Asses different circuit and device models 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the Laboratory

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Installations and demonstration of CAD Design software: types, working roles in IC design	5,6	02
2	Plot long and short channel MOSFET characteristics	3,4,5,6	02
3	DC analysis of advance active load amplifier	3,4,5,6	02
4	DC analysis of Cascode amplifier	3,4,5,6	02
5	Transient analysis of Cascode amplifier	3,4,5,6	02
6	AC Analysis of Cascode amplifier	3,4,5,6	02
7	AC analysis of Differential amplifier	3,4,5,6	02
8	CMOS inverter simulation	3,4,5,6	02
9	CMOS inverter Layout simulation, DRC, LVS steps.	2,5,6	02
10	Layout of CS amplifier	2,5,6	02
11	Implement available Compact model equation in octave	3,5,6	02
12	Implementation of CAD Design software using simple techniques/available open source software for mobile devices	5,6	02
13	Study of Verilog-A software and design flow	5,6	02
		Total	**28**

Virtual Lab Links:

1. http://vlabs.iitkgp.ernet.in/be/
2. http://cmosedu.com/
3. https://www.youtube.com/watch?v=rXTEmojksd4

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Course Code	Department Level Elective Course– I Laboratory	Credits (P+TUT)
1UEXDLL5054	**Data Structures and Algorithm Laboratory**	**1+0**
Lab Prerequisite:	1. Computer Programming 2. Computer Programming Laboratory	
Lab Objectives:	1. To implement basic data structures such as linked lists, stacks and queues 2. To solve problem involving graphs and trees 3. To choose appropriate data structure and apply it to various problems	
Lab Outcomes:	1. Choose appropriate data structure as applied to specify problem definition and to select appropriate problem solving strategies. 2. Use linear and non-linear data structures like stacks, queues, linked list etc. 3. Calculate time complexity and space complexity of an algorithm. 4. Analyse different divide and conquer problems, dynamic programming problems. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Implementations of stack menu driven program	1,5,6	02
2	* Implementations of Infix to Postfix Transformation and its evaluation program	2,5,6	02
3	Implementations of queue menu driven program	1,5,6	02
4	* Implementations of double ended queue menu driven program	1,2,5,6	02
5	* Implementation of different operations on linked list – copy, concatenate, split, reverse, count no. of nodes etc.	1,2,5,6	02
6	Implementation of polynomials operations (addition, subtraction) using Linked List	2,5,6	02
7	*Implementations of Binary Tree menu driven program	2,5,6	02
8	*Implementation of construction of expression tree using postfix expression.	3,5,6	02
9	* Implementations of Graph menu driven program (DFS & BSF)	3,5,6	02
10	Write a program for a. selection sort b. insertion sort	3,5,6	02
11	* Write a program using Divide and Conquer for a. Merge sort analysis b. Quick sort analysis	4,5,6	02
12	Write a program using Divide and Conquer for a. binary search b. finding minimum and maximum	4,5,6	02
13	*Write a program for Optimal binary search tree using dynamic programming	4,5,6	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
14	*Write a program for Travelling salesman problem using dynamic programming	4,5,6	02
		Total	**30**

* Compulsory / **Minimum 28 Hrs. Lab / Mini Project to be conducted**

Useful Links:

1. https://www.programiz.com/dsa
2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

<table>
<tr><th>Course Code</th><th>Course Name</th><th>Credits
(TH+P+TUT)</th></tr>
<tr><td>1UEXL506</td><td>Business Communication & Ethics Laboratory</td><td>0+2+0</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Hardware Requirements:</td><td colspan="2">PC With following Configuration
1. Intel Dual core Processor or higher
2. Minimum 4 GB RAM
3. Minimum 40 GB Hard disk</td></tr>
<tr><td>Software Requirements:</td><td colspan="2">1. Microsoft Windows 10 Desktop OS
2. Language Laboratory Software: ODLL (Orell Digital Language Laboratory)</td></tr>
<tr><td>Lab Prerequisite:</td><td colspan="2">Fundamental knowledge of Professional Communication Skills as acquired in semester II</td></tr>
<tr><td>Course Rationale:</td><td colspan="2">This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student’s interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.</td></tr>
<tr><td>Lab Objectives:</td><td colspan="2">1. To discern and develop an effective style of writing important technical/business documents
2. To investigate possible resources and plan a successful job campaign
3. To comprehend the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement
4. To develop creative and impactful presentation skills
5. To ehavio personal traits, interests, values, aptitudes and skills
6. To understand the importance of integrity and develop a personal code of ethics</td></tr>
<tr><td>Lab Outcomes:</td><td colspan="2">1. Plan and prepare effective business/ technical documents which will in turn provide a solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional communication
6. Apply codes of ethical conduct, personal integrity and norms of organizational behaviour</td></tr>
</table>

Module No. & Name	Sub Topics	TO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Advanced Technical Writing: Project/ Problem Based Learning	1.1 Classification of Reports: Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.) Time Interval (Periodic, One-time, Special) Function (Informational, Analytical, etc.) Physical Factors (Memorandum, Letter, Short & Long)	1, 6	01	06
	1.2 Parts of a Long Formal Report: Prefatory Parts (Front Matter) Report Proper (Main Body) Appended Parts (Back Matter)		01	
	1.3 Language and Style of Reports Tense, Person & Voice of Reports Numbering Style of Chapters, Sections, Figures, Tables and Equations Proofreading through Plagiarism Checkers		01	
	1.4 Definition, Purpose & Types of Proposals Solicited (in conformance with RFP) & Unsolicited Proposals Types (Short and Long proposals)		01	
	1.5 Parts of a Proposal Elements Scope and Limitations Conclusion		01	
	1.6 Technical Paper Writing Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) Language and Formatting Referencing in IEEE Format		01	
2. Employment Skills	2.1. Cover Letter & Resume Parts and Content of a Cover Letter Difference between Bio-data, Resume & CV Essential Parts of a Resume Types of Resume (Chronological, Functional & Combination)	2, 4	01	06
	2.2 Verbal Aptitude Test		01	

Module No. & Name	Sub Topics	TO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Modelled on CAT, GRE, GMAT exams			
	2.3 Group Discussions Purpose of a GD Parameters of Evaluating a GD		01	
	Types of GDs (Normal, Case-based & Role Plays)		01	
	GD Etiquettes		01	
	2.4 Personal Interviews Planning and Preparation Types of Questions Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual		01	
3. Business Meetings	3.1 Conducting Business Meetings Types of Meetings Meeting etiquettes	3, 6	01	02
	3.2 Documentation Notice Agenda Minutes		01	
4. Technical/ Business Presentations	4.1 Effective Presentation Strategies Defining Purpose Analyzing Audience, Location and Event Gathering, Selecting & Arranging Material	2, 4	01	02
	4.2 Structuring a Presentation Making Effective Slides Types of Presentations Aids Closing a Presentation		01	
5. Interpersonal Skills	5.1 Emotional Intelligence	5, 6	01	08
	Motivation		01	
	Assertiveness		01	
	Time Management		02	
	Stress Management		02	
	5.2 Start-up Skills Financial Literacy Risk Assessment Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	2, 5	01	
6. Corporate Ethics	6.1 Intellectual Property Rights Copyrights Trademarks	6	01	02

Module No. & Name	Sub Topics	TO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Patents			
	6.2 Case Studies Cases related to Business/ Corporate Ethics	1 to 6	01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**28**

Activity No.	Activity/ Assignment Title (In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)	Hrs/ Lab
1.	Test of English as Foreign Language (TOEFL)	02
2.	Group discussion (Practice session)-I	02
3.	Group discussion (Practice session)-II	02
4.	Final Group discussion-I	02
5.	Final Group discussion-II	02
6.	English Aptitude Test	02
7.	Resume Writing	02
8.	Mock interview	02
9.	Role play techniques for interpersonal skills	02
10.	Project Report Presentation-I	02
11.	Project Report Presentation -II	02
12.	Technical proposal	02
13.	Corporate Ethics/role play/case studies	02
14.	Business Meetings: case studies/role play	02
	Total:	**28**

Books:	
Text Books	1. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press. 2. Bovée, C. L., & Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
Reference Books	1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill. 2. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning. 3. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning. 4. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.

	5. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press 6. Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press

Useful Links:

1. Interview techniques (How to answer tell me about yourself)
   https://www.youtube.com/watch?v=m5kR7TPAkSw
2. The 4 types of team members you can hire
   https://www.youtube.com/watch?v=5bYYFfpbSqc
3. Every Meeting Ever
   https://www.youtube.com/watch?v=K7agjXFFQJU

Useful Video links:

1. TOEFL listening Skill
   https://www.youtube.com/watch?v=jSUh0Civuv4
2. MBA Interview
   https://www.youtube.com/watch?v=cwW9QBNuwCw
3. How to write a successful CV
   https://www.youtube.com/watch?v=U0JAfqEak2c
4. Interview techniques (How to answer tell me about yourself)
   https://www.youtube.com/watch?v=m5kR7TPAkSw
5. The 4 types of team members you can hire
   https://www.youtube.com/watch?v=5bYYFfpbSqc
6. Every Meeting Ever
   https://www.youtube.com/watch?v=K7agjXFFQJU

Assessment:

Term Work (25 Marks)

Term work of 25 Marks shall consist of a minimum 8 Assignments.

The distribution of marks for term work shall be as follows:

Assignment : 10 Marks
Book Report (hard copy) : 10 Marks
Attendance : 05 Marks

Note: The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral (25 Marks)

Oral Examination will be based on a GD & the Project/Book Report presentation.

1	Group Discussion : 10 Marks
2	Project Presentation : 15 Marks

Note:

1. The Main Body of the project/book report should contain a minimum **25 pages** (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Course Code	Project Based Learning	Credits (TH+P+TUT)
1UEXPR53	**Minor Project Lab – I**	**0 +1+ 0**
Prerequisite:	1. Microcontrollers 2. Linear Integrated Circuits 3. Mini Project 1B: Arduino & Raspberry Pi based Projects	
Minor Project Objectives:	1. To develop background knowledge Embedded Systems. 2. To understand the design of embedded systems. 3. To choose proper microcontroller for Embedded systems 4. To understand use of wireless sensors/communications with Embedded systems 5. To understand communication techniques. 6. To write programs for embedded systems and real time operating systems / IoT	
Minor Project Outcomes:	1. Outline the embedded systems concept with design metrics 2. Outline microcontroller's concept. 3. Implement the Embedded systems with different sensors and peripherals as IoT. 4. Implement the Embedded systems with different communication protocols as IoT. 5. Analyze concepts of Real time operating systems. 6. Design embedded system applications using sensors, peripherals and RTOS	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
1. Introduction	1.1 Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas. Characteristics and quality attributes (Design Metric) of embedded system	1	02	04
	1.2 Identification of Project Title		02	
2. Controller boards and Programming – Embedded C	2.1 ARM LPC 21XX (2148), STM32 boards and Texas MSP 430 lunchbox/ Tiva C board and PIC/PSoc*	2	01	04
	2.2 Comparison of C and embedded C, Data Types, Variable, Storage Classes, Bit operation, Arrays, Strings, Structure and unions, Classifier		01	
	2.3 Exercise: Identify the suitable board required for the particular application with		01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
	respect to design metrics. (Hint: check clock frequency (speed), memory (program and data), no. of ports for peripherals, timers/counters and serial communication requirement for project)			
	2.4 Suggested Way to Identify: https://predictabledesigns.com/how-to-selectthe-microcontroller-for-your-new-product/		01	
3. Interfacing Sensors and peripherals using Embedded C	3.1 Sensors and Signal Conditioning Circuits amplifiers /attenuators /filters /comparators/ADC and DAC) , Interfacing with GLCD/TFT display, Relays and Drivers for interfacing Motors (DC and stepper)	3	02	05
	3.2 Exercise: Understand the Interfacing requirement like drivers, signal condition circuits for sensors, etc. for the selected application		01	
	3.3 Study Material: For LCD interfacing with MSP430 Launch Pad https://microcontrollerslab.com/lcd-interfacing-msp430-launchpad/#:~:text=LCD%20interfacing%20with%20MSP430%20microcontroller,Now%20I%20will&text=It%20requires%205%20volts%20dc,and%20second%20pin%20is%20vcc.		02	
4. Communication with programming in Embedded C	4.1 Serial communication, CAN bus, I2C, MOD bus, SPI	4	01	05
	4.2 Interfacing with Wi-Fi, Bluetooth ,ZigBee, LoRa, RFID and putting data on IoT		01	
	4.3 Interfacing with GSM module , GPS module, SD card		01	
	4.4 Exercise: Understand Communication requirement for selected application and test it		01	
	4.5 STM32:https://controllerstech.com/serial-transmission-in-stm32/#:~:text=Serial%20Transmission%20in%20Stm32&text=UART%20is%20widely%20used%20for, amongst%20which%20communication%20is%20 done.		01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Topic
	LPC2148: https://www.electronicwings.com/arm7/lpc2148-uart0 MSP430: https://www.ti.com/lit/ml/slap117/slap117.pdf			
5. Real Time Operating Systems [RTOS]	5.1 Operating system basics, Types of OS , Tasks, process, Threads	5	02	04
	5.2 Multiprocessing and Multitasking, Task scheduling		01	
	5.3 RTLinux/ Free RTOS and Mbed OS, Implementation with RTOS		01	
6. Cloud/ Web server	6.1 Implementation on web server	6	01	04
	6.2 Thingspeak, AWS cloud platform for IoT based programming and modelling		01	
	6.3 Exercise : Perform ESP8266 interface with microcontroller		01	
	6.4 Study Material: STM32: https://circuitdigest.com/microcontroller-projects/interfacingesp8266-with-stm32f103c8-stm32-to-create-a-webserver LPC2148: https://circuitdigest.com/microcontroller-projects/iot-based-ARM7-LPC2148-webserver-to-control-an-led MSP430: https://circuitdigest.com/microcontroller-projects/sending-emailusing-msp430-and-esp8266		01	

Books:	
Text Books	1. Shibu K.V," Introduction to Embedded Systems", Mc Graw Hill, 2nd edition. 2. Frank Vahid, and Tony Givargis, "Embedded System Design: A unified Hardware/Software Introduction", Wiley Publication. 3. Raj Kamal," Embedded Systems Architecture, Programming and design", Tata McGraw-Hill Publication. 4. 4. Dr. K.V.K.K. Prasad, "Embedded Real Time Systems: Concepts, Design & Programming", Dreamtech Publication.
Reference Books	1. Iyer, Gupta," Embedded real systems Programming", TMH 2. David Simon, "Embedded systems software primer', Pearson 3. Andrew Sloss, Dominic Symes and Chris Wright, "ARM_System_Developers_GuideDesigning_and_Optimizing_System_Software" Elsevier and Morgan Kaufmann Publishers.

Useful Links:

1. Introduction to Embedded System Design (using MSP430) https://onlinecourses.nptel.ac.in/noc20_ee98/preview
2. Embedded System Design with ARM https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. Embedded systems https://nptel.ac.in/courses/108/102/108102045/
4. Master Microcontroller and Embedded Driver Development (MCU1) STM32 Udemy course link mastering microcontrollers with peripherals
5. Texas Instruments (TI) Trainings: https://e2e.ti.com/support/archive/universityprogram/educators/w/wiki/2103/training-support
6. Texas Instruments (TI) Teaching material/ text books: https://e2e.ti.com/support/archive/universityprogram/educators/w/wiki/2035/textbooks

Continuous Assessment: Practical (25 Marks)

A. Guideline of Minor project are as follows :

1. To achieve proper selection of Minor Projects. Students should do a survey of different microcontroller board from given microcontroller series tools and identify which is most suitable for their selected topic. They should consult with their Guide/Mentors / Internal committee to finalize it.
2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of minor project.
3. A log book to be prepared by each group, wherein group can record weekly work progress. Guide/ supervisor will verify it and will put notes/comments.
4. Guide/supervisor guidance is very much important during minor project activities; however, focus shall be on self-learning.

Suggested steps for Minor project selection and implementation

Minor project should be completely microcontroller based

Follow these steps:

a) Take specification, using these specifications design project.
b) Select proper microcontroller board considering features and requirements of project.
c) Program it using Embedded C and perform verification of each module (sensors/communication protocol)
d) Test Functional Simulation and verify it using simulation tool.
e) Make hardware connection on GPP of peripherals with microcontroller board and execute the program.
f) Troubleshoot if not get expected result.

B. Project Topic selection and approval :

1. The group may be of maximum THREE (03) students.
2. Topic selection and approval by 2 Expert faculties from department at the start of semester.
3. Log Book to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed online with proper authentication method using Google sheets/forms or open source project management software.

C. Project Report Format:

1. Report should not exceed 30 pages. Simply staple it to discourage use of plastic.
2. Report must contain block diagram, circuit diagram, screenshot of outputs and datasheets of microcontrollers and peripherals (Include only required information pages).
3. The recommended report writing format is in LaTex.(https://youtu.be/YLm3sXlKpHQ)

Term Work: (25 marks)

1. Term Work evaluation and marking scheme:

a. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.
b. The progress of minor project to be evaluated on continuous basis, minimum two reviews in each semester.
c. At end of semester the above 2 expert faculty who have approved the topic will internally evaluate the performance.
d. Students have to give presentation and demonstration on the Embedded Systems Minor Project at end of semester before submission to above experts.
e. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.
f. Distribution of 25 Marks scheme is as follows:
   i. Marks awarded by guide/supervisor based on log book and output: 10
   ii. Marks awarded by review committee: 10
   iii. Quality of Project report: 05

2. Guidelines for Assessment of Minor Project Practical/Oral Examination:

a. Report should be prepared as per the guidelines issued by the University of Mumbai.
b. Minor Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.

Skill Based Learning Code	Skill Based Learning - VII	Credits (TH+P+TUT)
1UEXXS57	Aptitude/Logic Building and Competitive Programming skills	0+1+0
Skill Prerequisite	1. Knowledge of elementary mathematics (HSC level) 2. Knowledge of basic English grammar (SSC level) 3. Knowledge of Basic programming languages	

Skill Objectives	1. To have the basic awareness about how to prepare for recruitment process 2. To introduce the students to computational skills required to appear for recruitment tests. 3. To introduce the students to coding skills required to appear for recruitment tests/ project /coding competitions.

Skill Outcomes	1. Discuss the basic concepts of QUANTITATIVE ABILITY 2. Discuss the basic concepts of LOGICAL REASONING Skills 3. Acquire satisfactory competency in use of VERBAL REASONING 4. Solve campus placements aptitude papers covering Quantitative Ability, Logical Reasoning and Verbal Ability 5. Use most common algorithms for competitive programming 6. Analyse data structures for competitive up solving.

Module No & Name	Sub Topics	SO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
1. **Basics of Quantitative Abilities**	1.1Problems on Number System Problems on HCF and LCM Problems on Average	1,4	02	06
	1.2Problems on Ratio and Proportion, Problems on Percentage		02	
2. **Arithmetic Quantitative Abilities**	2.1 Problems on Ages, Problems on Profit and Loss	1,4	02	06
	2.2 Problems on Simple and Compound Interest, Problems on Time and Distance		02	
3. **Logical Reasoning**	3.1Number Series, Alpha Numerical, Letter & Symbol Series	2,4	02	04
	3.2Numerical and Alphabet Puzzles, Seating Arrangement			
4. Programming Techniques	4.1What is Competitive Programming? Programming Contests, Language Features	5	02	05
	4.2 Recursive Algorithms, Bit Manipulation		03	
5. Sorting and Searching	Sorting Algorithms, Solving Problems by sorting, Binary Search	6	05	05
ii. Course Conclusion	Course recap, Outcomes, Discussion	-	-	02
			Total:	**28**

Text Books:
1.Quantitative abilities by Arun Sharma 2. Quantitative Aptitude for Competitive Examinations by R S Agrawal 3. Verbal and Non-Verbal reasoning by R S Agrawal 4. Guide to Competitive Programming Learning and Improving Algorithms Through Contests Antti Laaksonen, Department of Computer Science, University of Helsinki, Finland
Reference Books: 1. Algorithms Illuminated by Tim Roughgarden 2. Algorithm Design, Jon Kleinberg and Éva Tardos 3. Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein 4. Competitive Programming 4: The Lower Bound of Programming Contests in the 2020s by Steven Halim and Felix Halim 5. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests Antti Laaksonen.
Useful Links: 1. https://doi.org/10.1007/978-3-319-72547-5 2. Algorithms by Jeff Erickson (freely available online) 3. https://onlinecourses.nptel.ac.in/noc21_cs99/preview 4. https://unacademy.com/a/i-p-c-beginner-track

Term Work (25 Marks):

Marks will be awarded based on Assessment Rubrics:

1. Student’s active participation in skill based learning.
2. Presenting/showcasing learned skills through Social /outreach/ extension activities/Events/ Competitions/Trainings/Internships etc.
3. Submission of Report/act/demonstrations/ specific participation/Idea creation/scope/creativity/Case study etc.
4. Achievement/Recognition.

Technology Based Learning Code	SAT Courses	Credits
1UEXXT58	**Technology Based Learning - VIII**	**01**

Prerequisite:	Basic Engineering and Technology courses
TBL Objectives:	1. To acquire competency in emerging areas of technology. 2. To create a mind set for life-long learning required to persist technological shifts and be abreast with the market trends. 3. To facilitate learning at self-paced schedules. 4. To boost time management ability and self-discipline. 5. To provide opportunities of strengthening digital footprints by showcasing the additional proficiency acquired as well as improve connectivity and networking. 6. To enhance employment and entrepreneurial opportunities requiring specialization.
TBL Outcomes:	1. Explain concepts of the emerging technology learned through the pursued course. 2. Describe social, ethical, and legal issues surrounding the learned technology. 3. Demonstrate professionalism and skills of digital age learning and working. 4. Demonstrate knowledge in entrance exams for higher technical education, placement interviews, and other avenues. 5. Analyze real-world case studies in society/industry for applicability of sustainable technological solutions. **6.** Apply the acquired knowledge in developing technology-based solutions to real-world problems or other projects at hand.

Guidelines for Technology Based Learning:

1. Learners should enrol for an online course based on their area of interest concerning emerging areas of technology in consultation with Faculty Supervisor nominated by the Head of Department.
2. The course duration should be of minimum 04 weeks.
3. Students should watch all the videos of the course to learn the course in-depth and entirety.
4. Students should solve weekly assignments that are to be submitted online within the prescribed deadline.
5. Students should register and appear for the course certification exam on scheduled date and time.
6. Students should submit the certificate of course completion to the Faculty Supervisor.
7. Faculty Supervisor shall monitor students' participation and progress at every stage — from course enrolment to certification.

Useful Learning Links:

1. https://swayam.gov.in
2. https://www.nptel.ac.in
3. https://www.coursera.org

Term Work (25 Marks):

Term Work shall be conducted for Total 25 Marks based on the following rubrics:

Performance Level	Not Qualifying	Poor	Acceptable	Good	Excellent
Marks	00	10	15	20	25
Compliance Status	Not Enrolled for any Course or Not Completed Course	Completed Course, Not Attempted Certification but Completed all Assignments.	Obtained Passing Grade or 40% of Total Score in Certification Exam **OR** Completed all Assignments with Score Above 70%.	Obtained First Class Grades or 60% of Total Score	Obtained Elite Grade or 75% of Total Score

Program Structure for Third Year UG Technology (ET)

Semester-VI- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		Course Category
		TH – P – TUT	Total (Hrs.)	TH – P – TUT	Credits	
1UEXC601	Electromagnetics and Antenna	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC602	Machine Learning	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC603	Image Processing and Machine Vision	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC604	Computer Communication Networks	3 – 0 – 0	03	3 – 0 – 0	03	PC
1UEXDLC605	Department Level Elective Course– II	3 – 0 – 0	03	3 – 0 – 0	03	DLE
1UEXL601	Electromagnetic and Antenna Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL602	Machine Learning Networks Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXL603	Image Processing and Machine Vision Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXDLL605	Department Level Elective Course – II Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	DLE
1UEXPR64	Project Based Learning – Minor Project Lab - II	0 – 2 – 0	02*	0 – 1 – 0	01	PBL
1UEXXS69	Skill Based Learning –IX	0 – 2* – 0	02	0 – 1 – 0	01	SAT
1UEXXT610	Technology Based Learning - X	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		**15– 14– 0**	**29**	**15 - 07 - 0**	**22**	

***Load of learner, not the faculty** **SAT shall be counted-TH/P/TUT**

Semester-VI- Examination Scheme

Course Code	Course Name	Marks								
		CA			ESE	TW	O	P	P&O	Total
		T1	T2	IA						
1UEXC601	Electromagnetic and Antenna	15	15	10	60	-	-	-	-	100
1UEXC602	Machine Learning	15	15	10	60	-	-	-	-	100
1UEXC603	Image Processing and Machine Vision	15	15	10	60	-	-	-	-	100
1UEXC604	Computer Communication Networks	15	15	10	60	-	-	-	-	100
1UEXDLC605	Department Level Elective Course – II	15	15	10	60	-	-	-	-	100
1UEXL601	Electromagnetic and Antenna Laboratory	-	-	-	-	25	25	-	-	50
1UEXL602	Machine Learning Laboratory	-	-	-	-	25	25	-	-	50
1UEXL603	Image Processing and Machine Vision Laboratory	-	-	-	-	25	-	25	-	50
1UEXDLL605	Department Level Elective Course – II Laboratory	-	-	-	-	25	-	-	-	25
1UEXXPR64	Project Based Learning – Minor Project Lab - II	-	-	-	-	25	25	-	-	50
1UEXXS69	Skill Based Learning - IX	-	-	-	-	25	-	-	-	25
1UEXXT610	Technology Based Learning - X	-	-	-	-	25	-	-	-	25
Total		**75**	**75**	**50**	**300**	**175**	**75**	**25**	**-**	**775**

Minor Project Lab - II:

- Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- Faculty Load : 1 hour per week per four groups

	Course Code	**Course Title and Group**
Department Level Elective Course - II	1UEXDLC6051	Group A: Speech and Audio Processing
	1UEXDLC6052	Group B: IoT and Industry 4.0
	1UEXDLC6053	Group C: Mixed Signal VLSI Design
	1UEXDLC6054	Group D: Database Management System

^ Student have freedom to select any course from Group A / B / C / D from Semester V to VIII

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC601	Electromagnetics & Antenna	3+0+0

Prerequisite:	Applications of Mathematics in Engineering – I (Vector Calculus, Fundamentals concepts of electricity and magnetism, Two-Port Networks)
Course Objectives:	1. To make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc. 2. To learn Electromagnetic radiation and propagation in space and within transmission lines 3. To learn different Antennas and its parameter. 4. To learn design of wired and patch Antenna.
Course Outcomes:	1. Describe electromagnetics field including static and dynamic in terms of Maxwell's equations 2. Apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave. 3. Describe transmission line parameters and equations. 4. Use smith chart to implement transmission line design. 5. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc. 6. Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Static fields	1.1 Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation.	1	02	05
	1.2 Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations.		02	
	1.3 Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential		01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Electromagnetic Field and Maxwell's Equations	2.1 Faraday's Law, Displacement current density, Maxwell's equation for time varying filed, Boundary conditions.	2	02	05
	2.2 EM wave propagation through lossy, perfect dielectric and conducting medium.		02	
	2.3 Power in EM Wave: Poynting theorem and Poynting vector, Applications of EM waves(add 2-3 applications)		01	
3. Transmission Line	3.1 Transmission line parameters, Transmission line equations, Input impedance, Standing wave ratio, Power, Transients on transmission lines.	3	03	07
	3.2 Smith Chart, Applications of Smith Chart in finding VSWR, and reflection coefficient, admittance calculations, impedance calculations over length of line		04	
4. Basic of Antennas & Wave Propagation	4.1 Basic concepts: Radiation mechanism, near field and far field radiation, retarded potential.	4	02	07
	4.2 Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity, Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRII's transmission formula.		03	
	4.3 Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation.		02	
5. Wire Elements & Antenna Arrays	5.1 Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna.	5	03	09
	5.2 Yagi antenna, Broadband antenna like Helical and Log Periodic antenna (Design of Yagi & Log periodic).		03	
	5.3 Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication (Design)		02	
	5.4 Introduction and types to Planner arrays.		01	
6. Aperture & Patch antennas	6.1 Horn Antennas: E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and	6	02	06

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Conical Horn (No Design).			
	6.2 Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector (No Design).		02	
	6.3 Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch) (Design)		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2^{nd} edition 2. Engineering Electromagnetics, William H Hayt and John A Buck - Tata McGraw-Hill Publishing Company Limited, Seventh Edition 3. “Electromagnetic Waves” written by Prof R K Shevgaonkar 4. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V. Kulkarni, Oxford university press, 6^{th} edition 5. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4^{th} edition 6. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4^{th} edition 7. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3^{rd} edition
Reference Books	1. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition.
Useful Links:	
1. https://nptel.ac.in/courses/108/104/108104087/ 2. https://www.udemy.com/course/electromagnetic-theory/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests(30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC602	**Machine Learning**	**3+0+0**

Prerequisite:	Skill lab Python Programming
Course Objectives:	1. To appreciate machine learning approach to Artificial Intelligence, and understand fundamental issues and challenges of supervised and unsupervised learning techniques 2. To understand the underlying mathematical relationships within and across Machine Learning algorithms.
Course Outcomes:	1. Explain the concepts related Machine Learning 2. Mathematically analyse various machine learning approaches and paradigms 3. Compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach 4. Deploy machine learning algorithms using various evaluation techniques. 5. Implement supervised and unsupervised machine learning algorithms for real-world applications, while understanding the strengths and weaknesses. 6. Fine tune machine learning algorithms and evaluate models generated from data.

