Program Structure for
B.E. Electronics & Telecommunication Engineering (Rev. 2016)
University of Mumbai
(With Effect from 2017-2018)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC301	Applied Mathematics- III	4	-	2@	4	1	5
ECC302	Electronic Devices and Circuits I	4	-	-	4	-	4
ECC303	Digital System Design	4	-	-	4	-	4
ECC304	Circuit Theory and Networks	4	-	2@	4	1	5
ECC305	Electronic Instrumentation and Control	4	-	2@	4	1	5
ECL301	Electronic Devices and Circuits I Laboratory	-	2	-	-	1	1
ECL302	Digital System Design Laboratory	-	2	-	-	1	1
ECL303	OOP using JAVA Laboratory	-	2	-	-	1	1
Total		**20**	**6**	**6**	**20**	**6**	**26**

@ 2 hour to be taken as tutorial classwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC301	Applied Mathematics-III	20	20	20	80	03	25	--	125
ECC302	Electronic Devices and Circuits I	20	20	20	80	03	--	--	100
ECC303	Digital System Design	20	20	20	80	03	--	--	100
ECC304	Circuit Theory and Networks	20	20	20	80	03	25	--	125
ECC305	Electronic Instrumentation and Control	20	20	20	80	03	25	--	125
ECL301	Electronic Devices and Circuits I Laboratory	--	--	--	--	--	25	25	50
ECL302	Digital System Design Laboratory	--	--	--	--	--	25	25	50
ECL303	OOP using JAVA Laboratory	--	--	--	--	--	25	25	50
Total				**100**	**400**		**150**	**75**	**725**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC401	Applied Mathematics- IV	4	-	2@	4	1	5
ECC402	Electronic Devices and Circuits II	4	-	-	4	-	4
ECC403	Linear Integrated Circuits	4	-	-	4	-	4
ECC404	Signals & Systems	4	-	2@	4	1	5
ECC405	Principles of Communication Engineering	4	-	-	4	-	4
ECL401	Electronic Devices and Circuits II Laboratory	-	2	-	-	1	1
ECL402	Linear Integrated Circuits Laboratory	-	2	-	-	1	1
ECL403	Principles of Communication Engineering Laboratory	-	2	-	-	1	1
Total		**20**	**6**	**4**	**20**	**5**	**25**

@ 2 hour to be taken as tutorial classwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC401	Applied Mathematics- IV	20	20	20	80	03	25	--	125
ECC402	Electronic Devices and Circuits II	20	20	20	80	03	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100
ECC404	Signals & Systems	20	20	20	80	03	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100
ECL401	Electronic Devices and Circuits II Laboratory	--	--	--	--	--	25	25	50
ECL402	Linear Integrated Circuits Laboratory	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Laboratory	--	--	--	--	--	25	25	50
Total				**100**	**400**		**125**	**75**	**700**

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC301	Applied Mathematics-III	04	--	@2	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC301	Applied Mathematics-III	20	20	20	80	25	--	--	125

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Mathematics I
- Applied Mathematics II

Course Objectives:

1. To build the strong foundation in Mathematics of students needed for the field of electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects.

Course Outcome:

After successful completion of the course student will be able to

1. Students will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable.
2. Students will demonstrate an ability to identify and Model the problems of the field of Electronics and Telecommunication and solve it.
3. Students will be able to apply the application of Mathematics in Telecommunication Engineering

Module No.	Unit No.	Detailed Content	Hours
1		**Laplace Transform**	**07**
	1.1	Laplace Transform (LT) of Standard Functions: Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of $e^{at}, Sin(at), \cos(at), \sinh(at), \cosh(at), t^n$ Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	
	1.2	Properties of Laplace Transform: Linearity, first shifting theorem, second shifting theorem, multiplication by t^n, Division by *t,* Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	
2		**Inverse Laplace Transform & its Applications**	**06**
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	
	2.2	Applications of Laplace Transform: Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3		**Fourier Series**	**11**
	3.1	Introduction: Orthogonal and orthonormal set of functions, Introduction of Dirchlet's conditions, Euler's formulae.	
	3.2	Fourier Series of Functions: Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4		**Vector Algebra & Vector Differentiation**	**07**
	4.1	Review of Scalar and Vector Product: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	
	4.2	Properties: Solenoidal and irrotational vector fields, conservative vector field	

5		**Vector Integral**	**06**
	5.1	Line integral	
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6		**Complex Variable & Bessel Functions**	**11**
	6.1	Analytic Function: Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories	
	6.2	Mapping: Conformal mapping, Bilinear transformations, cross ratio, fixed points	
	6.3	Bessel Functions: Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of $\cos(x\sin\theta)$, $\sin(x\sin\theta)$ in term of Bessel functions	

Note: Term Work should be based on Tutorials.

