Item No. 145
AC – 23/07/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

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

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

Item No. 145
AC – 23/07/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Electronics and Telecommunication Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date 02-07-2020

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

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

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

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

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

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 'C' Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS 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 analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC301	Engineering Mathematics-III	3	--	1*	3	--	1	4
ECC302	Electronic Devices & Circuits	3	--	--	3	--	--	3
ECC303	Digital System Design	3	--	--	3	--	--	3
ECC304	Network Theory	3	--	1	3	--	1	4
ECC305	Electronic Instrumentation & Control Systems	3	--	--	3	--	--	3
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1
ECL302	Digital System Design Lab	--	2	--	--	1	--	1
ECL303	Electronic Instrumentation & Control Systems Lab	--	2	--	--	1	--	1
ECL304	Skill Lab: C++ and Java Programming	--	4	--	--	2	--	2
ECM301	Mini Project 1A	--	4$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

*** Should be conducted batch wise.**
$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ECC302	Electronic Devices & Circuits	20	20	20	80	3	--	--	100
ECC303	Digital System Design	20	20	20	80	3	--	--	100
ECC304	Network Theory	20	20	20	80	3	25	--	125
ECC305	Electronic Instrumentation & Control Systems	20	20	20	80	3	--	--	100
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	--	25	25	50
ECL302	Digital System Design Lab	--	--	--	--	--	25	--	25
ECL303	Electronic Instrumentation & Control Systems Lab	--	--	--	--	--	25	--	25
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	--	25	25	50
ECM301	Mini Project 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC401	Engineering Mathematics-IV	3	--	1*	3	--	1	4
ECC402	Microcontrollers	3	--	--	3	--	--	3
ECC403	Linear Integrated Circuits	3	--	--	3	--	--	3
ECC404	Signals & Systems	3	--	1	3	--	1	4
ECC405	Principles of Communication Engineering	3	--	--	3	--	--	3
ECL401	Microcontrollers Lab	--	2	--	--	1	--	1
ECL402	Linear Integrated Circuits Lab	--	2	--	--	1	--	1
ECL403	Principles of Communication Engineering Lab	--	2	--	--	1	--	1
ECL404	Skill Lab: Python Programming	--	4	--	--	2	--	2
ECM401	Mini Project 1B	--	4$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**7**	**2**	**24**

*** Should be conducted batch wise.**

$ Indicates work load of a learner (Not Faculty) for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ECC402	Microcontrollers	20	20	20	80	3	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	3	--	--	100
ECC404	Signals & Systems	20	20	20	80	3	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	3	--	--	100
ECL401	Microcontrollers Lab	--	--	--	--	--	25	--	25
ECL402	Linear Integrated Circuits Lab	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Lab	--	--	--	--	--	25	25	50
ECL404	Skill Lab: Python Programming	--	--	--	--	--	25	25	50
ECM401	Mini Project 1B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC301	Engineering Mathematics-III	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Dura-tion (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ECC301	Engineering Mathematics-III	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. Scalar and Vector Product: Scalar and vector product of three and four vectors

Course Objectives: The course is aimed

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

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

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

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** 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 $t^n, n \geq 0$. 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). Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	7
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	7
04	**Module: 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). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	7
05	**Module: 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). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices.	6
06	**Module: Vector Differentiation and Integral** 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without Proof). 6.2 **Properties of vector field:** Solenoidal and irrotational (conservative) vector	6

	fields. 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	
Total		39

References:

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 Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work:

General Instructions:

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

The distribution of Term Work marks will be as follows –

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

Internal Assessment Test (20-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC302	Electronic Devices & Circuits	3	-	--	3	--	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC302	Electronic Devices & Circuits	20	20	20	80	03	--	--	100

Course pre-requisite:

FEC: 102 - Engineering Physics-I
FEC: 201 - Engineering Physics-II
FEC:105 - Basic Electrical Engineering

Course Objectives:

1. To explain functionality different electronic devices.
2. To perform DC and AC analysis of small signal amplifier circuits.
3. To analyze frequency response of small signal amplifiers.
4. To compare small signal and large signal amplifiers.
5. To explain working of differential amplifiers and it's applications in Operational Amplifiers

Course Outcomes:

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

1. Know functionality and applications of various electronic devices.
2. Explain working of various electronics devices with the help of V-I characteristics.
3. Derive expressions for performance parameters of BJT and MOSFET circuits.
4. Evaluate performance of Electronic circuits (BJT and MOSFET based).
5. Select appropriate circuit for given application.
6. Design electronic circuit (BJT, MOSFET based) circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction of Electronic Devices**	**05**
	1.1	Study of pn junction diode characteristics & diode current equation. Application of zener diode as a voltage regulator.	
	1.2	Construction, working and characteristics of BJT, JFET, and E-MOSFET	
2.0		**Biasing Circuits of BJTs and MOSFETs**	**06**
	2.1	Concept of DC load line, Q point and regions of operations, Analysis and design of biasing circuits for BJT (Fixed bias & Voltage divider Bias)	
	2.2	DC load line and region of operation for MOSFETs. Analysis and design of biasing circuits for JFET (self bias and voltage divider bias), E-MOSFET (Drain to Gate bias & voltage divider bias).	
3.0		**Small Signal Amplifiers**	**06**
	3.1	Concept of AC load line and Amplification, Small signal analysis (Zi, Zo, Av and Ai) of CE amplifier using hybrid pi model.	
	3.2	Small signal analysis (Zi, Zo, Av) of CS (for EMOSFET) amplifiers.	
	3.3	Introduction to multistage amplifiers.(Concept, advantages & disadvantages)	
4.0		**Frequency response of Small signal Amplifiers:**	**08**
	4.1	Effects of coupling, bypass capacitors and parasitic capacitors on frequency response of single stage amplifier, Miller effect and Miller capacitance.	
	4.2	High and low frequency analysis of CE amplifier.	
	4.3	High and low frequency analysis of CS (E-MOSFET) amplifier.	
5.0		**Large Signal Amplifiers:**	**06**
	5.1	Difference between small signal & large signal amplifiers. Classification and working of Power amplifier	
	5.2	Analysis of Class A power amplifier (Series fed and transformer coupled).	
	5.3	Transformer less Amplifier: Class B power amplifier. Class AB output stage with diode biasing	
	5.4	Thermal considerations and heat sinks.	
6.0		**Introduction to Differential Amplifiers**	**08**
	6.1	E-MOSFET Differential Amplifier, DC transfer characteristics, operation with common mode signal and differential mode signal	
	6.2	Differential and common mode gain, CMRR, differential and common mode Input impedance.	
	6.3	Two transistor (E-MOSFET) constant current source	
		Total	**39**

Text books:

1. D. A. Neamen, “Electronic Circuit Analysis and Design,” Tata McGraw Hill, 2ndEdition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, “Microelectronic Circuits Theory and Applications,” International Version, OXFORD International Students, 6thEdition
3. Franco, Sergio. Design with operational amplifiers and analog integrated circuits. Vol. 1988. New York: McGraw-Hill, 2002.

References:

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.
4. S. Salivahanan, N. Suresh Kumar, “Electronic Devices and Circuits”, Tata Mc-Graw Hill, 3rd Edition
5. Bell, David A. Electronic devices and circuits. Prentice-Hall of India, 1999.

NPTEL/ Swayam Course:

1. Course: Analog Electronic Circuit By Prof. Shouribrata chatterjee (IIT Delhi); https://swayam.gov.in/nd1_noc20_ee89/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC303	Digital System Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC105 – Basic Electrical Engineering

Course Objectives:

1. To understand number system representations and their inter-conversions used in digital electronic circuits.
2. To analyze digital logic processes and to implement logical operations using various combinational logic circuits.
3. To analyze, 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:

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

1. Understand types of digital logic, digital circuits and logic families.
2. Analyze, design and implement combinational logic circuits.
3. Analyze, design and implement sequential logic circuits.
4. Develop a digital logic and apply it to solve real life problems.
5. Classify different types of memories and PLDs.
6. Simulate and implement basic combinational and sequential circuits using VHDL/Verilog.

Module No.	Unit No.	Topics	Hrs.
1.0		**Number Systems and Codes**	**04**
	1.1	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	04
2.0		**Logic Family and Logic Gates**	**05**
	2.1	Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics	03
	2.2	Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan's Theorem	02
3.0		**Combinational Logic Circuits**	**12**
	3.1	SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions	04
	3.2	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder, Magnitude Comparator	04
	3.3	Multiplexer and De-Multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder	04
4.0		**Sequential Logic Circuits**	**12**
	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, Universal Shift Register	04
	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
5.0		**Different Types of Memories and Programmable Logic Devices**	**04**
	5.1	Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	02
	5.2	Introduction: Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL)	02
6.0		**Introduction to VHDL**	**02**
	6.1	Basics of VHDL/Verilog Programming, Design and implementation of adder, subtractor, multiplexer and flip flop using VHDL/Verilog	02
		Total	**39**

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, Forth 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).

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).

NPTEL / Swayam Course:

1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee70/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Network Theory	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of Test 1 and Test 2					
ECC304	Network Theory	20	20	20	80	03	25	--	125

Course Pre-requisite:

1. FEC105 - Basic Electrical Engineering
2. FEC201 - Engineerring Mathematics II

Course Objectives:

1. To evaluate the Circuits using network theorems.
2. To analyze the Circuits in time and frequency domain.
3. To study network Topology, network Functions and two port networks.
4. To synthesize passive network by various methods.

Course Outcomes:

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

1. Apply their knowledge in analyzing Circuits by using network theorems.
2. Apply the time and frequency method of analysis.
3. Evaluate circuit using graph theory.
4. Find the various parameters of two port network.
5. Apply network topology for analyzing the circuit.
6. Synthesize the network using passive elements.

Module No.	Unit No.	Topics	Hrs.
1.0		**Electrical circuit analysis**	**08**
	1.1	Circuit Analysis: Analysis of Circuits with and without dependent sources using generalized loop and node analysis, super mesh and super node analysis technique Circuit Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems (Use only DC source).	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using mesh analysis (for Two Loops only).	
2.0		**Graph Theory**	**06**
	2.1	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced Incident matrix, Tieset matrix, f-cutset matrix.	
	2.2	Relationship between sub matrices A, B & Q. KVL & KCL using matrix.	
3.0		**Time and frequency domain analysis**	**07**
3.0	**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 equation with step signals.	
	3.2	Frequency domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step signal.	
4.0		**Network functions**	**06**
	4.1	Network functions for the one port and two port networks, driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, calculation of residues by graphical methods, testing for Hurwitz polynomial.	
	4.2	Analysis of ladder & symmetrical lattice network (Up to two nodes or loops)	
5.0		**Two port Networks**	**05**
	5.1	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry.	
	5.2	Interconnections of Two-Port networks T & π representation.	
6.0		**Synthesis of RLC circuits**	**07**
	6.1	Positive Real Functions: Concept of positive real function, necessary and sufficient conditions for Positive real Functions.	
	6.2	Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II , Foster-I & Foster-II forms (Up to Two Loops only).	
		Total	**39**

Textbooks:

1. Franklin F Kuo, "Network Analysis and Synthesis", Wiley Toppan, 2nd ed. ,1966.
2. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.

Reference Books:

1. A. Chakrabarti, *"Circuit Theory",* Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammohan S. Palli "Circuits and Networks", Tata McGraw-Hill education.
3. Smarajit Ghosh "Network Theory Analysis & Synthesis", PHI learning.
4. K.S. Suresh Kumar, "Electric Circuit Analysis" Pearson, 2013.
5. D. Roy Choudhury, "Networks and Systems" , New Age International, 1998.

NPTEL / Swayam Course:

1. Course: Basic Electrical Circuits By Prof. Nagendra Krishnapura (IIT Madras); https://swayam.gov.in/nd1_noc20_ee64/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Term Work (25-Marks):

At least **10 assignments** covering entire syllabus must be given during the **"Class Wise Tutorial".** The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control Systems	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC305	Electronic Instrumen-tation & Control Systems	20	20	20	80	03	--	--	100

Course pre-requisites:

1. FEC105 – Basic Electrical Engineering

Course Objectives:

1. To provide basic knowledge about the various sensors and transducers
2. To provide fundamental concepts of control system such as mathematical modeling, time response and Frequency response.
3. To develop concepts of stability and its assessment criteria.

Course Outcomes:

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

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 time domain and frequency domain.
6. Predict stability of given system using appropriate criteria.

Module No.	Unit No.	Topics	Hrs.
1		**Principle of Measurement, Testing and Measuring instruments**	04
	1.1	Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	1.2	Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Mega ohm bridge Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge	
2		**Sensors and Transducers**	06
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers	
	2.2	Displacement and pressure- Potentiometers, pressure gauges, linear Variable differential transformers (LVDT) for measurement of pressure and displacement strain gauges	
	2.3	Temperature Transducers- Resistance temperature detectors (RTD). Thermistors and thermocouples, their ranges and applications	
3		**Introduction to control system Analysis**	08
	3.1	Introduction: Open and closed loop systems, example of control systems	
	3.2	Modelling: Modelling, Transfer function model	
	3.3	Block diagram reduction techniques and Signal flow graph	
4		**Response of control system**	04
	4.1	Dynamic Response: Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types	
	4.2	Concept of lag and lead compensator.	
5		**Stability Analysis in Time Domain**	08
	5.1	Concept of stability: Routh and Hurwitz stability criterion	
	5.2	Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system	
6		**Stability Analysis in frequency domain**	09
	6.1	Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	
	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	
	6.3	Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion, gain and phase margin	
Total			39

Textbooks:

1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation"* – DRS .India
2. B.C Nakra, K.K. Cahudhary, 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 McGrawHill.
5. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed.,2004.
6. K.Ogata, "*Modern Control Engineering*, Pearson Education", IIIrd edition.

Reference Books:

1. Helfrick&Copper, "*Modern Electronic Instrumentation & Measuring Techniques"* –PHI
2. M.M.S. Anand, "*Electronic Instruments and instrumentationTechnology"*.
3. Gopal M., "Control Systems Principles and Design", Tata McGraw Hill Publishing Co. Ltd.New Delhi, 1998.
4. Benjamin C.Kuo, "*Automatic Control Systems*, Eearson education", VIIthedition
5. Doeblin E.D., Measurement system, Tata Mc Graw Hill., 4th ed, 2003.Madan Gopal, "Control Systems *Principles and Design"*, Tata McGraw hill, 7th edition,1997.
6. Normon, "*Control System Engineering"*, John Wiley & sons, 3rdedition.

NPTEL/ Swayam Course:

1. Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras); https://swayam.gov.in/nd1_noc20_ee90/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	25	25	50

Course Objectives:

1. To make students familiar with equipments and measuring instruments used to perform Electronics Devices and Circuits laboratory work.
2. To provide hands on experience to develop laboratory setup for performing given experimental using various equipments, electronic devices and measuring instruments.
3. To develop an ability among students to gather appropriate data and analyse the same to relate theory with practical.
4. To develop trouble shooting abilities among students.

Course Outcomes:

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

1. Know various equipments, electronics devices and components, and measuring instruments used to perform laboratory work.
2. Students will be able to explain functionality of various equipments, electronics devices and components and neasu6 instruments used to perform laboratory work.
3. Students will be able connect various equipments, devices, components and measuring devices using bread board as per the circuit diagram for experiment to be performed.
4. Students will able to perform experiment to gather appropriate data.
5. Students will able to analyze data obtained from experiment to relate theory with experiment results.
6. Students will able to prepare laboratory report (Journal) to summarise the outcome each experiment.

Laboratory plan:

Maximum of 10 practicals including minimum 2 to 3 simulations should be conducted.
Suggested list of experiments:

1. To study of pn junction diode characteristics.
2. To study zener as a voltage regulator.
3. To study characteristics of CE configuration.
4. To study BJT biasing circuits.
5. To study BJT as CE amplifier.
6. To study frequency response of CE amplifier.
7. To study EMOSFET biasing circuits.
8. Simulation experiment on study of CS amplifier.
9. Simulation experiment on study frequency response of CS amplifier.
10. Simulation experiment on study of differential amplifier.
11. Simulation experiment on multistage amplifier.

Term Work: At least 10 Experiments including not more than 03 simulations covering entire syllabus must be given during the "Laboratory session batch wise". Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL302	Digital System Design Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL302	Digital System Design Lab	--	--	--	--	25	--	25

Course objectives:

1. To get familiarise with basic building blocks of Digital System Design and verify the operation of various digital ICs.
2. To train students to design and implementation of combinational circuits.
3. To instruct students on how to design and implement sequential circuits.
4. To introduce simulation software like VHDL/Verilog to design basic digital circuits.

Course outcomes:

Learners will be able to …

1. Identify various Digital ICs and basic building blocks of digital system design
2. Design and implement combinational circuits like adder, subtractor, multiplexer, code converters etc.
3. Identify and understand working of various types of flip flops and their inter conversions.
4. Design and implement basic sequential circuits such as counters, registers etc.
5. Acquire basic knowledge of VHDL/Verilog basic programming.

Suggested list of experiments:

1. Simplification of Boolean functions.
2. Design AND, OR, NOT, EXOR, EXNOR gates using Universal gates: NAND and NOR.
3. Implement digital circuits to perform Binary to Gray and Gray to Binary operations.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Design and implement BCD adder using 4-bit Binary Adder IC-7483.
6. Implement logic equations using Multiplexer.
7. Verify encoder and decoder operations.

8. Design and implement Magnitude Comparator.
9. Verify truth table of different types of flip flops.
10. Flip flop conversions JK to D, JK to T and D to TFF.
11. Design asynchronous/synchronous MOD N counter using IC7490.
12. Verify different counter operations.
13. Write VHDL/Verilog simulation code for different logic gates.
14. Write VHDL/Verilog simulation code for combinational and sequential circuits.
15. Write VHDL/Verilog simulation code for 4:1 Multiplexer, 2 to 4 line binary decoder.

Term Work:

At least 08 experiments covering the entire syllabus must be given "**Batch Wise"**. Out of these, **06 hardware experiments**, to be done strictly on breadboard and **at least 02 software experiments** using VHDL/Verilog. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Pract.	Tut.	Total
ECL303	Electronic Instrumentation & Control Systems Lab.	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam			
ECL303	Electronic Instrumentation & Control Systems Lab.	--	--	--	--	25	--	25

Course 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 system using Root locus, Bode plot, polar plot and Nyquist plot.