Module No. & Name	Sub Topic	CO Mapped	Hrs./ Sub Topic	Total Hrs.
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Definition, Types of machine learning : Supervised/unsupervised/reinforcement	1	02	03
	1.2 Applications of machine learning		01	
2. Linear Regression	2.1 Univariate Linear Regression: Model representation, Cost Function, Gradient Descent, Gradient Descent for linear regression, Optimization, Overfitting, Regularization, Feature selection	2,6	06	10
	2.2 Multivariate Linear Regression: Multiple features: Model representation, Gradient Descent for multivariate linear regression, Feature scaling, Normal Equation		04	
3. Logistic Regression	3.1 Classification : Model representation, Decision boundary, Cost function, Gradient Descent, Optimization	3,6	02	12
	3.2 Feature selection, Multiclass Classification, Over fitting, ROC curve, Confusion Matrix		02	

	3.3 KNN		01	
	3.4 Decision Tree algorithms		02	
	3.5 Random forest		02	
	3.6 Support Vector Machine: Introduction, Kernel, Application, Difference between logistic regression and SVM		03	
4. Deployment of Machine learning algorithm	4.1 Evaluation of hypothesis	4	1	05
	4.2 Cross validation		1	
	4.3 K-fold Cross validation		2	
	4.4 Learning Curve		1	
5. Unsupervised Learning	5.1 Introduction	3	2	05
	5.2 Clustering : K Mean Algorithm			
	5.3 Dimensionality reduction		1	
	5.4 Principal Component Analysis		2	
6. Advance Machine Learning topics	6.1 Anomaly Detection	5	1	04
	6.2 Recommender System		1	
	6.3 Gradient Descent with large dataset			
	6.4 Online learning		1	
	6.5 Map reduce and data parallelism		1	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Introduction to statistical Learning 7th Edition Gareth James Daniela Witten Trevor Hastie Robert Tibshirani Springer 2017 2. Foundation of Machine Learning 2nd Edition Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar MIT Press 2018 3. Introduction to Machine Learning 2nd Edition Ethem Alpaydın The MIT Press 2010
Reference Books	1. Pattern Recognition and Machine Learning C. M. Bishop Springer 2010 2. Understanding Machine Learning: From Theory to Algorithms Shai Shalev-Shwartz and Shai Ben-David Cambridge University Press 2014
Useful Links:	
1. https://www.coursera.org/learn/machine-learning 2. https://paperswithcode.com/ 3. https://nptel.ac.in/courses/106/106/106106139/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC603	**Image Processing and Machine Vision**	**3+0+0**
Prerequisite:	1. Signals and Systems 2. Discrete Time Signal Processing	
Course Objectives:	1. To introduce students to the fundamental concepts of Image Processing and Image Enhancement Techniques 2. To make the students well versed with image morphology and restoration techniques 3. To impart knowledge on the concepts of the students to segmentation and feature extraction 4. To teach modern techniques of Classification and Basics of Machine Vision.	
Course Outcomes:	1. Explain the basic fundamentals required for Image processing 2. Explain the theory and models in Image Processing. 3. Implement image processing operations on 2D signals in spatial & frequency domain. 4. Discuss segmentation and restoration of 2D signals in spatial & frequency domain. 5. Explain the image representation techniques. 6. Describe the image classification of 2D signals	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Digital Image Fundamentals and Processing	1.1 Introduction – Steps in Digital Image Processing, concept of Sampling and quantization, spatial and intensity resolution, Relationships between pixels: Neighbourhood relations between pixels, Distance measures, connectivity of pixels, Definitions of path, Region and Boundary. Numericals on distance measures and connectivity	1, 2	02	04
	1.2 Point Processing: Image Negative, Log Transform, Power Law transform, Bit plane slicing, Contrast stretching, Histogram equalization and Histogram Specification		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Image Enhancement with Time Domain and Frequency Domain Filters	2.1 Spatial Domain filtering : The Mechanics of Spatial Filtering, Smoothing Spatial Filters- Linear Filters-Averaging filter, Order-Statistic Filters- Median filter, Application of Median filtering for Noise removal Sharpening Spatial Filters- The Laplacian, Unsharp Masking and High boost Filtering, Using First-Order Derivatives —The Gradient- Sobel, Prewitt and Roberts masks	2 & 3	03	08
	2.2 Frequency Domain Filtering: Introduction to 2-D DFT and its application in frequency domain filtering, Wavelet transform, Haar transform		02	
	2.3 Frequency Domain Filtering Fundamentals, Fourier Spectrum and Phase angle, Steps for Filtering in the Frequency Domain, Correspondence Between Filtering in the Spatial and Frequency Domains, Frequency domain Image Smoothing and sharpening filter - Ideal, Butterworth, Gaussian Self-Learning: Homomorphic filters, comparison and Applications of Frequency Domain filters	2	03	
3. Image Morphology and Restoration	3.1 Morphology: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction , Hole filling, Thinning and thickening	3	03	06
	3.2 Restoration: A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering.	4	03	
4. Image Segmentation	4.1 Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm, Edge linking: Hough transforms and Graph Theoretical Method.	2,3	05	08
	4.2 Thresholding: Foundation, Role of illumination and reflectance, Basic global thresholding	2	01	
	4.3 Region Based segmentation: Region Growing, Region Splitting and Merging.		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Self-Learning: Watershed Segmentation and Otsu's techniques			
5. Introduction to Machine Vision and Descriptors	5.1 Principle of machine vision, chain code, simple geometric border representation, Fourier Descriptors, (Specify Different Techniques), Regional Descriptors based on Histogram and Texture Features.	5	03	05
	5.2 Introduction to Texture, co-occurrence matrix		02	
6. Machine Vision Algorithms	6.1 Knowledge representation, Classification Principles, Classifier Design, Classifier Learning, Confusion Matrix	6	02	08
	6.2 Introduction to clustering, K-means clustering algorithm, Introduction, Bayes decision theory continuous case, Maximum Likelihood Classification Bayesian classifier, Introduction to Support Vector Machine. Comparison of Supervised and Unsupervised Classification		06	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. "Digital Image Processing", 3rd Edition Gonzales and Woods PHI publications Indian Edition 2013 2. "Introduction to Image Processing", 2nd Edition Jayaraman, Isakkirajan Wiley 2009 3. "Digital Image Processing", 1st Edition S. Sridhar Oxford Education Press 2014 4. "Pattern Recognition and Machine Learning", 3rd Edition Christopher M. Bishop; Springer Publication Series 2006
Reference Books	1. Image Processing, Analysis, and Machine Vision 3rd Edition Milan Sonka, Vaclav Hlavac, Roger Boyle Pearson Edition 2013 2. Fundamentals of Image Processing 1st Edition Anil Jain Prentice Hall of India 1989 3. Digital Image Processing 3rd Edition W. Pratt Wiley Publication 2002 4. Image Processing and Pattern Recognition: Fundamentals and Techniques 1st Edition Frank Y Shish Wiley- IEEE Press, 2010 5. Pattern classification and scene analysis 2nd Edition R. O. Duda and P. E. Hart Wiley Inter Science Publication 2009
Useful Links:	
Some important links of NPTEL Courses 1. https://onlinecourses.nptel.ac.in/noc21_ee78/preview 2. https://onlinecourses.nptel.ac.in/noc21_cs70/course	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC604	Computer Communication Networks	3+0+0
Prerequisite:	1. Principles of Communication Engineering 2. Digital Communication	
Course Objectives:	1. To introduce networking architecture and protocols. 2. To understand and recognize the layer wise functions, services, data formats, protocols, hardware devices and addresses in the TCP/IP architecture. 3. To build an understanding of application layer protocols. 4. To apply different addressing and routing schemes.	
Course Outcomes:	1. Discuss network topologies, hardware devices, addressing schemes and the protocol stacks. 2. Compare various transmission media and broadband technologies. 3. Analyze the flow control, error control and the medium access control techniques. 4. Analyze network layer addressing and routing schemes. 5. Compare connection oriented and connectionless services. 6. Explore application layer protocols.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Network Architectures, Protocol Layers, and Service models	1.1. Applications of computer networks. Network types: LAN, MAN, and WAN, Network topologies.	1	01	06
	1.2.Protocols and standards, need of layered protocol architecture, OSI reference model.	1	01	
	1.3.TCP/IP architecture: protocol suite, comparison of OSI and TCP/IP	1	01	
	1.4. Layer wise network hardware devices (NIC, Repeaters, Hubs, Bridges, Switches, Routers, Gateway and their comparison)	1	02	
	1.5. Addressing: physical / logical /port addressing/socket addressing.	1	01	
2. Physical Layer	2.1 Guided transmission media: comparison among coaxial, optical fiber and twisted pair cables.	2	01	04
	2.2 Unguided transmission media	2	01	
	2.3 Transmission impairments	2	01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.3 Broadband standards: Cable modem, DSL, and HFC	2	01	
3. Data Link Layer	3.1 Data link services: Framing, Flow control, Error control	3	01	09
	3.2 ARQ methods: transmission efficiency, Piggybacking	3	03	
	3.3 High Level Data Link Control (HDLC): HDLC configurations, Frame formats, HDLC bit stuffing and de-stuffing, Typical frame exchanges.	3	02	
	3.4 Medium Access Control Protocols: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	3	03	
4. Network Layer	4.1. Introduction to telephone networks and circuit switching principles, Introduction to data networks and packet switching principles, Routing in Packet Switching Networks: Characteristics, Routing strategies, Network layer services and functions.	4	02	12
	4.2. Internet Protocol: Principles of Internetworking, requirements, IPv4 packet, IPv4 addressing (classful and classless (CIDR)), IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6).	4	03	
	4.3. Routing algorithms: Link state Routing, Distance vector Routing and Path vector routing, Routing protocols: RIP, OSPF, BGP and EIGRP.	4	04	
	4.4. Subnetting, Supernetting, VLSM, and NAT	4	01	
	4.5. Introduction to ICMP, ARP, RARP	4	01	
	4.6. Quality of service	4	01	
5. Transport Layer	5.1. Connectionless and Connection–oriented services at transport layer, Transmission Control Protocol (TCP): TCP Services, TCP Segment, TCP three way handshake	5	03	06
	5.2. User datagram Protocol (UDP), UDP Services, UDP Datagram	5	01	
	5.3. TCP and UDP checksum calculation	5	01	
	5.4. Flow control, error control and congestion control	5	01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
6. Application Layer	Introduction to Application layer Protocols: HTTP, FTP, DNS, SMTP, TELNET, SSH, DHCP.	6	02	02
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			TOTAL	**42**

Books:	
Text Books	1. Data Communications and Networking, Behrouz A. Forouzan, TMH, 5th Edition, 2013 2. Computer Networks, Andrew S Tanenbaum, Pearson Education, 5th Edition, 2013 3. Computer Networking: A Top-Down Approach, J. J. F. Kurose and K. W. Ross, Addison Wesley, 5th Edition, 2010
Reference Books	1. Communication Networks, Alberto Leon Garcia, McGraw Hill Education, 2nd &4th edition, 2008 2. An Engineering Approach to Computer Networks, S. Keshav, Pearson Education, 2nd Edition, 2015 3. Understanding communications and Networks, W. A. Shay, Cengage Learning, 3rd Edition, 2008 4. Data and Computer Communications, William Stallings, Pearson Education, 10th Edition, 2014
Useful Links:	
NPTEL course videos on Computer Networks and Internet Protocol- https://nptel.ac.in/courses/106/105/106105183/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – II	Credits

		(TH+P+TUT)
1UEXDLC6051	**Speech and Audio Processing**	**3+0+0**
Prerequisite:	1. Signal Systems 2. Discrete Time Signal Processing	
Course Objectives:	1. To understand basic concepts and methodologies for the analysis and modelling of speech signal 2. To characterize the speech signal as generated by a speech production model 3. To understand the mechanism of speech and audio perception 4. To extract the information of the speech or audio signals. 5. To provide knowledge of Compression of Audio signals.	
Course Outcomes:	1. Demonstrate advanced Knowledge in Digital model representation of speech signals. 2. Analysis of Speech by Time Domain Approach and Frequency Domain Approach. 3. Design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing. 4. Analyse speech signals to extract the characteristics of vocal tract (formants) and vocal cords (pitch). 5. Acquired knowledge about audio compression, speech signal estimation and detection.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Digital Models for Speech signals	Speech production and acoustic tube modelling, acoustic phonetics, anatomy, and physiology of the vocal tract and ear, hearing and perception.	1	05	05
2. Time Domain Approach	Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech V/S silence discrimination using energy & Zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.	2	10	10
3. Frequency Domain Approach	Introduction- Definition and Properties, Fourier Transform Interpretation, Linear Filtering Interpretation, Sampling rates of Xn (ejw) in Time and Frequency, Filter Bank 6 Summation Method of Short -Time Synthesis,	2	10	10

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Overlap Addition Method for Short -Time Synthesis.			
4. **Speech Coding, Recognition and Enhancement**	Vocoder, LPC vocoder, CELP, Adaptive predictive coding of speech, Speech Recognition, Speaker verification, Speech Enhancement, Speech recognition pattern comparison techniques.	4	06	06
5. **Fundamentals of Audio Signal Processing**	Signal processing model of Audio perception, Basic anatomy of hearing system, Auditory filter bank, Psyco acoustic model/analysis, Threshold of hearing,- Temporal masking and Spectral masking, MPEG Psycho acoustic model, Audio signal processing for Music applications.	3, 5	06	06
6. **Audio Compression method**	Sampling rate and bandwidth requirement for digital audio, redundancy removal and perceptual irrelevancy removal, transform coding of digital audio,- MPEG 2, MDCT	6	03	03
ii. **Course Conclusion**	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				**42**

Books:	
Text Books	1. Digital processing of speech signals# L R Rabiner and S W Schafer Pearson Education 2009 2. Speech & Audio Signal Processing# Ben Gold and Nelson Morgan Wiley 2007 3. Fundamentals of speech Recognition# L R Rabiner, B H Juang, B Yegnanarayana Pearson Education 1993 # refer latest addition
Reference Books	1. Discrete Time Speech Signal Processing# Thomas F Quateri Pearson Edition 2006 2. Speech Communications 2nd Edition Douglas O Shaughnessy Oxford University Press 2000
Useful Links:	
1. https://nptel.ac.in/courses/117/105/117105081/ 2. https://nptel.ac.in/courses/117/105/117105145/	

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – II	Credits (TH+P+TUT)
1UEXDLC6052	**IoT and Industry 4.0**	**3+0+0**

Prerequisite:	Microcontrollers
Course Objectives:	1. To offer introduction to Internet of Things and industry 4.0 standard 2. To understand the design features of Internet of Things (IoT) 3. To understand concepts of data management and data analytics in IoT 4. To understand the concept and framework of industry 4.0 standard 5. To understand the application of IoT and Industry 4.0 standard.
Course Outcomes:	1. Describe the concepts of Internet of Things. 2. Illustrate various protocols of web connectivity. 3. Analyse and compare tools for data management and analytics in IoT. 4. Explain various frameworks for industry 4.0 standards. 5. Prepare case studies on applications of IIOT. 6. Explain advanced concepts and applications of industry 4.0

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to IoT	1.1 Introduction - Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, IoT and M2M - IoT/M2M System layers and Design standardization, Difference between IoT and M2M	1	02	04
	1.2 Defining Specifications About - Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Application Development,		02	
2. Network & Communication aspects	2.1 Design Principles & Web Connectivity - Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets (Publish — Subscribe), MQTT, AMQP, CoAP Protocols	2	04	08

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.2 Internet Connectivity: - Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT, CAT LTE Ml, SIGFOX,		04	
3. Data Management and Analytics for IoT	3.1 Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, ApacheStorm, Using Apache Storm for Real-time Data Analysis	3	04	08
	3.2 Analysis, Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study- Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generation		04	
4. Introduction to Industry 4.0	4.1 Industry 4.0: Managing the Digital Transformation, Conceptual framework for Industry 4.0, Industrial IoT (IIoT) - Introduction, Business Model and Reference Architecture, Industrial IoTLayers, Sensing, Processing, Communication.	4	04	08
	4.2 Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality		04	
5. Introduction to Industrial IoT (IIoT)	5.1 Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Facility Management.	5	03	06
	5.2 Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions		03	
6. Industry 4.0 Technologies and Applications	6.1 Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries., IoTs Value Creation Barriers: Standards, Security and Privacy Concerns	6	03	05
	6.2 Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solution		02	
ii. Course	Recap of Modules, Outcomes, Applications and	-	01	01

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Conclusion	Summarization.			
			Total:	**42**

Books:	
Text Books	1. ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press. 2. Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw Hill Education ,First edition 3. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications, 4. Andrew Minteer ,"Analytics for the Internet of Things(IoT)",Kindle Edition 5. Giacomo Veneri , Antonio Capasso," Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt
Reference Books	1. Alp Ustundag Emre Cevikcan," Industry 4.0: Managing The Digital Transformation",Springer Series in Advanced Manufacturing 2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0. EAI/Springer Innovations in Communication and Computing 3. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications). 4. The Internet of Things (MIT Press) by Samuel Greengard 5. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback,First Edition

Useful Links:

1. https://onlinecourses.nptel.ac.in

Suggested MOOCs:

1. 1.https://onlinecourses.nptel.ac.in/noc20_cs69 - Introduction to Industry 4.0 and Industrial Internet of Things, By Prof. Sudip Misra, IIT Kharagpur
2. https://www.edx.org/course/industry-40-how-to-revolutionize-your-business - Industry 4.0: How to Revolutionize your Business
3. https://onlinecourses.nptel.ac.in/noc21_cs17 - Introduction to internet of things, by Prof. Sudip Misra , IIT Kharagpur
4. 4 https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design By Prof. Anupam Basu, IIT Kharagpur

Recommended list of tools:

1. Node Red - https://nodered.org/
2. M2MLabs Mainspring - http://www.m2mlabs.com/
3. Tensor Flow - https://www.tensorflow.org/
4. Things Speak - https://thingspeak.com

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course - II	Credits (TH+P+TUT)
1UEXDLC6053	Mixed Signal VLSI Design	3+0+0
Prerequisite:	1. Electronics Devices & Circuits 2. Digital Logic Design 3. Digital VLSI Design 4. Linear Integrated Circuits 5. Microelectronics	
Course Objectives:	1. To know the importance of Mixed Signal VLSI design in the field of Electronics and Telecommunication and emerging technologies. 2. To understand various methodologies for analysis and design of fundamental CMOS analog and mixed signal Circuits 3. To learn various issues associated with high performance Mixed Signal VLSI Circuits 4. To design, implement and verify various mixed signal VLSI circuits using open source tools like NGspice and Magic	
Course Outcomes:	1. Explain operation of the various building blocks of analog and mixed signal VLSI circuits 2. Demonstrate the understanding of various building blocks and their use in design of analog and mixed signal circuits. 3. Derive expression for various performance measures of analog and mixed signal circuits in terms of parameters of various building blocks used to build the circuit 4. Analyse and relate performance of analog and mixed signal VLSI circuits in terms of design parameters 5. Evaluate and select appropriate circuit/configuration for given application 6. Design analog and mixed signal VLSI circuits for given application	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Integrated Circuit Biasing Techniques	1.1.Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch	1, 2	03	06
	1.2. Active resistance, current source, current sink, simple current mirror, cascode current mirror			
	1.3. Current and voltage references, Band gap reference generator		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Noise in MOS Circuits	2.1. Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise	4	02	06
	2.2. Representation of noise in circuits, noise in single stage CS, CD and CG amplifier		02	
	2.3. Noise in differential pairs, noise bandwidth		02	
3. MOS Operational Amplifiers	Op-amp Design: General Considerations, performance parameters, One- stage op- amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations(ICMR), Slew Rate, Power supply rejection, Noise in op-amps. Design of single ended and double ended two stage Op-amps	6	06	06
4. Phase-Locked Loop and Switched Capacitor circuits	4.1. PLL: Simple PLL, Charge-pump PLL, Non-ideal effect in PLL, Delay-Locked Loop, Applications	1, 4	04	09
	4.2. Switched Capacitor circuit: General consideration, Sampling Switches, Switched-capacitor amplifier, Switched-capacitor integrator		05	
5. Data Converter Fundamentals	5.1. Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics	3	03	06
	5.2 Mixed signal Layout issues, Floor planning, power supply and Ground issues, other interconnect Considerations		03	
6. Data Converter architectures	6.1. DAC architectures, digital input code, charge scaling DACs, Cyclic DAC, pipeline DAC	5	03	06
	6.2. ADC architectures, flash, pipeline ADC, integrating ADC, and successive approximation ADC		03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Design of Analog CMOS Integrated Circuits first edition B. Razavi McGraw Hill 2001 2. CMOS Circuit Design, Layout and Simulation Second edition R. Jacob Baker Wiley 2013 3. CMOS Analog Circuit Design Second edition P. E. Allen and D R Holberg Oxford University Press 2002
Reference Books	1. Analog Circuit Design Second Edition Tony Chan Carusone, David Johns, Kenneth Martin Wiely 2012 2. Microelectronics Circuits Theory and Applications Fifth Edition Adel S. Sedra, Kenneth C. Smith, A.N. Chandorkar Oxford University Press 3. Analysis and design of Analog Integrated Circuits Fourth Edition Gray, Meyer, Lewis and Hurst Willey International 2002

Useful Links:

1. https://nptel.ac.in/courses/117/101/117101105/
2. http://cmosedu.com/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – II	Credits (TH+P+TUT)
1UEXDLC6054	**Database Management System**	**3+0+0**

Prerequisite:	1. Basic knowledge of programming
Course Objectives:	1. To learn and practice data modelling using the entity-relationship and developing database designs 2. To understand the use of Structured Query Language (SQL) and learn SQL syntax. 3. To understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access
Course Outcomes:	1. Explain the fundamentals of database systems. 2. Design ER and EER diagram for real life problems. 3. Apply concepts of Normalization to relational database design 4. Explain the relational algebra queries 5. Solve database Query using SQL. 6. Explain the concept of transaction, concurrency and recovery.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Databases and Transactions	Introduction to databases, History of database system, Benefits of Database system over file system, relational databases, database architecture, transaction management	1	02	02
2. Data Models	The importance of data models, Basic building blocks, Business rules, Evolution of data models (hierarchical, Network, Relational, Entity relationship and object model), Degrees of data abstraction.	2	05	05
3. Database Design, ER-Diagram and Unified Modelling Language	Database design and ER Model: overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, and integrity rules. Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF).	3	08	08
4. Relational Algebra and Calculus	Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational	4	08	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	comparison. Calculus: Tuple relational calculus, Domain relational Calculus, Calculus Vs Algebra, computational capabilities.			
5. Constraints, Views and SQL	What are constraints, types of constrains, Integrity constraints, Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	5	08	08
6. Transaction management and Concurrency control	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	6	08	08
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. A Silberschatz, H Korth, S Sudarshan, "Database System and Concepts", Fifth Edition McGraw-Hill 2. Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning 3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System", Seventh Edition, Person. 4. G. K. Gupta: "Database Management Systems", McGraw – Hill.
Reference Books	1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition 2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press 3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley 4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH 5. Debabrata Sahoo "Database Management Systems" Tata McGraw Hill, Schaum's Outline
Useful Links:	
1. https://www.tutorialspoint.com/dbms/index.htm 2. https://www.studytonight.com/dbms/ 3. https://beginnersbook.com/2015/04/dbms-tutorial/ 4. https://www.w3schools.in/dbms/ 5. https://www.tutorialcup.com/dbms	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 15 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be awarded based on the rubrics designed.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Lab Code	Lab Name	Credits (P+TUT)
1UEXL601	**Electromagnetics and Antenna Laboratory**	**1+0**
Lab Prerequisite:	Applications of Mathematics in Engineering-I (Vector Calculus, Fundamental concepts of electricity and magnetism, Two Port Network)	
Lab Objectives:	1. To learn the fundamentals of Electromagnetics 2. To learn the basic parameters and design of Transmission Line 3. To learn the applications of Electromagnetics 4. To learn about Antenna measurements and radio wave propagation. 5. To learn about linear wire antenna elements and Antenna arrays. 6. To learn Aperture Antenna, Patch antenna and its designing.	
Lab Outcomes:	1. Design of Electromagnetic application using Simulation. 2. Design of Transmission Line using Simulation. 3. Define Basic Antenna parameters like radiation pattern, directivity and gain. 4. Design of uniform linear, basic radiating elements like wire antenna, loop antenna, planar antenna, arrays using isotropic and directional Sources, Micro strip and aperture antennas and reflectors. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory	

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
0	Lab Prerequisites	-	02
1	Electromagnetics Simulation using HFSS	1,5,6	02
2	Transmission line design using HFSS	2,5,6	02
3	Plot Radiation pattern of i. Dipole Antenna ii. Monopole iii. Folded Dipole Antenna through measurement setups iv. Broadside Array Antenna v. End Fire Array Antenna vi. Helical through measurement setups	2,5,6	02
4	Analyse and design: Monopole Antenna for a frequency 2.4 GHz using HFSS software Dipole Antenna for a frequency 2.4 GHz using HFSS software	3,5,6	02
5	Design Yagi-Uda Antenna for a frequency of 2.4 GHz using HFSS software.	3,5,6	02
6	Design Rectangular Micro strip Antenna (RMSA) for a frequency of 2.4 GHz using HFSS software.	4, 5, 6	02
7	Design Circular Micro strip Antenna (CMSA) for a frequency of 2.4GHz using HFSS software.	4, 5, 6	02
8	Design Horn Antenna for a frequency of 2.4 GHz using	4, 5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
	HFSS software.		
9	Case Study of Recent reported variations of Antenna types	1 to 6	10
		Total	**28**

Virtual Lab Links:

1. https://www.labster.com/simulations/electromagnetic-spectrum/
2. https://www.ee.iitb.ac.in/course/~vel/

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Oral examination will be based on the experiment list and content of the entire theory syllabus.

Lab Code	Lab Name	Credits (P+TUT)
1UEXL602	**Machine Learning Laboratory**	**1+0**
Lab Prerequisite:	Skill lab Python Programming	
Lab Objectives:	**1.** To learn how to process the data **2.** To apply machine learning algorithms to the real lie data	
Lab Outcomes:	**1.** Understand the basics of machine learning **2.** Apply optimization and regularization techniques to train machine. **3.** Construct and train machines using various algorithms. **4.** Implement and apply machine learning algorithms. **5.** Write accurate documentation for experiments performed. **6.** Write the report on experiments performed.	

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
0	Lab Prerequisites	-	02
1	Linear regression using python	1,2,3,4,5,6	02
2	Logistic regression using python	1,2,3,4,5,6	02
3	KNN using python	1,2,3,4,5,6	02
4	SVM using python	1,2,3,4,5,6	02
5	Random forest using python	1,2,3,4,5,6	02
6	Random forest using python	1,2,3,4,5,6	02
7	K-mean using python	1,2,3,4,5,6	02
8	PCA using python	1,2,3,4,5,6	02
9	Mini Project	1,2,3,4,5,6	10
		Total	**28**
Virtual Lab Links:			
https://vlab.spit.ac.in/ai/#/experiments			

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Oral examination will be based on the experiment list and content of the entire theory syllabus.

Lab Code	Lab Name	Credits (P+TUT)
1UEXL603	**Image Processing and Machine Vision Laboratory**	**1+0**

Lab Prerequisite:	Knowledge of Programming languages, Python / any other suitable tool available
Lab Objectives:	1. To implement the basic of Image Processing and Machine Vision on Image Enhancement, Image transforms, Morphology and Segmentation. 2. To hands on Practice to students to object recognition/ classification techniques in Machine Vision. 3. To facilitate students for understanding practical aspects of Image Processing and Machine Vision through an application.
Lab Outcomes:	1. Perform enhancement of digital images in spatial and frequency domain 2. Perform edge detection and morphological operations on digital images 3. Classify patterns using standard Machine vision classification techniques like SVM 4. Apply theoretical knowledge in image processing and machine vision to practical case studies 5. Adhere to the Ethical Practices in the lab while building codes. 6. Work in teams to solve any problem based on Activity, Skill or Technology based Methods.

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
0	Lab Prerequisites	-	02
1	Point Processing Methods – Negative, Log, Power law, Contrast stretching, Bit plane slicing	1,5,6	02
2	Form Histogram of an image and its histogram equalization	1,5,6	02
3	Spatial Domain Filtering: 1. Smoothening filters 2. Sharpening with Laplacian 3. Unsharp masking & high boost filtering Edge detection using 1st and 2nd order derivatives	1,5,6	02
4	Frequency Domain Filtering : Ideal, Butterworth and Gaussian filters	1,5,6	02
5	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform, Boundary extraction	2,5,6	02
6	Image segmentation using global Thresholding Algorithm	2,5,6	02
7	Shape representation using chain code	3,5,6	02
8	Canny edge detection	3,5,6	02
9	Feature extraction using co-occurrence matrix	4,5,6	02
10	Classification using k-means algorithm	4,5,6	02
11	Classification using Bayesian classifier	4,5,6	02
12	Basic binary classification of any data or pattern using Support Vector Machine	4,5,6	02
13	Case Studies	1 to 6	02
		Total	**28**

Virtual Lab Links:
https://ssp-iiith.vlabs.ac.in/

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Oral/Practical/P&O :

Practical examination will be based on the experiment list and content of the entire theory syllabus.