Textbooks :

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Murry R. Spieget, *"Vector Analysis",* Schaum's outline series, Mc-Graw Hill Publication

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC302	Electronic Devices & Circuits-I	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC302	Electronic Devices & Circuits-I	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Basic Electrical Engineering
- Applied Physics

Course Objectives:

1. To understand operation of semiconductor devices.
2. To understand DC analysis and AC models of semiconductor devices.
3. To apply concepts for the design of Regulators and Amplifiers
4. To verify the theoretical concepts through laboratory and simulation experiments.
5. To implement mini projects based on concept of electronics circuit concepts.

Course Outcome:

After successful completion of the course student will be able to

1. Understand the current voltage characteristics of semiconductor devices,
2. Analyze dc circuits and relate ac models of semiconductor devices with their physical Operation,
3. Design and analyze of electronic circuits,
4. Evaluate frequency response to understand behaviour of Electronics circuits.

Module No.	Unit No.	Detailed Content	Hours
1		**Diode and material science**	**06**
	1.1	Study of various types of resistor, capacitor and inductors	
	1.2	Basic fabrication steps of passive elements.	
	1.3	PN junction Diode characteristics, small signal model	
2		**Rectifier, Filters and Regulator**	**08**
	2.1	Analysis and design of rectifier circuit with Filters (L, LC, C,CLC,CRC)	
	2.2	Concept of load and line regulation in power supply circuits.	
	2.3	Analysis and design of zener voltage regulator	
3		**Transistor biasing and design**	**08**
	3.1	Operation of BJT, FET (N-CHANNEL, P-CHANNEL) with characteristics and equation.	
	3.2	Bipolar Junction Transistor: BJT characteristics, DC/AC load line, DC analysis and design of fixed bias, collector to base bias and voltage divider bias, stability factor analysis	
	3.3	Junction Field Effect Transistor: Analysis and design of self-bias and voltage divider bias, zero temp drift biasing.	
4		**Transistor modeling and Small signal analysis of amplifier**	**12**
	4.1	Hybrid and hybrid-pi model of BJT with graphical representation.	
	4.2	Small signal model of FET with graphical representation.	
	4.3	Small signal analysis (Zi, Zo, Av and Ai) of CE, CB, and CC configurations using hybrid-pi model of BJT	
	4.4	small signal (mid-frequency) analysis of CS, CD and CG amplifiers using FET	
5		**High frequency response of BJT and FET amplifiers**	**08**
	5.1	High frequency hybrid-pi equivalent Circuits of BJT and FET, Miller effect and Miller capacitance, gain bandwidth product	
	5.2	Effects of capacitors on frequency response of single stage amplifier using BJT and FET	
	5.3	Analysis of single stage amplifiers at HF and gain bandwidth product.	

6		**Design of small signal amplifiers**	**06**
	6.1	Design of single stage RC Coupled CE amplifier.	
	6.2	Design of single stage RC Coupled CS amplifier. (USE of parameters from data sheet compulsory)	

Textbooks :

1. D. A. Neamen, *"Electronic Circuit Analysis and Design,"* Tata McGraw Hill, 2nd Edition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, *"Microelectronic Circuits Theory and Applications,"* International Version, OXFORD International Students, 6th Edition
3. R. S. Dudhe and M. Farhan, "*Electronic Devices and Circuits*," Synergy Knowledgeware, 1st Edition, 2013.