Course Outcomes:

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

1. Plot and validate the performance characteristics of transducers.
2. Validate the characteristics of various temperature, pressure and level transducers.
3. Plot frequency response of first-order electrical system.
4. Plot time response of second-order electrical system and calculate the steady-state error.
5. Validate the effect of damping factor on the response of second order system.
6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system

List of experiments:

1. Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)
2. Designing AC bridge Circuit for capacitance measurement.
3. Study and characteristics of Resistive Temperature Detector (RTD).
4. Study of Linear Variable Differential Transformer (LVDT)
5. To plot the effect of time constant on first-order systems response.
6. To plot the frequency response of first-order System
7. To plot the time response of second-order systems
8. To plot the frequency response of second-order System
9. To Examine Steady State Error for Type 0, 1, 2 System
10. To study the performance of Lead and Lag Compensator
11. To inspect the relative stability of systems by Root-Locus using Simulation Software.
12. To determine the frequency specification from Polar plot of system
13. To inspect the stability of system by Nyquist plot using Simulation software.
14. To inspect the stability of system by Bode plot using Simulation software.
15. Any other experiment based on syllabus which will help students to understand topic/concept.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the "Laboratory session batch wise". Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL304	Skill Lab: C++ and Java Programming	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks						
		Internal assessment			End Sem. Exam	Term Work	Practical And Oral	Total
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	25	25	50

Note: Before performing practical **'Necessary Theory'** will be taught by concern faculty

Course Pre-requisites:

1. FEL204 - C-Programming

Course Objectives:

1. Describe the principles of Object Oriented Programming (OOP).
2. To understand object-oriented concepts such as data abstraction, encapsulation, inheritance and polymorphism.
3. Utilize the object-oriented paradigm in program design.
4. To lay a foundation for advanced programming.
5. Develop programming insight using OOP constructs.

Course Outcomes:

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

1. Describe the basic principles of OOP.
2. Design and apply OOP principles for effective programming.
3. Develop programming applications using OOP language.
4. Implement different programming applications using packaging.
5. Analyze the strength of OOP.
6. Percept the Utility and applicability of OOP.

Module No.	Unit No.	Topics	Hrs.
1.0		**C++ Overview**	**08**
	1.1	Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object oriented programming language.	
	1.2	C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2.0		**C++ Control Structures**	**08**
	2.1	**Branching -** If statement, If-else Statement, Decision. **Looping –** while, do-while, for loop **Nested control structure-** Switch statement, Continue statement, Break statement.	
	2.2	**Array-** Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array.	
3.0		**Object-Oriented Programming using C++**	**12**
	3.1	**Operator Overloading-** concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function-** Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. **Constructor-** Definition, Types of Constructor, Constructor Overloading, Destructor.	
	3.2	**Inheritance-** Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism-** concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4.0		**Introduction to Java**	**06**
	4.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based. Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5.0		**Inheritance, Polymorphism, Encapsulation using Java**	**10**

	5.1	**Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java.	
	5.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6.0		**Exception Handling and Applets in Java**	**08**
	6.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception sub classes). **Managing I/O:** Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. **Threading:** Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	6.2	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	**52**

Suggested list of Experiments:

Note: *Before performing practical necessary Theory will be taught by concern faculty*

Sr.No	Write C++ Program to
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance
10	Create a class for student to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No.	Write JAVA Program to
1	Display addition of number
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail””
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Textbooks:

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.

Skill-Enhancement:

1. The students should be trained to code in Eclipse (an industry accepted software tool). Also, for a given problem statement, there is need to include external library files (other than JDK files). Moreover, the students need to be trained on Maven (a build tool).
2. Real-life mini-problem statements from software companies (coming in for placement) to be delegated to groups of 3-4 students each and each group to work on the solution for 8-12 hours (last 2 lab sessions).

Software Tools:

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

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Term Work:

At least **12** experiments (**06 experiments** each on **C++** and **JAVA**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.
The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

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

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam should cover all **12** experiments for examination.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

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

Outcome: At the end of the course learners will be able to…

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

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

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

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

One-year project:

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

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

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

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

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini Project shall be assessed based on following points;

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

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1A, in case it is half-year project.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Pre-requisite:

1. FEC105 - BEE

Course 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

Course outcomes:

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

1. Create the electronics circuit for 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's (like DMM, CRO, DSO etc.)
6. Analysis of hardware fault (Fault detection and correction)

Module No.	Unit No.	Topics	Hrs.
1.0		**Identification and Designing of Circuit**	**08**
	1.1	Identification of particular application with understanding of its detail operation. Study of necessary components and devices required to implement the application.	
	1.2	Designing the circuit for particular application (either analog , digital, electrical , analog and digital, etc)	
2.0		**Software simulation and Implementation on GPP**	**12**
	2.1	Simulation of circuit for particular application using software's to verify the expected results	
	2.2	Implementation of verified circuit on general purpose printed circuit board (GPP). Now Verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
3.0		**PCB design and optimization**	**08**
	3.1	Design the circuit by placing components using PCB design software's.	
	3.2	Reduce the size of PCB by varying the position of components or devices for optimize use of copper clad material	
4.0		**Implementation of PCB**	**08**
	4.1	Transfer the designed PCB on Copper clad either by using dark room or taking printout on glossy paper, etc (use available suitable method).	
	4.2	Perform Etching and then Soldering.	
5.0		**Detection of Hardware faults and Result verification**	**08**
	5.1	Identify the hardware faults in designed circuit and subsequently rectify it	
	5.2	Now again verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
6.0		**Understanding the Troubleshooting**	**08**
	6.1	Understand the trouble shooting by removing some wired connection.	
	6.2	Understand the trouble shooting of track. Troubleshoot the faculty components or devices	
		Total	**52**

NOTE: During 1st week or within 1-month of the beginning of the semester, following topics related to ADC and DAC 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.**

Reference books:

1. Schultz Mitchel E., *"Grob's Basic Electronics",* McGraw-Hill Education; 10th edition, 25 October , 2006.
2. Charles Platt, *"Make Electronics: Learning by discovery",* O'Reilly; 2nd edition, 18 September , 2015.
3. Forrest M Mims III, *"Getting started in Electronics",* Book Renter, Inc.; 3rd edition , 1 January 2000.

4. R S Khandpur, "*Printed circuit board*", McGraw-Hill Education; 1st edition, 24 February , 2005.
5. Kraig Mitzner, "*Complete PCB Design Using OrCAD Capture and PCB Editor",* Academic Press; 2nd edition , 20 June 2019.

Suggested Software tools:

1. LTspice:https://www.analog.com/en/design-center/design-tools-and-calculators/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/webench-power-designer.html
6. Tinkercad : https://www.tinkercad.com/

Online Repository:

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC401	Engineering Mathematics-IV	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Dura-tion (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem exam				
		Test1	Test2	Avg. of Test 1 & 2					
ECC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. ECC301-Engineering Mathematics-III & Binomial Distribution.

Course Objectives: The course is aimed:

1. To understand line and contour integrals and expansion of complex valued function in a power series.
2. To understand the basic techniques of statistics for data analysis, Machine learning and AI.
3. To 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:

On successful completion of course learner/student will be able to:

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 extremals of the functional using the concept of Calculus of variation.

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

06	**Module: Calculus of Variations:** 6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'. 6.2 Isoperimetric problems- Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-** Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action , Several dependent variables.	6
Total		39

References:

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

Term Work (25-Marks):

General Instructions:

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

The distribution of Term Work marks will be as follows –

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

Internal Assessment Test (25-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Micro-controllers	3	-	--	3	-	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC402	Micro-controllers	20	20	20	80	03	-	-	100

Course Pre-requisites:

1. ECC303 - Digital System Design

Course objectives:

1. To develop background knowledge of Computer and its memory System.
2. To understand architecture of 8051 and ARM7 core.
3. To write programs for 8051 microcontrollers.
4. To understand design of Microcontroller Applications.

Course outcomes:

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

1. Understand Computer and its memory System,
2. Understand the detailed architecture of 8051 and ARM7 Core.
3. Write programs for 8051 microcontrollers.
4. Design an applications using microcontroller.

Module No.	Unit No.	Topics	Hrs
1		**Overview of Microprocessor based System**	5
	1.1	Overview of microcomputer systems and their building blocks, Memory Interfacing, Steps taken by the microprocessor to fetch and executes an instruction from the memory	
	1.2	Concepts of Program counter register, Reset, Stack and stack pointer , Subroutine, Interrupts and Direct Memory Access	
	1.3	Concept of RISC & CISC Architecture	
	1.4	Harvard & Von Neumann Architecture	
2		**The Memory Systems**	4
	2.1	Classification of Memory : Primary and Secondary	
	2.2	Types of Semiconductor memories	
	2.3	Cache Memory	
	2.4	Virtual Memory Concept with Memory Management Unit with Segmentation and Paging (Address Translation Mechanism)	
3		**8051 Microcontroller**	8
	3.1	Comparison between Microprocessor and Microcontroller	
	3.2	Features, architecture and pin configuration	
	3.3	CPU timing and machine cycle	
	3.4	Input / Output ports	
	3.5	Memory organization	
	3.6	Counters and timers	
	3.7	Interrupts	
	3.8	Serial data input and output	
4		**8051 Assembly Language Programming and Interfacing**	9
	4.1	Addressing modes	
	4.2	Instruction set	
	4.3	Need of Assembler & Cross Assemble, Assembler Directives	
	4.4	Programs related to: arithmetic, logical, delay subroutine , input, output, timer, counters, port, serial communication, and interrupts	
	4.5	Interfacing with LEDs, Relay and Keys	
5		**ARM7**	8
	5.1	Introduction & Features of ARM 7	
	5.2	Concept of Cortex-A, Cortex-R and Cortex-M	
	5.3	Architectural inheritance, Pipelining	
	5.4	Programmer's model	
	5.5	Brief introduction to exceptions and interrupts handling	
	5.6	Instruction set: Data processing, Data Transfer, Control flow	
6		**Study 8 bit microcontroller Applications**	5
	6.1	Understanding features of NXP 89v51RD2, Atmega 328P and PIC16F886	
	6.2	Selecting a microcontroller for an application	
	6.3	Study of 89v51 based Clock Using I2C RTC and Seven Segment Display	
	6.4	PIC16F886 Speed Control of DC Motor.	
	6.5	Atmega 328P based remote temperature monitoring with LCD display	
		Total	39

Text Books:

1. Douglas V Hall, SSSP Rao "Microprocessors & Interfacing", McGraw Hill
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, Tata McGraw-Hill
3. Shibu K. V "Introduction to embedded systems" McGraw Hill.
4. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006.
5. C. Kenneth J. Ayala and D. V. Gadre, "The 8051 Microcontroller & Embedded system using assembly & 'C' ", Cengage Learning, Edition 2010.
6. Steve Furber, "ARM System on chip Architecture", Pearson,2nd edition.

Reference books:

1. "MCS@51 Microcontroller, Family User's Manual" Intel
2. "PIC16F882/883/884/886/887 Data Sheet", Microchip.
3. ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash datasheet, Atmel
4. P89V51RB2/RC2/RD2 8-bit 80C51 5 V low power 16/32/64 kB flash microcontroller, Data Sheet NXP founded by Philips
5. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand& Sons Inc., Edition 2014

NPTEL/ Swayam Course:

1. Course: Microprocessors and Microcontrollers By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee42/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC403	Linear Integrated Circuits	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs)	Term Work	Prac. and Oral	Total
		Internal assessment			End Sem. Exam. (ESE)				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC105-Basic Electrical Engineering
2. ECC302-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 Outcome:

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

1. Outline and classify all types of integrated circuits.
2. Understand the fundamentals and areas of applications for the integrated circuits.
3. Develop the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical & practical results in integrated circuits.
5. Identify the appropriate integrated circuit modules for designing engineering application.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Operational Amplifier**	**07**
	1.1	Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.	
	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.	
	1.3	Summing amplifier, difference amplifiers and Instrumentation amplifier using Op-amp.	
2.0		**Linear Applications of Operational Amplifier**	**08**
	2.1	Voltage to current and current to voltage converter.	
	2.2	Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters.	
	2.3	Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3.0		**Non-Linear Applications of Operational Amplifier**	**07**
3.0	**3.1**	Comparators: Inverting comparator, non-inverting comparator, zero crossing detectors, window detector.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator. Basics of Precision Rectifiers: Half wave and full wave precision rectifiers. Peak detector.	
4.0		**Timer IC 555 and it's applications**	**07**
	4.1	Functional block diagram and working of IC 555	
	4.2	Design of Astable and Monostable multivibrator using IC 555	
	4.3	Applications of Astable and Monostable multivibrator as Pulse width modulator and Pulse Position Modulator.	
5.0		**Voltage Regulators.**	**06**
	5.1	Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series).	
	5.2	Functional block diagram, working and design of general purpose IC 723 (HVLC and HVHC).	
	5.3	Introduction and block diagram of switching regulator, Introduction of LM 317.	
6.0		**Special Purpose Integrated Circuits**	**04**
	6.1	Functional block diagram and working of VCO IC 566 and application as frequency modulator.	
	6.2	Functional block diagram and working of PLL IC 565 and application as FSK Demodulator.	
		Total	**39**

Textbooks:

1. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Prentice Hall, 4th Edition.
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, “Operation Amplifiers and Linear Integrated Circuits”, Oxford University Press, Indian Edition.
4. R. F. Coughlin and F. F. Driscoll, “Operation Amplifiers and Linear Integrated Circuits”, Prentice Hall, 6th Edition.
5. J. Millman, Christos CHalkias, and Satyabratatajit, Millman’s,“Electronic Devices and Circuits,” McGrawHill, 3rdEdition.

NPTEL/ Swayam Course:

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

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	03	--	01	03	--	01	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 & Test 2					
ECC404	Signals and Systems	20	20	20	80	03	25	--	125

Course pre-requisite:

1. ECC301 – 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:

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

1. Classify and Analyze different types of signals and systems
2. Analyze continuous time LTI signals and systems in transform domain
3. Analyze and realize discrete time LTI signals and systems in transform domain
4. Represent signals using Fourier Series and Analyze the systems using the Fourier Transform.
5. Demonstrate the concepts learnt in Signals and systems Course using the modern engineering tools.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to signals and systems**	**07**
	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.	
	1.2	**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.	
2.0		**Time domain analysis of Continuous Time and Discrete Time systems**	**07**
	2.1	**Linear Time Invariant (LTI) systems:** Representation of systems using differential /difference equation, Impulse, step and exponential response, System Stability and Causality.	
	2.2	Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems.	
	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.	
3.0		**Fourier Analysis of Continuous and Discrete Time Signals and Systems**	**07**
	3.1	Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform, Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform.	
4.0		**Laplace Transform and Continuous time LTI systems**	**06**
	4.1	Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform, Relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform, inverse Laplace Transform.	
	4.2	**Analysis of continuous time LTI systems using Laplace Transform: C**ausality and stability of systems in *s*-domain, Total response of a system.	
5.0		***z*-Transform and Discrete time LTI systems**	**08**
	5.1	Need of *z*-Transform, *z*-Transform of finite and infinite duration sequences, Concept of Region of Convergence, *z*-Transform	

		properties, Standard *z*-transform pairs, relation between *z*-transform and discrete time Fourier Transform, one sided *z*-Transform. Inverse *z*-Transform: Partial Fraction method only.	
	5.2	**Analysis of discrete time LTI systems using *z*-Transform**: Systems characterized by 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.	
6.0		**FIR and IIR systems**	**04**
	6.1	Concept of finite impulse response systems and infinite impulse response systems, Linear Phase FIR systems.	
	6.2	**Realization structures of LTI system:** Direct form –I and direct form II, Linear Phase FIR structures.	
Total			**39**

Text books:

1. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.
2. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Signals and Systems, Pearson Education, Fourth Edition 2009.
3. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.
4. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

Reference books:

1) Hwei. P Hsu, Signals and Systems, Tata McGraw Hill, Third edition, 2010
2) Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.
3) V. Krishnaveni and A. Rajeshwari, Signals and Systems, Wiley-India, First Edition 2012.
4) Michael J Roberts, Fundamentals of Signals and systems, Tata McGraw Hill, special Indian Economy edition, 2009.
5) Luis F. Chaparro, Signals and Systems Using MATLAB, Academic Press
6) Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach", Wiley 2002.
7) Signals and Systems Laboratory: Virtual Laboratory http://ssl-iitg.vlabs.ac.in/

NPTEL/ Swayam Course:

1. Course: Principles of Signals & Systems By Prof. Aditya K. Jagannatham (IIT Kanpur); https://swayam.gov.in/nd1_noc20_ee15/preview

Teachers and students are encouraged to use *Signals and Systems Laboratory: Virtual Laboratory* (Reference number 8) for demonstration of concepts such as systems and their properties, Fourier analysis etc.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Term Work (25-Marks):

At least 06 Tutorials covering entire syllabus and 01 course project must be given during the "Class Wise Tutorial".

Students can form team of maximum 4 members and work on course project using any software viz. C, Python, Scilab, Matlab, Octave, etc. The course project should be appropriately selected in order to demonstrate any concept learnt in this course.

03-hours (out of the total 12-hours allotted for the tutorials) can be utilized for the course project completion.

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC405	Principles of Communication Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Prac. & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ECC301 - Engineering Mathematics- III
2. ECC302 - Electronic Devices and Circuits

Course Objectives:

1. To illustrate the fundamentals of basic communication system.
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 techniques.

Course Outcomes:

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

1. Understand the basic components and types of noises in communication system.
2. Analyze the concepts of amplitude modulation and demodulation.
3. Analyze 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 demultiplexing techniques.

Module No.	Unit No.	Topics	Hours
1		**Basics of Communication System**	**05**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain. Basic concepts of wave propagation.	**03**
	1.2	Types of noise, signal to noise ratio, noise figure, noise temperature and Friss formula.	**02**
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concepts, need for modulation, waveforms (time domain and frequency domain), modulation index, bandwidth, voltage distribution and power calculations.	**04**
	2.2	DSBFC: Principles, low-level and high-level transmitters, DSB suppressed carrier, Balanced modulators with diode (Ring modulator and FET) and SSB systems.	**04**
	2.3	Amplitude demodulation: Diode detector, practical diode detector, Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television.	**04**
3		**Angle Modulation and Demodulation**	**10**
	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.	**04**
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle, pre- emphasis and de-emphasis	**03**
	3.3	FM demodulation: Balanced slope detector, Foster-Seely discriminator, Ratio detector, FM demodulator using Phase lock loop, amplitude limiting and thresholding, Applications of FM and PM.	**03**
4		**Radio Receivers**	**04**
	4.1	Characteristics of radio receivers, TRF, Super - heterodyne receiver block diagram, tracking and choice of IF, AGC and its types and Communication receiver.	**03**
	4.2	FM receiver block diagram, comparison with AM receiver.	**01**
5		**Analog and Digital Pulse Modulation & Demodulation**	**06**
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing error and aperture effect.	**03**
	5.2	PAM, PWM, PPM generation, detection and applications. Basics of PCM system and differential PCM system. Concepts of Delta modulation (DM) and Adaptive Delta Modulation (ADM).	**03**
6		**Multiplexing & De-multiplexing**	**02**
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram and applications. Time Division Multiplexing transmitter & receiver block diagram and applications.	**02**
		Total	**39**

Textbooks:

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.