Lab Code	Department Level Elective Course Laboratory – II	Credits (P+TUT)
1UEXDLL6051	Speech and Audio Processing Laboratory	1+0

Lab Prerequisite:	1. Knowledge of open source simulator
Lab Objectives:	1. To learn properties of Speech signal 2. To learn time domain and frequency domain analysis of speech 3. To learn speech coding, recognition and enhancement techniques 4. To learn application of Speech and Audio signal
Lab Outcomes:	1. Distinguish properties of Speech signal 2. Demonstrate time domain and frequency domain approach 3. Demonstrate speech coding, recognition and enhancement techniques 4. Applications of Speech and Audio signal 5. Write accurate documentation for experiments performed 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	To simulate / demonstrate properties of speech signal	1,5,6	02
2	To simulate / demonstrate limitations of Fourier transform in speech signal	1,5,6	02
3	To simulate / demonstrate zero crossing rate and pitch period estimation	2,5,6	02
4	To simulate / demonstrate speech enhancement techniques	3,5,6	02
5	To simulate / demonstrate short term auto correlation method	2,5,6	02
6	To simulate / demonstrate voice/unvoice/salience classification of speech using short term time domain parameter	2,5,6	02
7	To simulate / demonstrate LPC of speech signal	3,5,6	02
8	To simulate / demonstrate Automatic speech recognition, Dynamic time warping and Hidden Markov model	3,5,6	02
9	To simulate / demonstrate Audio processing for music	4,5,6	02
10	Case Study/ Mini Project	1to 6	08
		Total	**28**

Virtual Lab Links:

1. https://ssp-iiith.vlabs.ac.in/
2. https://vlab.amrita.edu/index.php?sub=59&brch=164

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Lab Code	Department Level Elective Course Laboratory - II	Credits (P+TUT)
1UEXDLL6052	IoT and Industry 4.0 Laboratory	1+0

Lab Prerequisite:	1. Project Based Learning - Mini Project Lab-II 2. Skill Based Learning - IV 3. Project Based Learning - Minor Project Lab-I
Lab Objectives:	1. To understand Internet of Things and its hardware and software components 2. To interface I/O devices, sensors & communication modules 3. To remotely monitor data and control devices 4. To understand the concepts of Industry 4.0 and basics of Industrial IoT.
Lab Outcomes:	1. Demonstrate the concept of IoT, Arduino/Raspberry Pi, and also able to install software setup of Arduino/ Raspberry Pi 2. Retrieve data from sensors and display the data, status of devices and sensors from web cloud 3. Identify the use of Communication and Networking in Industrial IoT Application 4. Implementation of analytics in Industrial IoT. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Familiarization with the concept of IoT, Arduino/Raspberry Pi and perform necessary software installation.	1, 5, 6	02
2	LED and IR sensor interfacing with Nodemcu.	1, 5, 6	02
3	Ultrasonic sensor interfacing with Nodemcu for distance measurement.	2, 5, 6	02
4	Temperature/Humidity monitoring using Blynk App.	2, 5, 6	02
5	DHT sensor interfacing with Nodemcu and communication of data using MQTT protocol	2, 5, 6	02
6	To study the MQTT and ThingSpeak and upload the DHT sensor data on ThingSpeak	2, 5, 6	02
7	Identify the use of Communication and Networking in Industrial IoT Application	3, 5, 6	02
8	Study of IoT based industrial process monitoring and control system	3, 5, 6	02
9	Implementation of analytics in Industrial IoT Application	4, 5, 6	02
10	Design prototype of IoT based smart system	4, 5, 6	02
11	Case Study / Mini Project	1 to 6	06
		Total	**28**

Note: Suggested 8 lab exercises based on six modules of IoT and Industry 4.0 Syllabus

Virtual Lab Links:

https://www.vlab.co.in/

Useful Links:

1. Node Red - https://nodered.org/
2. M2MLabs Mainspring - http://www.m2mlabs.com/
3. Tensor Flow - https://www.tensorflow.org/
4. Things Speak - https://thingspeak.com

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Lab Code	Department Level Elective Course Laboratory – II	Credits (P+TUT)
1UEXDLL6053	**Mixed Signal VLSI Laboratory**	**1+0**

Lab Prerequisite:	1. Microelectronics Devices & Circuits 2. Electronics Devices & Circuits
Lab Objectives:	1. To understand analysis and design of building blocks of CMOS Analog VLSI Circuits. 2. To highlight the issues associated with the CMOS analog VLSI circuit design. 3. To emphasize upon the issues related to mixed signal layout design.
Lab Outcomes:	1. Simulate electrical characteristics of biasing techniques 2. Design and simulate analog circuits 3. Analyze the performance of the analog circuits 4. Design and simulate ADC and DAC circuits 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Analysis of MOSFETs for analog performance	1,3,5,6	02
2	Transconductance plots (voltage bias, current bias and technology bias).	1,3,5,6	02
3	Design of regulated current sink.	2,5,6	02
4	Design and simulate various types of oscillators	2,5,6	02
5	Design and simulate ideal Opamp	2,5,6	02
6	10 bit ADC	4,5,6	02
7	Design of basic current sink.	4,5,6	02
8	Design of cascode current sink	4,5,6	02
9	Simulate noise in CMOS amplifier	3,5,6	02
10	Design and simulate differential amplifier	2,5,6	02
11	Design and simulate operational transconductance amplifier	2,5,6	02
12	Case Study / Mini Project	1 to 6	04
		Total	**28**

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
   The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Lab Code	Department Level Elective Course Laboratory – II	Credits (P+TUT)
1UEXDLL6054	**Database Management System Laboratory**	**1+0**

Lab Prerequisite:	Any programming skills
Lab Objectives:	1. To study and design modelling in database 2. To learn and apply SQL commands in queries. 3. To create database and apply transaction management command. 4. To use databases and solve real world problems.
Lab Outcomes:	1. Demonstrate how to retrieve data from more than one table or views using the key 2. Apply the select information from the tables and manipulate it. 3. Apply create, alter and drop on tables and apply insert, update and delete statements. 4. Build a Database using all the concepts of DBMS 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Identify the case study & detail statement of problem. Design an ER/ ERR model	4,5,6	02
2	Mapping ER/ERR to relational Schema Model	4,5,6	02
3	Create and populate database using DDL and DML commands for your specified system	3,5,6	02
4	To study and apply Integrity Constraint for the specified system	1,5,6	02
5	To study various select commands in SQL	2,5,6	02
6	To study Nested and Complex queries	2,5,6	02
7	To study and Perform Join operation	2,5,6	02
8	To study Views and Triggers in SQL	1,5,6	02
9	To study functions, cursor and Procedure	4,5,6	02
10	To study Transaction and concurrency	4,5,6	02
11	Write SQL queries for Sorting of the data in database.	4,5,6	02
12	Case Study/ Mini Project	1 to 6	04
		Total	**28**

Virtual Lab Links:

1. https://www.tutorialspoint.com/dbms/index.htm
2. https://www.studytonight.com/dbms/
3. https://beginnersbook.com/2015/04/dbms-tutorial/
4. https://www.w3schools.in/dbms/

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/Project/demo/presentation: 05-marks)

Course Code	Project Based Learning	Credits (TH+P+TUT)
1UEXPR64	**Minor Project Lab – II**	**0+1+0**
Prerequisite:	1. Digital Logic Design 2. Digital VLSI Design	
Minor Project Objectives:	1. To train students for FPGA based project implementation and management 2. To make students VLSI industry ready 3. To make students familiar with the Verilog Programming 4. To make students familiar with the targeted FPGA design and implementation 5. To familiarize the students with the Interfacing of FPGA boards	
Minor Project Outcomes:	1. Explain various FPGA families and method of FPGA synthesis and implementation 2. Program, simulate and synthesize circuits in Verilog HDL using modern tools. 3. Choose FPGA platform for an application 4. Design various digital systems using FPGA. 5. Analysis of FPAG fault detection and verification principles 6. Document the project development report	

Module No.	Topics	CO Mapped	Hrs/ Sub Topics	Total Hrs.
0	Lab Prerequisites	-	02	0
1. Introduction to FPGA and Synthesis	1.1 Compare FPGA, ASIC, SOC, Basic FPGA architecture, Compare various FPGA Boards, Understanding VLSI Design flow	1, 3	01	03
	1.2 Understanding Tools : Functional simulation , Synthesis and implementation, Synthesis tool flow, Implementation and bit generation, making User constraint files (UCF)	1	02	
	Study Material https://www.xilinx.com/support/university/ise/ise-workshops/ise-fpgadesign-flow.html			
2. Writing First program in Verilog	2.1 Introduction to Verilog: Module definition, port declaration, connecting ports, Writing first Test bench	2	02	03
	2.2 Exercise : Program for All gates, Writing Test bench and UCF	2	01	
	Study Material https://www.xilinx.com/support/university/ise/ise-teaching-material/hdldesign.html			
3. Combinational design using VERILOG	3.1 Gate Level Modelling, hierarchical name referencing, Data Flow Modelling: Continuous assignments, delay	2	03	06

Module No.	Topics	CO Mapped	Hrs/ Sub Topics	Total Hrs.
	specification, expressions, operators, operands, operator types			
	3.2 Exercise: Programming and FPGA implementation of Adders, 4-bit adders, Mux and decoders, Interfacing LED, switches with FPGA	2	03	
	Study Material: https://onlinecourses.nptel.ac.in/noc20_cs63/preview			
4. Sequential design using VERILOG	4.1 Behavioural Modelling : Structured procedures, initial and always, blocking ‘and nonblocking statements, delay control, event control, conditional statements, multi way branching, loops, sequential and parallel blocks Advanced topics: Tasks and Functions, generic programming with parameters.	2	03	06
	4.2 Exercise: Programming and FPGA implementation of Counters FFs and Shift registers Interfacing Seven Segment Display, UART with FPGA	2	03	
5. Project Outline	5.1 Clocked Synchronous State-Machine Analysis, State-Machine Structure, Output Logic, Characteristic Equations Analysis of State Machines with D Flip-Flops, Clocked Synchronous State-Machine Design, Designing State Machines Using State Diagrams, State Tables	4, 5	03	06
	5.2 Project Design Steps: Designing state diagram, block diagram of project, Selection of FPGA for project, Selection of synthesis and simulation tool.	4, 5	03	
6. Project Implementation and management	6.1 Git Repositories, Learning of Project management software’s like CVS, SVN etc.	6	02	02
	6.2 Project Implementation: Verilog coding, simulation, Synthesis, Bit generation and downloading on FPGA.	6		
	6.3 Result verification and testing	6		
			Total	**28**

Reference Books:

1. Samir Palnitkar, “Verilog HDL A guide to Digital Design and Synthesis”, 2nd Edition, Pearson Education, 2009
2. Simon D Monk, “Programming FPGAs : Getting started with Verilog”, 1st Edition, McGraw Hill Eduction 2016
3. M. Morris Mano,Michael D. Ciletti, “Digital Design: With a Introduction to the Verilog Hdl”, Pearson Prentice Hall, 2013
4. David Romano, “Make: FPGAs: Turning Software into Hardware with Eight Fun and Easy DIY”, Shroff/Maker Media; First edition,2016
5. Frank Vahid, “Digital Design”, Wiley India Private Limited; Preview edition, 2009
6. Behrooz Parhami ,“COMPUTER ARITHMETIC Algorithms and Hardware Designs”, Oxford University Press, 2010
7. Clive Maxfield ,“Design Warrior’s Guide to FPGA”, 2004, Elsevier

Reference links:

1. https://www.sanfoundry.com/vlsi-questions-answers-aptitude-test/
2. Free Tool : https://www.edaplayground.com/
3. https://github.com/

****Suggested FPGA Hardware Boards:**

1. Numato FPGA boards -https://numato.com/shop/
2. Papilio FPGA boards -http://store.gadgetfactory.net/fpga/
3. CMOD s6 -https://store.digilentinc.com/cmod-s6-breadboardable-spartan-6-fpga-module/
4. TinyFPGA -https://tinyfpga.com/
5. Zync,Zed Board -https://www.xilinx.com/products/silicon-devices/soc/zynq-7000.html
6. Artix -7, Kinetex Boards -https://store.digilentinc.com/arty-a7-artix-7-fpga-development-board/

Suggested Software tools:

1. Xilinx ISE Webpack
2. Modelsim/Questasim
3. Leonardo spectrum
4. MATLAB
5. Quartus
6. Actel
7. Icarus Verilog Simulator

Suggested Projects (FPGA downloading is must)

1) Shift-Add Multiplication,
2) Hardware Multipliers
3) Programmed Multiplication
4) Shift-Subtract Division
5) CORDIC Algorithm
6) Design of functions such as reciprocal, square root, sine, cosine, exponential
7) Wallace Multiplier
8) 8- Bit ALU
9) Matrix Multiplication
10) Booths Multiplier
11) NRZ,NRZI etc. coding techniques

Suggested Courses

1. NPTEL Verilog Programming - Free
2. Workshops -Xilinx University Program- Freely available

Suggested Competitions for Funding

1. Government Swadeshi Microprocessor Challenge
2. IICDC – TI challenge
3. Sankalp Semiconductors Hackathons

General Guidelines of minor project are as follows :

1. To achieve proper selection of Minor Projects. Students should do survey of FPGA boards, tools and identify needs, which shall be converted into problem statement for minor project in consultation with faculty supervisor/head of department/ internal committee of faculties.
2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of minor project.
3. A log book to be prepared by each group, wherein group can record weekly work progress, guide/ supervisor can verify and record notes/comments.
4. Faculty supervisor may give inputs to students during minor project activity; however, focus shall be on self-learning.
5. The solution to be verified with standard tools and procedures and report to be compiled in standard format of University of Mumbai.

Suggested steps for minor project selection and implementation

1. Minor project should be completely FPGA based
2. Follow these steps:
   i. Take specification, using these specifications design project.
   ii. Select proper FPGA considering features and requirements of project. Create UCF file
   iii. Program it using Verilog and write test benches for verification of each module
   iv. Test Functional Simulation and verify it using simulation tool
   v. Synthesize, map and place and rout the design using synthesis tool
   vi. Generate bit stream and download on FPGA
   vii. Verify results on FPGA hardware/hardware setup made for project

Project Topic selection and approval :-

1. The group may be of maximum **Three (03) students**.
2. Topic selection and approval by **2 Expert** faculty from department at the start of semester
3. **Log Book** to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed **online** with proper authentication method using google sheets/forms or open source project management software.

Project Report Format:

1. Report should not exceed **15 pages**. Simply staple it to discourage use of plastic.
2. The recommended report format is in LaTeX.

Term Work (25 Marks):

Term Work evaluation and marking scheme:

a. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.
b. The progress of minor project to be evaluated on continuous basis, minimum two reviews in each semester.
c. At end of semester the above 2 expert faculty who have approved the topic will internally evaluate the performance.
d. Students have to give presentation and demonstration on the FPGA Based Mini Project- 2B
e. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.

Distribution of 25 Marks scheme is as follows:

i. Marks awarded by guide/supervisor based on log book : 10
ii. Marks awarded by review committee : 10
iii. Quality of Project report : 05

Oral (25 Marks):

Guidelines for Assessment of Minor Project Oral Examination:

a. Report should be prepared as per the guidelines issued by the University of Mumbai.
b. Minor Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by head of Institution.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Skill Based Learning Code	Skill Based Learning - IX	Credits (TH+P+TUT)
1UEXXS69	Linux , Networking & Server Configuration	0+1+0

Prerequisite:	C-Programming
Skill Objectives:	1. To install Linux and implement standard Linux commands 2. To study basic theory of Linux Operating System 3. To implement the system administrative functionality 4. To write shell script programs to solve problems 5. To study basic commands of networking 6. To develop implementation skill of different servers on Linux
Skill Outcomes:	1. Install Linux using different platforms and execute Linux commands 2. Apply the system administrative functionality and solve the problems using shell script programming. 3. Develop network based applications. 4. Apply the Linux commands using programming skills to different servers like FTP, Telnet 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	SO Mapped	Hrs/ Lab
1.	Linux Installation process using following method CD-ROM, Network Installation or Kickstart Installation.	1, 5, 6	02
2.	Basic commands to create users, change permission, software selection and installation and do changes in Grub file.	1, 5, 6	02
3.	Practical on configuration of Linux disk Management such as SWAP, LVM, RAID, Primary Partition, Extended Partition and Linux files system.	1, 5, 6	02
4.	Write a shell script to show various system configuration like currently logged user and his log name, your current shell, home directory, operating system type, current path setting, current working directory, show currently logged number of users, show memory information, Hard disk information like size of hard-disk, cache memory, model etc. and file system mounted.	2, 5, 6	02
5.	Write a shell script to add user and password on Linux system.	2, 5, 6	02
6.	Write a shell script to print last login details.	2, 5, 6	02
7.	Write a shell script to upgrade and cleans the system automatically instead of doing it manually	2, 5, 6	02
8.	Write a shell script to delete all log files present inside your var/log directory.	2, 5, 6	02
9.	Write a script that accepts the hostname and IP address as command-line arguments and adds them to the /etc/hosts file.	2, 5, 6	02
10.	Write a awk script to find the number of characters, words and lines in a file?	2, 5, 6	02
11.	Write a shell script that delete all lines containing a specified word	2, 5, 6	02

Lab No.	Experiment Title	SO Mapped	Hrs/ Lab
12.	write a shell script to find the factorial of given integer	2, 5, 6	02
13.	Configuration of DHCP Server and Client	3, 5, 6	02
14.	Configuration of DNS Server with Domain Name.	3, 5, 6	02
15.	Configuration of NFS File server and transfer files to a windows client.	3, 5, 6	02
16.	Setting up a Samba Server and creating a print server.	4, 5, 6	02
17.	Configuration of Internet Server by creating a Proxy Server and configure browser to use as a proxy	4, 5, 6	02
18.	Configuration of Mail Server	4, 5, 6	02
19.	Configuration of Web Server.	4, 5, 6	02
20.	Configuration of FTP server and transfer files to demonstrate the working of the same	4, 5, 6	02
		Total	**40**

Online Repository:

1. How to Install a DHCP Server in Ubuntu and Debian (tecmint.com)
2. How to Install and Configure Postfix as a Send-Only SMTP Server on Ubuntu 16.04 | Digital Ocean
3. Network - DHCP | Ubuntu

Books:	
Text Books	1. Yeswant Kanetkar – "UNIX Shell Programming", First edition, BPB 2. Cristopher Negus – "Red Hat Linux Bible", Wiley Dreamtech India 2005 edition 3. Jason Cannon ,"Linux for Beginners: An Introduction to the Linux Operating System and Command line" 4. W. Stevens, Stephen Rago, "Advanced Programming in the UNIX Environment", Addison- Wesley Professional Computing Series
Reference Books	1. Official Red Hat Linux Users guide by Redhat, Wiley Dreamtech India 2. Graham Glass & King Ables – UNIX for programmers and users, Third Edition, Pearson Education. 3. Neil Mathew & Richard Stones – Beginning Linux Programming, Fourth edition, Wiley Dreamtech India. 4. Richard Petersen, Linux: The Complete Reference, Sixth Edition

Term Work (25 Marks):

Term Work shall be awarded on basis of

1. Student's active participation in skill based learning.
2. Presenting / showcasing learned skills through Social / outreach / extension activities / Events / Competitions / Trainings / Internships etc.
3. Submission of Report / act / demonstrations / specific participation / Idea creation / scope / creativity / Case study etc.
4. Assessment Rubrics.

Students have to perform any 8 experiments.

Technology Based Learning Code	SAT Courses	Credits
1UEXXT610	**Technology Based Learning - X**	**01**

Prerequisite:	Knowledge of SE subjects
TBL Objectives:	1. Identify, describe, and apply emerging technologies in teaching and learning environments 2. Plan, design, and assess effective learning environments and experiences 3. Compare and contrast social, ethical, and legal issues surrounding technology 4. Facilitate instruction in the new literacies that emerge within digital / interactive learning environment
TBL Outcomes:	1. Identify, describe, and apply emerging technologies in teaching and learning environments 2. Demonstrate knowledge, attitudes, and skills of digital age work and learning 3. Plan, design, and assess effective learning environments and experiences 4. Implement curriculum methods and strategies that use technology to maximize student learning 5. Develop technology-enabled assessment and evaluation strategies **6.** Compare and contrast social, ethical, and legal issues surrounding technology

Guidelines for Technology Based Learning:

1. Selection of course with 4 weeks/8 weeks Duration (Subject related to Emerging Technology and approval from department)
2. Faculty supervisor is allotted at department level.
3. The faculty supervisor will monitor the activities and documentation of the students assigned to them.
    1. Whether students are going through the four lectures, weekly (One lecture will be of duration 25 to 30 minutes.)
    2. Weekly submission of Assignments.
    3. Registration for the Exam.
    4. Appearing for the Exam on schedule date and time.
    5. Submission of Certificate

Term Work (25 Marks):

1. Marks will be awarded based on Assessment Rubrics designed
2. Use of Technology for Minor Project development
3. Technical Competition Participation
4. Course Completion Certificate
5. Certification Grades/performance

Program Structure for Last Year UG Technology (ET)

Semester-VII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		Course Category
		TH – P – TUT	Total (Hrs.)	TH – P – TUT	Credits	
1UEXC701	Microwave Engineering	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXC702	Mobile Communication Systems	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXDLC703	Department Level Elective Course – III	3– 0 – 0	03	3 – 0 – 0	03	DLE
1UEXDLC704	Department Level Elective Course – IV	3 – 0 – 0	03	3 – 0 – 0	03	DLE
1UILE705	Institute Level Elective Course - I	3 – 0 – 0	03	3 – 0 – 0	03	ILE
1UEXL701	Microwave Engineering Laboratory	0 – 2 – 0	02	0 – 2 – 0	01	PC
1UEXDLL702	Department Level Elective Course – III Laboratory	0 – 2 – 0	02	0 – 2 – 0	01	DLE
1UEXDLL704	Department Level Elective Course – IV Laboratory	0 – 2 – 0	02	0 – 2 – 0	01	DLE
1UEXPR75	Project Based Learning – Major Project-A#	0 – 6# – 0	06*	0 – 3 – 0	03	PBL
Total		**15– 12– 0**	**27**	**15 - 06 - 0**	**21**	

 # PBL-PR-A- (Preparation for Conference paper, TPP, participation in competition as Term work)
***Load of learner, not the faculty**
Major Project A: Students can form groups with minimum 2 (Two) and not more than 3 (Three)
Faculty Load: In Semester VIII– ½ hour per week per project group

Semester-VII - Examination Scheme

Course Code	Course Name	Marks								
		CA			ESE	TW	O	P	P&O	Total
		T1	T2	IA						
1UEXC701	Microwave Engineering	15	15	10	60	-	-	-	-	100
1UEXC702	Mobile Communication Systems	15	15	10	60	-	-	-	-	100
1UEXDLC703	Department Level Elective Course–III	15	15	10	60	-	-	-	-	100
1UEXDLC704	Department Level Elective Course–IV	15	15	10	60	-	-	-	-	100
1UILE705	Institute Level Optional Course - I	15	15	10	60	-	-	-	-	100
1UEXL701	Microwave Engineering Laboratory	-	-	-	-	25	25	-	-	50
1UEXDLL703	Department Level Elective Course–III Laboratory	-	-	-	-	25	25	-	-	50
1UEXDLL704	Department Level Elective Course –IV Laboratory	-	-	-	-	25	25	-	-	50
1UEXPR705	Project Based Learning – Major Project – A	-	-	-	-	25	-	-	50	75
Total		**75**	**75**	**50**	**300**	**100**	**75**	**-**	**50**	**725**

Department Level Elective Courses	Group	Course Code	Course Name
Department Level Elective Course –III	A B C D	1UEXDLC7031 1UEXDLC7032 1UEXDLC7033 1UEXDLC7034	Artificial Intelligence Satellite and Nano Satellite Communication Embedded Systems & RTOS Big Data Analytics
Department Level Elective Course – IV	A B C D	1UEXDLC7041 1UEXDLC7042 1UEXDLC7043 1UEXDLC7044	Neural Network and Deep Learning Wireless Networks Robotics Cloud Computing & Security

^ Student have freedom to select any course from Group A / B / C / D from Semester V to VIII

Institute Level Optional Course	Course Code	Course Name#
Institute Level Elective Course - I	1UILC7051 1UILC7052 1UILC7053 1UILC7054 1UILC7055 1UILC7056 1UILC7057 1UILC7058 1UILC7059	Product Life Cycle Management Reliability Engineering Management Information System Design of Experiments Operation Research Cyber Security and Laws Disaster Management and Mitigation Measures Energy Audit and Management Development Engineering

 # Common with all branches

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC701	Microwave Engineering	3+0+0
Prerequisite:	1. Electromagnetics and Antenna 2. Principles of Communication Engineering	
Course Objectives:	1. To learn the fundamentals of microwave systems. 2. To learn to make system level design decisions. 3. To learn passive and active device characteristics. 4. To learn the applications of microwaves.	
Course Outcomes:	1. Explain the basic concepts and theory of Microwave Engineering. 2. Design microwave transmission lines and matching techniques. 3. Analyze microwave passive components and semiconductor devices. 4. Classify the microwave tubes. 5. Measure microwave parameters. 6. Explain the applications of microwaves in day to day life.	

Module No. & Name	Sub Topics	CO Mapped	Hrs. / Sub Topic	Total Hrs./ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Microwaves	1.1 Microwave Frequency and Band designation, Characteristics, Advantages, disadvantages and Applications of Microwaves and its hazards.	1, 2	01	08
	1.2 Scattering parameters: Characteristics and Properties.		01	
	1.3 Strip lines, Micro strip lines and coupled lines: Analysis and design. (Numerical)		01	
	1.4 Impedance Matching with Reactive Elements, Single and Double stub matching. (Numerical)		05	
2. Waveguides and Passive Devices	2.1 Rectangular and circular waveguides: Construction, Working and Mode analysis. (Numerical)	2, 3	04	08
	2.2 Resonators, Re-entrant cavities, Tees (E, H and Magic), Hybrid ring, Directional couplers, Phase shifters, Terminations, Attenuators and Ferrite devices such as Isolators, Gyrators, and Circulators.		04	

Module No. & Name	Sub Topics	CO Mapped	Hrs. / Sub Topic	Total Hrs./ Module
3. Microwave Generators	3.1 Two-Cavity Klystron. Reflex Klystron: Construction, Operating Mechanism, Modes, velocity modulation (Analytical treatment) (Numerical)	4	03	07
	3.2 Magnetron: Cylindrical type, Construction, Operation, Bunching effect, Hull cut-off conditions, modes, mode bunching. (Numerical)		02	
	3.3 Traveling Wave Tubes: Types, Construction, Operation, Propagation Modes, Analytical treatment (Numerical)		01	
	3.4 Gyrotron's, Backward Wave Oscillator		01	
4. Microwave Semiconductor Devices	4.1 Diodes: Varactor, PIN, Tunnel, Point Contact, Schottky Barrier, Gunn, IMPATT, TRAPATT, and BARITT	3	04	07
	4.2 Transistors: BJT, Hetro junction BJT, MESFET, and HEMT		02	
	4.3 Parametric Amplifiers and Applications. (No derivation)		01	
5. Microwave Measurements	VSWR, Frequency, Power, Noise, Q-Factor, Impedance, Attenuation, Dielectric Constant, Antenna Gain.	5	05	05
6. Microwave Applications	6.1 Industrial application of microwaves: Microwave heating, Industrial control and measurements e.g. thickness measurement and moisture content measurements and medical applications e.g. diathermy and hyperthermia	1, 6	01	04
	6.2 Microwave Radar systems: Basic radar system, radar equation, Introduction of Radar, Radar Parameters and their Classification (Freq., waveform, PRF & application based)- Pulse, CW/FMCW/SFCW, MTI/MST, SAR, Tracking/ Phase Array Radar (Basic Only)		03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Samuel Liao, "Microwave Devices and Circuits", Prentice Hall. 2. David Pozar, "Microwave Engineering", Wiley Publication (Fourth Edition).**.** Matthew M. Radmanesh, "Radio Frequency and Microwave Electronic", Pearson Education. 3. Annapurna Das and S. K Das, "Microwave Engineering", McGraw Hill Education (Third Edition). 4. Merill Skolnik, "Introduction to RADAR Systems", Tata McGraw Hill (Third Edition). 5. G.S.N. Raju, "Radar Engineering and Fundamentals of Navigational Aids", Wiley Publication.
Reference Books	1. Colin, "Foundations of Microwave Engineering" Wiley Interscience. (Second Edition) 2. Devendra Mishra, "Radio Frequency and Microwave Communication Circuits- Analysis and Design" John Wiley & Sons. (Second Edition)

Useful Links:

1.www.nptelvideos.in
2.www.tutorialspoint.com
3.https://onlinecourses.nptel.ac.in/noc19_ee57/preview

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC702	Mobile Communication Systems	3+0+0

Prerequisite:	1. Digital Communication 2. Computer Communication and Networks
Course Objectives:	1. To understand the cellular fundamentals 2. To understand different types of radio propagation models. 3. To study the system architecture of 2G, 2.5 G and 3G. 4. To develop the concepts of emerging technologies for 4 G standards and beyond.
Course Outcomes:	1. Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems. 2. Classify different types of propagation models and analyse the link budget. 3. Illustrate the fundamentals, system architecture signalling protocol of GSM, 2.5G and IS-95. 4. Apply the concepts of 3G technologies of UMTS and CDMA 2000. 5. Elaborate the principles of 3GPP LTE. 6. Describe the emerging technologies for upcoming mobile communication systems.