Reference Books:

1. Boylestad and Nashelesky, "*Electronic Devices and Circuits Theory*," Pearson Education, 11th Edition.
2. A. K. Maini , "*Electronic Devices and Circuits*," Wiley.
3. T. L. Floyd, "*Electronic Devices,"*Prentice Hall, 9th Edition, 2012.
4. A. Rockett, "*Material Science of Semiconductors*,", Springer, 1stEdition, 2009
5. A. Mottershead, "*Electronic Devices and Circuits; An Introduction,*"

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC303	Digital System Design	20	20	20	80	--	--	--	100

Course Objectives:

1. To understand number representation and conversion between different representation in digital electronic circuits.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand characteristics of memory and their classification.
4. To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines.
5. To understand concept of Programmable Devices, PLA, PAL, CPLD and FPGA and implement digital system using VHDL.
6. To implement combinational and sequential circuits using VHDL.

Course Outcome:

After successful completion of the course student will be able to

1. Develop a digital logic and apply it to solve real life problems.
2. Analyze, design and implement combinational logic circuits.
3. Classify different semiconductor memories.
4. Analyze, design and implement sequential logic circuits.
5. Analyze digital system design using PLD.
6. Simulate and implement combinational and sequential circuits using VHDL systems.

Module	Unit No.	Detailed Content	Hours

No.			
1		**Number Systems and Codes**	**04**
	1.1	Review of Number System, Binary Code, Binary Coded Decimal, Octal Code, Hexadecimal Code and their conversions, Binary Arithmetics, Gray Code	
2		**Logic Gates and Combinational Logic Circuits**	**18**
	2.1	Analog and Digital signals and systems, Logic levels, TTL and CMOS Logic families and their characteristics	
	2.2	Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables and Quine-McClusky method	
	2.3	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Serial and Parallel Addition, Carry Look ahead adder and BCD adder. Binary Multiplier, Magnitude Comparator,	
	2.4	Multiplexer and De-multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean Function implementation using multiplexer and basic gates, de-multiplexer, encoder and decoder	
3		**Different Types of Memory**	**02**
		Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	
4		**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 registers.	
	4.2	Counters: Asynchronous and Synchronous, Up/Down, MOD N, BCD	
	4.3	Applications of Sequential Circuits: Frequency division, Ring Counter, Johnson Counter. models, State transition diagram, Design of Moore and Mealy circuits-Design of Serial Adder and vending Machine	
	4.4	State Reduction Techniques: Row elimination and Implication table methods	
5		**Programmable Logic Devices:**	**09**
		Introduction : Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array	

		Logic(PAL), CPLD and FPGA, Keyboard Encoder system design using PLD	
6		**VHSIC Hardware Description Language (VHDL)**	**03**
	6.1	Data types, Structural modeling using VHDL, Attributes, Data Flow behavioral, Implementation of Priority Encoder-combinational circuit and Fibonacci Series Generator-sequential circuits using VHDL	

Textbooks :

1. John F. Warkerly, "*Digital Design Principles and Practices*", Pearson Education, Fourth Edition (2008).
2. R. P. Jain, "*Modern Digital Electronics*", Tata McGraw Hill Education, Third Edition (2003).
3. J. Bhaskar, "*VHDL Primer"*, PHI, Third Edition (2009).
4. Volnei A. Pedroni, "*Digital Electronics and Design with VHDL*" Morgan Kaufmann Publisher (2008)

Reference Books:

1. Morris Mano / Michael D. Ciletti, "*Digital Design"*, Pearson Education, Fourth Edition (2008).
2. Thomas L. Floyd, "*Digital Fundamentals*", Pearson Prentice Hall, Eleventh Global Edition (2015).
3. Mandal, "*Digital Electronics Principles and Applications*", McGraw Hill Education, First Edition (2010).
4. Stephen Brown & Zvonko Vranesic, "*Fundamentals of Digital Logic Design with VHDL*", Second Edition, TMH (2009).
5. Ronald J. Tocci, Neal S. Widmer, "*Digital Systems Principles and Applications*", Eighth Edition, PHI (2003)
6. Donald P. Leach / Albert Paul Malvino/Gautam Saha, "*Digital Principles and Applications"*, The McGraw Hill, Seventh Edition (2011).