NPTEL/ Swayam Course:

1. Course: Analog Communication By Prof. Goutam Das (IIT Kharagpur);
   https://swayam.gov.in/nd1_noc20_ee69/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL401	Micro-controllers Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL401	Micro-controllers Lab	-	-	-	-	-	25	--	25

Course 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.

Course Outcomes:

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

1. Understand different development tools required to develop microcontroller based systems.
2. Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations.
3. Write assembly language programs for general purpose I/O, Timers & Interrupts.
4. Interface & write programs for Input and Output devices
5. Develop microcontroller based Applications.

Suggested Experiment List:

1. Perform Arithmetic and Logical Operations (Using Immediate, Direct and Indirect addressing)
2. Code Conversion
3. Transfer of data bytes between Internal and External Memory
4. Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay, etc
5. Interfacing of Matrix Key board, LED, 7 Segment display, LCD, Stepper Motor, UART

At Least 10 experiment Minimum two from each category of above list must be given during the **Laboratory session batch wise**. Computation/simulation based experiments are also encouraged.

Before starting the experiments there should be one session on Study of development tools like Editor, Assembler-cross Assembler, Compiler-Cross compiler, Linker, Simulator, emulator etc.

Mini project based on 8051 derivatives, PIC, AVR & other 8 bit microcontrollers using Assembly and/or C language. (Readymade of Arduino & raspberry pi are **not recommended here**)

Note: Mini Project can be considered as a part of term-work.

Term Work (25-Marks):

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL402	Linear Integrated Circuits Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECL402	Linear Integrated Circuits Lab.	--	--	--	--	--	25	25	50

Course Outcomes:

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

1. Understand the differences between theoretical, practical and simulated results in integrated circuits.
2. Apply the knowledge to do simple mathematical operations.
3. Apply knowledge of op-amp, timer and voltage regulator ICs to design simple applications.

Laboratory Plan:

Minimum 8 hardware practical (compulsorily based on IC 741, IC 555, IC 723 and remaining on VCO 566 or PLL 565) and 2 simulations should be conducted. At least one experiment from each Module of syllabus.

Suggested list of experiments:

1. Design inverting, non-inverting amplifier and buffer using IC 741.
2. Design summing and difference amplifier using op-amp.
3. Design voltage to current converter with grounded load.
4. Design and analyze Integrator
5. Design and analyze Differentiator
6. Design Schmitt trigger using Op-amp.
7. Design Wein bridge and RC phase shift Oscillator.
8. Design and analyze second order High pass and Low pass filter
9. Design and analyze Band pass and Band reject filter.
10. Design Astable multivibrator using IC 555 for fixed frequency and variable duty cycle.
11. Design Monostable Multivibrator using IC 555.
12. Design Low voltage Low current voltage regulator using IC 723.
13. Design High voltage High current voltage regulator using IC 723.
14. Design Frequency Modulator using IC 566
15. Design FSK Demodulator using IC 565
16. Design Instrumentation amplifier using 3 Op-Amp.
17. Design Precision rectifier
18. Design Square & Triangular wave generator

Term Work (25-Marks):

At least 10 Experiments including 02 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL403	Principles of Communication Engineering Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL403	Principles of Communication Engineering Lab.	--	--	--	--	--	25	25	50

Course Pre-requisites:

1. Usage of basic Electronic instruments and components.
2. Fundamentals of Electronic Devices and circuits

Course Objectives:

1. To give an understanding of Time and Frequency domain representation of signals.
2. To demonstrate continuous wave modulation and demodulation.
3. To demonstrate analog and digital pulse communication.
4. Able to use simulation software to build communication circuits.

Course Outcomes:

After successful performance of the practicals student will be able to:

1. Analyze analog modulation techniques.
2. Analyze the waveforms of Radio receivers.
3. Implement analog pulse modulation and demodulation circuits.
4. Demonstrate digital pulse modulation and demodulation techniques.
5. Verify the concepts of TDM and FDM.

Suggested list of Experiments:

Sr. No	Title
1	Generation of AM modulation and demodulation.
2	Analyze waveforms at various stages of SSB system.
3	Generation of FM modulation and demodulation.
4	Analyze the output waveforms of each block of AM transmitter /receiver
5	Analyze the output waveforms of each block of FM transmitter /receiver
6	Design and implement Pre-emphasis and De-emphasis circuit.
7	Verification of sampling theorem.
8	Generation of PAM modulation and demodulation.
9	Generation of PWM and PPM modulation and demodulation.
10	Demonstrate Digital pulse transmission technique (PCM)
11	Demonstrate Digital pulse transmission technique (DM,ADM)
12	Observation of TDM multiplexing and de-multiplexing signals.
13	Observation of FDM multiplexing and de-multiplexing signals.

Term Work (25-Marks):

At least **10** experiments (**07 hardware experiments and at least 03 software experiments**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and application oriented. Signal should be analyzed in time and frequency domain.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

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

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 10 experiments for examination.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL404	Skill Lab: Python Programming	-	04	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL404	Skill Lab: Python Programming	-	-	-	-	25	25	50

NOTE: Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Course pre-requisite:

1. ECL304 – Skill Lab: C++ and Java Programming.

Course Objectives:

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

Course Outcomes:

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

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

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Python**	6
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements	
2.0		**Functions and File I/O Handling**	8
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, *with* keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3.0		**Object Oriented Programming**	9
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4.0		**Graphical User Interface and Image processing**	9
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqilite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5.0		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	
6.0		**Python Applications**	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor,	
	6.5	Support Vector Machines	
		Total	**52**

Text Books:

1. Yashavant Kanetkar, “Let us Python: Python is Future, Embrace it fast”, BPB Publications; 1 edition (8 July 2019).
2. Dusty Phillips, “Python 3 object-oriented Programming”, Second Edition PACKT Publisher August 2015.
3. John Grayson, “Python and Tkinter Programming”, Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python , E Balagurusamy, McGraw Hill Education.
7. Zed A. Shaw, “Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code”, Addison Wesley; 3 edition (1 October 2013).

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. Andreas C. Mueller, “Introduction to Machine Learning with Python”, O′Reilly; 1 edition (7 October 2016)
4. David Beazley, Brian K. Jones, “Python Cookbook: Recipes for Mastering Python 3”, O'Reilly Media; 3 edition (10 May 2013).
5. Bhaskar Chaudhary, “Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application”, Packt Publishing (November 30, 2015)

Software Tools:

1. Python IDE: https://www.python.org/downloads/
2. Anaconda Environment: https://www.anaconda.com/distribution/

Online Repository:

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

The following list of experiments and course project is for illustration purpose. Faculty members are required to introduce their own innovative list of experiments based on above curriculum.

Sr. No.	Problem Statement	Module No.
1.	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures.	Module 1

	4. Assume a suitable value for distance between two cities (in km). Write a program to convert and print this distance in meters, feet, inches and centimetre. 5. Write a program to carry out the following operations on the given set s = {10, 2, -3, 4, 5, 88} a. Number of items in sets s b. Maximum element in sets s c. Minimum element in sets s d. Sum of all elements in sets s e. Obtain a new sorted set from s, set s remaining unchanged f. Report whether 100 is an element of sets s g. Report whether -3 is not an element of sets s.	
2.	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. Generate and print a list of tuples containing name, age and salary from the 3lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3.	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number entered through the keyboard. 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write a recursive function to calculate sum of digits of 5-digit number.	Module 3
4.	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain individual histograms. 4.Write Python program for histogram equalization 5 Write Python Program for edge detection 6. Write Python Program for image segmentation 7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	Module 4
5.	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: a. Find and print the name of the country with the highest GDP b. Find and print the name of the country with the lowest GDP c. Print text and input values iteratively	Module 5

	d. Print the entire list of the countries with their GDPs e. Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a. a. View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, b. fatal flag c. b. Clean the dataset and replace the fatal flag NaN with "No". d. c. Find the aircraft types and their occurrences in the dataset e. d. Remove all the observations where aircraft names are not available f. Display the observations where fatal flag is "Yes" 5. Analyze the "auto mpg data" and draw a pair plot using seaborn library for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous • horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 5. Write python program to use SciPy to solve a linear algebra problem. 6. There is a test with 30 questions worth 150 marks. The test has two types of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	
6.	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server. 7. Write Python Program to study image morphological operations.	Module 6

Suggested list of course projects:

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

Note:

1. Use of free cloud service such as Google Colab to run python scripts is encouraged.

2. Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Term Work (25-Marks):

At least **12 experiments and 01 course project** should be performed. Term work assessment must be based on the overall performance of the student with every experiment and project graded from time-to-time. The grades will be converted to marks as per "**Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini Project 1B	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM401	Mini Project 1B	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

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

Outcome: At the end of the course learners will be able to…

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

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

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

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

One-year project:

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

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

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

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

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini Project shall be assessed based on following points;

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

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1B, in case it is half-year project.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	04$	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	-	-	-	25	25	50

$ indicates work load of Learner (Not Faculty), for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course pre-requisite:

1. ECM301 – Mini-Project 1A
2. ECL304 – C++ and Java Programming
3. ECC302 – Electronic Devices and Circuit

Course 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.

Course Outcomes:

After successful completion of the course student will be able to

1. Write basic codes for the Arduino board using the IDE for utilizing the onboard 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.

Experiment No.	Unit No.	Section A: Arduino Board	Hrs.
EX.1.0		**Introduction to Arduino Board**	**02**
	1.1	**Introduction to Arduino Uno board and integrated development environment (IDE**	
	1	**Write the code for blinking the on board led with a specified delay** Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software.	
EX.2.0		**GPIO (along with Analog pin) Programming**	**04**
	2.1	**Introduction to programming GPIO, Analog and PWM PINS.**	
	1	**Interface any Digital Sensors to the Arduino board and display sensor values on serial Monitor.**	
	2	**Interface any Analog sensor to the Arduino board and display sensor values on serial Monitor.**	
	3.	**Generate varying duty cycle PWM using Arduino.**	
EX.3.0		**Controlling output devices/Displaying**	**04**
	3.1	**Introduction to different sensor (Analog and Digital), Relays, Motors and display.**	
	1	**Interface an Analog Sensors to the Arduino board and display sensor values on LCD/TFT/Seven segment Display.**	
	2	**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**	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**Interface Wi-Fi /Bluetooth/GSM/Zigbee/RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from the above-mentioned modules needs to be interfaced.**	
5.0		**Sample Projects**	**10**
	1.	**Waste Management System**	
	2.	**Smart City Solutions**	
	3.	**Energy Monitoring Systems**	
	4.	**Smart Classrooms and learning Solutions**	
	5.	**Home security systems**	
	6.	**Smart Agriculture solutions**	
	7.	**Healthcare solutions.**	
	8.	**Industrial Applications**	
	9.	**IoT Applications**	
	10.	**Robotics**	
		Section 'A' Total Hrs.	**24**

Experiment No.	Unit No.	Section B: Raspberry Pi	Hrs.
EX.1.0		**Introduction to Raspberry PI**	**02**
	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.**	
	1	**Familiarization with Raspberry PI and perform necessary software installation.** Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power adapter, Memory Writer. Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.	

EX.2.0		**Interfacing with Input / Output Devices using Python**	**04**
	2.1	**Introduction to Python, Connecting to the outside World with GPIO.**	
	1	**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.	
	2	**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.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR).	
	3.	**To interface analog sensor using MCP 3008 analog to digital converter chip.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip.	
EX.3.0		**Interfacing Temperature Sensor, Motors, Display Devices.**	**04**
	3.1	**Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits.**	
	1	**To interface 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.	
	2	**To interface motor using relay with Raspberry PI and write a program to turn ON motor when push button is pressed.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors.	
	3	**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.	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**To interface Bluetooth/Zigbee/RFID/WiFI with Raspberry PI and write a program to send sensor data to smartphone using Bluetooth/Zigbee/RFID/WIFI. (Any one can be used for performing)** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/Zigbee/RFID/WIFI.	
	2	**Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry PI**	
	3	**Write a program on Raspberry PI to upload temperature and humidity data from thingspeak cloud.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thingspeak (open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.	
EX.5.0		**Understanding of Communication Protocols**	**04**
	5.1	**Introduction to MQTT, IFTTT protocols and configuration steps.**	
	1	**Write a program on Raspberry PI to publish temperature data to MQTT broker**	
	2	**Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.**	
	3	**Configuration of Webserver using Raspberry PI.**	
6.0		**Sample Projects**	**10**
	1.	**MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud**	
	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**	
	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**	
	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 Color Sensor TCS3200**	
	15.	**Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor**	
	16.	**Call and Text using Raspberry Pi and GSM Module**	
	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**	
	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**	
		Section 'B' Total Hrs.	**28**
		Total A + B	**52**

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)

Software Tools:

1. Raspbian OS: https://www.raspberrypi.org/downloads/
2. Win32 Disk Imager: https://sourceforge.net/projects/win32diskimager/
3. SD Card Formatter: https://www.sdcard.org/downloads/formatter/
4. 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/tutorial-search/?search_foss=Arduino&search_language=English
7. Teachers are recommended to use a free online simulation platform “Tinkercad” for the simulation of Arduino based circuits before the students implement it in the hardware: https://www.tinkercad.com/

AC 29/6/2021
Item No. 6.5

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

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

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

AC 29/6/2021
Item No. 6.5

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year in Bachelor of Electronics and Telecommunication Engineering**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	~~New~~ / **Revised** (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date **29-06-2021**

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

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

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

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

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

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 'C' Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS 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 analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Third Year Engineering
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC501	Digital Communication	3	--	--	3	--	--	3
ECC502	Discrete Time Signal Processing	3	--	--	3	--	--	3
ECC503	Digital VLSI	3	--	--	3	--	--	3
ECC504	Random Signal Analysis	3	--	1	3	--	1	4
ECCDLO 501X	Department Optional Course-1	3	--	--	3	--	--	3
ECL501	Digital Communication Lab	--	2	--	--	1	--	1
ECL502	Discrete Time Signal Processing Lab	--	2	--	--	1	--	1
ECL503	Digital VLSI Lab	--	2	--	--	1	--	1
ECL504	Professional Communication & Ethics - II	--	2*+2~	--	--	2	--	2
ECM501	Mini Project 2A- Embedded System Project	--	4$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

*** Theory should be conducted for the full class.**

~ Batch-wise practical's to be conducted

$ Indicates work load of a learner (Not Faculty) for Mini Project 2A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC501	Digital Communication	20	20	20	80	3	--	--	100
ECC502	Discrete Time Signal Processing	20	20	20	80	3	--	--	100
ECC503	Digital VLSI	20	20	20	80	3	--	--	100
ECC504	Random Signal Analysis	20	20	20	80	3	25	--	125
ECCDLO 501X	Department Level Optional Course-1	20	20	20	80	3	--	--	100
ECL501	Digital Communication Lab	--	--	--	--	--	25	25	50
ECL502	Discrete Time Signal Processing Lab	--	--	--	--	--	25	25	50
ECL503	Digital VLSI Lab	--	--	--	--	--	25	25	50
ECL504	Business Communication and Ethics Lab	--	--	--	--	--	25	25	50
ECM501	Mini Project 2A- Embedded System Project	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

Department Level Optional Course-1

Course Code	Department Level Optional Course-1
ECCDLO5011	Digital and IPTV Engineering
ECCDLO5012	Data Compression and Cryptography
ECCDLO5013	IT Infra and Security
ECCDLO5014	Data Structures and Algorithm
ECCDLO5015	Sensor Technology

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC601	Electromagnetics and Antenna	3	--	--	3	--	--	3
ECC602	Computer Communication Networks	3	--	--	3	--	--	3
ECC603	Image Processing and Machine Vision	3	--	--	3	--	--	3
ECC604	Artificial Neural Network and Fuzzy Logic	3	--	--	3	--	--	3
ECCDLO 601X	Department Level Optional Course-2	3	--	--	3	--	--	3
ECL601	Electromagnetics and Antenna Lab	--	2	--	--	1	--	1
ECL602	Computer Communication Networks Lab	--	2	--	--	1	--	1
ECL603	Image Processing and Machine Vision Lab	--	2	--	--	1	--	1
ECL604	Skill Lab: Linux and Networking and Server Configuration	--	4	--	--	2	--	2
ECM601	Mini Project 2B- FPGA based Project	--	4$	--	--	2	--	2
Total		**15**	**14**	**--**	**15**	**07**	**--**	**22**

$ Indicates work load of a learner (Not Faculty) for Mini Project 2B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC601	Electromagnetics and Antenna	20	20	20	80	3	--	--	100
ECC602	Computer Communication Networks	20	20	20	80	3	--	--	100
ECC603	Image Processing and Machine Vision	20	20	20	80	3	--	--	100
ECC604	Artificial Neural Network and Fuzzy Logic	20	20	20	80	3	--	--	100
ECCDLO 601X	Department Level Optional Course-2	20	20	20	80	3	--	--	100
ECL601	Electromagnetics and Antenna Lab	--	--	--	--	--	25	25	50
ECL602	Computer Communication Networks Lab	--	--	--	--	--	25	25	50
ECL603	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50
ECL604	Skill Lab: Linux and Networking and Server Configuration	--	--	--	--	--	25	25	50
ECM601	Mini Project 2B- FPGA based Project	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**125**	**750**

Department Level Optional Course-2

Course Code	Department Level Optional Course-2
ECCDLO6011	Mixed Signal VLSI
ECCDLO6012	Computer Organization and Architecture
ECCDLO6013	Digital Forensic
ECCDLO6014	Database Management System
ECCDLO6015	IoT and Industry 4.0
ECCDLO6016	Radar Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC501	Digital communication	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC501	Digital communi-cation	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC401 - Engineering Mathematics-IV
ECC404 - Signals and Systems
ECC405 - 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:

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

1. Apply the concepts of information theory in source coding.
2. Compare different error control systems and apply various error detection codes.
3. Analyze 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.	Unit No.	Topics	Hrs.
1.0		**Information Theory and Source Codes**	**05**
	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.	03
	1.2	Introduction of source code, Huffman code, Shannon-Fano code.	02
2.0		**Error Control System and Error Detection Codes**	**03**
	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.	01
	2.2	Error detection codes: Vertical Redundancy Check (VRC) code, Longitudinal Redundancy Check (VRC) code, Cyclic Redundancy Check (CRC) code and Checksum code.	02
3.0		**Error Correction Codes**	**10**
	3.1	Linear block 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
	3.2	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
4.0		**Baseband Transmission**	**05**
	4.1	Block diagram of baseband transmitter-receiver system, Line codes (RZ and NRZ UniPolar 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.	03
	4.2	Inter Symbol Interference (ISI), Inter Channel Interference (ICI). Nyquist criterion for distortionless baseband binary transmission, Nyquist bandwidth and practical bandwidth.	02
5.0		**Optimum Detection of Baseband Signal**	**04**
	5.1	Matched filter, Output SNR, Transfer function, Impulse response and Error probability. Integrate and dump receiver, Correlator receiver.	04
6.0		**Digital Modulations**	**12**
	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 modulations: Binary ASK, Binary PSK, Quadrature PSK, Off-Set QPSK, M-ary PSK, Binary FSK, M-ary FSK, 16-ary QASK and MSK.	12
		Total	**39**

Text Books:

1.H. Taub, D. Schlling, and G. Saha-Principles of Communication Systems, Tata Mc- Graw Hill, New Delhi, Third Edition, 2012.
2. Lathi B P, and Ding Z-Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017.
3. Haykin Simon-Digital Communications, John Wiley and Sons, New Delhi, Fourth Edition, 2014.
4. John G. Proakis-Digital Communications, McGraw-Hill, Fourth Edition

Reference Books:

1. Sklar B, and Ray P. K.-Digital Communication: Fundamentals and applications, Pearson,Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. T L Singal-Analog and Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2012.
3. P Ramakrishna Rao-Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2011.
4. K. Sam Shanmugam-Digital and analog communication Systems, John Wiley and sons.
5. Upamanyu Madhow- Fundamentals of Digital Communication- Cambridge University Press
6. W.C. Huffman, Vera Pless- Fundamentals of Error Correcting Codes, Cambridge University Press
7. Graham Wade-Coding Techniques, Palgrave, New York

NPTEL / Swayam Course:

1. https://nptel.ac.in/courses/108/101/108101113/
2. https://nptel.ac.in/courses/108/102/108102096/
3. https://nptel.ac.in/courses/108/102/108102120/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC502	Discrete-Time Signal Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC502	Discrete-Time Signal Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC404 Signals & Systems

Course Objectives:

1. To develop a thorough understanding of discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2. To design and realize IIR filters and FIR filters, gain an appreciation for the tradeoffs 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 audio signal processing.