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Fundamentals of Mobile Communication	1.1 Introduction to wireless communication: Mobile radio telephony, Examples of Wireless Communication Systems, Related design problems	1	02	06
	1.2 The Cellular Concept System Design Fundamentals: Frequency Reuse, Channel Assignment Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular Systems		03	
	1.3 Features of all conventional multiple access techniques: Frequency division multiple access (FDMA), time division multiple access (TDMA), space spectrum multiple access (SSMA), space division multiple access (SDMA), OFDM-PAPR, OFDMA		01	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Mobile Radio Propagation	2.1 Large scale fading: Free space propagation model, the three basic propagation mechanisms, reflection, ground reflection (two-ray) model, diffraction, scattering, practical Link budget design using path loss models	2	04	08
	2.2 Small scale fading: small scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Rician distributions		04	
3.2G Technologies	3.1 GSM: GSM Network architecture, GSM signalling protocol architecture, identifiers used in GSM system, GSM channels, frame structure for GSM, GSM speech coding, authentication and security in GSM, GSM call procedures, GSM hand-off procedures, GSM services and features	3	04	07
	3.2 GSM evolution: GPRS and EDGE-architecture, radio specifications, channels.		01	
	3.3 IS-95: Architecture of CDMA system, CDMA air interface, power control in CDMA system, power control, handoff, rake receiver		02	
4.3G Technologies	4.1 UMTS: Objectives, standardization and releases, network architecture, air interface specifications, channels, security procedure	4	04	06
	4.2 CDMA2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control.		02	
5. 3GPP LTE	5.1 Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure	5	02	06
	5.2 Logical and Physical Channels: Mapping of data onto (logical) sub-channels.		02	
	5.3 Physical layer procedures: Establishing a connection, retransmissions and reliability, scheduling, power control, handover.		02	
6. Advanced techniques for 4G deployment	6.1 Multi-antenna Techniques: Smart antennas, multiple input multiple output systems	6	02	06
	6.2 Cognitive radio: Architecture, spectrum sensing		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	6.3 Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Textbooks	1. Theodore S. Rappaport ―Wireless Communications - Principles and Practice, PEARSON, Second edition 2. T L Singal ―Wireless Communications, McGraw Hill Education 3. Andreas F. Molisch ― Wireless Communications Wiley India Pvt Ltd., Second Edition 4. Raj Pandya- Mobile and Personal Communication Services and Systems (IEEE Series on Mobile & Digital Communications)
Reference Books	1. Upena Dalal ―Wireless and Mobile Communications‖, Oxford University Press. 2. Vijay K. Garg ―Wireless Communications and Networking‖, Morgan–Kaufmann series in Networking-Elsevier

Useful Links:

1. MITOpenCourseware
2. https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-452-principles-of-wireless-communications-spring-2006/
3. http://nptel.ac.in/courses/117104099/
4. Virtual Lab : http://vlab.co.in/

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – III	Credits (TH+P+TUT)
1UEXDLC7031	Artificial Intelligence	3+0+0
Prerequisite:	1. Programming 2. Data Structures	
Course Objectives:	1. To create appreciation and understanding of both the achievements of AI and the theory underlying those achievements. 2. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems 3. To review the different stages of development of the AI field from human-like behaviour to Rational Agents. 4. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques like searching and game playing. 5. To create an understanding of the basic issues of knowledge representation and Logic and blind and heuristic search, as well as an understanding of other topics such as minimal resolution, etc. that play an important role in AI programs. 6. To introduce advanced topics of AI such as planning, Bayes networks, and applications of natural language processing and Robotics.	
Course Outcomes:	1. Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents. 2. Analyse and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them. 3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing 4. Demonstrate various real life problem domains using logic based techniques and use this to perform inference or planning. 5. Formulate and solve problems with uncertain information using Bayesian approaches. 6. Apply concept Natural Language processing and AI to solve the real time problems.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Intelligent Systems and Intelligent Agents	Introduction to AI, AI Problems and AI techniques, Solving problems by searching, Problem Formulation. State Space Representation .model based and learning based agents, PEAS	1, 2	04	04
2. Search Techniques	Uninformed Search: DFS, BFS, Uniform cost search, Depth Limited Search, Iterative Deepening. Informed Search: Heuristic functions, Best First Search, A* Local Search: Hill Climbing, Simulated Annealing, Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning	2, 3	09	09
3. Knowledge and Reasoning	A Knowledge Based Agent, Overview of Propositional Logic, First Order Predicate Logic, Inference in First Order Predicate Logic: Forward and Backward Chaining, Resolution.	4	10	10
4. Planning	Introduction to Planning, Planning with State Space Search, Partial Ordered planning, Hierarchical Planning, Conditional Planning.	4	06	06
5. Uncertain Knowledge and Reasoning	Uncertainly, Representing Knowledge in an Uncertain Domain, Conditional Probability, Joint Probability, Bayes' theorem, Belief Networks, Simple Inference in Belief Networks.	5	06	06
6. AI Application	Architecture of Expert system and its components Robotics - Robots, Robot hardware, Problems Robotics can solve AI applications in Healthcare, Retail, Banking Application of NLP- chat bot	6	04	04
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education. 2. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition 3. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Comp uting and Big Data Analytics, Wiley India
Reference Books	1. George Lugar, .AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education. 2. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication. 3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education. 4. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication 5. John Kelly , Steve Hamm, Smart Machines - IBM′s Watson and the Era of Cognitive Computing, Columbia Business School Publishing

Useful Links:

1. https://nptel.ac.in/courses/106/105/106105078/
2. https://thestempedia.com/blog/simple-ai-and-machine-learning-projects-for-students- and-beginners/
3. https://nptel.ac.in/courses/106/105/106105079/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – III	Credits (TH+P+TUT)
1UEXDLC7032	**Satellite and Nano Satellite Communication**	**3+0+0**
Prerequisite:	1. Principles of Communication Engineering 2. Digital Communication	
Course Objectives:	1. To understand the basics of satellite communications and different satellite communication orbits. 2. To provide an in-depth understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology. 3. To explain the tools necessary for the calculation of basic parameters in a satellite communication system. 4. To review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite.	
Course Outcomes:	1. Explain basics of satellite communication, space segment and earth segment. 2. Explain different satellite orbits and orbital parameters. 3. Analyse and design link budget of satellite signal for proper communication. 4. Explain various applications of satellite communications. 5. Explain the basics of the Nano satellite and its design. 6. Compare the Space segment access techniques.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Overview of Satellite Systems, Orbits and Launching	1.1 An overview of space and satellite Frequency allocation for satellite communication Polar orbiting satellites, Kepler’s First, second and third law, orbital elements, apogee, perigee heights, orbital perturbations (Numerical), effects of a non-spherical earth, atmospheric drag	1	03	08
	1.2 Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch, launch vehicles; satellite launch vehicle (SLV), augmented satellite launch vehicle (ASLV), polar SLV, geostationary satellite launch vehicle (GSLV)	1	02	
	1.3 Sub-satellite Point, predicting satellite position, antenna look angles, polar mount antenna, limits of visibility, near	2	03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	geostationary orbits, earth eclipse of satellite, sun transit outage			
2. Space Segment	2.1 Satellite configuration, Transponder sub-system, Antenna sub-system, AOC Sub-system, TT&C Sub-system, power sub-system, Thermal sub-system	2	05	06
	2.2 Reliability and quality Assurance	2	01	
3. Earth Station	3.1 General configuration- Block diagram, Antenna system, Feed system, Tracking system, LNA, HPA	1	02	04
	3.2 Optical/laser communication, advantage disadvantage of optical communication, optical ground station	1	01	
	3.3 Introduction of Software defined radio	5	01	
4. Satellite Links	4.1 Isotropic radiated power, transmission losses, free-space transmission, feeder losses, antenna misalignment losses, fixed atmospheric and ionospheric losses, link power budget	3	02	08
	4.2 System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks, overall system noise temperature, carrier to noise ratio	3	02	
	4.3 Uplink: Saturation flux density, input back off, earth station HPA, Downlink: Output back off, satellite TWTA output	3	02	
	4.4 Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio, intermodulation noise	3	02	
5. The Space Segment Access and Utilization	5.1 Space segment access methods, pre-assigned FDMA, demand assigned FDMA, SPADE system, bandwidth-limited and power-limited TWT amplifier operation	6	03	08
	5.2 TDMA: Reference Burst; Preamble and Postamble, carrier recovery, network synchronization, unique word detection, traffic date, frame efficiency, channel capacity, preassigned TDMA, demand assigned TDMA, satellite switched TDMA	6	03	
	5.3 Code Division Multiple Access: Direct-sequence spread spectrum–acquisition and tracking, spectrum spreading and despreading – CDMA throughput	6	02	
6. Nano Satellite	6.1 The evolution of nano satellite, Nano satellite structure. Microsatellites, Nano satellites, Pico satellites (CubeSats), Femto satellites	5	02	05

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	6.2 Areas of Application: Military, Commercial, Civilian, Educational, Experimental Notable Missions and Trends Small satellite mega-constellations: Starlink, OneWeb, Kuiper, Guowang InSight Mission- MarCO CubeSats, CubeSat Launch Initiative (NASA), Artemis1, Artemis 2, KiboCUBE, Nanosatellite Launch System (NLS), QB50, StudSat, Q-SAT	4	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:

Text Books	1. Dennis Roddy, "Satellite Communications", 4th Ed., Mc. Graw-Hill International Ed. 2009 2. Gerard Maral, "VSAT Networks", John Willy & Sons 3. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, "Satellite Communications", John Willy & Sons (Asia) Pvt. Ltd. 2004 4. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson, "Satellite Communication systems Engineering", Pearson Publication . 5. Planet Aerospace India "Quintessence of Nano-Satellite Technology", Notion Press
Reference Books	1. M. Richharia, "Satellite Communication Systems Design Principles", Macmillan Press Ltd. Second Edition 2003 2. R. N. Mutangi, "Satellite Communication", Oxford University Press, 2016. 3. Gerard Maral and Michel Bousquet, "Satellite Communication Systems", 4th Edition Wiley Publication, TMH (2009)

Useful Links:

1.https://nptel.ac.in/courses/117/105/117105131/
2 https://www.udemy.com/course/nep-certification/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – III	Credits (TH+P+TUT)
1UEXDLC7033	**Embedded Systems & RTOS**	**3+0+0**
Prerequisite:	1. Microcontrollers 2. Digital Communication 3. Digital Logic Design	
Course Objectives:	1. To develop background knowledge on Embedded Systems. 2. To understand communication techniques used in embedded systems 3. To understand the embedded product development life cycle 4. To write programs for embedded systems and real time operating systems	
Course Outcomes:	1. Classify embedded systems 2. Choose appropriate hardware platform for an Embedded application 3. Choose appropriate communication technique for an Embedded application 4. Analyse the task communication and synchronization issues 5. Write programs for embedded applications using RTOS 6. Design an embedded system using Embedded Product Development Life Cycle concepts	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1. Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas	1	02	04
	1.2. Characteristics and quality attributes (Design Metric) of embedded systems. Real time system‘s requirements, real time issues, interrupt latency	1	02	
2. Embedded Hardware Elements	2.1 Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA.	2	01	06
	2.2 ARM Cortex-M3 Features, Architecture, Programmer’s model, Special Registers, Operating Modes and States, MPU, Memory map and NVIC.	2	05	
3. Communication	3.1 CAN bus, I2C, MOD bus, SPI, RS -485, USB, RS-232	3	05	07
	3.2 Wi-Fi, Bluetooth	3	02	
4. Real Time	4.1 Operating system basics, Types of OS	5	01	07

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Operating Systems [RTOS]	4.2 Task, Process, Thread	4, 5	02	
	4.3 Multiprocessing and Multitasking	4, 5	01	
	4.4 Task scheduling, Schedulabality	4	02	
	4.5 Threads, Process , Scheduling :- Putting them all together	5	01	
5. RTOS-Synchronization	5.1 Task communications: Pipes, Memory Mapped Object, Message queues, Mailbox, Signalling/ Task Notification, Remote Procedure Call and Socket	4, 5	03	08
	5.2 Synchronization Problems: Racing, Deadlock, Livelock, Starvation, Dining Philosopher's problem, Producer-Consumer problem, Reader-Writer problem, Priority Inversion, etc.	3, 4	02	
	5.3 Task synchronization Techniques: Mutex, Semaphore, etc.	3, 4	02	
	5.4 Device drivers	5	01	
	5.5 How to choose RTOS	6		
6. Design of Embedded applications and case studies	6.1 Program Modelling Concepts: DFG, CDFG, FSM, UML	6	02	07
	6.2 Embedded Product development life cycle	6		
	6.3 Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator. Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing	6	02	
	6.4 Case Study: a. Automatic Chocolate Vending Machine b. Digital Camera	6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization**.**	-	01	01
			Total	**42**

Books:

Text Books	1. Introduction to Embedded Systems 2nd edition Shibu K.V Mc Graw Hill 2009 2. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid and Tony Givargis Wiley Publication 1999 3. The definitive guide to the ARM Cortex-M3 2nd edition Jospeh Yiu Elesevier 2010
Reference Books	1. Embedded Real Time Systems: Concepts, Design & Programming Second edition K.V.K.K. Prasad Dreamtech Publication 2003 2. Embedded systems software primer First edition David Simon Pearson 2002 3. Embedded real systems Programming First edition Iyer, Gupta Tata MCgraw- Hill Publication 2010 4. Embedded Systems Architecture, Programming and design 3rd edition Raj Kamal Tata MCgraw- Hill Publication 2017

Useful Links:

1. https://www.freertos.org/
2. https://www.digikey.com/en/maker/projects/getting-started-with-stm32-introduction-to-freertos/ad275395687e4d85935351e16ec575b1
3. https://scienceprog.com/freertos-on-stm32/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – III	Credits (TH+P+TUT)
1UEXDLC7034	**Big Data Analytics**	**3+0+0**
Prerequisite:	1. Database Management System	
Course Objectives:	1. To Provide an Overview of an exciting growing field of Big Data Analytics. 2. To introduce the tools required to manage and analyze big data using Hadoop, Map Reduce and Nosql 3. To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability.	
Course Outcomes:	1. Describe the basic concepts of big data, Hadoop Framework and various clustering techniques. 2. Use various distributed storage system to Collect, manage, store, query and analyze big data. 3. Apply scalable algorithms based on hadoop to perform big data analytics. 4. Analyze various stream management algorithms used to solve the complex problems. 5. Apply different distance measure techniques for determining similar items from a large dataset. 6. Interpret Complex real world problems in various applications like recommender systems, social media applications, page ranking, etc.	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Big Data Analytics	1.1 Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach.	1	02	04
	1.2 Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	1	02	
2. Hadoop	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem, Physical Architecture, Hadoop limitations.	2	04	04
3. NoSQL	3.1 Introduction to NoSQL, NoSQL business drivers, NoSQL case studies.	3	02	08
	3.2 NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document	3	03	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	stores, Variations of NoSQL architectural patterns			
	3.3 Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems	3	03	
4. Batch processing using MapReduce	4.1 MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization	4	02	08
	4.2 MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	4	03	
	4.3 Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce.	4	03	
5. Stream data management i n Big Data Analytics	5.1 Finding Similar Item: Nearest Neighbour Search, Similarity of Documents	1, 5	01	10
	5.2 Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis	5	03	
	5.3 Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce	5	03	
	5.4 Frequent Itemset Mining : Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	5	03	
6. Big Data Analytics Applications	6.1 Recommendation Systems: Introduction, A Model for Recommendation Systems, Collaborative-Filtering System: Nearest Neighbour Technique, Example.	6	02	05
	6.2 Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce.	6	03	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Radha Shankarmani and M Vijayalakshmi “Big Data Analytics”, Wiley 2. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press. 3. Dan McCreary and Ann Kelly “Making Sense of NoSQL” – A guide for managers and the rest of us, Manning Press.
Reference Books	1. Bill Franks “Taming the Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics”, Wiley 2. Chuck Lam, “Hadoop in Action”, Dreamtech Press 3. Jared Dean, “Big Data, Data Mining and Machine Learning: Value Creation for Business Leadersand Practitioners”, Wiley India Private Limited, 2014. 4. Jiawei Han and MichelineKamber, “Data Mining: Concepts and Techniques”, Morgan Kaufmann Publishers, 3rd ed, 2010. 5. LiorRokach and OdedMaimon, “Data Mining and Knowledge Discovery Handbook”, Springer 2nd Edition, 2010 6. Ronen Feldman and James Sanger, “The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data”, Cambridge University Press, 2006 7. Vojislav Kecman, “Learning and Soft Computing”, MIT Press, 2010. 8. Tom White “Hadoop: The Definitive Guide”, O'Reilly Media, Inc., June 2009
Useful Links:	
1. https://hadoop.apache.org 2. https://hadoop.apache.org/docs/r2.8.0/hadoop-project-dist/hadoop-co mmon/core-default.xml 3. https://sqoop.apache.org/ 4. https://hive.apache.org/ 5. https://pig.apache.org/docs/r0.16.0/start.html 6. https://medium.com/@deepeshtripathi/setup-multi-node-hadoop-cluster-using-ambari-fc929cd1d0d4	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – IV	Credits (TH+P+TUT)
1UEXDLC7041	**Neural Networks and Deep Learning**	**3 + 0 + 0**
Prerequisite:	Machine Learning	
Course Objectives:	1. To understand the fundamentals of neural networks 2. To learn advanced topics such as recurrent neural networks, long short term memory cells and convolutional neural network 3. To understand tuning of the parameters of neural networks. 4. To learn applications of neural networks in real-world problem	
Course Outcomes:	1. Explain the basic concepts of perceptron. 2. Mathematically illustrate the forward and back propagation in Neural Networks. 3. Use optimization models to overcome the limitations in Neural Networks. 4. Tune the parameters of Neural Networks. 5. Implement Deep Learning algorithm to the given dataset. 6. Describe the applications of the Neural Networks.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Perceptron	Overview of Deep Learning Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm.	1	03	03

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Neural Network	2.1 One hidden layer Neural Network- Output, Vectorization, - Activation functions: types and comparison - Loss functions : Mean square loss, cross entropy loss - Optimizers : Gradient Descent Algorithm - Back propagation	2	05	06
	2.2 Random Initialization, Regularization, Learning rate Why Neural Network didn't take off?		01	
3. Better Training of Neural Networks	3.1 Over fitting, Under fitting, bias and variance - Vanishing gradients, exploding gradients - Second order methods for training - Saddle point problem in Neural Network	3	02	05
	3.2 Regularization methods (dropout, drop connect, batch normalization)		01	
	3.3 Newer optimization methods for neural networks (SDG, rmsprop, adam)		02	
4. Deep Neural Network	4.1 Forward propagation, Vectorised implementation, Backward propagation (2 hidden layers- introduction)	2, 4	03	06
	4.2 Hyper parameters - Difficulty of training deep neural networks: Vanishing gradients, exploding gradients, etc. - Greedy layerwise training		03	
5. Convolutional Neural Networks	- Convolution filters - Pooling - FC layers - Hyper parameters - LeNet - AlexNet. - VGG - ResNet	5	08	08
6. Recurrent Neural Networks and Applications	6.1 Recurrent Neural Networks Back propagation through time - Why RNN? (Vanishing Gradient) - Types of RNN (Single input single output, etc.) - Long Short Term Memory - RNN using LSTM - Bidirectional LSTMs - Introduction to Transformers and attention	5	06	11
	6.2 Applications of Neural Networks - Applications in Healthcare , Marketing, Education, Business	6	05	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	- Computer Vision - NLP - Speech			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016 2. Deep Learning Tutorial, LISA Lab, University of Montreal 3. Deep Learning: Methods and Applications By Li Deng and Dong Yu 4. Neural Networks and Deep Learning By Michael Nielsen
Reference Books	1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996 2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

Useful Links:

1. https://www.deeplearningbook.org/
2. http://deeplearning.net/tutorial/deeplearning.pdf
3. https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/DeepLearning-NowPublishing-Vol7-SIG-039.pdf
4. https://ee541.cankaya.edu.tr/course.php?page=Syllabus
5. https://d2l.ai/index.html
6. https://research.google.com/colaboratory/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – IV	Credits (TH+P+TUT)
1UEXDLC7042	Wireless Networks	3+0+0

Prerequisite:	1. Computer Communication Network
Course Objectives:	1. To Understand Basics of Wireless Networks 2. To Know different IEEE standards like IEEE 802.15, IEEE 802.11, IEEE 802.16 3. To develop the concept of Wireless Ad Hoc Networks and Sensor networks. 4. To understand Wireless sensor networks, mesh networks and IoT
Course Outcomes:	1. Explain the fundamentals, architecture, design issues and standards of wireless networks and Body area networks. 2. Discuss the specifications, architectures, protocol stack, security procedures of personal area network (PAN) technologies such as Zigbee, Bluetooth, UWB, RFID, NFC etc. 3. Classify different Wireless Local Area Networks based on their Architecture, Radio specifications, Protocol Stack, Security procedures. 4. Illustrate the fundamentals and architecture of wireless Metropolitan Area Networks (WMAN) and describe the phases of planning and design of wireless networks with link budgets 5. Describe the basic architecture, Protocol Stack and working of Wireless Ad hoc Networks. 6. Describe the basic architecture, Protocol Stack and working of Wireless Sensor networks, Ad hoc Networks and IOT

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Basics of Wireless Networks	1.1 Wireless network architecture, currently working Classifications, switching technology, communication problems	1	02	04
	1.2 Wireless body area networks: Properties Network architecture Network components Applications	1	02	
2. Wireless Personal Area Networks	2.1 WPAN: Bluetooth (IEEE802.15.1): Radio specifications protocol stack link types security state model Error correction topologies application	2	04	10

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.2 ZigBee (IEEE 802.15.4): Radio specifications components topologies protocol stack applications	2	02	
	2.3 RFID: Radio specifications architecture and types	2	02	
	2.4 Near field communication & UWB (IEEE 802.15.3a): Introduction and working	2	02	
3. Wireless Local Area Network	3.1 Equipment Technologies Topologies Applications IEEE 802.11 WLAN	3	02	06
	3.2 Joining an existing basic service set Security and Power management	3	02	
	3.3 Main features of IEEE 802.11 a/b/g/n/ac/ax	3	02	
4. Wireless Metropolitan and Wide Area Networks	4.1 WMAN (IEEE 820.16): Introduction WMAN network architecture Network protocols. Broadband wireless networks application	4	02	07
	4.2 WWAN: Planning and design of Wireless network: radio link and Coverage planning	4	02	
	4.3 Link budgets for GSM, CDMA, CDMA 2000, HSDPA Systems	4	03	
5. Wireless Ad- hoc networks	5.1 Wireless Ad hoc Networks: Features, advantages & applications	5	02	06
	5.2 Mobile Ad-hoc Networks: (MANETs) Network Architecture, MAC protocols	5	02	
	5.3 Vehicular Ad hoc Networks: (VANETs): Characteristics, Protocols and Applications	5	02	
6. Wireless Sensor Networks	6.1 Wireless Sensor Networks: Network architecture, Protocols, technologies, and applications	6	02	06
	6.2 Wireless Mesh Networks: Network architecture, Protocols, technologies, Applications	6	02	
	6.3 Internet of Things: Framework, Architecture, Technology, and examples, M2M communication	6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Vijay K. Garg,” Wireless Communication and networking”, Morgan-Kaufmann Series in Networking-Elsevier 2. Dr. Sunil Kumar S. Manvi, Mahabaleshwar S. Kakkasageri, “Wireless & Mobile Networks: Concepts and Protocols” Wiley India.
Reference Books	1. Kazem Sohrby, Daniel Minoli and Taieb Znati,” Wireless Sensor Networks: Technology, Protocols, and Applications”, Wiley Student Edition 2. Raj Kamal,” Internet of Things Architecture & Design Principles

Useful Links:

1. https://zigbeealliance.org/solution/zigbee/
2. https://www.bluetooth.com/
3. https://www.ieee802.org/
4. https://www.wi-fi.org/discover-wi-fi/wi-fi-certified-6

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – IV	Credits (TH+P+TUT)
1UEXDLC7043	**Robotics**	**3+0+0**
Prerequisite:	1. Microcontroller 2. Linear Algebra, matrix transformation 3. Control system	
Course Objectives:	1. To introduce industrial Robotic ARM 2. To offer mathematical and engineering knowledge for sensor and actuators of Robotics 3. To offer understanding of control of Robot 4. To give exposure of intelligent Robotics	
Course Outcomes:	After taking this course student will be able to 1. Describe the steps involved in ARM manipulator design 2. Select a suitable drive System for robot application 3. Select a suitable sensor for robot application 4. Solve Direct Kinematics and inverse kinematics problem 5. Explain working of semi and autonomous Robot for structure and unstructured environment. 6. Describe Algorithm for Robot Navigation in structured and unstructured environment	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Fundamentals of Robotics	1.1 Evolution of Robotics: Automation to AI Robotics, Robotic Paradigm: Sense, plan and act, Laws of Robotics, D-H Algorithm	5	03	04
	1.2 Specification of Robot, Classification of Robot, Robot Configuration	5	01	
2. Industrial Robotics	2.1 Simple manipulators: two / three ARM manipulators and their kinematics equation, Work space homogeneous	1, 4	02	06
	2.2 D-H Procedure, ROBOT Parameter, ARM matrix, DH matrix	1, 4	02	
	2.3 Inverse kinematics for manipulators	4	02	
3. Actuators, sensors and their control	3.1 DC motors, Brushless PM DC motor, AC/DC servomotor	2	01	06
	3.2 Sensors for Robots: camera, position encoders, tactile, hall, Force	3, 5	02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Sensors, Lidar			
	3.3 Spring mass damper model, Combination of P,I and D control, PID control, Case study of Robocon Bots designed by KJSIEIT Robocon students team.	2, 5	03	
4. Introduction to Software for Robotics	4.1 ARM training, VAL	5, 6	01	08
	4.2 Matlab /octave for fast prototyping of Robots, Introduction to C++, C ++ for Robot Operating System (ROS)	5, 6	07	
5. Probabilistic Robotics for Navigation	5.1 Basics of Probability, Recursive state Estimation: Bayes filter	5, 6	03	07
	5.2 Mobile Robot Localization problem, path planning strategies: BFS; DFS; Dijsktra; A star ; D star; SLAM algorithm	5, 6	04	
6. AI Robotics and case study	6.1 State machine for Behavioural planning Machine Learning for Robotics, Supervised learning, Unsupervised Learning, Reinforcement Learning: State, action and award, RL for Robotics, Convolution Neural Networks for supervised Learning: Object detection, NLP for Robotics	5, 6	04	08
	6.2 Business Use Cases : Swaaytt Robotics, Boston Dynamics	5, 6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. ROBOTICS, Appu Kuttan K.K., I.K. international Publishing house,1st Edition 201`2 2. Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, Bradford Company Scituate, USA 2004
Reference Books	1. Fundamental of Robotics: Analysis and Control Robert J. Schilling 2. Introduction to AI Robotics, 2nd Edition, R. Murphy, MIT Press

Useful Links:

1. http://www.swaayatt-robots.com/
2. https://www.bostondynamics.com/
3. http://www.iitg.ac.in/cse/robotics/?page_id=1349
4. https://modernrobotics.northwestern.edu/nu-gm-book-resource/2-2-degrees-of-freedom-of-a-robot/#department

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – IV	Credits (TH+P+TUT)
1UEXDLC7044	**Cloud Computing & Security**	**3+0+0**
Prerequisite:	1. Computer Communication Networks 2. Data Structures & Algorithms	
Course Objectives:	1. To understand Basics of cloud computing. 2. To know Key concepts of virtualization. 3. To explain Different Cloud Computing services 4. To explain Cloud Implementation, Programming and Mobile cloud computing	
Course Outcomes:	1. Describe basics of cloud computing and memorize the different Cloud service and deployment models 2. Explain the Key concepts of virtualization along with their technologies. 3. Select the cloud computing services based on business requirements 4. Analyse the components of open stack & Google Cloud platform and understand Mobile Cloud Computing 5. Explore the Components of Amazon Web Service 6. Apply security measures in cloud computing environments	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Defining Cloud Computing, Cloud and other similar configurations, Components of Cloud Computing, Cloud types: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models	1	02	04
	1.2 Cloud computing architecture, Advantages and Disadvantages of Cloud Computing		02	
2. Virtualization	2.1 Virtualization: Characteristics of virtualized environment. Understanding the importance of Hypervisors, Type I & Type II Hypervisors	2	02	05
	2.2 Taxonomy of virtualization, Implementation Levels of Virtualization, Virtualization of CPU, Memory and I/O Devices, Virtualization and Cloud Computing,	2	01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.3 Pros and Cons of virtualization, Technology Examples: KVM, Xen, Vmware, Virtual box and HyperV	2	01	
	2.4 Introduction to Containers/docker, image building registry, volumes secrets, networks	2	01	
3. Cloud Computing Services	3.1 Exploring Cloud Computing Services: SPI Model: Software as a service, Platform as a service, and Infrastructure as a service.	3	03	10
	3.2 Anything as a service or Everything as a service (XaaS): Security as a Service, Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service	3	04	
	3.3 Compliance as a Service, Monitoring as a Service, Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.	3	02	
	3.4 Cloud Backup Solutions and their features, Cloud data management interface (CDMI), Cloud Storage gateways (CSG), Comparison between different cloud platforms: Amazon web services & Open stack (Based on Type of deployment, Services supported and their components)	3	01	
4. Cloud Implementation, Programming and Mobile Cloud Computing	4.1 Open Stack Cloud Architecture: Feature of Open stack, Components of Open stack, mode of operations	4	02	08
	4.2 Programming support for Google apps engine GFS, Big tables, Chubby, Google APIs.	4	04	
	4.3 Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing	4	02	
5. Exploring the Components of Amazon Web Service	5.1 AWS cloud computing Platform a) Elastic Compute Cloud (EC2): Compute Basics, Instance types, Life cycle of instances. b) Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3.	5	01	04
	5.2 c) Elastic Block Storage (EBS): Basics and Types of EBS Volumes d) Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP	5	02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Addresses (EIP), Elastic Network Interfaces (ENIs) & Security groups & ACL. e) Exploring Elastic Load Balancing (ELB): Basics, Types of load balancers, Configuring Elastic Load Balancing, Basics of Cloud Watch & Auto Scaling			
	5.3 Introduction to MS AZ/Google Cloud	5	01	
6. Cloud computing security	6.1 Risk associated with cloud computing, Security challenges in cloud computing environment	6	04	08
	6.2 IAM-Identity access managements, SAAS, IAAS, PAAS security, Security compliances and standards- HIPPA, PCI-DSS, SoX, GLBA, GDPR, ISO27001	6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			TOTAL	**42**