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Circuit Theory and Networks	04	--	@2	04	--	1	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC304	Circuit Theory and Networks	20	20	20	80	25	--	--	125

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Basic Electrical Engineering
- Solution to Differential Educations and Laplace Transform

Course Objectives:

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

Course Outcome:

After successful completion of the course student will be able to

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

Module No.	Unit No.	Detailed Content	Hours
1		**Electrical circuit analysis**	**08**
	1.1	Analysis of DC & AC Circuits: Analysis of Circuits with and without controlled sources using generalized loop and node matrix methods Circuit Theorems: Superposition, Thevenin's, Norton's, maximum power transfer and reciprocity theorems	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit Coupled circuit- solution using mesh analysis	
2		**Graph Theory**	**08**
	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.	
	2.3	KVL & KCL using matrix	
3		**Time and frequency domain analysis**	**08**
	3.1	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values Solution using first order differential equation for impulse, step, ramp, exponential & sinusoidal signals	
	3.2	Time domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step, ramp, exponential & sinusoidal signals.	
	3.3	Frequency domain analysis: Frequency - domain representation of R, L,C , initial value theorem & final value theorem, applications of Laplace Transform in analyzing electrical circuits	
4		**Network functions**	**08**
	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 analytical and graphical methods, Time domain behavior as related to the Pole-Zero plot Stability & causality, testing for Hurwitz polynomial	
	4.2	Analysis of ladder & symmetrical lattice network	
5		**Two port Networks**	**08**
	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.	
	5.3	Terminated two-port networks	
6		**Synthesis of RLC circuits**	**08**
	6.1	Positive Real Functions: Concept of positive real function , testing for 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	

Note: Term Work should be based on Tutorials.

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, 6h Edition
2. A. Sudhakar, Shyammohan S. Palli "circuits and Networks, Tata McGraw-Hill education
3. Smarajit Ghosh, Network Theory Snallysis & Syntshesis, PHI learning
4. K.S. Suresh Kumar, Elecric circuit analysis, Pearson (2013)
5. D Roy Choudhury, Networks and Systems, New Age International 1998.

TUTORIALS: At least 10 tutorials covering various topics of the syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control	04	--	@2	04	--	1	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC305	Electronic Instrumentation & Control	20	20	20	80	25	--	--	125

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Basic Electrical Engineering

Course Objectives:

1. To provide basic knowledge about the various sensors and data acquisition systems applied in Wireless sensor network.
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 Outcome:

After successful completion of the course student will be able to

1. Students will be able to explain principle of operation for various sensors.
2. Students will be able to describe functional blocks of data acquisition system.
3. Students will be able to find transfer functions for given system.
4. Students will be able to calculate time domain and frequency domain parameter for given system
5. Students will be able to predict stability of given system using appropriate criteria.

Module No.	Unit No.	Detailed Content	Hours
1		**Principle of Measurement, Testing and Measuring instruments**	**07**
	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 Q-Meter: Operating principle and applications Energy and power meters: Working of energy and power meter	
2		**Sensors and Transducers**	**08**
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers, working principle of Eddy-current sensors, Pizoelectric transducers, photoelectric and photovoltaic sensors, capacitive sensors	
	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		**Telemetry and Data Acquisition System**	**08**
	3.1	Introduction and characteristics, Landline Telemetry, Radio Telemetry Types of Multiplexing Systems,	
	3.2	Data Acquisition: Components of Analog and Digital Data Acquisition System,	
	3.3	Uses of Data Acquisition System, Use of recorders in Digital systems, Modern Digital Data Acquisition System.	

4		**Introduction to control system Analysis**	**07**
	4.1	Introduction: Open and closed loop systems, example of control systems	
	4.2	Modelling: Modelling, Transfer function model of electrical systems, Block diagram reduction techniques and Signal flow graph	
	4.3	Dynamic Response: Standard test signals, transient and steady state behaviour of first and second order systems , steady state errors in feedback control systems and their types	
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, concept of design of lag and lead compensator	
6		**Stability Analysis in frequency domain**	**10**
	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	

Note: Term Work should be based on Tutorials.

Textbooks :

1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation"* – DRS . India
2. M.M.S. Anand, "*Electronic Instruments and instrumentation Technology"*.
3. H.S.Kalsi, "*Electronic Instrumentation"*-TMH, 2nd Edition.
4. Nagrath, M.Gopal, "*Control System Engineering*", Tata McGraw Hill.
5. K.Ogata, "*Modern Control Engineering*, Pearson Education", IIIrd edition.