Course Outcomes:

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

1. Recall the system representations and understand the relation between different transforms.
2. Understand the concepts of discrete-time 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 and pole-zero representations to choose a particular filter for the given application.
4. Interpret the different realization structures of Digital IIR and FIR filters.
5. Analyze the impact of hardware limitations on the performance of digital filters.
6. Apply signal processing concepts, algorithms in applications related to the field of biomedical and audio signal processing.

Module No.	Unit No.	Topics	Hrs.
1.0		**Discrete Fourier Transform & Fast Fourier Transform**	**08**
	1.1	Discrete Fourier transform (DFT), DFT as a linear transformation, Properties of the DFT, Relationship of the DFT to other transforms, Filtering of long data sequences: Overlap-Save and Overlap-Add Method	05
	1.2	Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	03
2.0		**IIR Digital filters**	**08**
	2.1	LTI systems as frequency-selective filters like low pass, high pass, band pass, notch, comb, all-pass filters, and digital resonators, Analog filter approximations: Butterworth, Chebyshev I, Elliptic	03
	2.2	Mapping from s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations	05
3.0		**FIR Digital Filters**	**09**
	3.1	Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and mixed phase systems	04
	3.2	Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Bartlett), Design of FIR filters using Frequency Sampling Technique – Type I low pass filter design, Comparison of IIR and FIR filters	05
4.0		**Digital Filter Structures**	**05**
	4.1	Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure, Computational complexities for N length filter	02
	4.2	Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter	03
5.0		**Finite Word Length Effects in Digital Filters**	**05**
	4.1	Rounding and truncation errors, Quantization error, Output noise power from a digital system	02
	4.2	Product quantization, Noise model for direct form and cascaded IIR structure (first order), Coefficient quantization error and zero input limit cycle	03
6.0		**Applications of Digital Signal Processing**	**04**
	6.1	Application of DSP for ECG and EEG signals analysis.	02
	6.2	Application of DSP for echo cancellation and sub-band coding of speech signal	02
		Total	**39**

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", Prentice-Hall 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.

NPTEL / Swayam Course:

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/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC503	Digital VLSI	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC503	Digital VLSI	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC302 – Electronic Devices and Circuits
ECC303 – Digital System Design
ECC403 – Linear Integrated Circuits

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 various tradeoffs.
4. To design, implement and verify combinational and sequential logic circuits using various MOS design styles.
5. To provides an exposure to RTL design and programming

Course Outcomes:

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

1. Know various tools and processes used in VLSI Design.
2. Explain working of various CMOS combinational and sequential circuits used in VLSI Design.
3. Derive expressions for performance parameters of basic building blocks like CMOS inverter.
4. Relate performance parameters with design parameters of VLSI circuits.
5. Select suitable circuit and design style for given application.
6. Design and realize various combinational and sequential circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Review of MOSFET operation and Fabrication**	**08**
	1.1	Overview of VLSI Design Flow, Review of MOSFET operation, MOSFET Capacitances, MOSFET scaling, Short channel effects	03
	1.2	Fabrication process flow of NMOS and CMOS, Lambda based design rules	03
	1.3	Novel MOSFET Architectures FinFET, GAA-FET, CNTFET	02
2.0		**Combinational CMOS Logic Circuits**	**06**
	2.1	CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins, Propagation Delay, Power Dissipation, Design of CMOS Inverter, Layout of CMOS Inverter	03
	2.2	Realization of CMOS NAND gate, NOR gate, Complex CMOS Logic Circuits, Layout of CMOS NAND, NOR and complex CMOS circuits	03
3.0		**MOS Design Logic Styles**	**09**
	3.1	Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, NORA, Zipper, C^2MOS	04
	3.2	Setup time, Hold time, clocked CMOS SR Latch, CMOS JK Latch, MS –JK Flip Flop, Edge triggered D-Flip Flop and realization using design styles	03
	3.3	Realization of Shift Register, MUX, Decoder using above design styles ,1-bit full adder	02
4.0		**Semiconductor Memories**	**06**
	4.1	ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM	03
	4.2	Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory	03
5.0		**Data path and system design issues**	**06**
	5.1	Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder, Array Multiplier	04
	5.2	On chip clock generation and distribution, Interconnect delay model, interconnect scaling and crosstalk	02
6.0		**RTL Design**	**04**
	6.1	High Level state machines, RTL design process	02
	6.2	RTL design of Soda dispenser machine, FIR Filter	02
		Total	**39**

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "*Digital Integrated Circuits: A Design Perspective*", Pearson Education, 2nd Edition.
3. Frank Vahid, "Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011.

Reference Books:

1. Neil H. E. Weste, David Harris and Ayan Banerjee, ―*CMOS VLSI Design: A Circuits and Systems Perspective*‖, Pearson Education, 3rd Edition.
2. John P. Uyemura, "*Introduction to VLSI Circuits and Systems*", Wiley, Student Edition, 2013.
3. R. Jacob Baker, "*CMOS Circuit Design, Layout and Simulation*", Wiley, 2nd Edition, 2013

NPTEL / Swayam Course:

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

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on completion of approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC504	Random Signal Analysis	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC504	Random Signal Analysis	20	20	20	80	03	25	--	125

Course Pre-requisite:

ECC401- Engineering Mathematics IV
ECC404 - Signals and Systems

Course Objectives:

1. To strengthen the foundations of probability
2. To teach continuous and discrete random variables.
3. To explain statistical behavior 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 and statistical learning.
5. To develop problem solving skills and explain how to make the transition from a real world problem to a probabilistic model.

Course Outcomes:

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

1. Apply theory of probability in identifying and solving relevant problems.
2. Differentiate continuous and discrete random variables and their distributions.
3. Analyze mean, variance, and distribution function of random variables and functions of random variables.
4. Define a random process, determine the type of the process and find the response of LTI system for WSS process.
5. Explain linear regression algorithms and apply for predictive applications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Basic Concepts in Probability**	**04**
	1.1	Definitions of probability, joint, conditional, and total probability, Bayes' theorem, independence of events, binary symmetric communication channel analysis using Bayes' theorem.	
2.0		**Introduction to Random Variables**	**08**
	2.1	Continuous, discrete, and mixed random variables, probability density function, probability distribution function, and probability mass function, properties of PDF and CDF	
	2.2	Special distributions- Binomial, Poisson, Uniform, Gaussian and Rayleigh Distributions Mean, variance and moments of random variables	
3.0		**Operations on One Random Variable**	**08**
	3.1	Function of a random variable and their distribution and density functions.	
	3.2	Expectation, variance, moments, and characteristic function of random variable.	
	3.3	Transformation of a random variable, Markov and Chebyshev inequality, characteristic functions, moment theorem.	
4.0		**Multiple Random Variables and Convergence**	**08**
	4.1	Pairs of random variables, joint CDF and joint PDF.	
	4.2	One function of two random variables; joint moments, covariance and correlation-independent, uncorrelated and orthogonal random variables.	
	4.3	Central limit theorem and its significance	
5.0		**Random Processes**	**06**
	5.1	Definitions, statistics of stochastic processes, n^{th} order distribution, second-order properties: mean and autocorrelation, Poisson process, normal processes, SSS, WSS.	
	5.2	Mean and correlation ergodic processes, transmission of WSS through LTI system, introduction to Markov process.	
6.0		**Introduction to Statistical Learning and Applications**	**05**
	6.1	Regression and model building, simple linear regression, multiple linear regression, least square estimation of the coefficients, residual calculations.	
	6.2	Applications of simple linear regression in prediction of new observations.	
		Total	**39**

Text Books:

1. T. Veerarajan, "Probability, Statistics and Random Process", Tata McGraw Hill Education, Third Edition (2018).
2. Athanasios Papoulis and S. Unnikrishna 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

4. Douglas C. Montgomery, Elizabeth A. Peck and G. Geoffrey Vining, “Introduction to linear regression Analysis”, student edition, Wiley publications.

Reference Books

1. Scott Miller and Donald Childers, “Probability and Random Processes with Applications to Signal Processing and Communications”, Elsevier Publication.
2. Hwei Hsu, “Theory and Problems of Probability, Random Variables, and Random Processes”, Schaum’s Outline Series, McGraw Hill, 1997.
3. P. Ramesh Babu, “Probability Theory and Random Process”, Tata McGraw Hill Education.
4. Alberto Leon Garcia, “Probability and Random Processes for Electrical Engineering”, second edition , Pearson education.
5. Daniela Witten, Trevor Hastie , Robert Tibshirani, “An Introduction to Statistical Learning by Gareth James”, 7th Edition, Springer 2017.
6. Ronald Walpole, et. al., “Probability and Statistics for Engineers and Scientists”, 8th edition, Pearson Education.
7. P. Kousalya, “Probability, Statistics, and Random Processes”, Pearson Education.

NPTEL / Swayam Course:

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

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Term Work (25-Marks):

At least 08 Tutorials covering entire syllabus must be given during the “Class Wise Tutorial”. Term work assessment must be based on the overall performance of the student with every tutorial graded from time to time. The grades will be converted to marks as per “Credit and Grading System” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5011	Digital and IP TV Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ECCDLO 5011	**Digital and IP TV Engineering**	20	20	20	80	03	--	--	100

Prerequisite:

1. Basics of various Television standards and operation
2. TCP/IP Protocol
3. Basics of conventional video camera and standards

Course Objectives:

1. To provide in depth knowledge about Digital Television system
2. To familiarize students' various types of advanced types of Video cameras and Displays
3. To introduce the students to different television standards and applications
4. Acquaintance with HDTV and 3D TV system
5. To familiarize the students to IPTV, Its architecture, Protocols and hardware
6. To Introduce students to IP delivery networks, threats and mitigation

Course Outcomes:

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

1) Understand the working principles of advanced digital television systems.
2) Enable to choose or develop an appropriate camcorder and displays based on applications.
3) Familiar with current digital TV standards.
4) Evaluate the Stereoscopic images and binocular depth perception.
5) Acquire knowledge of IPTV and develop hardware and protocols.
6) Ability to provide customized IPTV services to end user.

Module No	Unit No	Topics	Hrs
1		**Fundamentals of Digital Television**	**7**
	1.1	Fundamentals of colour television, Compatibility, and reverse compatibility, colour perception, Three colour theory, luminance, hue and saturation. Interlaced scanning, Composite video signal	
	1.1	Introduction to Digital TV, Digital TV signals and parameters	
	1.2	Digital TV transmitter and Receiver its merits and demerits	
	1.3	MAC Signals and advanced MAC Signal Transmission	
	1.4	Digitization, Chroma sub sampling, Digital audio compression techniques and video compression techniques MPEG1,MPEG2,H.264,MPEG- 4,AVC,H.265, SMPTE 421M,	
	1.5	Set Top Box with recording	
2		**Digital Video Cameras, Displays and Streaming media device**	**5**
	2.1	Colour TV Digital cameras, Camcorders, Handycams, and Digicams	
	2.2	LED, LCD, OLED, PLASMA, Quantum Dot LED Displays	
	2.3	Chromecast	
	2.4	Consumer applications: DVD, Blue ray DVD	
3		**Digital TV standards and advanced TV**	**8**
	3.1	DVB-T, and its successors	
	3.2	ISDB -T	
	3.3	ATSC	
	3.4	ISD TV	
	3.5	DTMB	
	3.6	Ultra HDTV	
	3.7	CCTV	
	3.8	Direct to Home TV(DTH)	
	3.9	Smart TV and its functions	
	3.10	3D TV	
4		**IPTV**	**6**
	4.1	Introduction to IPTV	
	4.2	IP TV hardware	
	4.3	Features of IPTV	
	4.4	Architecture of IPTV	
	4.5	Bandwidth requirement	
	4.6	IPTV Set top Box, Smart TV comparison	
5		**IP TV Protocols and Applications**	**9**
	5.1	Internet Group Management Protocol (IGMP)	
	5.2	Real-Time Streaming Protocol (**RTSP**)	
	5.3	Real-Time Messaging Protocol (**RTMP**)	
	5.4	Hypertext Transfer Protocol (HTTP).	
	5.5	Applications of IPTV	

	5.6	IPTV Delivery: Broad cast. Unicast, Multicast	
	5.7	IPTV Streaming: Time Shifted Stream-On -the- fly streaming	
	5.8	experimental framework used for evaluating the classification algorithm	
	5.9	Experimental framework for evaluating the classification algorithm (Self learning) Configuring IPTV to android phone, Tablet, Television and Computer(Self Learning)	
6		**IPTV Network Security: Threats and Countermeasures**	**4**
	6.1	Threats on IPTV Delivery Networks, Theft or Abuse of Network Assets, Theft of Service, Theft of IPTV-Related Data, Disruption of Service, Privacy Breach, Compromise of Platform Integrity	
	6.2	Security Issues of IPTV Delivery Networks: Protocols Vulnerabilities, Countering the threats	
	6.3	Advantages and disadvantages of IPTV	
	6.4	Future of IPTV	
		Total	**39**

Textbooks:

1.Television and video Engineering, A. M. Dhake, Tata McGraw Hill Publication.

2. Video Demystified, Kelth jack, Hand book for digital engineers, Newness, Elsevier

3.Digital Television Systems. Marcelo S. Alencar, Cambridge University Press

4.Understanding IPTV, Gilbert Held, CRC Press

Reference Books:

1.The digital evolution of Television, D. Gerbarg, Springer

2. Applications and Usability of interactive TV, Maris Jos Abisolo, Springer

3. IPTV Delivery network, Suliman Mohamed Fati, Saiful Azad, Al-Sakib Khan Pathan, Wiley Publications

4. Television Engineering & Video Systems, R. G. Gupta, McGraw Hill Publication

5. Quantum dot based light emitting diodes, Morteza Sasani Ghamsari, Google book

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO5012	Data Compression and Cryptography	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECCDLO5012	Data Compression and Cryptography	20	20	20	80	03	--	--	100

Course Objectives:

1. Gain a fundamental understanding of data compression methods for text, images, video and audio.
2. Understand the concepts of cryptography and different algorithms to provide system security.