Books:	
Text Books	1. Enterprise Cloud Computing by Gautam Shroff, Cambridge, 2010 2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010 , 3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013 4. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice) 1st Edition, Kindle Edition by Tim Mather
Reference Books	1. Rajkumar Buyya et. el., Cloud Computing: Principles and Paradigms, Wiley India Edition 2. Sosinsky B., “Cloud Computing Bible”, Wiley India 3. Mastering Cloud Computing by Rajkumar Buyya, C. Vecchiola & S. Thamarai Selvi Mc GRAW Hill Publication 4. Miller Michael, “Cloud Computing: Web Based Applications that Change the Way You Work and Collaborate Online”, Pearson Education India 5. Velte T., Velte A., Elsenpeter R., “Cloud Computing – A practical Approach”, Tata Mc Graw Hill

Useful Links:

1. www.openstack.org
2. https://www.nist.gov/news-events/news/2011/10/final-version-nist-cloud-computing-definition-published
3. https://cloudsecurityalliance.org/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
1UILC7051	Product Life Cycle Management	3+0+0
Course Objectives:	1. To familiarize the students with the needs, benefits and components of PLM. 2. To acquaint students with Product Data Management & PLM strategies. 3. To give insights into new product development programs and guidelines for designing and developing a product. 4. To familiarize the students with Virtual Product Development**.**	
Course Outcomes:	1. Apply the different phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. 2. Analysis various approaches and techniques for designing and developing products. 3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. 4. Applying virtual product development tools for components, machining and manufacturing plants. 5. Create an Integration of Environmental Aspects in Product Design 6. Analysis the Life Cycle Assessment and Life Cycle Cost Analysis	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs /Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Product Lifecycle Management (PLM)	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy ,Change management for PLM	1	10	10
2. Product Design:	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the	2	09	09

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs /Module
	Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.			
3. Product Data Management (PDM)	Product Data Management (PDM):Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.	3	05	05
4. Virtual Product Development Tools	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	4	05	05
5. Integration of Environmental Aspects in Product Design	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	5	05	05
6. Life Cycle Assessment and Life Cycle Cost Analysis	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books	1. Product Lifecycle Management Authors: Saaksvuori, Antti, Immonen, Anselmi ISBN 978-3-540-26906-9 2. Product Lifecycle Management: 21st Century Paradigm for Product Realisation Decision engineering, ISSN 1619-5736,2005
Reference Books	1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105 2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 08493272293. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314 **3.** Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN:0070636265

Useful Links:

1. https://www.intechopen.com/books/product-lifecycle-management-terminology-and-applications/introductor y-chapter-product-lifecycle-management-terminology
2. https://www.spectechular.walkme.com/top-3-product-lifecycle-management-books/
3. https://dasme.co/wp-content/uploads/2016/07/plm.pdf
4. https://books.google.co.in/books/about/Product_Lifecycle_Management.html?id=PiVri4OyU7AC&redir_esc=y

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
1UILC7052	**Reliability Engineering**	**3+0+0**
Course Objectives:	1. To familiarize the students with various aspects of probability theory 2. To acquaint the students with reliability and its concepts 3. To introduce the students to methods of estimating the system reliability of simple and complex systems 4. To understand the various aspects of Maintainability, Availability and FMEA procedure	
Course Outcomes:	1. Apply the concept of Probability to engineering problems 2. Apply various reliability concepts to calculate different reliability parameters 3. Estimate the system reliability of simple and complex systems 4. Apply the knowledge to improve reliability of complex system 5. Analysis the Maintainability and Availability of system 6. Identity a Failure Mode Effect and Criticality Analysis.	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Probability	1.1 Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.	1	03	08
	1.2 Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.		03	
	1.3 Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.		02	
2. Reliability Concept	2.1 Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve	2	03	08
	2.2 Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.		03	
	2.3 Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
	Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.			
3. System Reliability	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	3	05	05
4. Reliability Improvement	4.1 Reliability Improvement: Redundancy Techniques: Element redundancy, Unit Redundancy, Standby redundancies. Markov analysis.		04	08
	4.2 System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	4	04	
5. Maintainability and Availability	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	5	05	05
6. Failure Mode, Effects and Criticality Analysis	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, Severity/ criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	01	01
			Total	**42**

<table>
<tr><td colspan="2">Books:</td></tr>
<tr><td>Text Books</td><td>1. Introduction To Reliability Engineering 2Nd Edition by Lewis, Wiley India
2. Reliability Engineering Theory And Practice 8Ed (Hb 2017) by BIROLINI A., SPRINGER
3. The Certified Reliability Engineer Handbook by Donald W. Benbow, Hugh W. Broome, New Age International (P) Ltd., Publishers</td></tr>
<tr><td>Reference Books</td><td>1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.</td></tr>
<tr><td colspan="2">Useful Links:</td></tr>
<tr><td colspan="2">1. https://victorops.com/blog/the-comprehensive-site-reliability-engineering-sre-pdf
2. https://nptel.ac.in/courses/105/108/105108128/
3.https://nptel.ac.in/content/storage2/courses/112101005/downloads/Module_5_Lecture_3_final.pdf
4. https://documents.in/document/curso-nptel-reliability-engineering.html
5. https://www.coursera.org/learn/site-reliability-engineering-slos</td></tr>
</table>

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credit (TH+P+TUT)
1UILC7053	**Management Information System**	**3+0+0**
Course Objectives:	1. To discuss the roles played by information technology in business and define various technology architectures on which information systems are built. 2. To define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage. 3. To identify the basic steps in systems development.	
Course Outcomes:	1. Describe how information systems transform business. 2. Identify the impact information systems have on an organization. 3. Describe IT infrastructures and its components and its current trends. 4. Explain the principal tools and technologies for accessing information from databases. 5. Apply to improve business performance and decision making. 6. Identify the types of systems used for enterprise wide knowledge management.	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Information System	1.1 Computer Based Information Systems, Impact of IT on organizations.	1	02	04
	1.2 Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	1	02	
2. Data and Knowledge Management	2.1 Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.	2,3	04	07
	2.2 Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results.	2,3	03	
3. Ethical Issues and Privacy	3.1 Ethical issues and Privacy: Information Security.	3	03	07
	3.2 Threat to IS and Security Controls.	3	04	
4. Social Computing (SC)	4.1 Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing.	4	03	07
	4.2 Operational and Analytical CRM, E-business and E-commerce – B2B B2C.	4	04	

	Mobile commerce.			
5.Computer Networks	5.1 Computer Networks Wired and Wireless technology.	5	03	06
	5.2 Pervasive computing, Cloud computing model.	5	03	
6.Project leadership and Ethics and Closing the projects	6.1 Information System within Organization: 6.2 Transaction Processing Systems, Functional Area Information System.	6	04	08
	6.3 ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models. Managing without authority; Areas of further study.	6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	_	01	01
			Total	**42**

Books:	
Text Books:	1. K. Rainer, Brad Prince,Management Information Systems, Wiley . 2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm 10th Ed., Prentice Hall.
Reference Books:	1. S. Jawadekar's Management Information Systems: published by McGraw-Hill Education. 2. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall.

Useful Links:

1. https://www.nptel.ac.in/
2. https://www.coursera.org/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
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Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
1UILC7054	**Design of Experiments**	**3+0+0**
Prerequisites:	---	
Course Objectives (COBs):	1. To understand the issues and principles of Design of Experiments (DOE) 2. To list the guidelines for designing experiments 3. To become familiar with methodologies that can be used in conjunction with designs for robustness and optimization	
Course Outcomes(COs):	1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action. 2. Analyze the different fitting regression models. 3. Apply the different two level factorial designs. 4. Distinguish the different fractional factorial methods. 5. Apply the methods taught to real life situations. 6. Plan, analyze, and interpret the results of experiments.	

Module No & Name	Sub Topics	CO Mapped	Hrs/Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Strategy of Experimentation, Typical Applications of Experimental Design.	1	01	03
	1.2 Guidelines for Designing Experiments, Response Surface Methodology.	1	02	
2. Fitting Regression Models	2.1 Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression.	2	04	08
	2.2 Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	2	04	
3. Two Levels Factorial Designs	3.1 The 2^2 Design, The 2^3 Design, The General2k Design.	3	04	08
	3.2 A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs.	3	04	
4. Two Levels Fractional Factorial Methods	4.1 The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design.	4	04	08
	4.2 Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	4	04	

Module No & Name	Sub Topics	CO Mapped	Hrs/Sub Topic	Total Hours
5. Response Surface Methods and Designs	5.1 Introduction to Response Surface Methodology, The Method of Steepest Ascent.	5	04	08
	5.2 Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.	5	04	
6. Taguch Approach	6.11 Crossed Array Designs and Signal-to-Noise Ratios.	6	02	04
	6.2 Analysis Methods, Robust design examples.	6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	02	01
			Total	**42**

Books:	
Text Books	1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, John Wiley & Sons, New York. 2. D. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, New York. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, John Wiley and Sons.
Reference Books	1. G. Box, J Hunter and W. Hunter, Statics for Experimenters: Design, Innovation and Discovery, Wiley. 2. A. Dean, and D. Voss, Design and Analysis of Experiments, Springer. 3. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill. 4. M. Phadake, Quality Engineering using Robust Design, Prentice Hall.

Useful Links:

1. https://nptel.ac.in/courses/110/105/110105087/
2. https://www.udemy.com/course/design-of-experiments-i/

Continuous Assessment (CA):

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1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
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Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
1UILC7055	Operation Research	3+0+0

Course Objectives:	1. To understand Research and Research Process 2. To acquaint students with identifying problems for research and develop research strategies 3. To familiarize students with the techniques of data collection, analysis of data and interpretation
Course Outcomes:	1. Explain the models, limitation and relate it with problems related to operations 2. Examine the operation environment and its resources. 3. Explain and analyse the simulation algorithms 4. Apply dynamic programming to solve the problems 5. Apply various algorithms to collect, analyse and report data 6. Judge classical and probabilistic inventory models

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Operations Research	1.1 Introduction, Structure of the Mathematical Model, Limitations of Operations Research	1	01	14
	1.2 Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method,	1	02	
	1.3 Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complementary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	1	02	
	1.4 Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel‘s approximation method. Optimality test: the stepping stone method and MODI method.	1	03	
	1.5 Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n	1	03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem			
	1.6 Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	1	03	
2. Queuing Models	Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	2	05	05
3. Simulation	Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	3	05	05
4. Dynamic programming	Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach /Shortest Path, cargo loading and Reliability problems.	4	05	05
5. Game Theory	Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	5	05	05
6. Inventory Models	Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Reference Books:	1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002. 2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009 3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002. 4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut 5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons
Useful Links:	

1. https://onlinecourses.nptel.ac.in/noc19_ma29/preview

2. https://www.coursera.org/courses?query=operations%20research

Continuous Assessment (CA):
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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
IUILC7056	**Cyber Security and Laws**	**3+0+0**
Course Objectives:	1. To understand and identify different types cybercrime and cyber law 2. To recognized Indian IT Act 2008 and its latest amendments 3. To learn various types of security standards compliance	
Course Outcomes:	1. Explain the concept of cybercrime and its effect on outside world 2. Classify and Examine the Cyber Offences and security implications. 3. Illustrate and identify the modus operandi followed in cyber-crimes. 4. Explain the aspects in Indian Cyber Laws 5. Explain the penalties in cyber law. 6. Apply Information Security Standards compliance during software design and development	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Cybercrime	Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the	1	04	04
2. Cyber Offenses & Cybercrime	How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	2	09	09
3. Tools and Methods Used in Cyber line	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer OverFlow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	4	04	06
4. The Concept of Cyberspace	E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber	3	08	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law			
5. Indian IT Act	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	5	06	06
6. Information Security Standard compliance	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6	06	06
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books:	1. William Stallings, *Cryptography and Network Security*, Pearson Publication The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi 2. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi 3. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
Reference Books:	1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi 2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi 3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi. 4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai 5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi 6. Kennetch J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing. 7. William Stallings, *Cryptography and Network Security*, Pearson Publication

Useful Links:

1. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
2. Website for more information , A Compliance Primer for IT professional https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals- 33538

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Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
1UILC7057	Disaster Management and Mitigation Measures	3+0+0

Prerequisites:	Basics of Physics
Course Objectives:	1. To Understand Physics and Various Types of Disaster Occurring Around the World. 2. To Identify Extent and Damaging Capacity of a Disaster. 3. To Study and Understand the Means of Losses and Methods to Overcome Minimize it. 4. To Understand Application of GIS in the Field of Disaster Management. 5. To Understand the Emergency Government Response Structures Before, During and after Disaster.
Course Outcomes:	1. Illustrate the importance of Disaster Management 2. Discuss natural as well as man made disaster and their extent and possible effects on the economy. 3. Use government policies, acts and various organizational structures associated with an emergency. 4. Devise various Framework for Disaster Management in India. 5. Reviewing various approaches of disaster relief measures. 6. Generalize the simple do's and don's in such extreme events and act accordingly

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Definition of Disaster, Hazard, Global and Indian Scenario, General Perspective, Importance of Study in Human Life.	1	02	04
	1.2 Direct and Indirect Effects of Disasters, Long Term Effects of Disasters.		02	
2. Natural Disaster and Manmade disasters	2.1 Natural Disaster: Meaning and Nature of Natural Disaster, Flood, Flash Flood, Drought, Cloud Burst.	2	01	07
	2.2 Earthquake, Landslides, Avalanches, Volcanic Eruptions, Mudflow, Cyclone, Storm, Storm Surge.		01	
	2.3 Climate Change, Global Warming, Sea Level Rise, Ozone Depletion.		02	
	2.4 Man Made Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of Growing Population and Subsequent Industrialization.		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.5 Urbanization and Changing Lifestyle of Human Beings in Frequent Occurrences of Manmade Disasters.		01	
3. Disaster Management, Policy and Administration	3.1 Disaster Management: Meaning, Concept, Importance.	3	02	06
	3.2 Objective of Disaster Management Policy, Disaster Risks in India, Paradigm Shift in Disaster Management.		02	
	3.3 Policy and Administration Importance and Principles of Disaster Management Policies, Command and Coordination of Disaster Management.		01	
	3.4 Rescue Operations: How to Start With And How to Proceed in Due Course of Time, Study of Flowchart Showing the Entire Process.		01	
4. Institutional Framework for Disaster Management in India	4.1 Importance of Public Awareness, Preparation and Execution of Emergency Management Programme. Scope and Responsibilities of National Institute of Disaster Management (NIDM) and National Disaster Management Authority (NDMA) in India.	4	02	06
	4.2 Methods and Measures to Avoid Disasters, Management of Casualties, Set Up of Emergency Facilities, Importance of Effective Communication Amongst Different Agencies in Such Situations.		02	
	4.5 Use of Internet and Software for Effective Disaster Management. Applications of GIS, Remote Sensing and GPS.		02	
5. Financing Relief Measures	5.1 Ways to Raise Finance for Relief Expenditure, Role of Government Agencies and NGO's in this Process.	5	02	08
	5.2 Legal Aspects Related to Finance Raising as well as Overall Management of Disasters.		02	
	5.3 Various NGO's and the Works they have Carried Out in the Past on the Occurrence of Various Disasters, Ways to Approach these Teams.		02	
	5.4 International Relief Aid Agencies and Their Role in Extreme Events.		02	
6. Preventive and Mitigation Measures	6.1 Pre-Disaster, During Disaster and Post-Disaster Measures in Some Events in General.	6	02	08
	6.2 Structural Mapping: Risk Mapping, Assessment and Analysis, Sea Walls and Embankments, Bio Shield, Shelters, Early Warning and Communication.		02	
	6.3 Non-Structural Mitigation: Community Based Disaster Preparedness, Risk Transfer and Risk Financing, Capacity Development and Training,		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Awareness And Education, Contingency Plans.			
	6.4 Do's And Don'ts in Case of Disasters and Effective Implementation of Relief Aids.		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books:	1. H Gupta Disaster Management, Universities Press Publications. 2. O Dagur, Disaster Management: An Appraisal of Institutional Mechanisms in India, Centre for Land Warfare Studies. 3. C Damon and Butterworth, Introduction to International Disaster Management, Elseveir Publications.
Reference Books:	1. K. Yonng, Concepts and Techniques of GIS –C.P.Lo, Prentice Hall (India) Publications. 2. R Singh, Natural Hazards and Disaster Management, Vulnerability and Mitigation, Rawat Publications.

Useful Links:

1 www.msme.gov.in/
2. www.dcmesme.gov.in/
3. www.msmetraining.gov.in/

Continuous Assessment (CA):

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Internal Assessment(IA):

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End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
1UILC7058	Energy Audit and Management	3+0+0
Prerequisite:	——	
Course Objectives:	1. To understand the importance of energy security for sustainable development and the fundamentals of energy conservation. 2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management 3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.	
Course Outcomes:	1. Identify and describe the present state of energy security and its importance. 2. Identify and describe the basic principles and methodologies adopted in energy audit of an utility. 3. Describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. Describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. Analyze the data collected during performance evaluation and recommend energy saving measures. 6. Reviewing the concepts of Energy Conservation in buildings	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-		02
1. Energy Scenario	Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	1	04	04
2. Energy Audit Principles	Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of	2	08	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	return (IRR)			
3. Energy Management and Energy Conservation in Electrical System	Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting systems, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives	3		10
4. Energy Management and Energy Conservation in Thermal Systems	Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	4	10	10
5. Energy Performance Assessment	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	5	04	04
6. Energy conservation in Buildings	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	6	03	03
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	01	01
			Total	**42**

Books:	
Text Books	1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science 2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System 3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons 4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI). 5. Energy Management Principles, C.B.Smith, Pergamon Press
Reference Books	1. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press 2. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Useful Link

1. www.energymanagertraining.com
2. www.bee-india.nic.in

Continuous Assessment (CA):
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1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
1UILC7059	Development Engineering	3+0 +0
Prerequisite:	-	
Course Objectives:	1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development 2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas 3. To explain exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals 4. To understand the Nature and Type of Human Values relevant to Planning Institutions	
Course Outcomes:	1. Apply knowledge for Rural Development. 2. Demonstrate post-independence rural development. 3. Apply knowledge for Initiatives and Strategies 4. Develop acumen for higher education and research. 5. Master the art of working in groups of different nature. 6. Develop confidence to take up rural project activities independently	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1.Introduction to Rural Development	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services	1	08	08
2. Post-Independence rural Development	Post-Independence rural Development Balwant Rai Mehta Committee – three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee -	2	05	05

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	linkage between Panchayati Raj, participation and rural development			
3. Rural Development Initiatives in Five Year Plans	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Database for local planning; Need for decentralized planning; Sustainable rural development.	3	06	06
4. Post 73rd Amendment Scenario	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments	4	05	05
5. Values and Science and Technology Material development	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	5	10	10
6. Ethics Canons	Ethics Canons of ethics; ethics of virtue; ethics	6	05	05

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
of ethics	of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. ITPI, "Village Planning and Rural Development", ITPI, New Delhi 2. Thooyavan, K.R, " Human Settlements: A 2005", MA Publication, Chennai 3. GoI, "Constitution (73rd GoI, New Delhi Amendment) Act", GoI, New Delhi 4. Planning Commission, Five Year Plans, Planning Commission 5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
Reference Books	1. Planning Guide to Beginners 2. Weaver, R.C., The Urban Complex, Doubleday. 3. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington. 4. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150. 5. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395– 407

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (P+TUT)
1UEXL701	**Microwave Engineering Laboratory**	**1+0**

Prerequisite:	1. Electromagnetic and Antenna Laboratory 2. Principles of Communication Engineering Laboratory
Lab. Objectives:	1. To learn the design of matching circuits using simulation software. 2. To learn the mode analysis in waveguide using simulation software. 3. To learn microwave passive components and semiconductor devices. 4. To analyse the characteristics of microwave tubes (Reflex Klystron). 5. To measure microwave parameters using a microwave bench.
Lab. Outcomes:	1. Analyse microwave matching techniques and waveguide using any simulation software. 2. Analyse microwave passive components and semiconductor devices. 3. To measure microwave parameters using a microwave bench. 4. Write a code for the calculation of Speed, cross range & Range of Doppler Radar. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab. No.	Experiment Title (suggested)	LO Mapped	Hrs. / Lab
0	**Lab Prerequisites**	-	02
1.	Measurement of Microwave Frequency Using Slotted Line section and verification using direct frequency meter.	3,5,6	02
2.	Study and analyse the characteristics of Reflex Klystron.	2,5,6	02
3.	Demonstrate the measurement of Voltage Standing Wave Ratio & Reflection Coefficient of Different load.	3,5,6	02
4.	Demonstrate the measurement of Guided Wavelength & Free Space Wavelength using Microwave bench.	3,5,6	02
5.	Study and modal analysis of Rectangular waveguide using simulation software.	1,5,6	02
6.	Demonstrate the measurement of dielectric constant of solid using Microwave bench.	3,5,6	02
7.	Simulation of impedance matching by using any familiar software.	1,5,6	02
8.	Write a code for the calculation of Speed, cross range & Range of Doppler Radar by using any familiar software.	4,5,6	02

Lab. No.	Experiment Title (suggested)	LO Mapped	Hrs. / Lab
9.	To analyses the performance of Gunn diode using Microwave bench.	2,5,6	02
10.	Mini Project/ Case study	1 to 6	08
11.	Assignment 1	-	-
12.	Assignment 2	-	-
		Total	**28**

Useful Links:

1. http://www.iitk.ac.in/mimt_lab/vlab/index.php
2. https://onlinecourses.nptel.ac.in/noc19_ee57/preview
3. https://www.youtube.com/c/KJSIEITofficial/videos

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory – III	Credits (P+TUT)
1UEXDLL7031	Artificial Intelligence Laboratory	1+0

Lab Prerequisite:	Programming, Data Structures
Lab Objectives:	1. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems 2. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques. 3. To make students understand various AI methods like searching and game playing and how to apply them to solve real applications 4. To explain to students the basic issues of knowledge representation and Logic so as to build inference engines 5. To impart a basic understanding of some of the more advanced topics of AI such as planning. 6. To understand Bayes networks, natural language processing and introduce the concept of cognitive computing.
Lab Outcomes (LOs):	1. Implement the building blocks of an Intelligent Agent using PEAS representation. 2. Implement the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them. 3. Implement various real life problem domains using logic based techniques and use this to perform inference or planning. 4. Solve problems with uncertain information using Bayesian approaches. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the Laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	**Lab Prerequisites**	-	02
1.	Tutorial exercise for Design of Intelligent System using PEAS Problem Definition with State Space Representation	1, 2,5,6	02
2.	Implementation of Uninformed (BFS/DFS) and Informed Search Algorithms (A*)	2,5,6	06
3.	Implementation of CSP and Game playing algorithms	2,5,6	04
4	Assignment on Predicate Logic, for forward and backward reasoning and resolution. Design of a Planning system using STRIPS.	3.4,5,6	04
5	Implementation of Bayes' Belief Network.	4,5,6	02
6	Mini project Construction of a domain specific Chat Bot using Natural Language Processing techniques. (Applications can include: Medical Diagnosis, Personal	1,2,3,4,5,6	08

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
	Shopping Assistant, Travel Agent, Troubleshooting etc.)		
		Total	**28**

Virtual Lab Links:
1. https://nptel.ac.in/courses/106/105/106105078/ 2.https://thestempedia.com/blog/simple-ai-and-machine-learning-projects-for-students- and-beginners/ 3.https://nptel.ac.in/courses/106/105/106105079/
Term work:
Term work should consist of a minimum of 8 experiments Journal must include assignments on content of theory and practical of the course The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory – III	Credits (P+TUT)
1UEXDLL7032	**Satellite and Nano Satellite Communication Laboratory**	**1+0**

Lab Prerequisite:	1. Principles of Communication Engineering 2. Digital Communication
Lab Objectives:	1. To understand the **basics** of satellite communications and different satellite communication orbits. 2. Provide an **in-depth** understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology. 3. To explain the **tools** necessary for the calculation of basic parameters in a satellite communication system. 4. Review the state of the art in **new research** areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite.
Lab Outcomes (LOs):	1. Apply direct communication link between Uplink Transmitter & Down link Receiver using tone signal. 2. Apply AUDIO-VIDEO satellite link between Transmitter and Receiver. 3. Apply waveforms through satellite link. Explain Active satellite link and demonstrate link fail operation. 4. Analyze satellite link between Transmitter and Receiver using software. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
0	**Lab Prerequisites**	**-**	02
1.	To set up a communication link between uplink transmitter and downlink receiver using Satellite	1,5,6	02
2.	To transmit and receive three separate signals (Audio, Video, and Tone) simultaneously through satellite link.	2,5,6	02
3.	To transmit digital waveform through a satellite communication link.	3,5,6	02
4.	Active satellite link and demonstrate link fail operation	4,5,6	02
5.	To estimate the C/N ratio	3,5,6	02
6.	To estimate S/N ratio	3,5,6	02
7.	To find the gain of the antenna using Matlab software.	4,5,6	02
8.	To find the Speed and time period of a satellite as a function of Altitude using Matlab software.	4,5,6	02
9.	To calculate propagation delay in a SATCOM link.	3,5,6	02
10.	Velocity of satellite in given orbit at apogee and perigee using Matlab software.	4,5,6	02
11.	Case Study/Mini Project	1 to 6	06
		Total	**28**

Virtual Lab Links:
1. https://aero04-iitb.vlabs.ac.in/
Term work:
1. Term work should consist of a minimum of 8 experiments 2. Journal must include assignments on content of theory and practical of the course 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks
Oral/Practical/P&O: Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory– III	Credits (P+TUT)
1UEXDLL7033	**Embedded System & RTOS Laboratory**	**1+0**
Lab Prerequisite:	**1.** Microcontroller Laboratory	
Lab Objectives:	1. To understand various communication protocols used in Embedded System 2. To learn configuration of Free RTOS 3. To learn Inter Task communication in Free RTOS 4. To learn Task synchronization in Free RTOS	
Lab Outcomes	1. Interface embedded system modules. 2. Write program for embedded application 3. Demonstrate Inter Process Communication in RTOS 4. Demonstrate task synchronization in RTOS 5. Develop applications to solve big data problems. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory	

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	**Lab Prerequisites**	-	02
1	Interfacing of I2C with ARM	1,2,5,6	02
2	Interfacing of SPI with ARM	1,2,5,6	02
3	Interfacing of UART with ARM	1,2,5,6	02
4	Simulation of multitasking using FreeRTOS	2,5,6	02
5	Simulation of mutex using FreeRTOS	2,4,5,6	02
6	Interprocess communication using Message Buffer in FreeRTOS	2,3,5,6	02
7	Interprocess communication using queues in FreeRTOS	2,4,5,6	02
8	Simulation of synchronization using Semaphore in FreeRTOS	2,4,5,6	02
9	Simulation of synchronization using Task Notification in FreeRTOS	2,4,5,6	02
10	Simulation of software timer using FreeRTOS	2,5,6	02
11	Case Study / Mini Project	1 to 6	06
		Total	**28**