Course Outcomes:

After successful completion of the course student will be able to

1. Apply various compression techniques for text and understand image compression and its standards.
2. Select suitable compression techniques for specified lossless and lossy audio and video applications.
3. Compare between symmetric and asymmetric cryptography and also describe different symmetric cryptographic techniques and standards.
4. Apply number theory concepts to solve the cryptographic problems.
5. Analyze different public key cryptography algorithms and also describe methods that provide the goals for integrity, confidentiality and authentication.
6. Describe system security facilities designed to protect a computer system from security threats and also appreciate ethical issues related to system security.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Data Compression**	**06**
	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.	
	1.2	Image Compression DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards.	
2.0		**Video and Audio Compression**	**06**
	2.1	Video compression: Motion compensation, temporal and spatial prediction, MPEG-4, H.264 encoder and decoder.	
	2.2	Sound, Digital Audio, μ-Law and A-Law Companding, MPEG –4 Audio Layer, Advanced Audio Coding (AAC) standard.	
3.0		**Data Security**	**10**
	3.1	Security Goals, Cryptographic Attacks and Techniques	
	3.2	Symmetric Key: Substitution Cipher, Transposition Cipher , Stream and Block Cipher	
	3.3	DES, double DES and triple DES, AES	
4.0		**Number Theory**	**04**
	4.1	Prime Numbers, Fermat's and Euler's Theorem.	
	4.2	Chinese Remainder Theorem	
5.0		**Asymmetric Key Cryptography**	**09**
	5.1	Principles of Public Key Crypto System, RSA, Key Management, Deffie-Hellman Key Exchange.	
	5.2	Message Integrity, Message Authentication and Hash Functions, SHA, HMAC, Digital Signature Standards.	
6.0		**System Security**	**04**
	6.1	Intrusion Detection System, Secure Electronic Transactions.	
	6.2	Firewall Design, Digital Immune systems, Biometric Authentication, Ethical Hacking.	
		Total	**39**

Textbooks:

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. 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.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5013	IT Infra & Security	**03**	--	--	**03**	--	--	**03**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 5013	IT Infra & Security	20	20	20	80	03	--	--	100

Course prerequisite:

- **Principles of Communication**

Course Objectives:

1. **To introduce basic fundamentals of IT Infrastructure and its Management.**
2. **To develop underlying principles of infrastructure security.**
3. **To explore software vulnerabilities and attacks.**
4. **To introduce the protection mechanisms for operating systems and database security.**
5. **To explore the security aspects of wireless network infrastructure and protocols.**
6. **To investigate the different attacks on Web Applications and Web services.**

Course Outcomes: Students will be able to:

1. **Understand IT Infrastructure and its Management.**
2. **Understand the concept of Information securities.**
3. **Summarize the concepts of vulnerabilities, attacks and protection mechanisms.**
4. **Analyze software vulnerabilities and attacks on databases and operating systems.**
5. **Explain the need for security protocols in the context of wireless communication.**
6. **Analyze the different attacks on Open Web Applications and Web services.**

Module No.	Unit No.	Topics	Hrs
1.0		**Overview of Networks and IT Infrastructure**	**09**
	1.1	**Overview of OSI and TCP/ IP Networks, introduction to IP Addressing scheme, introduction to Networking Components**	
	1.2	**Information Technology, Design Issues of IT Organizations and IT Infrastructure, Information System Design Process, IT Infrastructure Management, Challenges in IT Infrastructure Management, Determining Customers, Requirements, Security controls and safeguards, IT security Plans.**	
2.0		**Introduction to Information Security**	**06**
		Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC, MAC, RBAC, BIBA, Bell La Padula), Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	
3.0		**Software Vulnerabilities**	**04**
		Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits	
4.0		**Operating System and Database Security**	**08**
	4.1	**Introduction operating system security, system security planning, Application security, Linux/ Unix security, Windows, security, Security Maintenance,**	
	4.2	**Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security**	
5.0		**Wireless Security**	**05**
		The need for Wireless Network Security, Attacks on Wireless Networks, Security services, WEP & WPA protocols, Mobile IP, Virtual Private Network (VPN): PPTP, L2TP, IPSec	
6.0		**Web Security**	**07**
		Introduction: Transport Protocol and Data Formats, Web Browser, Threat Model **Authenticated Sessions: Cookie Poisoning, Cookies and Privacy, Making Ends Meet** **Code Origin Policies, Cross-Site Scripting: Cookie Stealing, Defending against XSS, Cross-Site Request Forgery, JavaScript Hijacking**	
		Total	**39**

Text Books:

1. **Gupta, "IT Infrastructure & Its Management", First Edition, Tata McGraw-Hill Education.**
2. **Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education**
3. **Computer Security, Dieter Gollmann, Third Edition, Wiley Publications.**
4. **Data Communications and Networking, Forouzan, Fourth Edition, Mc Graw Hill Publication**
5. **Wireless Networks, P. Nicopolitidis, M.S. Obaidat, G.I Papadimitriou, A.S Pomportsis, Wiley Publications**

Reference Books:

1. **Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education**
2. **CCNA Security Study Guide, Tim Boyle, Wiley Publications**
3. **Introduction to Computer Security, Matt Bishop, Pearson.**

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5014	Data Structure & Algorithm	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 5014	Data Structure & Algorithm	20	20	20	80	03	--	--	100

Course pre-requisite:

ECL404 Skill Lab: Python Programming

Course Objectives:

The course aims:

1. To Introduce the fundamental knowledge & need of Data Structures.
2. To Abstract the concept of Algorithm and these concepts are useful in problem solving.
3. To Implement fundamental knowledge and applications of Stack, Queue, Linked List, Trees, Graphs etc.
4. To Understand the working of different Sorting, Searching & Hashing techniques.
5. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Course Outcome:

After successful completion of the course the student will: -

1. Compare functions using asymptotic analysis and describe the relative merits of worst-, average-, and best-case analysis.
2. Apply various operations on Stack and Queue.
3. Ability to demonstrate the operation of Linked list.
4. Ability to demonstrate and apply Trees & Graph data structures.
5. Become familiar with various Sorting and Searching Algorithms and their performance characteristics.
6. Describe the hash function and concepts of collision and its resolution methods

Module No.	Unit No.	Topics	Hrs.
		Prerequisite: Control Structures, Arrays, Recursion, Pointers, Structures, Memory Allocation Techniques, Self-referential structures.	
1.0		**Introduction to Data Structure & Algorithm**	**5**
	1.1	Introduction to Data Structures, Concept of ADT, Types of Data Structures- Linear and Nonlinear, Operations on Data Structures.	
	1.2	Algorithm: Performance characteristics of algorithm, Importance of Algorithm Analysis, Complexity of an Algorithm, Introduction to Asymptotic Analysis and Notations.	
2.0		**Stack & Queue**	**8**
	2.1	Introduction to Stack, ADT of Stack, Operations on Stack, Array Implementation of Stack	
	2.2	Applications of Stack- Infix to Postfix Expression Conversion, Infix Expression to Prefix Expression Conversion, Postfix Expression Evaluation	
	2.3	Introduction to Queue, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction to Double Ended Queue	
	2.4	Applications of various types of Queue	
		Self-Learning Topic: Well form-ness of Parenthesis using Stack	
3.0		**Linked List**	**7**
	3.1	Introduction, Linked List v/s Array, Representation of Linked List, Types of Linked List - Singly Linked List, Doubly Linked List	
	3.2	Operations on Singly Linked List and Doubly Linked List	
	3.3	Singly Linked List Application-Polynomial Representation and Addition, Doubly Linked List Application	
		Self-Learning Topic: Stack and Queue using Singly Linked List	
4.0		**Trees & Graph**	**9**
	4.1	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree,	
	4.2	Applications of Binary Tree- Expression Tree, Huffman Encoding.	
	4.3	**Graph:** Introduction, Graph Terminology, Memory Representation of Graph, Operations Performed on Graph.	
	4.4	Graph Traversal, Breadth First Search, Depth First Search, Applications of the Graph, Shortest Path, Minimum Spanning Tree.	
5.0		**Searching & Sorting**	**6**
	5.1	**Searching:** Sequential Search, Index Sequential Search, Binary Search	
	5.2	**Sorting:** Bubble Sort, Quick Sort, Merge Sort	
		Self-Learning Topic: Selection Sort, Insertion Sort	
6.0		**Hashing**	**4**
	6.1	Hashing-Concept, Hash Functions, Common hashing functions	
	6.2	Collision resolution Techniques	
		Total	**39**

Text Books:

1. Jean Paul Tremblay, P. G. Sorenson, "Introduction to Data Structure and its Applications", McGraw-Hill Higher Education

2. "Fundamentals of Computer Algorithms" Ellis Horowitz, Sartaj Sahani and Sanguthevar Rajasekaran, Second Edition, Universities Press (India) Pvt. Ltd.

3. "Learning with Python" Allen Downey, Jeffrey Elkner, Chris Meyers, Dreamtech Press

Reference Books:

1. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984

2. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGrawHill Edition.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5015	Sensor Technology	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 5015	Sensor Technology	20	20	20	80	03	--	--	100

Course Pre-requisite:
1. FEC202 – Engineering Physics-II
2. ECC302 -- Electronic Devices & Circuits
3. ECC403 - Linear Integrated Circuits

Course Objectives:
1. To understand various physical parameters and its sensing techniques
2. To familiarize about MEMS sensors and Actuators
3. To introduce wireless sensing technologies
4. To develop understanding about signal conditioning using ADC and DAC
5. To provide insight into various sensor applications

Course Outcome:
After successful completion of the course student will be able to

1. Understand the transduction principal of various sensors.
2. Select sensors suitable for required application
3. Analyze wireless sensing techniques
4. Design the data acquisition system
5. Identify signal conditioning method for particular application
6. Create an application using various sensor technologies

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**03**
	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	
	1.2	**Criteria to choose a Sensor:** Accuracy, Environmental condition, Range, Calibration, Resolution , Cost and Repeatability	
	1.3	**Digital sensors** : Principle and its advantage over analog sensors	
	1.4	**Smart Sensors:** Low-power, Self –diagnostic and Self- calibration	
2.0		**Types of Sensors**	**09**
	2.1	**Temperature Sensors :** RTD, Thermocouple and Thermistors sensor	
	2.2	**Proximity Sensors :** Inductive (LVDT), Capacitive, Photoelectric and Ultrasonic sensors	
	2.3	**Chemical Sensors :** Gas , Smoke, Conductivity and pH sensor	
	2.4	**Other Sensors :** Optical, Infrared (IR), Sound, Motion , Pressure , Level , Moisture, Humidity, Laser , Image and GPS sensor	
3.0		**MEMS Sensors and Actuators**	**06**
	3.1	**MEMS SENSORS:** General design methodology, techniques for sensing, Pressure sensor , Mass Flow sensor , Acceleration sensor , Angular Rate sensor and Gyroscopes, Micro machined microphones, Chemical sensors, Taguchi Gas sensor, Combustible Gas sensors	
	3.2	**MEMS ACTUATORS:** Techniques for actuation, Digital Micro mirror Device, Micro Machined Valves	
4.0		**Wireless Sensing Technologies**	**05**
	4.1	**Bluetooth:** Concepts of Pico net, Scatter net, Link types, Network connection establishments	
	4.2	**ZigBee:** components, architecture, network topologies	
	4.3	**Ultra Wide Band (UWB), Near Field Communication (NFC) and RFID:** technical requirements, components and characteristics	
	4.4	**WLAN (WiFi) :** WLAN Equipment, WLAN topologies , IEEE 802.11 Architecture	
5.0		**Data Acquisition and Signal Conditioning**	**08**
	5.1	**Fundamentals of Data Acquisition:** Analog and Digital data acquisition system with different configurations, Data loggers, Noise and interference	
	5.2	**Signal Conditioning :** Wheatstone Bridge, Flash ADC, R2R DAC	
	5.3	Utilization of Signal conditioning circuits for Temperature, Pressure, Optical, Strain gauges, Displacement and piezoelectric Transducers	
6.0		**Sensor Applications**	**08**
	6.1	Onboard Automobile sensing system, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring, Biomedical Sensing Applications	
	6.2	Radio sensors for industrial applications, Radio Astronomy, Remote Sensing, Ground Penetrating Radars, Underwater sensing, LIDAR	
		Total	**39**

Textbooks:

1. D.V.S. Murthy, “Transducers and Instrumentation”, PHI Learning, 2nd Edition, 2013.
2. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
3. Antti V. Raisanen, Arto Lehto, “Radio Engineering for Wireless Communication and Sensor Applications”, Artech House mobile communications series, USA, 2003.

4. Sensors and Signal Conditioning, Ramon Pallas Areny, John G. Webster, 2nd edition, John Wiley and Sons, 2000.
5. Vijay K. Garg, "Wireless Communication and Networking", Morgan -Kaufmann Series in Networking, Elsevier, 2010.

Reference Books:

1. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Kirt Williams, Artech House, 2004.
2. Micro Electro Mechanical System Design, James J. Allen, Taylor and Francis, 2005
3. A.K. Sawhney, "A Course in Electrical and ElectronicMeasurements and Instrumentation", Dhanpatrai & Co., 19th Edition, 2011.
4. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020
5. Instrumentation Devices and System, C.S. Rangan, G.R. Sarma, V.S. Mani, TMH,1997.
6. Jacob Fraden Handbook of Modern Sensors Physics, Designs, and Applications Fourth Edition, Springer, 2010.

NPTEL / Swayam Course :
https://nptel.ac.in/courses/108/108/108108147/ https://www.youtube.com/watch?v=vjhp0zTXEsc

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL501	Digital Communication Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL501	Digital communication Lab	--	--	--	--	25	25	50

Course 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

Course outcomes:

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

1. Compare various source coding schemes
2. Design and implement different error detection codes
3. Design and implement different error correction codes
4. Compare various line coding techniques
5. Illustrate the impulse response of a matched filter for optimum detection
6. Demonstrate various digital modulation techniques

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

1. Huffman code generation
2. Shannon-Fano code generation
3. Vertical redundancy Check (VRC) code generation and error detection
4. Horizontal Redundancy Check (HRC) code generation and error detection
5. Cyclic redundancy Check (CRC) code generation and error detection
6. Checksum code generation and error detection
7. Compare the performances of HRC and Checksum
8. Linear block code generation and error detection
9. Error detection and correction using Hamming code virtual lab http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks_sm/labs/exp1/index.php
10. Cyclic code generation and error detection
11. Convolutional code generation

12. Line Codes generation and performance comparison
13. Spectrum of line codes (NRZ unipolar and polar)
14. Impulse responses of ideal (Nyquist filter) and practical (Raised cosine filter) solution for zero ISI
15. Matched filter impulse response for a given input
16. Generation (and detection) of Binary ASK
17. Generation (and detection) of Binary PSK
18. Generation (and detection) of Binary FSK
19. Generation (and detection) of QPSK
20. Generation (and detection) of M-ary PSK
21. Generation (and detection) of M-ary FSK
22. Generation (and detection) of 16-ary QASK
23. Generation (and detection) of MSK

Term Work, Practical and Oral:

At least 8 experiments covering the entire syllabus must be given "**Batch Wise"**. The experiments can be conducted with the help of simulation tool (preferably open source) and breadboard and components. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL502	Discrete-Time Signal Processing Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL502	Discrete-Time Signal Processing Laboratory	--	--	--	--	25	25	50

Course objectives:

1. To carryout 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.

Course outcomes:

Learners will be able to …

1. Perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results.
2. Demonstrate their ability towards interpreting and performing frequency analysis of different discrete time sequences and systems.
3. Design and implement the FIR and IIR Filters for given specifications.
4. Implement and analyse applications related to the field of biomedical signal processing and audio signal processing.

Suggested list of experiments:

1) To perform linear convolution of two signals, auto correlation of non-periodic signals, periodic signals and random noise and interpret the results obtained.
2) To linearly convolve swept frequency sinusoidal wave with LPF and HPF impulse response filters in time domain and interpret the results obtained.

3) To obtain cross correlation of a signal with its delayed and attenuated version (Concept of radar signal processing).
4) To perform block convolution using overlap - add method and overlap-save method.
5) To determine impulse, magnitude, phase response and pole-zero plot of given transfer functions.
6) To perform circular convolution and linear convolution of two sequences using DFT.
7) To perform the DFT of DT sequence and sketch its magnitude and phase spectrum or To Generate a discrete time signal having minimum three frequencies and analyse its frequency spectrum.
8) To study the effect of frequency resolution and zero padding.
9) DFT based spectral analysis to detect the signal buried in noise.
10) To perform denoising of a speech signal using circular convolution.
11) Design of IIR digital filters and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc).
12) Design a notch filter to supress the power supply hum in audio signals.
13) Design a comb filter to suppress 50Hz hum in biomedical signals.
14) Design of FIR filter using windowing method and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc.
15) Design of FIR filter using frequency sampling technique.
16) Design of minimum phase, maximum phase and mixed phase systems.
17) To verify the location of zeros in symmetric and antisymmetric FIR filters.
18) To reconstruct DT signals contaminated with sinusoidal interference using FIR filters.
19) To realise an IIR filter in cascade and parallel form.
20) To obtain lattice parameters of a given transfer function (FIR and IIR systems).
21) To perform coefficient quantisation using truncation and rounding.
22) To study the effect of coefficient quantisation on the frequency response of an IIR filter.
23) To study the effect of coefficient quantisation on the frequency response of an FIR filter.
24) To investigate the behaviour of limit cycle in an IIR system.
25) To generate the ECG signal and detect the characteristic points.
26) Classification of ECG signals.
27) To read an ECG signal and separate the QRS Complex.
28) To filter out the noise in an ECG signal using Spectral subtraction.
29) To extract delta, theta, alpha, sigma, and beta waveforms from EEG signal.
30) Perform sub-band coding on speech signal.
31) To generate Echo, Reverberation, Flanging effects in a sound signal.
32) Musical tone generation.
33) DTMF tone generation and detection.
34) Echo cancellation.

Also check

Virtual Laboratory http://vlabs.iitkgp.ernet.in/dsp/# for demonstration of concepts like DFT and its inverse, FIR filter using windowing method etc

Term Work:

At least 08 experiments covering the entire syllabus must be given "Batch Wise" and implemented using any software namely C, Python, Scilab, Matlab, Octave, etc. The experiments should be set to have well predefined inference and conclusion. Application oriented one course-project can be conducted for maximum batch of four students. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and averaged. Based on above scheme, grading and term work assessment should be done. Practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 08 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL503	Digital VLSI Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL503	Digital VLSI Lab	--	--	--	--	25	25	50

Course objectives:

1. To become familiar with open source circuit simulation tools like Ngspice, Magic etc.
2. To perform various type of analysis of combinational and sequential CMOS circuits
3. To evaluate performance of given combinational and sequential CMOS circuits
4. To design, implement and verify combinational and sequential CMOS circuits using open source VLSI design tools.

Course outcomes:

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

1. Write spice code for given combinational and sequential CMOS circuits.
2. Perform various analysis like operating point, dc, transient etc of given CMSO circuits.
3. Evaluate performance of given CMOS circuits.
4. Draw layout of given CMOS circuit and also able extract various parasitic using open source layout tool like Magic.
5. Design, simulate, and verify CMOS circuit for given specifications.

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

1. Constant Voltage and Constant field MOSFET scaling
2. Layout of MOSFET and extraction of parasitic capacitances
3. Voltage transfer characteristics of CMOS inverter and calculation of Noise Margin and static power
4. Transient Analysis of CMOS inverter and calculation of tpHL, tpLH, tr, tf, average power
5. Design of CMOS inverter for given specifications
6. Layout of CMOS inverter and comparison of pre layout and post layout performance.
7. Voltage transfer characteristics of 2 input NAND/NOR gate and calculation of noise margins and validation using equivalent inverter approach.
8. Transient Analysis of 2 input NAND/NOR CMOS gate and calculation of tpHL, tpLH, tr, tf, average power and validation using equivalent inverter approach.

9. Layout of 2 input CMOS NAND/NOR gate and comparison of pre layout and post layout performance.
10. Static and transient analysis of Complex CMOS gate.
11. Layout of complex CMOS gate using euler path.
12. Implementation of various combinational and sequential circuits using different design styles.
13. Design and implementation of NAND based and NOR based ROM array.
14. Performance analysis of 6T-SRAM Cell
15. Design of 6T SRAM cell robust read and write operation.
16. Performance analysis of 1T and 3T DRAM Cell
17. RTL design of Soda dispenser machine
18. RTL design of FIR Filter

Link for virtual lab
http://www.vlsi-iitg.vlabs.ac.in

Term Work, Practical and Oral:

At least 8 experiments (at least three experiments on layout) covering the entire syllabus must be given "**Batch Wise"**. The experiments can be conducted with the help of simulation tool (preferably. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECL504	Professional Communication & Ethics-II	--	2*+ 2 Hours (Batch-wise)	--	--	2	--	02

***Theory class to be conducted for full class.**

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Internal Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ECL504	Professional Communication & Ethics-II (abbreviated PCE-II)	--	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
ECL504	Business Communication & Ethics	02
Course Rationale	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.	
Course Objectives	• To discern and develop an effective style of writing important technical/business documents. • To investigate possible resources and plan a successful job campaign. • To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement. • To develop creative and impactful presentation skills. • To analyze personal traits, interests, values, aptitudes and skills. • To understand the importance of integrity and develop a personal code of ethics.	