Virtual Lab Links:
1. http://vlabs.iitkgp.ernet.in/rtes/exp15/index.html#
Term work:
1. Term work should consist of a minimum of 8 experiments **2.** Journal must include at least 2 assignments on content of theory and practical of the course **3.** The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory– III	Credits (P+TUT)
1UEXDLL7034	Big Data Analytics Laboratory	(1+0)
Lab Prerequisite:	1. Database Management System 2. Java Programming	
Lab Objectives:	1. To Interpret business models and scientific computing paradigms, and apply software tools for big data analytics	
Lab Outcomes (LOs):	1. Apply scalable algorithms based on Hadoop and Map Reduce to perform Big Data Analytics. 2. Apply NoSQL tools to solve big data problems. 3. Implement commands of various technologies of the Hadoop Ecosystem. 4. Implement different algorithms of mining, use stream data models and to develop applications to solve big data problems. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	**Lab Prerequisites**	-	02
1.	Hadoop distributions for installation of Hadoop And execution of Basic HDFS Commands	1,5,6	02
2.	Copying File to Hadoop. Copy from Hadoop File system and deleting file Moving and displaying files in HDFS	1,5,6	02
3.	Implementing simple algorithms in Map-Reduce: Matrix multiplication/ Aggregates and Joins/ Sorting and Searching, etc.	1,5,6	02
4	To install and configure MongoDB/ Cassandra/ HBase/ Hyper table to execute NoSQL commands.	2,5,6	02
5	Use Sqoop tool to transfer data to Hadoop and To execute basic commands of Sqoop.	3,5,6	02
6	Create HIVE Database and Descriptive analytics-basic statistics, visualization using Hive/PIG/R.	3,5,6	02
7	Implementing DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language.	4,5,6	02
8	Implement a Frequent Item set algorithm on Big Data	4,5,6	02
9	Mini Project: One large data application to be implemented (Use standard Datasets available on the web) (mandatory)	1,2,3,4,5,6	10

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
		Total	**28**

Virtual Lab Links:
1. https://hadoop.apache.org 2. https://hadoop.apache.org/docs/r2.8.0/hadoop-project-dist/hadoop-common/core-default.xml 3. https://sqoop.apache.org/ 4. https://hive.apache.org/ 5. https://pig.apache.org/docs/r0.16.0/start.html 6. https://medium.com/@deepeshtripathi/setup-multi-node-hadoop-cluster-using-ambari-fc929cd1d0d4
Term work:
1. Term work should consist of a minimum of 8 experiments 2. Journal must include assignments on content of theory and practical of the course 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory – IV	Credits (P+TUT)
1UEXDLL7041	**Neural Networks and Deep Learning Laboratory**	**(1+0)**

Lab Prerequisite:	Machine Learning
Lab Objectives:	1. To simulate the various phenomenon related to CMOS circuits 2. To analyze simple CMOS circuits using SPICE tools 3. To simulate the logic circuits using various design style 4. To draw mask layout of various circuits
Lab Outcomes (LOs):	**After taking the course students will be able to,** 1. Demonstrate implementation of perceptron. 2. Build Neural Network model for the given problem 3. Implement a Neural Network for the given problem using various libraries. 4. Tune the parameters of Neural Networks. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	**Lab Prerequisites**	-	02
1.	Implementation of perceptron	1,5,6	02
2.	Implementation of shallow dense neural network with one hidden layer	2,5,6	02
3.	Implementation of Stochastic Gradient Descent	2,5,6	02
4.	Implementation of dropout	4,5,6	02
5.	Implementation of regularization	4,5,6	02
6.	Implementation of RMSprop optimizer	4,5,6	02
7.	Implementation of Adam optimizer	4,5,6	02
8.	Build and implement A Deep Learning Model using Keras	3,5,6	02
9.	Hyper parameter tuning for Neural Network	4,5,6	02
10.	Implementation of ConvNet for using PyTorch	3,5,6	02
11.	Implementation of LeNet-5 using PyTorch	3,5,6	02
12.	Implementation of AlexNet using Keras	3,5,6	02
13.	Implementation of ResNet using Keras	3,5,6	02
		Total	**28**

Virtual Lab Links:
1. http://cse22-iiith.vlabs.ac.in/
Term work: 1. Term work should consist of a minimum of 8 experiments 2. Journal must include assignments on content of theory and practical of the course 3. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing marks in term work. **4.** Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory – IV	Credits (P+TUT)
1UEXDLL7042	**Wireless Networks Laboratory**	**1+0**
Lab Prerequisite:	Computer Communication Networks Laboratory	
Lab Objectives:	1. Study of Hardware and Software aspects of Wireless Network and IoT 2. Analysis of ZigBee network wireless transmission of information. 3. Configuration of WPAN using Bluetooth module. 4. Link budget analysis of GSM and CDMA network	
Lab Outcomes (LOs):	1. Implement capacity and network efficiency of different multiple access schemes like, SCMA, OFDMA, 2. Design WPAN, WLAN, WMAN and WWAN. 3. Estimate link budget of GSM, CDMA, HSDPA, CDMA2000 4. Implement Wireless Ad hoc Networks, Sensor Network and IoT. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
0	**Lab Prerequisites**	**-**	02
1	Write Hardware and Software aspects of Wireless Network and Internet of Things	1,5,6	02
2	Establish Bluetooth a network connection	2,5,6	02
3	Estimate a range of Interference in Bluetooth and IEEE802.11a	2,5,6	02
4	Estimate a Capacity and Spectral Efficiency of CDMA system	1,5,6	02
5	Calculate the Uplink and downlink budget for CDMA system	3,5,6	02
6	Calculate SINR of HSDPA	3,5,6	02
7	To turn motor, relay on and off using ZigBee kit	2,5,6	02
8	Establish Wireless Local Area Network.	2,5,6	02
9	Write a program to randomly place the sensor node in the given space connecting each 2 nodes if distance between them is less than or equal to common radius.	4,5,6	02
10	To understand basic beam forming in wireless communication	1,5,6	02
11	Establish a WMAN	2,5,6	02
12	Mini projects based on wireless technologies simulation/ coding using MATLAB/NS3	1,2,3,4,5,6	04
		Total	**28**

Useful Links:
1. http://vlabs.iitkgp.ernet.in/ant/
Term work:
1. Term work should consist of a minimum of 8 experiments **2.** Journal must include assignments on content of theory and practical of the course **3.** The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments, Attendance Theory & Practical: 15-marks, Assignments/Case study/Mini project demo/presentation: 10-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Course Code	Department Level Elective Course Laboratory - IV	Credits (P+TUT)
1UEXDLL7043	**Robotics Laboratory**	**1+0**

Hardware Requirements:	PC With following Configuration 1. Intel Dual core Processor or higher 2. Minimum 4 GB RAM 3. Minimum 40 GB Hard disk
Software Requirements:	1. Windows / Linux Desktop OS 2. Atmel Studio 3. ROS, Gajebo, Matlab/Octave
Lab Prerequisite:	1. Control Lab 2. Microcontroller Lab
Lab Objectives:	1. To explain DC drive and control 2. To introduce Sensor for Robotics 3. To understand Kinematics of robot 4. To introduce ROS/Gajebo Environment
Lab Outcomes:	1. Write the program for Simple motor maneuver for Robotic movement 2. Calculate and simulate Direct/indirect kinematics for robot 3. Use DC drives for Robotic arms 4. Deploy Sensors/actuators/output devices for Wheeled Robots in ROS Environment 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laborator

Lab No.	Experiment Title	LOs Mapped	Hrs./ Lab
0	**Lab Prerequisites**	**-**	02
1	Software Installation and study of hardware and software required for practical: Motion Control of Firebird	1,3,5,6	02
2	Practicals on Firebird: Speed control	1,3,4,5,6	02
3	Different Maneuvers' using Firebird Robot	2,5,6	02
4	Obstacle Avoidance in structured Environment	1,5,6	03
5	Map Generation Using Robot	3,4,5,6	03
6	Study of ROS and Gajebo Environment	4,5,6	02
7	Study of 3d Printers as Cartesian Robot	2,5,6	02
8	Development of 3d objects for Robotic Parts	2,3,5,6	02
9	Practical on Navigation of Robot in structured/Non Structured Environment	2,4,5,6	02
10	Study and simulation of Industrial Robot	2,5,6	02

Lab No.	Experiment Title	LOs Mapped	Hrs./ Lab
11	PID control of DC motors and Robotic ARM	1,3,5,6	02
12	Simulation of Wheeled Robot in ROS Environment	4,5,6	02
		Total	**28**

Virtual Lab Links:

1. http://vlabs.iitkgp.ernet.in/mr/

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include at least 2 assignments on content of theory and practical of the course " ROBOTICS Lab"
3. Term work evaluation shall be for Total 25 Marks (Experiments: 15 Marks, Attendance in Lectures and Lab Sessions: 05 Marks, Assignments: 05 Marks).
4. The final certification and acceptance of term work is based on satisfactory performance of laboratory work and minimum passing marks in term work evaluation.

Practical & Oral (P&O):

Oral examination will be based on entire theory syllabus and carries 25 Marks.

Lab Code	Department Level Elective Course Laboratory - IV	Credits (P+TUT)
1UEXDLL7044	**Cloud Computing & Security Lab**	**1+0**

Lab Prerequisite:	1. 1UEXC604- Computer Communication Networks 2. 1UEXDLC505-Data Structures & Algorithms
Lab Objectives:	Students to get familiar with: 1. To Understand Key concepts of virtualization & different types of Hypervisors used in virtualization along with implementation 2. To Understand the concept of On demand Application Delivery like SaaS 3. To explain Open source cloud implementation and administration using OpenStack 4. To explain Various Cloud services provided by Amazon Web Services 5. To Learn Programming on Platform as a Service cloud and Implementation of Storage as a service using Own Cloud
Lab Outcomes (LOs):	1. Adapt different types of virtualizations and increase resource utilization 2. Use the functioning of PaaS, IaaS, SaaS 3. Examine the installation and configuration of Open stack cloud 4. Build a private cloud using open-source technologies, Demonstrate Platform as a Service, Design & Synthesize Storage as a service using own Cloud. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Creating and running virtual machines on Hosted Hypervisors like KVM Type 1 ,VMware Workstation, Oracle Virtualbox	1,5,6	02
2	Creating and running virtual machines on Bare-Metal Hypervisors Type 0 like Xen,Vmware ESXI or HyperV	1,5,6	02
3	Implement IaaS using your resources. Technology: OpenStack / Eucalyptus	2,5,6	02
4	Installation and Configuration of Ulteo to demonstrate on demand Application delivery over web browser to explore SaaS Environment.	2,5,6	02
5	To demonstrate installation and Configuration of Open stack Private cloud.(MS AZ and Google Cloud)	3,5,6	02
6	How to create IAM role in AWS	4,5,6	02
7	How to create EC2 instance How to connect with the instance	4,5,6	02
8	How to create s3 bucket and how to give permission to bucket and its operation	4,5,6	02
9	How to Access database operation in Documentdb and Dynamodb and redshift	4,5,6	02
10	How to do Like auto scaling, elastic load balancing, virtual private computing & Networking. Security service provided	4,5,6	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
	by Amazon web services. Accessing AWS using web services API provided by Amazon.		
11	To Demonstrate Platform as a Service using Google app Engine/IBM BlueMix/tSuru	4,5,6	02
12	Explore Storage as a service using its own Cloud for remote file access using web interfaces. S3 glacier storage	4,5,6	02
13	Title: Mini Project Objective: Using the concepts studied throughout the semester students shall be able to 1. Create their private cloud for the institute using the available resources. 2. Apply security concepts to secure a private cloud. 3. Implement efficient load balancing. 4. Compare various virtualization technologies with given resources. 5. Create cloud applications such as messenger, photo editing website, your own social media etc. OR Docker Project- 1. How to create docker image 2. How to publish to docker hub 3. How to run docker image how to attach volume to docker image 4. How to create network in docker Note: Evaluators must check if students have used appropriate cloud computing tools for their projects	1,2,3,4,5,6	10
		Total	**36**
***Minimum 28 Hrs. Lab / Mini Project to be conducted**			

Note: Suggested 8 lab exercises based on virtualisation, Cloud computing stack, cloud programming and cloud security.
Also suggested one project with example

References:

1. Implementing and Developing Cloud Computing Applications, DAVID E.Y. SARNA, Auerbach Publications,2011
2. Handbook of Cloud Computing, Borko Furht, Armando Escalante, Springer, 2010
3. Cloud Computing Tutorial: tutorialspoint.com

Virtual Lab Links:

https://www.vlab.co.in/

Useful Link:

1. www.openstack.org
2. https://www.nist.gov/news-events/news/2011/10/final-version-nist-cloud-computing-definition-published
3. https://cloudsecurityalliance.org/

Term work :

1. Term work should consist of a minimum of 8 experiments and one mini project
2. Journal must include one project on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 10-marks, Attendance Theory & Practical: 05-marks, Project: 10-marks)

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks.

Course Code	Project Based Learning	Credits(TH+P+TUT)
1UEXPR75	**Major Project - A**	**0+3+0**

Prerequisite:	1. Mini Project
Lab Objectives:	The Project work enables the students, 1. To develop the required skills and knowledge about research. 2. To analyse a specific problem or issue by using the latest technologies with a multidisciplinary approach. 3. To demonstrate proficiency in the design of a research project, application with appropriate research methods. 4. To present and adopt various research ideas with appropriate solution
Lab Outcomes:	1. Identify, formulate, review research literature, and analyse complex engineering problems 2. Design solutions, components or processes for complex engineering problems. 3. Select appropriate modern engineering tools and analyse and interpret data to meet the problem statement. 4. Apply ethical principles and commit to professional ethics, responsibilities norms of the engineering practice, and engage in independent and life-long learning. 5. Comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects.

Syllabus:

Project Topic:

- To proceed with the project work it is especially important to select the right topic. Project can be undertaken on any domain of Electronics and Telecommunication programme. Research and development
- Projects on problems of practical and theoretical interest should be encouraged.
- Project work must be carried out by the group of at least two students and maximum three and must be original.
- Students can certainly take ideas from anywhere but be sure that they should evolve them in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Students must consult an internal guide along with external guide (if any) in selection of topic.
- Head of department and senior staff/project coordinator in the department will take decisions regarding selection of projects.
- Students have to submit a weekly progress report to the internal guide whereas the internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding the term work marks. In case of industry projects, visits by internal guides will be preferred.
- Students shall be motivated to publish a paper based on the work in Conferences/Technical paper presentations/project competitions/Poster presentations.

Project Report Format

At the end of semester, a project report should preferably contain at least following Details: -

1. Abstract
2. CO-PO mapping
3. Introduction
4. Literature Survey
   a) Comparative Survey of Existing system
   b) Limitation of the Existing system or research gap
5. Proposed System
   a) Problem Statement and Objective
   b) Methodology (your approach to solve the problem)
   c) Analysis/Framework/ Algorithm
   d) Details of Hardware & Software
   e) Design details
   f) Budget details
   g) Implementation Plan for next semester
6. Conclusion and future scope
7. References
8. Term Work:
   Distribution of marks for term work shall be as follows:
   a) Weekly Attendance on Project Day
   b) Contribution in the Project work
   c) Project Report (Spiral Bound)
   d) Term End Presentation (Internal)
9. The final certification and acceptance of Term Work will carry 25 Marls ensuring satisfactory performance on the above aspects.
10. Oral & Practical:
    Oral &Practical examination of Major Project-A should be conducted by Internal and External will carry 50 Marks based on satisfactory presentation, demonstration of implementation of the project

Useful Links:

1. https://ieeexplore.ieee.org/
2 https://www.electronicsforu.com/

Term Work:

Students have to submit a weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visits by an internal guide will be preferred to get the status of the project.

Students shall be motivated to publish a paper based on the work in Conferences/Technical paper presentations/project competitions/Poster presentations.

Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (soft Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of Term Work ensures the satisfactory performance on the above aspects which carries 25 Marks.

Oral & Practical:

Practical examination of Major Project-A shall be conducted by Internal and External examiners. Students must give a presentation and demonstration on the Major Project-A. Practical will carry 50 Marks.

Program Structure Last Year UG Engineering (ET)

Semester-V

III-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
1UEXC801	Optical Communication Networks	3– 0 – 0	03	3 – 0 – 0	03	PC
1UEXDLC802	Department Level Elective Course – V	3– 0 – 0	03	3 – 0 – 0	03	DLE
1UEXDLC803	Department Level Elective Course – VI	3 – 0 – 0	03	3 – 0 – 0	03	DLE
1UEXILC804	Institute Level Elective Course – II	3 – 0 – 0	03	3 – 0 – 0	03	ILE
1UEXL801	Optical Communication Networks Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
1UEXDLL802	Department Level Elective Course – V Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	DLE
1UEXDLL803	Department Level Elective Course – VI Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	DLE
1UEXPR86	Project Based Learning – Major Project - B	0 - 12# - 0	12#	0 – 6 – 0	06	PBL
Total		**12– 18– 0**	**30**	**12 - 09 - 0**	**21**	

 # PBL-PR-B- (1 hour- Conference /Journal Publication Filling Patent, Creation of Product & Licencing, Startup, SIH, Participation etc.)
Major Project B: Students can form groups with minimum 2 (Two) and not more than 3 (Three)
Faculty Load: In Semester VIII– 1 hour per week per project group

Semester- VIII- Examination Scheme

Course Code	Course Name	Examination Scheme								
		Marks								
		CA			ESE	TW	O*	P	P&O	Total
		T1	T2	IA						
1UEXC801	Optical Communication Networks	15	15	10	60	-	-	-	-	100
1UEXDLC802	Department Level Elective Course – V	15	15	10	60	-	-	-	-	100
1UEXDLC803	Department Level Elective Course – VI	15	15	10	60	-	-	-	-	100
1UILC804	Institute Level Elective Course - II	15	15	10	60	-	-	-	-	100
1UEXL801	Optical Communication Networks Laboratory	-	-	-	-	25	25	-	-	50
1UEXDLL802	Department Level Elective Course – V Laboratory	-	-	-	-	25	25	-	-	50
1UEXDLL803	Department Level Elective Course – VI Laboratory	-	-	-	-	25	-	25	-	50
1UEXPR86	Project Based Learning – Major Project – B	-	-	-	-	50	-	-	100	150

Total	60	60	40	240	125	50	25	100	700

Department Level Optional Courses	Group^	Course Code	Course Name
Department Level Elective Course – V	A B C D	1UEXDLC8021 1UEXDLC8022 1UEXDLC8023 1UEXDLC8024	Augmented Reality and Virtual Realty 5G Technology System On-Chip Web Design
Department Level Elective Course – VI	A B C D	1UEXDLC8031 1UEXDLC8032 1UEXDLC8033 1UEXDLC8034	Natural Language Processing RF Design Autonomous Vehicle Fundamentals of Data Science

^ Student have freedom to select any course from Group A / B / C / D from Semester V to VIII

Institute Level Optional Course	Course Code	Course Name #
Institute Level Elective Course - II	1UILC8041 1UILC8042 1UILC8043 1UILC8044 1UILC8045 1UILC8046 1UILC8047 1UILC8048 1UILC8049	Project Management Finance Management Entrepreneurship Development and Management Human Resource Management Professional Ethics and CSR Research Methodology IPR and Patenting Digital Business Management Environmental Management

 # Common with all branches

Course Code	Course Name	Credits (TH+P+TUT)
1UEXC801	**Optical Communication Networks**	**3 + 0 + 0**
Prerequisite:	1. Principles of Communication Engineering 2. Electromagnetics and Antenna 3. Digital Communication	
Course Objectives:	1. To optical fiber communication concepts, essentials, structures wave guide, and signal degradation in fiber. 2. To the characteristics of optical sources and detectors. 3. To link budget and optical networks, design and management. 4. To Study the multiplexing schemes.	
Course Outcomes:	1. Apply the fundamental principles of optics and light wave to design optical fiber communication systems. 2. Identify structures, functions, materials, and working principles of optical fibers, light sources, couplers, detectors, and multiplexers. 3. Describe the operation of transmitters and detectors in optical fiber communication. 4. Identify the basic components in an optical network system. 5. Explain the concepts of SONET/SDH and access networks. 6. Discuss the various design considerations in optical networks.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Optical fiber Communications	1.1 Historical development, The general system, Advantages of optical fiber communication	1, 2	02	07
	1.2 Optical fiber waveguides: Ray theory transmission, Modes in planar guide, Phase and group velocity, Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, fiber cables.		05	
2. Transmission characteristics of optical fiber	2.1 Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber	2, 3	04	06
	2.2 Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers.		02	
3. Optical sources and Detectors	3.1 Optical Sources: Working principle and characteristics of sources (LED, LASER), and optical amplifiers	3	02	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	3.2 Photodetectors: Working principle and characteristics of detectors (PIN, APD), noise analysis in detectors, coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance.		03	
	3.3 Point to point links system considerations, link power budget, and rise time budget Optical Receiver: Optical Receiver Operation: Error sources, Front End Amplifiers, Receiver sensitivity, Quantum Limit		03	
4. WDM Concepts and Optical Components	4.1 WDM Concepts: Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Introduction of Solitons	4	02	07
	4.2 Optical Components : Mach-Zehnder Interferometer Multiplexers, Couplers, Isolators, Circulators, Multiplexers, Filters, Fiber gratings, Fabry Perot filters, Arrayed waveguide grating, Switches and Wavelength converters Optical amplifiers: Basic application and Types, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers.		05	
5. Optical Networks	5.1 SONET and SDH standards, architecture of optical transport networks (OTNs), network topologies, protection schemes in SONET/SDH, and wavelength routed architectures.	5	03	07
	5.2 OTDM, multiplexing and demultiplexing, synchronization and broadcast OTDM networks.		02	
	5.3 Network architecture overview, OTDN networks, optical access networks, and future access networks		02	
6. Network Design and Management	6.1 Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization.	6	02	04
	6.2 Network management functions, configuration management, performance management, fault management, optical safety, and service interface		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:

Text Books	1. John M. Senior, ―Optical Fiber Communication‖, Prentice Hall of India Publication, Chicago, 3rd Edition, 2013 2. Gred Keiser, ―Optical Fiber Communication‖, Mc-Graw Hill Publication, Singapore, 4th Edition, 2012 3. Rajiv Ramaswami and Kumar N. Sivarajan, ―Optical Networks: A Practical Perespective‖, Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010
Reference Books	1. G. Agrwal, ―Fiber optic communication Systems‖, John Wiley and Sons, 3rd Edition, New York 2014 2. Biswanath Mukherjee, ―Optical Communication Networks‖, McGraw-Hill, 1997. 3. Le Nguyen Binh, ―Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink‖, CRC Press, 2010 4. P. E. Green, ―Optical Networks‖, Prentice Hall,1994

Useful Links:

1. https://nptel.ac.in/courses/117/101/117101054/
2. https://nptel.ac.in/courses/117/104/117104127/
3. https://nptel.ac.in/courses/108/106/108106167/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – V	Credits (TH+P+TUT)
1UEXDLC8021	Augmented Reality & Virtual Reality	3 + 0 + 0

Prerequisite:	Image Processing and Machine Vision
Course Objectives:	1. To learn the background of VR including a brief history of VR, different forms of VR and related technologies, and a broad overview of some of the most important concepts. 2. To provide background in perception to educate VR creators on concepts and theories of how we perceive and interact with the world around us. 3. To make learners aware of high-level concepts for designing/building assets and how subtle design choices can influence user behaviour. 4. Learning about art for VR and AR should be optimized for spatial displays with spatially aware input devices to interact with digital objects in true 3D.
Course Outcomes:	1. Apply the concepts of VR and AR in real life 2. Discuss 3D user interfaces 3. Explore VR, AR and today's resources 4. Elaborate 3D interaction techniques 5. Summarize strategies for designing and developing 3D user interfaces 6. Discuss AR and mixed reality

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Virtual Reality and Virtual Environments	1.1 The historical development of VR: Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality.	1	03	08
	1.2 Visual Physiology & Visual Perception- Photoreceptors, Sufficient resolution for VR, light intensity, Eye movements and its issues for VR		03	
	1.3 Neuroscience of vision, Depth perception, Motion perception, Frame rates and displays		02	
2. 3D User Interface Hardware	2.1 Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces	2	03	05
	2.2 Visual Displays Auditory Displays, Haptic Displays, Choosing Output		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Devices for 3D User Interfaces.			
3. Software Technologies	3.1 Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes	3	03	09
	3.2 VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts .		03	
	3.3 Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits		03	
4. 3D Interaction Techniques	4.1 3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Design Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding, User Centered Wayfinding Support, Environment Centered Wayfinding Support, Evaluating Wayfinding Aids, Design Guidelines - System Control, Classification, Graphical Menus, Voice Commands, Gestural Commands, Tools, Multimodal System Control Techniques, Design Guidelines	4	03	06
	4.2 Case Study: Mixing System Control Methods, Symbolic Input Tasks, symbolic Input Techniques, Design Guidelines, Beyond Text and Number entry		03	
5. Designing and Developing 3d User Interfaces	5.1 Strategies for Designing and Developing Guidelines and Evaluation	5	02	03
	5.2 Virtual Reality Applications- Engineering, Architecture, Education, Medicine, Entertainment, Science, Training		01	
6. Augmented and Mixed Reality	6.1 Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality	6	03	08
	6.2 Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	6.3 Mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. "Developing Virtual Reality Applications: Foundations of Effective Design", Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009. 2. "Designing Virtual Systems: The Structured Approach", Gerard Jounghyun Kim, 2005. 3. "3D User Interfaces, Theory and Practice", Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, Addison Wesley, USA, 2005. 4. "Understanding Augmented Reality, Concepts and Applications", Alan B. Craig, , Morgan Kaufmann, 2013.
Reference Books	1. "The VR Book, Human Centered Design for Virtual Reality", Jason Jerald, ACM Books, First Edition, 2016. Creating Augmented and Virtual Realities, Erin Pangilinan, Steve Lukas, Vasanth Mohan, O'Reilly, First Edition, 2019. Virtual reality with VRTK4, Rakesh Baruah, APress, First Edition, 2020. 2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, Morgan Kaufmann Publishers, San Francisco, 2002.

Useful Links:

1. NPTEL: Augmented Reality & Virtual Reality
   https://www.youtube.com/watch?v=zLMgdYI82IE
2. NPTEL: Virtual & Augmented Reality-
   https://www.youtube.com/watch?v=Nq3mPFgpREE

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – V	Credits (TH+P+TUT)
1UEXDLC8022	**5G Technology**	**3 + 0 + 0**
Prerequisite:	Mobile Communication	
Course Objectives:	1. To understand the basic architecture of Core network and Radio Access Network of 5G. 2. To study massive MIMO systems in 5G. 3. To know spectrum, Antenna and wave propagation. 4. To understand security in 5G technology.	
Course Outcomes:	1. Explain the fundamentals of 5G mobile technologies and their access schemes. 2. Describe Core network of 5G technology 3. Illustrate architecture and radio access network of 5G. 4. Discuss the concept of MIMO. 5. Elaborate on spectrum, antennas and wave propagation. 6. Describe security in 5G and applications of 5G.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to 5G Mobile Technology	1.1 Historical background 1.1.1 Industrial and technological revolution: from steam engines to the Internet Mobile communications generations: from 1G to 4G 1.1.2 From mobile broadband (MBB) to extreme MBB 6 IoT: relation to 5 1.1.3 Standardization activities	1	04	08
	1.2 The 5G radio-access technologies- OFDMA, NOMA, SCMA, IDMA		02	
	1.3 Requirements of 5G 1.3.1 eMMB 1.3.2 URLLC 1.3.3 mMTC		02	
2. Architecture of the Core Network	2.1 The Evolved Packet Core 2.1.1 Release 8 Architecture 2.1.2 Control and User Plane Separation	2	02	07
	2.2 The 5G Core Network 2.1.1 Representation Using Reference Points 2.1.2 Representation Using Service-based Interfaces 2.1.3 Data Transport		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.1.4 Roaming Architectures 2.1.5 Data Storage Architectures 2.1.6 Non-3GPP Access to the 5G Core			
	2.3 Network Areas, Slices and Identities 2.3.1 Signalling Protocol 2.3.2 Signalling Protocol Architecture		02	
3. Architecture of the Radio Access Network	3.1 The Evolved UMTS Terrestrial Radio Access Network 3.1.1 Release 8 Architecture 3.1.2 Carrier Aggregation 3.1.3 Dual Connectivity	3	02	06
	3.2 The Next-generation Node B 3.2.1 High Level Architecture 3.2.2 Internal Architecture 3.2.3 Deployment Options		02	
	3.3 Network Areas and Identities and Signalling Protocols 3.4.1 Tracking Areas 3.4.2 RAN Areas 3.4.3 Cell Identities 3.4.4 Signalling Protocol Architecture 3.4.5 Signalling Radio Bearers References		02	
4. Massive multiple-input multiple-output (MIMO) systems	4.1 Introduction 4.1.1 MIMO in LTE	4	01	06
	4.2 Theoretical background 4.2.1 Single user MIMO 4.2.2 Multi-user MIMO 4.2.3 Capacity of massive MIMO: a summary Fundamentals of baseband and RF implementations in massive MIMO		03	
	4.3.1 Basic forms of massive MIMO implementation 4.3.2 Hybrid fixed BF with CSI-based precoding (FBCP) 4.3.3 Hybrid beamforming for interference clustering and user grouping		02	
5. Spectrum, Antennas and Radio Propagation	5.1 Spectrum 5.1.1 Spectrum landscape and requirements 5.1.2 Spectrum Allocations for 5G 5.1.3 Bandwidth requirements 5.1.4 Spectrum access modes and sharing scenarios 5.1.5 spectrum technologies- Spectrum toolbox, Main technology component	5	02	06
	5.2 Antennas 5.2.2 Antennas and Propagation 5.2.3 Antenna Gain		01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	5.3 Radio Propagation Radio Propagation Issues for Millimetre Waves 5.3.1 Diffraction and Reflection 5.3.2 Penetration Losses 5.3.3 Foliage Losses 5.3.4 Atmospheric Losses 5.4 Multipath, Fading and Coherence 5.4.1 Introduction 5.4.2 Angular Spread and Coherence Distance 5.4.3 Doppler Spread and Coherence Time		03	
6. Security and Applications of 5G	6.1 **Security** 6.1.1 Introduction, issues, challenges in 5G Communication 6.1.2 Overview of a Potential 5G Communications System Architecture 6.1.3 Mobile Malware Attacks Targeting UE 6.1.4 Access Networks	6	02	06
	6.2 User Equipment and External IP Networks 6.2.1 Attacks on 4G Access Network 6.2.2 HeNB Femtocell Attacks 6.2.3 Mobile Operator's Core Network		02	
	6.3 5G Applications and Future Scope		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. An Introduction to 5G: The New Radio, 5G Network and Beyond, First Edition, Christopher Cox, Chris Cox Communications Ltd Cambridge, UK © 2021 John Wiley & Sons Ltd, 2021 2. 5G Mobile and Wireless Communications Technology, First Edition, AFIF OSSEIRAN JOSE F. MONSERRAT PATRICK MARSCH, CAMBRIDGE UNIVERSITY PRESS 2016 3. Fundamentals of 5G Mobile Network, Jonathan Rodriguez Senior Research Fellow Instituto de Telecommunications, Aveiro, Portugal, © 2015 John Wiley & Sons, Ltd., 2015
Reference Books	1. Evolution of Air Interface Towards 5G Radio Access Technology and Performance Analysis, Suvra Sekhar Das and Ramjee Prasad, c 2018 River Publishers, 2018

Useful Links:

1. https://www.ericsson.com/en/5g/what-is-5g
2. https://5g-ppp.eu/
3. https://techblog.comsoc.org/2020/07/10/5g-specifications-3gpp-5g-radio-standard-imt-2020-and-standard-essential-patents/

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – V	Credits (TH+P+TUT)
1UEXDLC8023	**System On-Chip**	**3 + 0 + 0**

Prerequisite:	1. Digital VLSI Design 2. Project Based Learning
Course Objectives:	1. To introduce modern system design using SoC 2. To understand the concept of hardware-software co-design 3. To learn integration of hardware and software design integration
Course Outcomes:	1. Explain basics of SoC 2. Design and verify the SoC systems 3. Explain the physical design flow 4. Analyze routing issues in SoC 5. Interpret complex SoC systems 6. Explain non-technical issues related to the SoC

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to SoC Design	1.1 The fundamental trends of SoC design, SoC design flow, The Semiconductor Economics, Challenges in SoC design	6	03	06
	1.2 Hardware system structure, Software structure, Accelerating Processors for traditional software task, System Design with multiple processor design	1	05	
2. System Level Design	2.1 Complex SoC system architecture, Processor centric SoC organization, Communication Design – Hardware and Software interconnects	2	03	06
	2.2 Balancing computation and Communication, SoC Design flow, Non-processor building block in SoC design	5	03	
3. RTL Synthesis	Review of Verilog - RTL Coding and RTL Synthesis RTL coding guidelines, Synthesizable coding	2	08	08
4. SoC Verification	Verification technology options, Verification methodology. System level verification, block-level verification. Timing verification.	1	08	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
5. Physical Design	Partitioning, Floor Planning, Placement, Routing, Goals of routing - Global routing –Maze routing, Detailed routing, Over the Cell Routing, Physical verification and design sign-off.	3	07	07
6. Routing	Clock routing, Power and Ground routing, Clock tree synthesis	4	04	04
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Engineering the Complex SOC: Fast, Flexible Design with Configurable Processors, Chris Rowen Pearson 2004 2. System on a chip verification: Methodology and Verification, Second edition, Prakash Rashinkar, Peter Paterson, Leena Singh, Kluwer Academic Publishers, 2013 3. Digital Design with RTL design, VHDL and VERILOG, Second edition, Frank Vahid, John Wiley and Sons Publisher 2010
Reference Books	1. System-on-a-Chip: Design and Test, First Edition, Rochit Rajsuman, Artech House 2. VLSI Physical design Automation: Theory and Practice, Sadiq Sait, Habib Youssef 3. World Scientific Publishing 4. Surviving the SoC revolution, Second Edition, Henry Chang, Larry Cooke, Grant Martin, Kluwer Academic Publishers

Useful Links:

1. https://nptel.ac.in/courses/117/101/117101058/
2. https://nptel.ac.in/courses/108/107/108107129/
3. http://cmosedu.com/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – V	Credits (TH+P+TUT)
1UEXDLC8024	Web Designing	3 + 0 + 0

Prerequisite:	1. Data Structures 2. Basics of Programming Languages
Course Objectives:	1. To design and create web pages using HTML5 and CSS3 2. To Create web pages and provide client side validation 3. To create dynamic web pages using server side scripting 4. To use MVC framework for web application development
Course Outcomes:	1. Describe the core concepts and features of Web Technology 2. Design static web pages using HTML5 and CSS3 3. Apply the concept of client side validation and design dynamic web pages using JavaScript and JQuery. 4. Evaluate client and server side technologies and create Interactive web pages using PHP , AJAX with database connectivity using MySQL 5. Apply the basics of XML, DTD and XSL and develop web pages using XML / XSLT 6. Analyse end user requirements and Create web application using appropriate web technologies and web development framework

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to WWW	1.1 Internet Standards – Introduction to WWW – WWW Architecture – SMTP – POP3 – File Transfer Protocol	1	02	04
	1.2 Overview of HTTP, HTTP request – response –– Generation of dynamic web pages- W3C Validator, How web works - Setting up the environment (LAMP/XAMP/WAMP server)		02	
2. Client Side Programming	2.1 Markup Language (HTML): Introduction to HTML and HTML5 - Formatting and Fonts –Commenting Code – Anchors – Backgrounds – Images – Hyperlinks	2	02	08
	2.2 Lists – Tables – Frames - HTML Forms and controls		02	
	2.3 Cascading Style Sheet (CSS): The need for CSS, Introduction to CSS 3 – Basic syntax and structure ,CSS Properties-Inline Styles – Embedding Style Sheets		02	
	2.4 Linking External Style Sheets – Backgrounds –Box Model(Introduction , Border Properties, Padding Properties,		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Margin Properties), Manipulating text - Margins and Padding - Positioning using CSS., Creating page Layout and Site Designs			
3. Introduction to Java Script	3.1 Introduction - Core features - Data types and Variables - Operators, 6 Expressions, and Statements, Functions - Objects - Array, Date and Math related Objects	3	**02**	08
	3.2 Document Object Model - Event Handling Controlling Windows & Frames and Documents Form handling and validations		**02**	
	3.3 Advanced JavaScript - Browser Management and Media Management – Classes – Constructors – Object-Oriented Techniques in JavaScript		**02**	
	3.4 Object constructor and Prototyping - Sub classes and Super classes – JSON - jQuery and AJAX., Rich Internet Application with AJAX, JQuery Framework		**02**	
4. Server Side Programming	4.1 Mixers: Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers	4	02	09
	4.2 Operators, Control structures and looping structures – Functions – Reading Data in Web Pages		02	
	4.3 Embedding PHP within HTML - Establishing connectivity with MySQL database, cookies, sessions and Authentication		03	
	4.4 AJAX with PHP - AJAX with Databases		02	
5. XML	5.1 Dynamic page generation (adding interactivity, styles, using HTML, DHTML, XHTML, CSS, Java Script), XML –DTD(Document Type Definition) - XML Schema	5	03	06
	5.2 XML –DTD(Document Type Definition) - XML Schema - Document Object Model - Presenting XML - Using XML Parsers: DOM and SAX,XSL-eXtensible Style sheet Language		03	
6. Web Development Framework	6.1 Introduction to Composer - MVC Architecture	6	02	04
	6.2 Web Application Development using web development framework :-Introduction to Laravel, Development of Web pages using Laravel., Example web applications – Interactive websites, web based information systems , blogs, social networking sites etc.		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Ralph Moseley , M.T. Savliya ,‖ Developing Web Applications‖, Willy India, Second Edition, ISBN: 978-81-265-3867-6 2. Web Technology Black Book‖, Dremtech Press, First Ediction, 978-7722-997 3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, 4. O'REILLY,2014. 5. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascri 6. pt_CSS_HTML5__Robin_Nixon_3e.pdf) 7. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward 8. Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
Reference Books	1. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, ―Internet and World Wide Web - How To Program‖, Fifth Edition, Pearson Education, 2011. 2. Achyut S Godbole and AtulKahate, ―Web Technologies‖, Second Edition, Tata McGraw Hill, 2012. 3. Thomas A Powell, Fritz Schneider, ―JavaScript: The Complete Reference‖, Third Edition, Tata McGraw Hill, 2013. 4. David Flanagan, ―JavaScript: The Definitive Guide, Sixth Edition‖, O'Reilly Media, 2011 5. Steven Holzner, ―The Complete Reference - PHP‖, Tata McGraw Hill, 2008 6. 6. Mike Mcgrath, ―PHP & MySQL in easy Steps‖, Tata McGraw Hill, 2012

Useful Links:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – VI	Credits (TH+P+TUT)
1UEXDLC8031	**Natural Language Processing**	**3+0+0**
Prerequisite:	1. Data structures & Algorithms 2. Project Probability Theory	
Course Objectives:	1. To understand natural language processing and apply basic algorithms in this field. 2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics. 3. To design and implement various language Models and applications of NLP techniques in real life applications	
Course Outcomes:	1. Explain about the basics of natural language processing. 2. Explore capabilities and limitations of current natural language technologies 3. Build model linguistic phenomena with formal grammars. 4. Apply algorithms for NLP based pragmatics problems 5. Analyze mathematical and linguistic foundations underlying approaches to the various areas in NLP 6. Apply NLP techniques to design real world NLP applications.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topics	Total Hrs.
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Natural Language Processing	1.1 Introduction to data and its significance in NLP. History of NLP, Generic NLP system, levels of NLP	1	01	03
	1.2 Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP		02	
2. Word Level Analysis	2.1 Morphology analysis —survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, finite automata	2	04	08
	2.2 Finite state transducers (FST), Morphological parsing with FST, Lexicon free FST Porter stemmer. N —Grams- N-gram language model, N-gram for spelling correction		04	
3. Syntax analysis	3.1 Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues—Multiple tags & words,	3	05	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topics	Total Hrs.
	Unknown words. Introduction to CFG, Types of Passing.			
	3.2 Sequence labelling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).		03	
4. Symantec Analysis	4.1 Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their sense	4	05	08
	4.2 Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD), Dictionary based approach		02	
5. Pragmatics	Discourse—reference resolution, reference phenomenon , syntactic & semantic constraints on co reference	5	06	06
6. Applications of NLP	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition	6	06	06
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008. 2. Christopher D. Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing ", MIT Press, 1999
Reference Books	1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008). 2. Daniel M Bikel and Inned Zitouni " Multilingual natural language processing applications" Pearson, 2013 3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin Editor)"The Handbook of Computational Linguistics and Natural Language Processing " ISBN: 978-1-118 4. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reill 5. Brian Neil Levine, An Introduction to R Programming 6. Nie1 J le Roux, Sugnet Lubbe, A step by step Tutorial : An introduction into R application and programming

Useful Links:

1. http://wordnetweb.princeton.edu/perl/webwn
2. https://onlinecourses.nptel.ac.in/noc21_cs102/preview
3. Kaggle Databases

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – VI	Credits (TH+P+TUT)
1UEXDLC8032	**RF Design**	**3 + 0 + 0**
Prerequisite:	1. Electromagnetic and Antenna 2. Principles of Communication Engineering 3. Microwave Engineering	
Course Objectives:	1. To learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver. 2. To learn the importance of EMI/EMC.	
Course Outcomes:	1. Analyze the impedance matching networks and passive RF filters. 2. Analyze RF amplifiers. 3. Analyze RF oscillators. 4. Differentiate the RF mixers. 5. Analyze EMI and EMC in RF circuits. 6. Analyze stability of RF trans-receiver.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. RF Filter Design	1.1 Introduction to Periodic Structure	1	01	08
	1.2 Filter design using Image parameter method (Theory and Numerical)		02	
	1.3 Filter design using Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation. (Theory and Numerical)		05	
2. Microwave Amplifier Design	2.1 Two-port power gain derivation, signal flow graph (SFG) and stability criterion. (Theory and Numerical)	2, 6	03	10
	2.2 Single stage amplifier design: Design for maximum gain, design for specified gain, low noise amplifier design (Theory and Numerical)		05	
	2.3 Power amplifier design: Characteristics of power amplifiers and classes of amplifiers, design of class A power amplifier. (Theory and Numerical)		02	
3. Microwave Oscillator	3.1 One-port microwave oscillator design. (Theory and Numerical)	3, 6	02	06
	3.2 Two-port microwave oscillator design. (Theory and Numerical)		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	3.3 Analysis of phase noise in oscillators.		01	
4. Microwave Mixer	4.1 Mixers: Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers	4	05	05
5. Electromagnetic Interference in RF circuits	5.1 Introduction. Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits. Quantification of Communication System EMI.	5	01	04
	5.2 Elements of Interference, Including Antennas, Transmitters, Receivers and Propagation. Electronic Equipment And System EMI Concepts. Examples Of EMI Coupling Modes.		01	
	5.3 Mode of coupling: Common-Mode coupling, Differential mode coupling, and other coupling mechanisms (Power supply and victim amplifiers)		02	
6. Electromagnetic Compatibility	6.1 For Achieving EMC: Grounding, Bonding, Shielding Effectiveness, EMI Diagnostics And Fixes: Techniques Used In EMI Diagnostics Fixes, troubleshooting	5	02	06
	6.2 Instruments, Tools, used to measure Electromagnetic Field (Radiated and Conducted Emission):- voltage and current probe, LISN, CDN, Clamp, Field probes, Spectrum analyzer, Oscilloscope, EMI Receiver.		02	
	6.3 Electromagnetic Noise specification: - Surge, EFT (Electrical Fast transients), PFMF, Radiated and conducted susceptibility, Voltage and dips interruption, Ring wave, Damped oscillatory wave.		01	
	6.4 EMC Specifications, Standards And Measurements. A Discussion of the Genesis of EMC documentation including a historical Summary, The Rationale, and A Review of MIL-Std., FCC And CISPR Requirements.		01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				**42**

Books:	
Text Books	1. David Pozar, "Microwave Engineering", Wiley Publication (Fourth Edition). 2. Ludwig R. and Bogdanov G., "RF Circuit Design", Prentice Hall. 3. Jack Smith, "Modern Communication circuits", Tata McGraw Hill. 4. W. Prasad Kodali, "Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models", Wiley-IEEE Press (Second Edition). 5. David. A. Weston, "Electromagnetic Compatibility principles and applications", Marcel Dekker (Second Edition). 6. MARK I. MONTROSE EDWARD M. NAKAUCHI, "Testing for EMC compliance: Approaches and Techniques".
Reference Books	1. Guillermo Gonzalez, "Microwave Transistor Amplifiers Analysis and Design" Prentice Hall. (Second Edition) 2. M. L. Sisodia, G. S. Raghuvanshi, " Microwave Circuits and Passive Devices", New Edge International Publisher (First Edition) 3. Clayton R. Paul, "Electromagnetic Compatibility", John Wiley & Sons. (Second Edition)

Useful Links:

1. www.nptelvideos.in
2. https://nptel.ac.in/courses/108/106/108106138/
3. https://freevideolectures.com/course/4367/nptel-microwave-theory-techniques

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – VI	Credits (TH+P+TUT)
1UEXDLC8033	Autonomous Vehicle	3 + 0 + 0
Prerequisite:	1. Basic Programming 2. Robotics 3. Control system	
Course Objectives:	1. To give Introduction to implementation of different levels of Autonomous vehicle (AV) 2. To give exposure to the technologies involved in AV. 3. To give Exposure to in the perception and path-planning techniques useful for AV	
Course Outcomes:	1. Differentiate levels of Autonomous vehicle (AV) 2. Differentiate role of Sensors in AV 3. Describe hardware for AV 4. Write API for AV 5. Explain Use cases of AV 6. Compare different technologies for AV	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Fundamentals of Autonomous Vehicle	1.1 Evolution in mobility, 6 Different levels of Autonomous Vehicle: Level 0 to Level 5, Block Diagram of Autonomous vehicle	1, 5	02	04
	1.2 Brief introduction on Technologies of AV, Modular Architecture of AV	5	02	
2. Passive Perception	2.1 Passive Perception, Radar specification, FMCW radar, Finding range, Finding velocity of object using radar signal, Based on platform classification, Classification platform, range and requirement	2, 6	04	08
	2.2 mmWave radar deployment: Software (API) and hardware interface, Sonar Deployment	3, 4, 6	04	
3. Vehicle Communication System	3.1 Can Bus, ,CAN protocol layers, CAN message Format, CANopen, CANopenNode implementation flow chart	4, 5	03	06
	3.2 FlexRay, FlexRay topology, FlexRay communication Protocols		03	
4. Computer Vision	4.1 Hardware layers of vision system, Hardware Synchronization, Calibration, open source for calibration	2, 3, 4	03	07

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	4.2 SLAM technique, Object Classification, detection using Neural networks	6	04	
5. Trajectory Planning and Control	5.1 TP&C architecture for AV, Path planning strategies, MDP	6	04	08
	5.2 Behavioural and motion Planning, Feedback control, PID controller and Auto tuning		04	
6. Case study	6.1 CASE study of L4 Autonomous Vehicle	2, 3,5	03	06
	6.2 Business Use cases: Tesla, Swayatta Robotics, Cruise		**03**	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Markus Maurer, J. hristian Gerde, Barbara Lenz, Hermann Winner, Autonomous Driving, Autonomous Driving, Springer publication, 2016 2. Xin Bi, Environmental Perception Technology for Unmanned Systems, Springer, 2021
Reference Books	1. Shaoshan Liu, Engineering Autonomous Vehicle and Robots, IEEE press, Wiley, 1st Edition 2020 2. Brooks Roodney, Cambrian Intelligence; The early history of New AI. MIT Press Bostorn, MA

Useful Links:

Virginia tech (2017). Automated vehicle crash rate comparison using naturalistic data. https://www.vtti,vt.edu/featured/?p=422
Github. Mask R-CNN. https://github.com/matterport/Mask_RCNN
Github Baidu Apollo. http://github.com/ApplloAuto/Apollo
https://www.swaayatt-robots.com

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Department Level Elective Course – VI	Credits (TH+P+TUT)
1UEXDLC8034	Fundamentals of Data Science	3+0+0
Prerequisite:	1. Basic Programming Knowledge 2. Knowledge of Machine Learning and Deep Learning	
Course Objectives:	1. To Identify the need for data science 2. To understand data collection methods 3. To apply Pre and post processing methods 4. To understand and implement the concept of exploratory data science and Data Mining.	
Course Outcomes:	1. Relate the concepts of python and mathematical concepts for data 2. science 3. Solve and interpret the concept of exploratory data science and processing of data. 4. Explain the concept of optimization methods 5. Interpret the concept of Data Mining 6. Explain and judge the models for Data Analysis 7. Illustrate the concept of Time Series Models for data science	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	**-**	**02**	**02**
1. Introduction To Data Science And Python Programming	1.1 Introduction to Data Science - Why Python? - Essential Python libraries - Python Introduction- Features, Identifiers, Reserved words, Indentation, Comments	1	01	07
	1.2 Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set - Type Conversion- Operators. Libraries for Data analysis using Machine Learning and Deep Learning.		02	
	1.3 Decision Making- Looping- Loop Control statement- Math and Random number functions.		02	
	1.4 User defined functions - function arguments & its types. Reading and Writing Data in Text Format.		02	
2. Data Manipulation With Pandas	2.1 Introduction to pandas Data Structures: Series, Data Frame	2	01	06
	2.2 Essential Functionality: Dropping Entries-Indexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking.		03	
	2.3 Summarizing and Computing Descriptive Statistics-Unique Values,		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Value Counts, and Membership.			
3. Data Cleaning, Preparation And Visualization	3.1 Data Cleaning and Preparation: Handling Missing Data, Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers	3	02	06
	3.2 String Manipulation: Vectorized String Functions in pandas.		02	
	3.3 Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.		02	
4. Data Mining and Machine Learning	4.1 What is Data Mining, Evolution of Data Mining, Why Data Mining? Knowledge-Based System, Data Mining Process, Phases of Data Mining Process,	4	02	08
	4.2 KDD Process Model, CRISP - DM, CRISP-DM – Elaborate view		01	
	4.3 Data Mining – On what kinds of Data? DM Tasks and Components of DM methods, Data mining operations, Data mining techniques.		02	
	4.4 Industry examples of application of DM, Challenges of Data Mining, and Why Machine should “Learn”? What is Machine Learning? Growth of Machine Learning, Machine Learning types, Unsupervised learning, Reinforcement Learning.		03	
5. Model Development and Evaluation	5.1 Simple and Multiple Regression, Model Evaluation using Visualization, Residual Plot, Distribution Plot, Polynomial Regression and Pipelines	5	02	06
	5.2 Measures for In-sample Evaluation, Prediction and Decision Making. Generalization Error, Out-of-Sample Evaluation Metrics, Cross Validation, Over fitting, Under Fitting		02	
	5.3 Model Selection, Prediction by using Ridge Regression, Testing Multiple Parameters by using Grid Search.		02	
6. Time Series Models	6.1 Autoregressive with exogenous(ARX), Autoregressive moving average(ARMAX)	6	03	06
	6.2 Autoregressive integrated moving average(ARIM), Extended version of ARIMA models		03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	**-**	01	**01**

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
			Total	**42**

Books:	
Text Books	1. David Dietrich, Barry Heller, and Beibei Yang, "Data Science and Big data Analytics", EMC Education Service, 2015 2. A. Agresti, C. Franklin, B. Klingenberg, "Statistics: The Art and Science of Learning from Data", Pearson. 2017. 3. Y. Daniel Liang, "Introduction to Programming using Python.", Pearson, 2012
Reference Books	1. P. Bruce and A. Bruce, "Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python", 2nd Edition, O'Reilly Media, Inc. 2. W. Hines, D. Montgomery, D. Goldman, C. Borror, "Probability and Statistics in Engineering,", 4th Edition, Wiley India Pvt. Ltd., 2003

Useful Links:

1. https://nptel.ac.in/courses/111/104/111104147/
2. https://nptel.ac.in/courses/111/104/111104146/
3. https://nptel.ac.in/courses/108/104/108104174/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Optional Course -II	Credits (TH+P+TUT)
1UILC8041	**Project Management**	**3 + 0 + 0**
Course Objectives:	1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. 2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.	
Course Outcomes:	1. Apply selection criteria and select an appropriate project from different options. 2. Write work breakdown structure for a project and develop a schedule based on it. 3. Identify opportunities and threats to the project and decide an approach to deal with them strategically. 4. Use Earned value technique and determine & predict status of the project. 5. Capture lessons learned during project phases and document them for future reference 6. Inculcate leadership qualities and ethics	

Module No. Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Project Management Foundation	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	1	05	05
2. Initiating Projects	How to get a project started, Selecting projects strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	2	06	06
3. Project Planning and Scheduling	Work Breakdown structure (WBS) and linear responsibility chart, Interface Coordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project	3	08	08

Module No. Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Management Information System (PMIS)			
4. Planning Projects	Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	4	06	06
5. Projects	5.1 Executing Projects: Planning, monitoring and controlling the cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.	5	03	08
	5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.		03	
	5.3 Project Contracting Project procurement management, contracting and outsourcing,		02	
6. Project Leadership and Ethics	**6.1** Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects.	6	03	06
	6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.		03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Edition 2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
Reference Books	1. Gido Clements, Project Management, Cengage Learning. 2. Gopalan, Project Management, , Wiley India 3. Dennis Lock, Project Management, Gower Publishing England, 9th Edition

Useful Links:

1. https://nptel.ac.in/courses/110/104/110104073/
2. https://nptel.ac.in/courses/110/107/110107081/
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-mg30/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course -II	Credits (TH+P+TUT)
1UILC8042	Finance Management	3 + 0 + 0

Course Objectives:	1. To Overview of Indian financial system, instruments and market 2. To Understand Basic concepts of value of money, returns and risks, corporate finance working capital and its management 3. To gain Knowledge about sources of finance, capital structure, dividend policy
Course Outcomes	1. Describe Indian financial system 2. Discuss basic concepts of returns and risks. 3. Use basic concepts of Time value of money. 4. Discuss sources of finance, capital structure, dividend policy 5 Discuss basic concepts of corporate finance 6 Use basic concepts of working capital management

Module No. Name	Sub- Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Overview of Indian Financial System	1.1 Characteristics, Components and Functions of Financial System.	1	01	06
	1.2 Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.		02	
	1.3 Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market		02	
	1.4 Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges		01	
2. Concepts of Returns and Risks & Time Value of Money	2.1 Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	2	03	06
	2.2 Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and		03	

Module No. Name	Sub- Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Annuity Due; Continuous Compounding and Continuous Discounting.			
3. Overview of Corporate Finance and Financial Ratio Analysis	3.1 Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	3	03	09
	3.2 Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.		06	
4. Capital Budgeting and Working Capital Management	4.1 Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value (NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	4	05	10
	4.2 Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.		05	
5. Sources of Finance & Capital Structure	5.1 Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short-Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	5	02	05
	5.2 Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure		03	
6. Dividend Policy	Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and	6	03	03

Module No. Name	Sub- Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Modigliani-Miller Approach			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				**42**

Books:	
Text Books	1. Fundamentals of Fin Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi. 2. Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
References:	1. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi. 2. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.
Useful Links:	
1. https://nptel.ac.in/courses/110/107/110107144/ 2. https://nptel.ac.in/courses/110/105/110105031/	

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course -II	Credits (TH+P+TUT)
1UILC8043	**Entrepreneurship Development and Management**	**3 + 0 + 0**
Prerequisites:	Fundamentals of Technology	
Course Objectives:	1. To Acquaint with Entrepreneurship and Management of Business. 2. To understand Indian environment for entrepreneurship. 3. To Ideate EDP, MSME. 4. To discuss the Government Plan for Start-up Business. 5. To analyze the Business Risk. 6. To discuss the Business Life Cycle.	
Course Outcomes:	1. Explain the concept of Business Plan and the Role of Money and Capital Markets in Entrepreneurial Development. 2. Analyze Key regulations and legal aspects of entrepreneurship in India. 3. Explain Government Policies for Start-up. 4. Describe Different Government initiatives for Start-up. 5. Explain Issues and Problems Faced by Micro and Small Enterprises. 6. Describe Growth Strategies for small businesses.	

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topics	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	**02**
1. Overview Of Entrepreneurship	1.1 Definitions, Roles and Functions/ Values of Entrepreneurship, History of Entrepreneurship Development.	1	01	04
	1.2 Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur.	1	01	
	1.3 Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.	1	02	
2. Business Plans and Importance of Capital to Entrepreneurship	2.1 Introduction: Preliminary and Marketing Plans, Management and Personnel.	2	02	09
	2.2 Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur.	2	03	

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topics	Total Hours
	2.3 Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business.	2	02	
	2.4 New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.	2	02	
3. Entrepreneurship Development	Women's Entrepreneurship Development, Social Entrepreneurship-Role and Need, EDP Cell, Role of Sustainability and Sustainable Development for SMEs, Case Studies, Exercises.	3	04	04
4. Indian Environment for Entrepreneurship	4.1 Key Regulations and Legal Aspects, MSMED Act 2006 and its Implications, Schemes and Policies of the Ministry of MSME, Role and Responsibilities of various Government Organisations, Departments, Banks etc.	4	03	09
	4.2 Role of State Governments in Terms of Infrastructure Developments and Support etc.	4	04	
	4.3 Public Private Partnerships, National Skill Development Mission, Credit Guarantee Fund, PMEGP, Discussions, Group Exercises etc.	4	02	
5. Effective Management of Business	5.1 Issues and Problems Faced by Micro and Small Enterprises and Effective Management of M and S Enterprises.	5	04	08
	5.2 Risk Management, Credit Availability, Technology Innovation, Supply Chain Management, Linkage with Large Industries, Exercises, E-Marketing.	5	04	
6. Achieving Success in The Small Business	Stages of the Small Business Life Cycle, Four Types of Firm-Level Growth Strategies, Options – Harvesting or Closing Small Business Critical Success Factors of Small Business.	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books:	1. P Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson 2. R Hisrich and M Peters, Entrepreneurship, McGraw Hill Company. 3. D Kuratko, Entrepreneurship- Principles and Practices, Thomson Publication
Reference Books:	1. Dr T Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi. 2. Law and Practice Relating to Micro, Small and Medium Enterprises, Taxmann Publication Ltd. 3. L Maddhurima, S Shikah, Entrepreneurship, Excel Books. 4. R Bansal ,STAY Hungry STAY Foolish, CIIE, IIM Ahmedabad

Useful Links:

1. www.msme.gov.in/
2. www.dcmesme.gov.in/
3. www.msmetraining.gov.in/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Optional Course -II	Credits (TH+P+TUT)
1UILC8044	Human Resource Management	3 + 0 + 0
Prerequisites:	--	
Course Objectives:	1. To introduce the students with basic concepts, techniques and practices of t human resource management. 2. To provide an opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today’s organizations. 3. To familiarize the students about the latest developments, trends & different aspects of HRM. 4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers.	
Course Outcomes:	1. Describe the concepts, aspects, techniques and practices of human resource management. 2. Describe the Human resource management (HRM) processes, functions, changes and challenges in today’s emerging organizational perspective. 3. Apply the knowledge about the latest developments and trends in HRM. 4. Analyze the knowledge of Cross-cultural Leadership and Decision Making. 5. Apply the knowledge of behavioural skills learnt and integrate it with in interpersonal and intergroup environment emerging as future stable engineers and managers. 6. Apply the Labour Laws & Industrial Relations and various Act.	