Course Outcomes	Learner will be able to… • plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles. • strategize their personal and professional skills to build a professional image and meet the demands of the industry. • emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. • deliver persuasive and professional presentations. • develop creative thinking and interpersonal skills required for effective professional communication. • apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module	Contents	Hours
1	**ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)** **1.1 Purpose and 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) **1.2. Parts of a Long Formal Report:** • Prefatory Parts (Front Matter) • Report Proper (Main Body) • Appended Parts (Back Matter) **1.3. Language and Style of Reports** • Tense, Person & Voice of Reports • Numbering Style of Chapters, Sections, Figures, Tables and Equations • Referencing Styles in APA & MLA Format • Proofreading through Plagiarism Checkers **1.4. Definition, Purpose & Types of Proposals** • Solicited (in conformance with RFP) & Unsolicited Proposals • Types (Short and Long proposals) **1.5. Parts of a Proposal** • Elements • Scope and Limitations • Conclusion	**06**

	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	
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) **2.2 Statement of Purpose** • Importance of SOP • Tips for Writing an Effective SOP **2.3 Verbal Aptitude Test** • Modelled on CAT, GRE, GMAT exams **2.4. Group Discussions** • Purpose of a GD • Parameters of Evaluating a GD • Types of GDs (Normal, Case-based & Role Plays) • GD Etiquettes **2.5. 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	**06**
3	**BUSINESS MEETINGS** **1.1. Conducting Business Meetings** • Types of Meetings • Roles and Responsibilities of Chairperson, Secretary and Members • Meeting Etiquette **3.2. Documentation** • Notice • Agenda • Minutes	**02**

4	**TECHNICAL/ BUSINESS PRESENTATIONS** **1.1 Effective Presentation Strategies** • Defining Purpose • Analyzing Audience, Location and Event • Gathering, Selecting &Arranging Material • Structuring a Presentation • Making Effective Slides • Types of Presentations Aids • Closing a Presentation • Platform skills **1.2 Group Presentations** • Sharing Responsibility in a Team • Building the contents and visuals together • Transition Phases	**02**
5	**INTERPERSONAL SKILLS** **1.1. Interpersonal Skills** • Emotional Intelligence • Leadership & Motivation • Conflict Management & Negotiation • Time Management • Assertiveness • Decision Making **5.2 Start-up Skills** • Financial Literacy • Risk Assessment • Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	**08**
6	**CORPORATE ETHICS** **6.1Intellectual Property Rights** • Copyrights • Trademarks • Patents • Industrial Designs • Geographical Indications • Integrated Circuits • Trade Secrets (Undisclosed Information) **6.2 Case Studies** • Cases related to Business/ Corporate Ethics	**02**

List of assignments:
(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal

3. Meeting Documentation
4. Writing a Technical Paper/ Analyzing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain 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.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments.

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

Assignment : 10 Marks
Attendance : 5 Marks
Presentation slides : 5 Marks
Book Report (hard copy) : 5 Marks

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

Internal oral:

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

Group Discussion : 10 marks
Project Presentation : 10 Marks
Group Dynamics : 5 Marks

Books Recommended:

Textbooks and 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. Bovée, C. L., &Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow,

England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM501	Mini Project 2A: Embedded System Project	--	04[$]	--	--	02	--	02

$ Indicates work load of a learner (Not Faculty) for Mini Project 2A. Faculty Load: 1 hour per week per four groups.

Subject Code	Subject Name	Examination Scheme						
		Theory Marks						
		Internal Assessment			End Sem. Exam	Term Work	Practical and Oral	Total
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECM501	Mini Project 2A: Embedded System Project	--	--	--	--	25	25	50

Course Pre-requisite:

1. ECC402- Microcontrollers
2. ECC403- Linear Integrated Circuits
3. ECM401- Mini Project 1B: Arduino & Raspberry Pi based Projects

Course Objectives

1. To develop background knowledge Embedded Systems.
2. To understand designing 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

Course Outcomes

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

1. Understand the embedded systems with design metrics.
2. Understand microcontrollers and programming in Embedded C.
3. Implementation of Embedded systems with different sensors and peripherals as IoT.
4. Implementation of 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

A. Guideline to maintain quality of mini project are as follows :

1. To achieve proper selection of Mini Projects.Students should do 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 mini 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 mini project activities; 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.
6. **Suggested steps for mini project selection and implementation**
    i. Mini project should be completely microcontroller based
    ii. 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 FOUR (04)** 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.

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)

<u>Term Work:</u>

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 mini 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 Mini Project- 2-A 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. <u>Distribution of 25 Marks scheme</u> 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 Mini Project Practical/Oral Examination:

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

Students shall be motivated to present their mini project work done

1. Participate in Project Competition
2. Publish paper in Conferences/Journals.

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction**	**8**
	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.	
	1.2	Identification of Project Title	
2		**Controller boards and Programming – Embedded C**	**8**
	2.1	ARM LPC 21XX (2148), STM32 boards and Texas MSP 430 lunchbox/ Tiva C board and **PIC/PSoc***	
	2.2	Comparison of C and embedded C, Data Types, Variable, Storage Classes, Bit operation , Arrays, Strings, Structure and unions, Classifier	
	2.3	**Exercise:** Identify the suitable board required for the particular application with 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-select-the-microcontroller-for-your-new-product/	
3		**Interfacing Sensors and peripherals using Embedded C**	**10**
	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)	
	3.2	Interfacing with BLDC motors and drivers, USB/HDMI camera interfacing	
	3.3	**Exercise :** Understand the Interfacing requirement like drivers, signal condition circuits for sensors, etc. for the selected application	
	3.4	**Study Material : For LCD interfacing with MSP430 LaunchPad** 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.	
4		**Communication with programming in Embedded C**	**10**
	4.1	Serial communication, CAN bus, I2C, MOD bus, SPI	
	4.2	Interfacing with Wi-Fi, Bluetooth ,ZigBee, LoRa, RFID and putting data on IoT	
	4.3	Interfacing with GSM module , GPS module, SD card	
	4.4	**Exercise:** Understand Communication requirement for selected application and test it	

	4.5	**Study Material :** Serial Communication Interface: **STM32:**https://controllerstech.com/serial-transmission-in-stm32/#:~:text=Serial%20Transmission%20in%20Stm32&text=UART%20is%20widely%20used%20for,amongst%20which%20communication%20is%20done. **LPC2148:** https://www.electronicwings.com/arm7/lpc2148-uart0 **MSP430:** https://www.ti.com/lit/ml/slap117/slap117.pdf	
5		**Real Time Operating Systems[RTOS]**	**08**
	5.1	Operating system basics , Types of OS , Tasks, process, Threads	
	5.2	Multiprocessing and ,Multitasking , Task scheduling	
	5.3	RTLinux/ Free RTOS and Mbed OS , Implementation with RTOS	
6		**Cloud/Web server**	**08**
	6.1	Implementation on web server ,	
	6.2	Thingspeak, AWS cloud platform for IoT based programming and modelling	
	6.3	**Exercise : perform ESP8266 interface with microcontroller**	
	6.4	**Study Material :** **STM32:** https://circuitdigest.com/microcontroller-projects/interfacing-esp8266-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-email-using-msp430-and-esp8266	
		Total	**52**

NOTE:

* **Advanced Microcontroller:** Like PSoc and PIC may be used as per the student's intellectual ability and strength.

** **Module 5 and 6 (RTOS and Cloud/Web Server):** Can be included by Guide /supervisor /Mentor depending upon need and scope of the project for selected topic and its application.

Textbooks:

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. Dr. K.V.K.K. Prasad, "Embedded Real Time Systems: Concepts, Design & Programming",Dreamtech Publication.
5. Iyer, Gupta," Embedded real systems Programming", TMH
6. David Simon, "Embedded systems software primer',Pearson
7. Andrew Sloss, Dominic Symes and Chris Wright, "ARM_System_Developers_Guide-Designing_and_Optimizing_System_Software" Elsevier and Morgan Kaufmann Publishers.
8. Michel J Pont "Embedded C" Pearson

Suggested Software tools:

1. Tinkercad : https://www.tinkercad.com/
2. Proteus software
3. KEIL for ARM LPC 2148
4. **STM32Cube software**

5. MSP Flasher - Command Line Programmer
6. msp430 code composer studio

Online Repository:

1. https://circuitdigest.com
2. www. Github.com
3. https://www.electronicshub.org
4. https://www.hackster.io/

NPTEL Courses:

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**
   https://www.udemy.com/course/mastering-microcontroller-with-peripheral-driver-development/?gclid=CjwKCAjw07qDBhBxEiwA6pPbHslLI-EqmAv7E17ysZETbreXe0XMb8Nai4NBqpUAvni5v-3fLKsfNBoC8LQQAvD_BwE&matchtype=b&utm_campaign=LongTail_la.EN_cc.INDIA&utm_content=deal4584&utm_medium=udemyads&utm_source=adwords&utm_term=_.ag_82876601447_.ad_511749008336_.kw_%2Bembedded+%2Bsystems+%2Bcourse_.de_c_.dm__.pl__.ti_kwd-671751469914_.li_1007785_.pd__.
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

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC601	Electromagnetics and Antenna	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC601	Electromagnetics and Antenna	20	20	20	80	03	--	--	100

Pre-requisites:

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

Course Objective: The objective of the course is to make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Course Outcome: Student will be able to:

1. Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations.
2. Students will be able to apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4. Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Static fields**	**06**
	1.1	Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation	
	1.2	Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations	
	1.3	Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential	
2.0		**Electromagnetic Field and Maxwell's Equations**	**09**
	2.1	Faraday's Law, Displacement current density, Maxwell's equation for time varying filed, Boundary conditions.	
	2.2	EM wave propagation through lossy, perfect dielectric and conducting medium.	
	2.3	Power in EM Wave: Poynting theorem and Poynting vector	
3.0		**Basic of Antennas**	**08**
	3.1	Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential	
	3.2	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	
	3.3	Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna	
4.0		**Antenna Arrays**	**06**
	4.1	Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication	
	4.2	Introduction to Planner and circular arrays Introduction to array synthesis using Binomial array	
5.0		**Types of antennas**	**06**
	5.1	Yagi antenna, Broadband antenna like Helical and Log Periodic antenna Horn Antennas**:** E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn	
	5.2	Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector	
	5.3	Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch)	
6.0		**Electromagnetic Wave Propagation**	**04**
	6.1	Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation	
		Total	**39**

Textbooks:

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
2. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V.Kulkarni, Oxford university press, 6th edition
3. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th edition
4. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
5. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

Reference Books:

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC602	Computer Communication Networks	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC602	Computer Communication Networks	20	20	20	80	03	--	--	100

Course pre-requisite:

ECC: 405– Principles of communication engineering

ECC: 501-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:

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

1. Analyze 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. Judge network layer addressing and routing schemes
5. Analyze connection oriented and connectionless services
6. Apply the knowledge of application layer protocols

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Network Architectures, Protocol Layers, and Service models**	**06**
	1.1	Applications of computer networks. Network types: LAN, MAN, and WAN, Network topologies.	
	1.2	Protocols and standards, need of layered protocol architecture, OSI reference model.	
	1.3	TCP/IP architecture: protocol suite, comparison of OSI and TCP/IP	
	1.4	Layer wise network hardware devices (NIC, Repeaters, Hubs, Bridges, Switches, Routers, Gateway and their comparison)	
	1.5	Addressing: physical / logical /port addressing/socket addressing.	
2.0		**Physical Layer**	**04**
	2.1	Guided transmission media: comparison among coaxial, optical fiber and twisted pair cables.	
	2.2	Unguided transmission media	
	2.3	Transmission impairments	
	2.4	Broadband standards: Cable modem, DSL, and HFC	
3.0		**Data Link Layer**	**07**
	3.1	Data link services: Framing, Flow control, Error control	
	3.2	ARQ methods: transmission efficiency, Piggybacking	
	3.3	High Level Data Link Control (HDLC): HDLC configurations, Frame formats, HDLC bit stuffing and de-stuffing, Typical frame exchanges.	
	3.4	Medium Access Control Protocols: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4.0		**Network Layer**	**12**
	4.1	Introduction to telephone networks and circuit switching principles.	
	4.2	Introduction to data networks and packet switching principles.	
	4.3	Network layer services and functions.	
	4.4	Internet Protocol: Principles of Internetworking, requirements, IPv4 packet, IPv4 addressing (classful and classless (CIDR))	
	4.5	Routing in Packet Switching Networks: Characteristics, Routing strategies	
	4.6	Routing algorithms: Link state Routing, Distance vector Routing and Path vector routing, Routing protocols: RIP, OSPF, BGP and EIGRP.	
	4.7	Subnetting, supernetting, VLSM, and NAT	
	4.8	Introduction to ICMP, ARP, RARP	
	4.9	IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6).	
	4.10	Quality of service	
5.0		**Transport Layer**	**06**
	5.1	Connectionless and Connection–oriented services at transport layer, Transmission Control Protocol (TCP): TCP Services, TCP Segment, TCP three way handshake	
	5.2	User datagram Protocol (UDP), UDP Services, UDP Datagram	
	5.3	TCP and UDP checksum calculation	
	5.4	Flow control, error control and congestion control	

6.0		**Application Layer**	**04**
	6.1	Introduction to Application layer Protocols: HTTP, FTP, DNS, SMTP, TELNET, SSH, DHCP.	
Total			**39**

Text books:

1. Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition TMH, 2013.
2. Computer Networks -- Andrew S Tanenbaum, 5th Edition, Pearson Education, 2013.
3. J J. F. Kurose and K. W. Ross," Computer Networking: A Top-Down Approach", Addison Wesley, 5th Edition, 2010

Reference books:

1. Alberto Leon Garcia, "Communication Networks", McGraw Hill Education, Second Edition, Fourth Edition, 2008.
2. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education, 2015.
3. Understanding communications and Networks, 3rd Edition, W.A.Shay, Cengage Learning
4. Data and Computer Communications, William Stallings, 10th Edition, Pearson Education, 2014.

Internal Assessment (IA):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.

3. Remaining questions will be mixed in nature and randomly selected from all the modules.

4.Total 04 questions need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC603	Digital Image Processing and Machine Vision	03	--	--	03	--	-	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC603	Digital Image Processing and Machine Vision	20	20	20	80	03	--	--	100

Prerequisites:

1. Signals and Systems
2. Discrete Time Signal Processing
3. Python Programming Skill Lab

Course Objectives:

1. To teach the fundamentals and mathematical models in digital image processing and Machine Vision
2. To teach quality enhancement of image through filtering operations
3. To teach the students image morphology and restoration techniques
4. To expose the students to segmentation techniques in image processing and Machine Vision
5. To teach the techniques of extracting image attributes like regions and shapes
6. To learn classification and recognition algorithms for machine vision

Course Outcomes:

After successful completion of the course student will be able to

1. Understand fundamentals of image processing and machine vision
2. Enhance the quality of image using spatial and frequency domain techniques for image enhancement
3. Learn image morphology and restoration techniques
4. Learn image segmentation techniques based on principle of discontinuity and similarity using various algorithms
5. Represent boundaries and shapes using standard techniques.
6. Classify the object using different classification methods

Module No.	Unit No.	Topics	Hrs.
1		**DIGITAL IMAGE FUNDAMENTALS AND POINT PROCESSING**	**04**
	1.1	Introduction –Steps in Digital Image Processing, concept of spatial and intensity resolution, Relationships between pixels	02
	1.2	**Point Processing :** Image Negative, Log Transform, Power Law transform, Bit plane slicing, Contrast stretching , Histogram equalization and Histogram Specification	02
2		**IMAGE ENHANCEMENT**	**08**
	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 Highboost Filtering, Using First-Order Derivatives —The Gradient- Sobel, Prewitt and Roberts	03
	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	03
3		**IMAGE MORPHOLOGY AND RESTORATION**	**06**
	3.1	**Morphology:** Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction , Hole filling, Thinning and thickening	04
	3.2	**Restoration** : A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering	02
4		**IMAGE SEGMENTATION**	**08**
	4.1	**Point, Line, and Edge Detection:** Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm , Edge linking : Local processing and boundary detection using regional processing (polygonal fitting)	05
	4.2	**Thresholding** : Foundation, Role of illumination and reflectance, Basic global thresholding	01
	4.3	**Region Based segmentation**: Region Growing, Region Splitting and merging	02
5		**INTRODUCTION TO MACHINE VISION AND DESCRIPTORS**	**05**
	5.1	Principle of machine vision , real world applications, chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences	03
	5.2	Introduction to Texture, co-occurrence matrix	02
6		**MACHINE VISION ALGORITHMS**	**08**
	6.1	Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Confusion Matrix	02
	6.2	K-means clustering algorithm, Introduction, bays decision theory continuous case, two category classification, Bayesian classifier ,Support vector machine	06
		TOTAL	**39**

Text Books:

1. Milan Sonka ,Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" Cengage Engineering, 3rd Edition, 2013
2. Gonzales and Woods, "Digital Image Processing", Pearson Education, India, Third Edition,
3. R. O. Duda and P. E. hart, Pattern classification and scene analysis, Wiley Interscience publication
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

Reference books:

1. Anil K.Jain, "Fundamentals of Image Processing", Prentice Hall of India, First Edition, 1989.
2. W Pratt, "Digital Image Processing", Wiley Publication, 3rd Edition, 2002
3. Forsyth and Ponce, Computer vision: A modern approach, PHI
4. Frank Y Shish ,Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley Wiley-IEEE Press, 2010

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC604	Artificial Neural Networks and Fuzzy Logic	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC604	Artificial Neural Networks and Fuzzy Logic	20	20	20	80	03	--	--	100

Course Prerequisites:

1. Basic linear Algebra
2. Engineering Mathematics-I to IV

Course Objectives:

1. To introduce the concepts and understanding of artificial neural networks
2. To provide adequate knowledge about supervised and unsupervised neural networks
3. To introduce neural network design concepts
4. To expose neural networks based methods to solve real world complex problems
5. To study the architecture of CNN and its application in image classification.
6. To introduce fuzzy logic and fuzzy inference systems

Course Outcomes:

After successful completion of the course, the student will be able to:

1. Comprehend the concepts of biological neurons and artificial neurons
2. Analyze the feed-forward and feedback neural networks and their learning algorithms.
3. Comprehend the neural network training and design concepts
4. Build a simple CNN model and apply in image classification
5. Analyze the application of neural networks and fuzzy logic to real world problems.