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction Human Resource Management	1.1 Introduction to HR Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.	1	03	05
	1.2 Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	1	02	
2. Organizational Behaviour (OB)	2.1 Introduction to OB Origin, Nature and Scope of Organizational Behaviour,	2	02	07

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
	Relevance to Organizational Effectiveness and Contemporary issues.			
	2.2 Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness.	2	01	
	2.3 Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior.	2	01	
	2.4 Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);	2	01	
	2.5 Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team, Case study.	2	02	
3. Organizational Structure & Design	3.1 Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	3	02	06
	3.2 Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	3	02	
	3.3 Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	3	02	
4. Human resource Planning	4.1 Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.	4	01	05
	4.2 Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning.	4 & 6	02	
	4.3 Training & Development: Identification of Training Needs, Training Methods.	4	02	
5. Emerging Trends in HR	5.1 Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment.	4	03	06

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
	5.2 Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	5	03	
6. Strategic HRM	6.1 HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries.	6	04	10
	6.2 Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	**6**	**03**	
	6.3 Labour Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labour Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act.	6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	**01**	**01**
			Total:	**42**

Books:	
Text Books	1. S. Robbins, Organizational Behaviour, Pearson Education Limited. 2. V.S.P. Rao, Human Resource Management, Excel publishing. 3. K. Aswathapa, Human resource management: Text & cases.
Reference Books	1. C. B. Mamoria and S. V. Gankar, Dynamics of Industrial Relations in India, Himalaya Publishing. 2. P. Subba Rao, Essentials of Human Resource management and Industrial relations, Himalaya Publishing. 3. L. Mullins, Management & Organizational Behaviour, Pearson Publications.
Useful Links:	
1. https://www.nptel.ac.in/ 2. https://www.coursera.org/ 3. https://nptel.ac.in/courses/110/105/110105069/ 4. https://nptel.ac.in/courses/122/105/122105020/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course -II	Credits (TH+P+TUT)
1UILC8045	Professional Ethics and Corporate Social Responsibility (CSR)	3 + 0 + 0
Course Objectives:	1. To understand professional ethics in business 2. To recognized corporate social responsibility	
Course Outcomes:	1. Explain rights and duties of business 2. Explain and understand the ethics in market and towards environment 3. Solve the problems of consumers and job discrimination ethically 4. Show corporate and social responsibility 5. Distinguish different aspects of corporate social responsibility 6. Explain global aspects of corporate social responsibility	

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Professional Ethics and Business	The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	1	04	04
2. Professional Ethics in the Marketplace	Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	3	08	08
3. Professional Ethics of Consumer Protection	Markets and Consumer Protection; Contract View of Business Firm‘s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	3	06	06
4. Introduction to Corporate Social Responsibility:	Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	2	05	05
5. Corporate Social Responsibility	Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	2	08	08
6. Corporate Social	Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of	4	08	08

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hours
Responsibility in Globalizing India	Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
Reference Books	1. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge. 2. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi. 3. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Useful Links:

1. https://nptel.ac.in/courses/110/105/110105081/
2. https://nptel.ac.in/courses/110/105/110105079/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course -II	Credits (TH+P+TUT)
1UILC8046	Research Methodology	3 + 0 + 0

Prerequisites:	Basic level knowledge of research
Course Objectives:	1. To understand Research and Research Process 2. To acquaint students with identifying problems for research and develop research strategies 3. To familiarize students with the techniques of data collection, analysis of data and interpretation.
Course Outcomes:	1. Describe about the methodologies in research 2. Prepare a preliminary research design for projects in their subject matter areas. 3. Accurately collect, analyze and report data. 4. Present complex data or situations clearly. 5. Review and analyze research findings. 6. Summarize the different aspects and steps in conducting research.

Module	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction and Basic Research Concepts	1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology	1	2	09
	1.2 Need of Research in Business and Social Sciences		2	
	1.3 Objectives of Research		1	
	1.4 Issues and Problems in Research		2	
	1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical		2	
2. Types of Research	2.1 Basic Research	2	1	07
	2.2 Applied Research		1	
	2.3 Descriptive Research		1	
	2.4 Analytical Research		1	
	2.5 Empirical Research		1	
	2.6 Qualitative and Quantitative Approaches		2	
3. Research Design and Sample Design	3.1 Research Design – Meaning, Types and Significance	1	4	07
	3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors		3	
4. Research Methodology	4.1 Meaning of Research Methodology	2	1	08
	4.2 Stages in Scientific Research Process: a. Identification and Selection of Research		7	

Module	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
	Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report			
5. Formulating Research Problem	5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	4	4	04
6. Outcome of Research	6.1 Preparation of the report on conclusion reached	3	2	04
	6.2 Validity Testing & Ethical Issues		1	
	6.3 Suggestions and Recommendation		1	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. C. Kothari, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited, 1985.
Reference Books	1. C. Dawson, Practical Research Methods, New Delhi, UBS Publishers Distributors, 2002. 2. R. Kumar, Research Methodology-A Step-by-Step Guide for Beginners, 2nd edition, Singapore, Pearson Education, 2005.

Useful Links:

https://libguides.newcastle.edu.au/researchmethods
https://nptel.ac.in/courses/121/106/121106007/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course -II	Credits (TH+P+TUT)
1UILC8047	IPR and Patenting	3 + 0 + 0
Course Objectives:	1. To understand intellectual property rights protection system 2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures 3. To get acquaintance with Patent search and patent filing procedure and applications	
Course Outcomes:	1. Explain Intellectual Property assets 2. Explain the enforcements in IPR 3. Investigate the issues in IPR. 4. Illustrate basics of patent. 5. Explain the patent rules 6. Apply the procedure of filing patent nationally and internationally	

Module No. & Name	Sub Topics	CO Mapped	Hour/ Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Intellectual Property Rights (IPR)	Meaning of IPR, Different categories of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	1	05	05
2. Enforcement of Intellectual Property Rights	Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	2	07	07
3. Emerging Issues in IPR	Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	2	05	05
4. Basics of Patents	Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures	3	07	07

Module No. & Name	Sub Topics	CO Mapped	Hour/ Sub Topic	Total Hours
	and non-disclosures, Patent rights and infringement, Method of getting a patent			
5. Patent Rules	Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	3	08	08
6. Procedure for Filing a Patent (National and International)	Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	3	07	07
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India 2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws 3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International 4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press 5. Cornish, William Rodolph & Llewelyn, David 2010, Intellectual Property: Patents, Copyrights, TradeMarks and Allied Right, 7th Edition, Sweet & Maxwell
Reference Books:	1. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO 2. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH 3. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books 4. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications 5. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications 6. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights, 7. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company 8. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency 9. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET 10. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley- IEEE Press
Useful Links:	
1. https://nptel.ac.in/courses/110/105/110105139/	

2. https://nptel.ac.in/courses/109/105/109105112/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Elective Course -II	Credits (TH+P+TUT)
1UILC8048	Digital Business Management	3 + 0+ 0

Prerequisite:	Business Intelligence
Course Objectives:	1. To familiarize with digital business concept 2. To acquaint with E-commerce 3. To give insights in to E-business and its strategies
Course Outcomes:	1. Identify drivers of digital business 2. Reviewing the concepts of E-commerce 3. Devise the services of Digital Business 4. Illustrate various techniques of managing E-business 5. Illustrate various approaches of E-business Strategy 6. Prepare E-business Plan

Module No. & Name	Sub Topics	CO Mapped	Hrs./ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Digital Business	Introduction to Digital Business Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy. Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services) Opportunities and Challenges in Digital Business.	1	09	09
2. Overview of E-Commerce	Meaning, Retailing in e-commerce-products and services, consumer behaviour, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful	2	06	06

Module No. & Name	Sub Topics	CO Mapped	Hrs./ Sub Topic	Total Hrs/ Module
	online business and EC project, Legal, Ethics and Societal impacts of EC.			
3. Digital Business Support services	ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure.	3	06	06
4. Managing E-Business	Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications.	4	06	06
5. E-Business Strategy	E-business Strategic formulation- Analysis of Company‘s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation).	5	04	04
6. Materializing e-business	From Idea to Realization-Business plan preparation Case Studies and presentations	6	08	08
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. A textbook on E-commerce, Er. Arunrajan Mishra, Dr. W K Sarwade, Neha Publishers & Distributors, 2011 2. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014 3. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson 4. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5 5. Measuring Digital Economy-A new perspective DoI:10.1787/9789264221796-enOECD Publishing
Reference Books	1. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002 2. Introduction to E-business-Management and Strategy, Colin Combe, ELSEVIER, 2006 3. Trend and Challenges in Digital Business Innovation, Vincenzo Morabito, Springer. 4. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan. 5. 5. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
Useful Links:	
1. https://nptel.ac.in/courses/110/105/110105083/ 2. https://onlinecourses.nptel.ac.in/noc19_mg54/preview	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Institute Level Optional Course -II	Credits (TH+P+TUT)
1UILC8049	Environmental Management	3 + 0 + 0
Prerequisites:	General Awareness of environment and factors affecting the environment.	
Course Objectives:	1. To understand and identify environmental issues relevant to India and global concerns **2.** To learn concepts of ecology **3.** To familiarise environment related legislations 4. To understand to protect and sustain our natural resources of land, water, air, and vegetation.	
Course Outcomes:	1. Interpret the concept of environmental management 2. Learn the ecosystem and interdependence, food chain etc. and interpret environment related legislations 3. Identify the environmental issues important to India 4. Learn the regulating policies of Government in environmental management 5. Identify solutions to protect the environment from pollution 6. Examine the quality environmental management	

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction and Definition of Environment	1.1 Significance of Environment Management for contemporary managers	1	02	10
	1.2 Career opportunities		01	
	1.3 Environmental issues relevant to India		02	
	1.4 Sustainable Development		03	
	1.5 The Energy scenario		02	
2. Global Environmental concerns	2.1 Global Warming	4	01	06
	2.2 Acid Rain		01	
	2.3 Ozone Depletion		01	
	2.4 Hazardous Wastes		30 min	
	2.5 Loss of Biodiversity		30 min	
	2.6 Industrial/Man-made		01	
	2.7 Industrial/Man-made disasters / Atomic / Biomedical hazards, etc		01	
3. Concepts of Ecology	3.1 Ecosystems and interdependence between living organisms	2	01	05
	3.2 Habitats		30 min	
	3.3 Limiting factors		30 min	
	3.4 Carrying capacity		01	
	3.5 Food chain		01	
	3.6 Ecology		01	
4. Scope of Environment Management	4.1 Scope of Environment Management	5	03	10
	4.2 Role and functions of Government as a planning and regulating agency		03	

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs
	4.3 Environment Quality Management and Corporate Environmental		04	
5. Quality Environmental Management	5.1 Total Quality Environmental Management	1	02	05
	5.2 ISO-14000		02	
	5.3 EMS certification		01	
6. General overview of major legislations	6.1 Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act	3	03	03
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	0	01	01
			Total	**42**

Books:	
Text Books	1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999 2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing 3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
Reference Books	1. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005 2. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC 3. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015 4. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

Useful Links:

1. https://libguides.library.qut.edu.au/EVB302_Environmental_pollution/links
2. https://www.epd.gov.hk/epd/epic/english/epichome.html
3. http://www.ecovacservices.com/Useful-Links-6-5511.html

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	15 marks
2.	Class Test 2	15 marks
3.	Internal Assessment	10 marks

Class Tests (30-Marks): Test-1 and Test-2 consists of two class tests of 15 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Three hour duration.

Course Code	Course Name	Credits (P+TUT)
1UEXL801	**Optical Communication Network Laboratory**	**1+0**

Lab Prerequisite:	1. Principles of Communication Engineering 2. Electromagnetics and Antenna 3. Digital Communication
Lab Objectives:	1. To understand the optical fiber communication concepts, essentials, structures wave guide, and signal degradation in fiber. 2. To understand the characteristics of optical sources and detectors. 3. To understand Link budget and optical networks, design and management. 4. To Study the multiplexing schemes.
Lab Outcomes:	1. Analyze Performance of Optical Link 2. Calculate dispersion, NA for given fiber 3. Calculate link Loss for given link 4. Analyze optical component performance 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	**Lab Prerequisites**	**-**	02
1	To perform analog and digital link with different source and receiver.	1,5,6	02
2	Calculation of Numerical aperture	2,5,6	02
3	To Measure bending loss	3,5,6	01
4	To Measure transmission loss.	3,5,6	01
5	Performance Analysis of Optical Amplifier.	4,5,6	02
6	Performance Analysis of Optical Link with Different source	4,5,6	02
7	Performance Analysis of Optical Link with Different Detectors	4,5,6	02
8	Calculation of link Loss for given link with nonlinearities	3,5,6	02
9	Performance analysis of WDM system using EDF amplifier	4,5,6	02
10	Performance Analysis of OTDM	4,5,6	02
11	Average soliton regime	1	02
12	System Design – Power Budget	3,5,6	02
13	Observe performance of Broadcast Star Coupler	4,5,6	02
14	Optical cross-connect (OXC)	4,5,6	02
15	To perform analog and digital link with different source and receiver.	1,5,6	02
		Total	**28**

Suggested Software List:
1. Matlab
2. OptiPerformer (Student version)
3. Comsol

Term work:
1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks.

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
1UEXDLL8021	**Augmented Reality & Virtual Reality Laboratory**	**1+0**

Lab Prerequisite:	Image Processing and Machine Vision
Lab Objectives:	1. To learn the background of VR including a brief history of VR, different forms of VR and related technologies, and a broad overview of some of the most important concepts. 2. To provide background in perception to educate VR creators on concepts and theories of how we perceive and interact with the world around us. 3. To make learners aware of high-level concepts for designing/building assets and how subtle design choices can influence user behaviour. 4. Learning about art for VR and AR should be optimized for spatial displays with spatially aware input devices to interact with digital objects in true 3D.
Lab Outcomes:	1. To design small ARVR system applications. 2. Gain insights into AR/VR industrial applications and future technologies like mixed reality. 3. Setup development Environment for projects. 4. Discuss Resources of ARVR system. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	**-**	02
1	Setup development environment for projects using Unity	3,5,6	02
2	Study of Sensors and actuators in AR/VR system	4,5,6	02
3	Write a Script code using Unity	3,5,6	02
4	Use of Graphics in 2D/3D using Unity	1, 5, 6	02
5	Create various Joints/ Colliders using Unity	1,5,6	02
6	Use of navigation and path finding feature in Unity	1,5,6	02
7	Unity with C# to code 2D / 3D games for computers/ mobile	1,5,6	02
8	Building a project using IL2CPP	1,5,6	02
9	Case Study/Mini Project	1 to 6	10
		Total	**28**

Virtual Lab Links:

1. Download and Install Unity- https://docs.unity3d.com/560/Documentation/Manual/InstallingUnity.html

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks.

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
1UEXDLL8022	**5G Technology Laboratory**	**1+0**

Lab Prerequisite:	Wireless Networks Lab
Lab Objectives:	1. To Implement basic multiple access techniques used in 5G technology. 2 To Simulate 5G Network Model. 3. To Implement basic beamforming in 5G technology 4.To detect signal in 5G technology
Lab Outcomes:	1. Implement basic multiple access techniques used in 5G technology. 2 Simulate 5G Network Model. 3. Implement basic beamforming in 5G technology 4.Detect signal in 5G technology 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	To find Antenna diversity in 5G	1,5,6	02
2	Implement MIMO system	1,5,6	02
3	Implement SU Massive MIMO	4,5,6	02
4	Find Spatial Diversity, Spatial Multiplexing	3,5,6	02
5	Implement Beamforming in 5G	3,5,6	02
6	Implement Channel Estimation IN wireless communication	2,5,6	02
7	Write a program Signal Detection in 5G	4,5,6	02
8	Wire a program for LDPC	2,5,6	02
9	Perform simulation of 5G network	4,5,6	02
10	Mini project performance can be based on different basic modulation schemes used, coding techniques, propagation parameters	2,5,6	08
		Total	**28**

Virtual Lab Links: 1. http://simu5g.org/ **2.** https://ourtechplanet.com/5g-rf-design-planning-fundamentals/
Term work: 1. Term work should consist of a minimum of 8 experiments 2. Journal must include assignments on content of theory and practical of the course 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks.

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
1UEXDLL8023	System on Chip Laboratory	1+0

Lab Prerequisite:	1. Digital VLSI 2. Project Based Learning II
Lab Objectives:	1. To design digital systems using SoC 2. To analyze the performance of digital systems implemented using different design methodologies
Lab Outcomes:	After taking the course students will be able to, 1. Design and implement systems with RTL design using verilog. 2. Design and implement systems software logic on the 3. Design digital systems with software- hardware co-design. 4. Interface Peripherals to the PL and PS of SoC. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Write an application to blink an LED.	2,4,5,6	02
2	Write an application to display different values on LEDs and verify it to be working	2,4,5,6	02
3	Write a software application to add 2 numbers and display their sum	2,4,5,6	02
4	Develop an accelerator which accepts start address, num of words as inputs and reads corresponding number of data from BRAM, adds them and displays on LED	3,4,5,6	02
5	Design a 4-bit wrap-around counter that increments every one second. The counter value is shown on the LEDS	1,4,5,6	02
6	Design a debouncer circuit switch	1,4,5,6	02
7	Design a counter with a button parser	1,5,6	02
8	Design an accumulator with memory block	1,5,6	02
9	Design a calculator that can perform some basic functionalities such as load, store, and sum of two operands	1,5,6	02
10	Design an UART transmitter	1,5,6	02
11	Design an UART receiver	1,5,6	02
12	Design a module that interfaces with Digi-lent video IP to draw a triangle to a monitor	1,4,5,6	02
13	Interfacing between PS and PL	3,5,6	02
14	Flash LED using timer	3,4,5,6	02
15	Design a system that will light an LED in response to a user input, but at the same time flash another LED at a frequency of 1Hz	3,4,5,6	02
16	Implement an interrupt based design to send and receive data from the external board via SPI	3,4,5,6	02
		Total	**34***
***Minimum 28 Hrs. Lab / Mini Project to be conducted**			

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks.

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
1UEXDLL8024	**Web Designing Laboratory**	**1+0**

Lab Prerequisite:	1. Data Structures **2.** Basics of Programming Languages
Lab Objectives:	1. To design and create web pages using HTML5 and CSS3 2. To Create web pages and provide client side validation 3. To create dynamic web pages using server side scripting 4. To use MVC framework for web application development
Lab Outcomes:	Apply the concept of client side validation and design static web pages using 1. HTML5 and CSS3 and dynamic web pages using JavaScript and JQuery. 2. Evaluate client and server side technologies and create Interactive web pages using PHP, AJAX with database connectivity using MySQL. 3. Apply the basics of XML, DTD and XSL and develop web pages using XML/ XSLT. 4. Analyze end user requirements and Create web application using appropriate web technologies and web development framework 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the 7. Laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Installation and Setting of LAMP / WAMP / XAMP	1,5,6	02
2	Create Simple web page using HTML5	1,5,6	02
3	Design and Implement web page using CSS3 and HTML5	1,5,6	02
4	Form Design and Client Side Validation using: a. Javascript and HTML5 b. Javascript and JQuery	1,2,5,6	02
5	Develop simple web page using PHP	2,5,6	02
6	Develop interactive web pages using PHP with database connectivity MYSQL	3,5,6	02
7	Develop XML web page using DTD, XSL	3,5,6	02
8	To implement MVC architecture	4,5,6	02
9	Implement a webpage using Ajax and PHP	2,5,6	02
10	Hosting the website with Domain Registration Process	4,5,6	02
11	Design a Web application using Laravel Framework	4,5,6	02
12	Case Study / Mini Project	1 to 6	04
		Total	**28**

Mini Project:
Setting up /buying the web host management system for hosting of mini project is recommended

Virtual Lab Links:
1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org

Term work:
1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks.

Lab Code	Department Level Elective Course – VI Laboratory	Credits (P+TUT)
1UEXDLL8031	Natural Language Processing Laboratory	1+0

Lab Prerequisite:	1. Python 2. R Language
Lab Objectives:	1. To implement basic algorithms of NLP. 2. To apply N Gram to the Text. 3. To implement Semantics of the Text using NLP algorithms 4. To apply different NLP techniques to the Indian Languages
Lab Outcomes:	1. Apply the basic algorithms using Python. 2. Implement the grammar rules of NLP to the text and test the results 3. Implement the error free Language reading by applying suitable algorithms 4. Implement the NLP techniques to real life applications. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
0	**Lab Prerequisites**	-	02
1	Pre-processing of Text (Tokenization,), filtration, Script Validation, Stop word removal, Stemming	1,5,6	02
2	Morphological Analysis	2,5,6	02
3	N-Gram Model	2,5,6	02
4	POS Tagging	2,5,6	02
5	Chunking	3,5,6	02
6	Named Entity Recognition	4,5,6	02
7	Case Studies (Proposed case studies) a) Sentiment Analysis / Opinion Mining Gauge attitude / sentiments / evaluations / emotions of a speaker or chat b) CV parsing Shortlisting Candidate Automated Interview c) Clause classification in legal contracts Contract Making d) Automate response to RFP Tender Filing e) Concept extraction from legal / lease documents Risk Analysis f) Text summarization Evaluation, Automated Paper Correction g) Meeting analyzer / Meeting notes summary generation MOM h) Automatic email response, Office Efficiency	4,5,6	14
		Total	**28**

Virtual Lab Links:
http://cse24-iiith.virtual-labs.ac.in/#
Term Work:
1. Term work should consist of a minimum of 6 experiments and a Case Study 2. Journal must include contents on practical performance and a report on case study of the course. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks 4. A practical/Oral exam of 25 marks will be conducted at the end of the semester.
Oral/Practical/P&O : Practical examination will be based on experiment list and performance of experiment.

Course Code	Department Level Elective Course – VI Laboratory	Credits (P+TUT)
1UEXDLL8032	RF Design Laboratory	1+0

Lab Prerequisite:	1. Electromagnetic and Antenna Laboratory 2. Principles of Communication Engineering Laboratory 3. Microwave Engineering Laboratory
Lab Objectives:	1. To learn the concept of impedance matching and RF filters. 2. To learn Microwave amplifiers. 3. To learn RF and Microwave oscillators. 4. To learn of the RF mixer. 5. To learn of the EMI/EMC.
Lab Outcomes:	1. Analyze impedance matching networks using any simulation software. 2. Analyze RF filters, amplifiers and oscillators using any simulation software. 3. Analyze RF mixer using any simulation software. 4. Explain the concept of EMI/EMC. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	To Study the non-ideal characteristics of Lumped elements using spectrum/network analyser.	1,5,6	02
2	Analysis of the Low-Pass and High pass composite filter design using simulation software.	1,2,5,6	02
3	Analysis of the filter design by Insertion Loss method using simulation software.	1, 2,5,6	02
4	Study the impedance matching in case of real and imaginary loads using simulation software.	1,5,6	02
5	Analysis of a Low Noise Amplifier (LNA) using simulation software.	2,5,6	02
6	Analysis of Microwave Oscillator using simulation software and its demonstration using spectrum analyser.	2,5,6	02
7	Measurement of gain factor & tunable bandwidth of voltage control oscillator (VCO) using spectrum analyser.	2,5,6	02
8	Analysis of a simple mixer using time domain and frequency domain response using simulation software.	3,5,6	02
9	Demonstrate the different stages of microwave amplifiers using a spectrum analyser.	2,5,6	02
10	Common-Mode Currents and Radiated Emissions of Cables.	4,5,6	02
11	Mini Project with Case Study	1 to 6	02
12	Assignment 1	-	02
13	Assignment 2	-	02
		Total	**28**

Virtual Lab Links:

1. http://www.iitk.ac.in/mimt_lab/vlab/index.php
2. https://nptel.ac.in/courses/108/101/108101112/

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Practical examination will be based on experiment list and performance of experiment.

Course Code	Department Level Elective Course – VI Laboratory	Credits (P+TUT)
1UEXDLL8033	Autonomous Vehicle Laboratory	1+0

Lab Prerequisite:	1. Octave 2. Control lab 3. Basics of FFT 4. Robotic lab
Software Requirements:	1. Windows / Linux Desktop OS 2. Matlab/Octave 3. Colab, Keras
Lab Objectives:	1. To provide Introduction to open cv libraries programs/API for computer vision of AV 2. To provide exposure of open source architecture model for Autonomous driving 3. To provide foundational knowledge in motion/trajectory control of AV
Lab Outcomes:	1. Implement sensors/ actuators in Octave/Matlab 2. Implement algorithm to control motion of vehicle 3. Train a model for image/traffic sign identification 4. Analyze the large set of data generated from vehicle using data analytics technique 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	**-**	**02**
1	Python introduction	2,3,5,6	02
2	Numpy Library usage for data analytics	3,5,6	02
3	Finding lanes- Image processing	3,5,6	02
4	Introduction to Perceptron	4,5,6	02
5	Introduction to keras	3,5,6	02
6	Deep learning for Binary data classification, multiclass classification, Amnist datasets	4,5,6	02
7	CNN algorithm for amnist data set	4,5,6	02
8	Classifying traffic sign data sets-48 classes	3,4,6	02
9	Polynomial regression: NVIDIA architecture model	4,5,6	02
10	Behavioral cloning	3,4,5,6	04
11	Radar measurement (range and Velocity) in octave	1,5,6	02
12	PID controller for speed control	1,2,5,6	02
13	Mini Project with Case Study	1 to 6	02
		Total	**28**

Virtual Lab Links:

1. https://github.com/udacity/self-driving-car-sim
2. https://www.kaggle.com/account/login?phase=startSignInTab&returnUrl=%2Fdatasets
3. https://uwaterloo.ca/autonomous-vehicle-research-intelligence-lab/about

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Practical examination will be based on experiment list and performance of experiment.

Lab Code	Department Level Elective Course – VI Laboratory	Credits (P+TUT)
1UEXDLL8034	**Fundamental of Data Science Laboratory**	**1+0**

Lab Prerequisite:	1. Knowledge of python programming 2. Linear Algebra 3. Statistical Techniques
Lab Objectives:	1. To understand the concept of Data Science. 2. To verify the procedures involved in the processing of data. 3. To develop models for the Analysis of data. 4. To Evaluate and test the models developed.
Lab Outcomes :	1. Develop an in-depth understanding of popular methods like regression, clustering using tools in python for Data Science. 2. Learn optimisation formulations to minimise errors and build 3. accurate models 4. Gain hands-on experience and Build statistical, predictive 5. models and time series data forecasting Models 6. Analyze the Data Mining algorithm using machine learning 7. Write accurate documentation for experiments performed. 8. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1.	Python Programming refresher download sample data set from repository	1	02
2.	Perform Reading and Writing Data in Text Format.	1	02
3.	Perform using Pandas Indexing, Selection, Filtering, and Mapping.	2	02
4	Perform using Pandas Summarizing, Computing Descriptive Statistics-Unique Values, Value Counts, and Membership.	2, 5	02
5	Perform Data Cleaning, Preparation, String Manipulation and plotting with pandas on Sample Data on sample data	3, 5	02
6	Optimize the sample data making use of Machine Learning	5	02
7	Perform Data mining using Machine learning	6	02
8	Develop a model using regression, validate it and test for multiple parameters	4,5	02
9	Implementation of ARX and ARMX models	4	02
10	Implementation of ARIM and ARIMA models	4	02
11	Mini Project with Case Study	1 to 6	06
		Total	**28**

Virtual Lab Links:

http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php
https://vlab.spit.ac.in/ai/#/experiments

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Case study/demo/presentation: 05-marks

Oral/Practical/P&O :

Practical examination will be based on experiment list and performance of experiment.

Lab Code	Project Based Learning	Credits (TH+P+TUT)
1UEXPR86	**Major Project – B**	**(0+6+0)**

Lab Prerequisite:	Major Project – A
Lab Objectives:	1. To meet the milestones formed in the overall project plan decided in Major Project-A. 2. To implement idea presented in Major Project -A with results, conclusion, and future work. 3. To culminate the production of a thesis by each individual student.
Lab Outcomes:	1. Identify, formulate, review research literature, and analyse complex engineering problems 2. Design solutions, components, or processes for complex engineering problems. 3. Select appropriate modern engineering tools and analyse and interpret data to meet the problem statement. 4. Apply ethical principles and commit to professional ethics, responsibilities norms of the engineering practice, and engage in independent and life-long learning. 5. Comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects.

Guidelines:

Project Report Format:

At the end of the semester the student needs to prepare a project report which should be prepared. Along with the project report a CD containing: project documentation, Implementation code, required utilities, softwares and user Manuals need to be attached.

Term Work:

Students have to submit a weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visits by an internal guide will be preferred to get the status of the project.

Students shall be motivated to publish a paper based on the work in Conferences/Technical paper presentations/project competitions/Poster presentations.

Distribution of marks for term work shall be as follows:

e) Weekly Attendance on Project Day
f) Project work contributions as per objective
g) Project Report (Hard Bound)
h) Term End Presentation (Internal)

The final certification and acceptance of Term Work ensures the satisfactory performance on the above aspects which carries **50 Marks**.

Practical & Oral (P&O):

Practical examination of Major Project-B should be conducted by Internal and External examiners. Students must give a presentation and demonstration on the Major Project-B. Oral and Practical will carry **100 Marks**.

Useful Links:

1. https://ieeexplore.ieee.org/
2. https://www.electronicsforu.com/