Module No.	Topics	Hrs.
1.0	**Introduction to Neural Networks and their Basic Concepts**	**07**
	Biological neuron and Artificial neuron, McCulloch-Pitts Model, Activation Function, various types of Activation Functions and types of Neural Network Architectures, Prerequisites for Training of Neural Networks. Linearly Separable and Linearly Non-Separable Systems with examples, Concepts of Supervised Learning, Unsupervised Learning, and Reinforcement Learning. Brief survey of applications of Neural Networks.	
2.0	**Supervised Learning Neural Networks**	**07**
	Perceptron - Single Layer Perceptron, Multilayer Perceptron and their Architecture. Error Functions: Mean Square Error and Sum Squared Error. Gradient Descent, Generalized delta rule, Error back propagation, Stopping Criterions for Training.	
3.0	**Unsupervised Learning Neural Networks**	**07**
	Competitive Learning Network – Kohonen Self-Organizing Networks – Architecture, Training Algorithm, Discrete Hopfield Network- Hopfield Matrix, Testing Algorithm, K-Means Clustering Algorithm.	
4.0	**Algorithms of Neural Networks**	**04**
	Basic concept of Machine Learning, Support Vector Machine (SVM) - Introduction and SVM based Binary Classifier, LMS Algorithm.	
5.0	**Convolution Neural Network (CNN)**	**07**
	Basic concept of Deep Learning, Convolution Operation, Overview of CNN Architecture, Input layer, Convolution layers, Pooling layers, Padding, Strided Convolutions, Rectified Linear Unit (ReLU), One Layer of a Convolutional Network, Fully Connected Layers, Complex Image Classification using CNN.	
6.0	**Introduction to Fuzzy Inference System**	**07**
	Introduction to Fuzzy Logic, Fuzzy Rules, Fuzzy Properties - Operations, Membership Functions, Fuzzification - Membership Value Assignments using Intuition Method, Defuzzification Methods -- Mean of Maxima and Centroid (Centre of Area) Methods, Fuzzy Inference System with reference to Mamdani Model, Brief Review of Applications of Fuzzy Logic to Speed Control of DC Motor and Washing Machine.	
	Total	**39**

Text Books:

1. S. N. Sivanandam and S. N. Deepa, Introduction to Soft Computing, Wiley India Publications, 3rd Edition.
2. Simon Haykin, Neural Networks and Learning Machines, Pearson Prentice Hall, 3rd Edition
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms, PHI Learning Pvt. Ltd, 2003.
4. Practical Convolutional Neural Networks by Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, Packt Publishing, 2018.
5. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley India Publications, 3rd Edition.

References:

1. Hagan, Demuth, and Beale, Neural Network Design, Thomson Learning, 2nd Edition.
2. Simon Haykin, Neural Network- A Comprehensive Foundation, Pearson Education, 2nd Edition.
3. Christopher M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 2005.
4. William W. Hsieh, Machine Learning Methods in the Environmental Sciences: Neural Network and Kernels, Cambridge University Press, 2009.
5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016
6. S. N. Sivanandam, S. Sumathi, and S. N. Deepa, Introduction to Neural Network using Matlab, Tata McGraw-Hill Publications, 2006.
7. Mehrotra Kishan, Mohan C. K. Ranka Sanjay, Elements of Artificial Neural Networks, Penram International Publishing Pvt. Ltd, 2nd Edition.
8. J. M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishers, 2006.
9. Bart Kosko, Neural Networks and Fuzzy Systems, Pearson Education, 2007.

Recommended NPTEL / Swayam Course and Online resources:

1. Course: Fuzzy Logic and Neural Networks by Prof. Dilip Kumar Pratihar, IIT Kharagpur
2. Course: Neural Network and Applications by Prof. Somnath Sengupta, IIT Kharagpur
3. Michael Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015. http://neuralnetworksanddeeplearning.com/

List of Suggested Experiments to be conducted in IPMV Laboratory (ECL 603):

1. Classification of Non-linearly Separable Binary Pattern using Multilayer Perceptron Neural Network.
2. Pattern Clustering using K-means Algorithm.
3. Binary Pattern Restoration using Discrete Hopfield Neural Network.
4. Image Classification using Support Vector Machine.
5. Object Recognition using Convolutional Neural Network.
6. Design Fuzzy Controller for Washing Machine

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed, and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6011	Mixed Signal VLSI	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6011	Mixed Signal Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC302 – Electronic Devices and Circuits
ECC303 –Digital System Design
ECC403 – Linear Integrated Circuits
ECC503 – Digital VLSI

Course Objectives:

1. To know 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:

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

1. Know 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. Analyze 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.	Unit No.	Topics	Hrs.
1.0		**Integrated Circuit Biasing Techniques**	**06**
	1.1	Active resistance, current source, current sink, simple current mirror, cascode current mirror	03
	1.2	Current and voltage references, Band gap reference generator	03
2.0		**Single Stage MOS Amplifiers**	**08**
	2.1	Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage, simulation of CMOS amplifiers using SPICE	04
	2.2	Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads, simulation of differential amplifiers using SPICE	04
3.0		**Noise in MOS Circuits**	**06**
	3.1	Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise	02
	3.2	Representation of noise in circuits, noise in single stage CS, CD and CG amplifier	02
	3.3	Noise in differential pairs, noise bandwidth	02
4.0		**CMOS Operational Amplifier**	**05**
	4.1	Design of Current Mirror Load Differential Amplifier	02
	4.2	Design of two stage Operational Transconductance Amplifier, OpAmp Compensation techniques	03
5.0		**Data Converter Fundamentals**	**06**
	5.1	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics	03
	5.2	Mixed signal Layout issues, Floor planning, power supply and Ground issues, other interconnect Considerations	03
6.0		**Data Converter Architectures**	**08**
	6.1	DAC architectures, digital input code, charge scaling DACs, Cyclic DAC, pipeline DAC	04
	6.2	ADC architectures, flash, pipeline ADC, integrating ADC, and successive approximation ADC	04
		Total	**39**

Text Books:

1. B. Razavi, **"***Design of Analog CMOS Integrated Circuits***"**, first edition, McGraw Hill,2001.
2. P.E.Allen and D R Holberg, **"***CMOS Analog Circuit Design***"**, second edition, Oxford University Press, 2002.
3. R. Jacob Baker, "*CMOS Circuit Design, Layout and Simulation*", Wiley, 2nd Edition, 2013

Reference Books:

1. Adel S. Sedra, Kenneth C. Smith, A.N. Chandorkar, "Microelectronics Circuits Theory and Applications", Fifth Edition, Oxford University Press.
2. Gray, Meyer, Lewis and Hurst **"***Analysis and design of Analog Integrated Circuits***"**, 4th Edition Willey International, 2002
3. Tony Chan Carusone, David Johns, Kenneth Martin, " Analog Circuit Design", Second Edition, Wiely

NPTEL / Swayam Course:

1. https://nptel.ac.in/courses/117/101/117101105/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on completion of approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6012	Computer Organisation and Architecture	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECCDLO 6012	Computer Organisation and Architecture	20	20	20	80	03	--	--	100

Course Pre-requisites:

ECC303-Digital System Design

ECC402-Microcontrollers

Course objectives:

1. To have a thorough understanding of the basic structure and operation of a digital computer.
2. To understand memory systems, processor organization and generation of control unit signals.
3. To demonstrate the operation of various arithmetic algorithm including integer and floating point representation.
4. To understand the working principles of multiprocessor and parallel organization's as advanced computer architectures.

Course outcomes:

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

1. Describe Computer system along with I/O operations and performance measures.
2. Demonstrate data representation and different arithmetic algorithm for solving ALU operations.
3. Categorize memory organization and identify the function of each element of memory hierarchy.
4. Demonstrate control unit operations.
5. Articulate design issues in the development of Multiprocessor organization & architecture

Module No.	Unit No.	Topics	Hrs
1		**Computer Organization, Architecture and Performance**	8
	1.1	Organization and Architecture,	
	1.2	Structure and Function,	
	1.3	Designing for Performance,	
	1.4	Multicore, MICs, and GPGPUs	
	1.5	Two Laws that Provide Insight: Amdahl's Law and Little's Law	
	1.6	Basic Measures of Computer Performance,	
	1.7	Calculating the Mean	
	1.8	Benchmarks and SPEC	
2		**Computer System**	6
	2.1	Computer Components	
	2.2	Computer Function	
	2.3	Interconnection Structures	
	2.4	Bus Interconnection	
3		**Data Representation and Arithmetic Algorithms**	5
	3.1	Unsigned & Signed multiplication- Add & Shift Method, Booth's algorithm. Unsigned & Signed division, Restoring and non-restoring division.	
	3.2	Integer and floating point representation, IEEE 754 standard for floating point (Single & double precision) number representation.	
4		**Memory System Organization**	7
	4.1	Classification and design parameters, Memory Hierarchy ,Internal Memory: RAM, SRAM and DRAM	
	4.2	Cache Memory: Characteristics of Memory Systems, Cache Memory Principles, Elements of Cache, Cache Coherence. Design problems based on mapping techniques	
	4.3	Virtual Memory, External Memory : Magnetic Discs, Solid State Drive, Optical Memory, Flash Memories, RAID Levels	
5		**Control Unit Design**	8
	5.1	Micro- Operations: The Fetch Cycle, The Indirect Cycle, The Interrupt Cycle, The Execute cycle, The Instruction Cycle	
	5.2	Control of the Processor: Functional Requirements, Control Signals, Internal Processor Organization	
	5.3	Hardwired Control Unit	
	5.4	Microinstructions Microprogrammed Control Unit, Advantages & disadvantages	
6		**Fundamentals of Advanced Computer Architecture**	5
	6.1	Parallel Architecture: Classification of Parallel Systems,	
	6.2	Flynn's Taxonomy, Array Processors, Clusters, and NUMA Computers	
	6.3	Multiprocessor Systems : Structure & Interconnection Networks	
	6.4	Multi-Core Computers: Introduction, Organization and Performance.	
		Total	**39**

Text Books:

1. William Stallings “Computer Organization and Architecture Designing for Performance” Tenth Edition, Pearson Education.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGrawHill,
3. Andrew S. Tanenbaum “Structured Computer Organization”, Pearson, Sixth Edition

Reference books:

1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design -
2. Morris Mano. “Computer System Architecture” Pearson Publication, 3rd Edition, 2007
3. J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998
4. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6013	Digital Forensic	3	--	--	3	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6013	Digital Forensic	20	20	20	80	03	--	--	100

Course prerequisite:

ECC602: Computer Communication Networks

Course Objectives:

1. To understand cyber attacks and various categories of Cybercrime.
2. To discuss the need and process of digital forensics and Incident Response Methodology.
3. To explore the procedures for identification, preservation, and extraction of digital evidence.
4. To explore techniques and tools used in digital forensics for system investigation.
5. To discuss the investigation process of network and host based system intrusions.
6. To understand the laws related to Cybercrime

Course Outcomes:

On successful completion of the course, students will be able to

1. Study the various cybercrimes and its prevention methods.
2. Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
3. Understand the process of collection, analysis and recovery of the digital evidence.
4. Explore various tools to perform the investigation of the crime scenario.
5. Investigate the process of monitoring and analysis of computer network traffic for network investigation.
6. Discuss the legal issues associated with the cyber laws.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Cybercrime and Hacking**	**08**
	1.1	Cybercrime, Categories of Cybercrime (Cybercrime against people, Cybercrime Against property, Cybercrime Against Government), Types of cybercrime (Violent- Cyber terrorism, Assault by Threat, Cyberstalking, Child Pornography, Non-violent - Cybertrespass, Cyber Theft, Cyberfraud, Destructive Cybercrimes), Computers' role in crimes	
	1.2	Hacking, Life cycle of Hacking, Types of Hackers (White Hat hackers, Black Hat hackers, Grey Hat hackers), Hacking techniques, Passive and Active Attacks, Social Engineering, Attacks vs Vulnerabilities, Prevention of Cybercrime	
		Self-learning topics: Distinction between computer crimes and conventional crimes.	
2.0		**Introduction to Digital Forensics**	**07**
	2.1	Objectives of digital forensics, Process of digital forensics, Types of digital forensics, Challenges faced by digital forensics	
	2.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	
		Self-learning topics: Distinction between Computer virus, worm, Trojan horse and trap door.	
3.0		**Digital Evidence and Forensics Duplication**	**07**
	3.1	Digital evidence, Admissibility of evidence, Challenges in evidence handling, collecting digital evidence, Preserving digital evidence, Documenting evidence	
	3.2	Necessity of forensic duplication, Forensic duplicates as admissible evidence, Forensic image formats, Forensic duplication techniques, Disk imaging, Analysis of forensic images using FTK Imager	
		Self-learning topics: Digital Evidence Investigation using Autopsy	
4.0		**System Investigation**	**08**
	4.1	Live/volatile data collection from Windows and Unix Systems	
	4.2	Investigating Windows systems, Investigating UNIX systems, Investigating applications, Web browsers, Email tracing	
	4.3	Recovering digital evidence, Acquiring, Analyzing and duplicating data: dd, dcfldd, foremost, scalpel	
		Self-learning topics: Methods of storing data (RAM and Hard disk)	
5.0		**Network Forensics**	**05**
	5.1	Introduction to intrusion detection systems, Types of IDS, Understanding network intrusion and attacks	
	5.2	Analyzing network traffic, collecting network based evidence, Evidence handling. Investigating routers	
		Self-learning topics: Use of packet sniffing tools like Wireshark	
6.0		**Laws related to cyber crime**	**04**
		Constitutional law, Criminal law, Civil law, Levels of law: Local laws, State laws, Federal laws, International laws. Levels of culpability: Intent, Knowledge, Recklessness, Negligence. CFAA, DMCA, CAN Spam	
		Self-learning topics: Relevant law to combat computer crime –Information Technology Act	
		Total	**39**

Text books

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
2. “Scene of the Cybercrime: Computer Forensics” Handbook 1st Edition, Kindle Edition
3. “Digital Forensics”, Nilakshi Jain & Kalbande, Wiley Publication
4. “Cyber Security”, Nina Godbole, Sunit Belapure, Wiley Publication

Reference books

1. Bill Nelson,Amelia Phillips,Christopher Steuart, “Guide to Computer Forensics and Investigations” . Cengage Learning, 2014
2. Debra Littlejohn Shinder Michael Cross “Scene of the Cybercrime: Computer Forensics Handbook”, 2nd Edition Syngress Publishing, Inc.2008.
3. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Suggested MOOCs for Self-Learning:

1. Course on “Ethical Hacking”
   https://nptel.ac.in/courses/106/105/106105217/
2. Course on “Digital Forensics”
   https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3. Course on “Computer Forensics”
   https://www.edx.org/course/computer-forensics
4. Course on Cyber Incident Response
   https://www.coursera.org/learn/incident-response
5. Course on “Penetration Testing, Incident Responses and Forensics”
   https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6014	Database Management System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 6014	Database Management System	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC 205 : C Programming
ECL 304 : Skill Lab :- C++ and Java Programming
ECL 405 : Skill Lab :- Python Programming

Course Objectives:

1. Learn and practice data modeling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access
4. Understand the concept of database security and privacy

Course Outcome:

After successful completion of the course student will be able to

1. Describe the fundamentals of database systems, different data models and design issues in database.
2. Understand the basics model of relational Algebra, calculus, transaction management, concurrency control , database security and privacy
3. Design ER diagram, relational schemas, apply concepts of normalization to relational database design.
4. Implement views, triggers and querying the database using SQL.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Databases**	**02**
	1.1	Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, Three tier database architecture, Data independence	
2.0		**Data Models**	**03**
	2.1	The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building blocks, Business rules, Degrees of data abstraction	
3.0		**Database Design, ER-Diagram and Unified Modeling Language**	**08**
	3.1	Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets	
	3.2	Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	
4.0		**Relational Algebra and Calculus**	**09**
	4.1	Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics.	
	4.2	Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	
	4.3	Normalization methods : 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	
5.0		**Constraints, Views and SQL**	**10**
	5.1	What is constraints, types of constrains, Integrity constraints,	
	5.2	SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	
	5.3	Views: Introduction to views, data independence, security, updates on views, comparison between tables and views	
	5.4	** SQL Tools : MySQL, ORACLE 10G, POSTGRESQL	
6.0		**Transaction management and Concurrency control**	**07**
	6.1	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	
	6.2	Database Security and privacy : Issues, Access Control based on grant and revoke privileges	
		Total	**39**

**** Teacher can select any one SQL Tool for implementation of SQL query**

Textbooks:

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

E-Resources:

1. https://www.w3schools.in/dbms/
2. https://www.tutorialspoint.com/dbms/index.htm
3. https://www.studytonight.com/dbms/

Self-Learning: Suggested Case Studies (Any such cases can be selected by Teacher)

1. Library Management System
2. Hospital Management System
3. Pharmacy Management System
4. Human Resource Database Management System in Java
5. Students Database Management System
6. Employee Management System
7. Inventory Control Management database

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6015	IoT and Industry 4.0	3	-	--	3	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work Oral	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 6015	IoT and Industry 4.0	20	20	20	80	03	--	--	100

Course pre-requisite:
ECM401: Mini Project – 1 B
ECC402: Microcontrollers
ECL404: Skill based Lab Course
ECM501: Mini Project 2A Embedded System Project

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 Outcome:

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

1. Discuss case studies and use cases of IoT design.
2. Illustrate various protocols of web connectivity.
3. Understand and use 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. Understand advanced concepts and applications of industry 4.0

Module No.	Unit No.	Topics	Hrs.
1		**Introduction to IoT**	**04**
	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	
	1.2	**Defining Specifications About -** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Application Development, Case Study	
2		**Network & Communication aspects**	**08**
	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	
	2.2	**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, Case Study	
3		**Data Management and Analytics for IoT**	**08**
	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	
	3.2	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 Generator	
4.0		**Introduction to Industry 4.0**	**08**
	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 IoT-Layers, Sensing, Processing, Communication.	
	4.2	Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality	
5.0		**Introduction to Industrial IoT (IIoT)**	**06**
	5.1	Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Facility Management.	
	5.2	Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions	
6.0		**Industry 4.0 Technologies and Applications**	**05**
	6.1	Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries., IoTs Value Creation Barriers: Standards, Security and Provacy Concerns	
	6.2	Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solutions	
Total			**39**

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

Suggested reference material (research papers):

1. https://www.mdpi.com/2071-1050/11/16/4371/pdf- Industry 5.0—A Human-Centric Solution – MDPI (open access)
2. https://www.researchgate.net/profile/Mary-Doyle-Kent/publication/336819748_Industry_50_Is_the_Manufacturing_Industry_on_the_Cusp_of_a_New_Revolution/links/5e84b810a6fdcca789e5ff75/Industry-50-Is-the-Manufacturing-Industry-on-the-Cusp-of-a-New-Revolution.pdf - Industry 5.0: Is the Manufacturing Industry on the Cusp of a New Revolution?

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

Suggested MOOCs:

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. https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design
5. By Prof. Anupam Basu, IIT Kharagpur

Recommended list of tools for self learning:

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/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6016	Radar Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6016	Radar Engineering	20	20	20	80	03	--	--	100

Pre requisites:
ECC405 - Principles of Communication Engineering

Course objectives:

1. To interpret Radar equations
2. To explain different types of radar
3. To introduce RADAR transmitters and receivers for given conditions
4. To understand/ implement the plotting for given RADAR target

Course outcomes:
After successful completion of the course student will be able to

1. Explain generalized concept of RADAR.
2. Solve problems using radar equations.
3. Describe different types of radar for specific application.
4. Explain concept of tracking radar.
5. Plot the RADAR target from given specification.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Radar and Radar Equation**	**08**
	1.1	Basics Radar, Radar equation, Block Diagram, Radar Frequencies	
	1.2	Detection of signal in noise, Receiver Noise and Signal-to-noise Ratio	
	1.3	Probability of detection and false alarm: Simple, complex Targets, Pulse Repetition Fr	
2.0		**MTI and Pulse Doppler Radar**	**08**
	2.1	Introduction to Doppler and MTI radar, Doppler frequency shift	
	2.2	Simple CW Doppler radar, MTI radar block diagram	
	2.3	Delay line canceler	
	2.4	Moving-target-detection	
	2.5	Pulse Doppler radar	
3.0		**Tracking Radar**	**06**
	3.1	Monopulse tracking	
	3.2	Conical scan and sequential lobbing	
	3.3	Limitation of tracking accuracy , Low angle tracking	
4.0		**Radar Transmitters and Receviers**	**06**
	4.1	Radar RF power sources: Klystron	
	4.2	Travelling wave tube	
	4.3	Magnetron	
	4.4	Radar Receiver: Superheterodyne Receiver	
5.0		**Radar Clutters and landing system**	**06**
	5.1	Types of clutter : surface clutter, sea clutter, land clutter	
	5.2	Instrument landing system	
	5.3	Ground controlled approach, Microwave landing system	
	5.4	Radar altimeter	
6.0		**General ideas on RADAR plotting**	**05**
	6.1	Radar plotting -general ideas	
	6.2	Relative plotting (passive derivations), Relative plotting (action taken by target)	
	6.3	Radar Display: Types of displays	
		Total	**39**

Text Books:

1. Merill Skolnik,—Introduction to RADAR Systems,Tata McGrawHill, Third Edition
2. Merill Skolnik,—RadarHandbook, TataMcgrawHill, Second Edition
3. Dr. A. K. Sen, Dr. A. B. Bhattacharya- Radar Systems and Radio Aids to Navigation Khanna Publishers

Reference books:

1. Mark A.Richards,James A.Scheer, William A.Holm, —Principles of Modern Radar Basic Principals‖, ScitechPublishing.
2. SimonKingsley,ShaunQuegon,—UnderstandingRadarSystems‖,ScientechPublishing Inc.
3. G.S. N.Raju, —Radar Engineering and Fundamentals of Navigational Aids‖, I. K International publishing House Pvt.Ltd.
4. Dr. Arjun Singh -Radar Systems and Radio Aids to Navigation,McGraw-Hill Education Private Limited
5. CAPT. H. SUBRAMANIAM- Shipborne Radar And Arpa Nutshell Series Book3

Online Resource:

1. NPTEL online Course: https://nptel.ac.in/courses/108/105/108105154/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ECL601	Electromagnetics and Antenna Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. of Test 1 and Test 2				
ECL601	Electromagnetics and Antenna Lab	--	--	--	--	25	25	50

Prerequisites:

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

Course Objective:

The objective of the course is to make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Course Outcomes:

After successful completion of the course student will be able to

1. Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations.
2. Students will be able to apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4. Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

SUGGESTED LIST OF EXPERIMENTS

Sr. No.	NAME OF EXPERIMENTS
1.	Study different Antenna parameters (compulsory to use: FSM, Spectrum Analyzer and VNA)
2.	Introduction to Different Antenna Types
3.	Study of Wire Antenna, (Radiation pattern of dipole, folded dipole and Monopole antenna, various loops)
4.	Study of Directive antenna, Yagi-Uda Antenna
5.	Study of Broad-band Antenna, Log-periodic Antenna
6.	Study of Antenna Arrays (Broadside, End-fire, Parametric study for various arrays parameters)
7.	Study of Aperture Antennas (Parabolic/ Hyperbolic/ Horn , with or without Reflector)
8.	Study of Regular shaped Microstrip Antenna
9.	Small Project report can be considered as a part of term-work (Design, Simulation and validation).
10.	Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the ― Laboratory session batch wise".

Computation/ simulation-based experiments are also encouraged. The experiments should be students centric, and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini project can be conducted for maximum batch of four students.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL602	Computer Communication Network Laboratory	-	02	-	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL602	Computer Communication Network Laboratory	--	--	--	--	25	25	50

Lab Course Outcomes: -

Upon completion of the computer communication networks lab, the students will be able to:

- Design a small or medium sized computer network including media types, end devices, and interconnecting devices that meets a customer‘s specific needs.
- Perform configurations on routers and Ethernet switches.
- Demonstrate knowledge of programming for network communications.
- Simulate computer networks and analyze the simulation results.
- Troubleshoot connectivity problems in a host occurring at multiple layers of the OSI model.
- Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator.

Laboratory plan

Minimum of 8 practicals should be conducted and a mini project.

Suggested list of experiments:

1. To study basic networking commands. (Linux/Netkit)
2. To prepare a patch cable (straight-through, crossover, rollover) using UTP, RJ-45 and crimping tool. Test the cable using a cable tester and use it in LAN.
3. To configure and compare different network topologies using Cisco Packet Tracer
4. To study and compare network hardware components using Cisco Packet Tracer
5. To configure static routes in a network using Cisco Packet Tracer.
6. To configure a network with Distance Vector Routing Protocol-RIP using Cisco Packet Tracer and check the updated routing tables.
7. To configure a network with Path Vector Routing Protocol- BGP using Cisco Packet Tracer and check the updated routing tables.

8. To configure a network with Link state Routing Protocol- OSPF using Cisco Packet Tracer and check the updated routing tables.
9. To configure a network with Hybrid Routing Protocol- EIGRP using Cisco Packet Tracer and check the updated routing tables.
10. To perform subnetting using Cisco Packet Tracer/Netkit
11. To install a network simulator (NS2.35), create a wired network and compare the performance of TCP and UDP **or** Compare TCP and UDP performance using Netsim
12. To Simulate and study stop and Wait protocol using NS 2.35/ C++
13. To Simulate Sliding Window protocol using NS 2.35/C++
14. To Simulate and study the implementation of TCP/IP stack using wireshark (observe the protocols, data formats, header structures, addresses, payload sizes and encapsulation at each layer)
15. To perform HDLC bit stuffing and de-stuffing using C++
16. To configure DNS, DHCP, TELNET, FTP, SMTP server (any one) on Cisco Packet Tracer
17. To compare performance of ALOHA and Slotted ALOHA using Netsim.

Term Work: At **least 08 Experiments** covering entire syllabus must be given during the "Laboratory session batch wise". Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented **one mini-project** can be conducted for a batch of maximum four students.

Term work assessment must be based on the overall performance of the student with every experiment and assignment graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. The practical and oral examination will be based on entire syllabus.

Termwork marks distribution: Journal and practical Performance: 15 marks

Attendance: 5 marks

Assignment: 5 marks

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL603	Image Processing and Machine Vision Laboratory	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg.				
ECL603	Image Processing and Machine Vision Laboratory	--	--	--	--	25	25	50

Prerequisites:

1. Python Programming Skill Lab

Course Objectives:

1. To teach implementing basic theoretical concepts in Image Processing and Machine Vision using relevant software.
2. To give an exposure 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.

Course Outcomes:

After successful completion of the course student will be able to

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

SUGGESTED LIST OF EXPERIMENTS

1. Eight experiments covering the whole syllabus with proportional weightage to Image Processing and Machine Vision, to be set with predefined and concrete objective problem statement.
2. At least 5 programs to be conducted in python programming
3. At least 1 case study from suggested ones to be conducted in lab.
4. An attempt should be made to make experiments more meaningful, interesting and innovative.
5. Conduct three experiment based on application of **Neural Network and Fuzzy logic** for Image Processing.

Sr. No.	NAME OF EXPERIMENTS
1.	Point Processing Methods - Negative, Log, Power law, Contrast stretching, Bit plane slicing
2.	Histogram calculation and equalization
3.	Spatial Domain Filtering: 1. Smoothening filters 2. Sharpening with Laplacian 3. Unsharp masking & high boost filtering 4. Edge detection using 1st and 2nd order derivatives
4.	Frequency Domain Filtering : Ideal, Butterworth and Gaussian
5.	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform, Boundary extraction
6.	Image segmentation using global Thresholding Algorithm
7.	Shape representation using chain code
8.	Canny edge detection
9.	Feature extraction using co-occurrence matrix
10.	Classification using k-means algorithm
11.	Classification using Basiyan classifier
12.	Basic binary classification of any data or pattern using Support Vector Machine.
13.	Case Study : 1. Face recognition 2. Finger print identification 3. License plate recognition

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL604	Skill Laboratory: Linux & Networking & Server Configuration	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL604	Skill Laboratory: Linux & Networking & Server Configuration	--	--	--	--	25	25	50

Course pre-requisite:

FEL204__C-Programming

Course Objectives:

1. Install Linux and implement standard Linux commands
2. Study basic theory of Linux Operating System
3. Implement the system administrative functionality
4. To write shell script programs to solve problems
5. Study basic commands of networking
6. Develop implementation skill of different servers on Linux

Course Outcome:

After successful completion of the course student will be able to :-

1. Install Linux using different platform and execute standard Linux commands.
2. Describe the basic knowledge of Linux Operating System
3. Deploy the system administrative functionality
4. Solve the problems using shell script programming
5. Develop network based applications
6. Apply the Linux commands using programming skill to deploy different servers like ftp, telnet etc.

Module No.	Unit No.	Topics	Hrs.
1.0		**Overview of Linux**	**08**
	1.1	Installing Software on Debian Based Linux: Debian, Ubuntu, Kali Linux	
	1.2	Overview of Unix and Linux architectures, Linux files system, Linux standard directories, Linux Directory Structure, Basic Linux Commands, Linux Networking commands, Viewing Files and the Nano Editor, Editing Files in Vi, Graphical Editors, Deleting, Copying, Moving, and Renaming Files	
2.0		**Linux OS**	**06**
	2.1	Linux Design Principles, Linux Booting Process, Kernel Modules, Process Management, Scheduling, Memory Management, Input and Output, Inter-process Communication.	
3.0		**System Administration**	**08**
	3.1	Common administrative tasks, Configuration and log files, Role of system administrator, Managing user accounts –adding, deleting users, Changing permissions and ownerships, Creating and managing groups, Modifying group attributes.	
	3.2	Temporary disabling of users accounts, Creating and mounting file system, becoming super user using su, Getting system information with uname, host name. Disk partitions & sizes, users, kernel, installing and removing packages, rpm command	
4.0		**Shell programming**	**12**
	4.1	Basics of shell programming, various types of shell available in Linux, Shell programming in bash, Conditional statements, Looping statements, Case statements, Parameter passing and arguments	
	4.2	System shell variables, Shell variables, shell keywords, Creating Shell programs for automating system tasks, Scheduling repetitive jobs using cron.	
5.0		**Linux Networking**	**08**
	5.1	Basics of Network Management, Setting up Dynamic and Static Addressing, Monitoring network services, Talking with DNS Servers, Remote System Administration with OpenSSH-Server & Putty.	
	5.2	TCP/IP Networking for Linux System Administrators, DNS and hostnames, DHCP, , Network Troubleshooting.	
6.0		**Servers and Configurations**	**10**
	6.1	Create and configure DHCP, Mail, DNS, FTP, Squid, Apache, Telnet, Samba servers	
		Total	**52**

Suggested List of Experiments:

Sr.	Title
1	Linux Installation process using following method CD-ROM, Network Installation or Kickstart Installation.
2	Basic commands to create users, change permission, software selection and installation and do changes in Grub file.
3	Practical on configuration of Linux disk Management such as SWAP, LVM, RAID, Primary Partition, Extended Partition and Linux files system.
4	Write a shell script to show various system configuration like currently logged user and his logname, 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.
5	Write a shell script to add user and password on Linux system.
6	Write a shell script to print last login details.

7	Write a shell script to upgrade and cleans the system automatically instead of doing it manually.
8	Write a shell script to delete all log files present inside your var/log directory.
9	Write a script that accepts the hostname and IP address as command-line arguments and adds them to the /etc/hosts file.
10	Write a awk script to find the number of characters, words and lines in a file?
11	Write a shell script that delete all lines containing a specified word
12	write a shell script to find the factorial of given integer
13	Configuration of DHCP Server and Client
14	Configuration of DNS Server with Domain Name.
15	Configuration of NFS File server and transfer files to a windows client.
16	Setting up a Samba Server and creating a print server.
17	Configuration of Internet Server by creating a Proxy Server and configure browser to use as a proxy.
18	Configuration of Mail Server
19	Configuration of Web Server.
20	Configuration of FTP server and transfer files to demonstrate the working of the same.

Text books:

1. YeswantKanethkar – "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

Software Tools:
1. Install Ubuntu desktop | Ubuntu
2. Chapter 4. Quick Installation Guide Red Hat Enterprise Linux 7 | Red Hat Customer Portal
3. Installation | Kali Linux Documentation

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 | DigitalOcean
3. Network - DHCP | Ubuntu

Term Work: At least **12 experiments** covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality. The experiments should be students centric as well as real time and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per "Choice Based Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. **The practical and oral examination will be based on entire syllabus.** Students are encourages to share their experiments codes on online repository. **Practical exam should cover all 12 experiments for examination.**

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM601	Mini Project 2B: FPGA based Project	--	04[$]	--	--	2	--	2

$ Indicates work load of a learner (Not Faculty) for Mini Project 2B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM601	Mini Project 2B: FPGA based Project	--	--	--	--	--	25	25	50

Course Pre-requisite:

1. ECC303 - Digital Design
2. ECM401- Mini Project 1B
3. ECC503- Digital VLSI

Course 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 students with the numerous FPGA solutions available in Market
6. To familiarize the students with the Interfacing of FPGA boards

Course outcomes :

1. Understand various FPGA families and method of FPGA synthesis and implementation
2. Learn the working of basic EDA tools like Xilinx, Modelsim cadence , etc
3. Able to program, simulate and synthesize circuits in Verilog HDL.
4. Learn the technique of interfacing of LED, switches and seven segment with FPGA.
5. Learn the project documentation, designing and handling techniques
6. Analysis of FPAG fault detection and verification principles

1. Guideline to maintain quality of mini project are as follows :

1. To achieve proper selection of Mini Projects. Students should do survey of FPGA boards, tools and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/ internal committee of faculties.
2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of mini 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 mini 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.
6. **Suggested steps for mini project selection and implementation**
    i. Mini project should be completely FPGA based
    ii. Follow these steps
        1. Take specification, using these specifications design project.
        2. Select proper FPGA considering features and requirements of project. Create UCF file
        3. Program it using Verilog and write test benches for verification of each module
        4. Test Functional Simulation and verify it using simulation tool
        5. Synthesize, map and place and rout the design using synthesis tool
        6. Generate bit stream and download on FPGA
        7. Verify results on FPGA hardware/hardware setup made for project

2. **Project Topic selection and approval :-**
    1. The group may be of maximum **FOUR (04)** 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.
3. **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:

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 mini 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- 2-B
    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 : 10
        ii. Marks awarded by review committee : 10
        iii. Quality of Project report : 05
2. **Guidelines for Assessment of Mini Project Practical/Oral Examination:**
    a. Report should be prepared as per the guidelines issued by the University of Mumbai.
    b. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by head of Institution.
    c. Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to FPGA and Synthesis**	**04**
	1.1	Compare FPGA, ASIC, SOC, Basic FPGA architecture, Compare various FPGA Boards**, Understanding VLSI Design flow	
	1.2	**Understanding Tools :** Functional simulation , Synthesis and implementation, Synthesis tool flow, Implementation and bit generation, making User constraint files (UCF)	
	1.3	**Study Material** : https://www.xilinx.com/support/university/ise/ise-workshops/ise-fpga-design-flow.html	
2.0		**Writing First program in Verilog**	**04**
	2.1	**Introduction to Verilog**: Module definition, port declaration, connecting ports, Writing first Testbench	
	2.2	**Exercise :** Program for All gates, Writing Test bench and UCF	
	2.3	**Study Material**: https://www.xilinx.com/support/university/ise/ise-teaching-material/hdl-design.html	
3.0		**Combinational design Using VERILOG**	**08**
	3.1	Gate Level Modelling, hierarchical name referencing, **Data Flow Modelling**: Continuous assignments, delay 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	
	3.3	**Study Material :** https://onlinecourses.nptel.ac.in/noc20_cs63/preview	
4.0		**Sequential design Using VERILOG**	**08**
	4.1	**Behavioral Modelling :** Structured procedures, initial and always, blocking 'and non-blocking statements, delay control, event control, conditional statements, multi way branching, loops, sequential and parallel blocks **Advanced topics:** Tasks and Functions, generic programming with parameters.	
	4.1	**Exercise:** Programming and FPGA implementation of Counters FFs and Shift registers Interfacing Seven Segment Display, UART with FPGA	
5.0		**Project Outline**	**08**
	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	
	5.2	**Project Design Steps**: Designing state diagram, block diagram of project, Selection of FPGA for project, Selection of synthesis and simulation tool.	
6.0		**Project Implementation and management**	**20**
	6.1	Git Repositories, Learning of Project management software's like CVS, SVN etc	
	6.2	Project Implementation: Verilog coding, simulation, Synthesis, Bit generation and downloading on FPGA. .	
	6.3	Result verification and testing	
		Total	**52**

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