Reference Books:

1. Helfrick&Copper, "*Modern Electronic Instrumentation & Measuring Techniques"* – PHI
2. W.D. Cooper, "*Electronic Instrumentation And Measuring Techniques"* – PHI

3. Benjamin C.Kuo, "*Automatic Control Systems*, Eearson education", VIIth edition
4. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed., 2004.
5. Bell David A."*Electronic Instrumentation and Measurements*", PHI Pearson Education, 2006.
6. Madan Gopal, "*Control Systems Principles and Design"*, Tata McGraw hill, 7th edition,1997.
7. Normon, "*Control System Engineering"*, John Wiley & sons, 3rd edition.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL301	Electronic Devices & Circuits-I Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL301	Electronic Devices & Circuits-I Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Maximum of 8 practicals including **minimum 2 simulations** should be conducted based on following topics

- Study of different measuring instruments such as CRO, Function Generator, Multimeter, and Power Supply. (Compulsory)
- Filter circuits
- Biasing of BJT and FET
- Frequency response
- Zener regulator
- Single stage amplifiers

Minimum One project based on:

- Design of single stage CE and CS amplifier
- Design of filter and regulator circuits
- Design of power supply
- Any other relevant topic based on syllabus

Note : Small project should be considered as a part of term-work.

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.

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 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.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL302	Digital System Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL302	Digital System Design Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Maximum of 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments:

1. Verify different logic gates.
2. Simplification of Boolean functions.
3. Verify Universal gates NAND and NOR and design EXOR and EXNOR gates using Universal gates.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Implement BCD adder using four bit binary adder IC-7483.
6. Flip flops conversion JK to D, JK to T and D to TFF.
7. Implement logic equations using Multiplexer.
8. Design synchronous MOD N counter using IC-7490.
9. Verify encoder and decoder operations.
10. Implement digital circuits to perform binary to gray and gray to binary operations.
11. Verify truth table of different types of flip flops.
12. Verify different counter operations.
13. Write VHDL simulation code for different logic gates.
14. Write VHDL simulation code for combinational and sequential circuits
15. Write VHDL simulation code for 4:1 Multiplexer, 2 line to 4 line binary decoder

Minimum One project

Suggested list of Mini Projects:

1. Design Clock pulse generator.
2. Design Clap operated remote control for Fan.
3. Design BCD counter and show operation on Seven Segment Display.
4. Design digital stop watch.
5. Write VHDL code to implement traffic light controller.
6. Design water level indicator for overhead water tank.
7. Design frequency divider circuit.
8. Design switch debounce circuit.
9. Design sequence generator circuit.
10. Design sequence detector circuit.
11. Design Even/Odd parity generator/checker circuit.
12. Design simple LED flasher circuit.
13. Design digital dice.
14. Design fastest finger first indicator.
15. Design Toggle switch using TFF.

Note : Small project should be considered as a part of term-work.

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.

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 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.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL303	OOP using JAVA laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL303	OOP using JAVA laboratory	--	--	--	--	25	25	--	50

Course Pre-requisites:

- Fundamentals of C-Programming
- Control Structures
- Arrays and String

Course Objectives:

1. To understand Object Oriented Programming and its principles.
2. To describe & explain keywords and Data types.
3. Able to implement Methods, Constructors, Arrays, Multithreding and Applet
4. To help students to understand how to use a programming language to resolve problems.

Course Outcomes:

1. Students will be able to code a program using JAVA constructs.
2. Students will be able to understand fundamental features of an object oriented language: object classes and interfaces, exceptions and libraries of object collections.
3. Students will be able to develop a program that efficiently implements the algorithm for given tasks.
4. Students will be able to utilize the knowledge acquired in this course to develop higher level algorithms.

Module No.	Unit No.	Detailed Content	Hours
1		**Fundamental Concepts of Object Oriented Programming**	**06**
	1.1	Introduction to Object-Oriented Programming	
	1.2	Classes, Objects, Creating Classes and Objects, Principles of OOP**:** Abstraction, Encapsulation, Inheritance, Polymorphism	
	1.3	Differences And Similarity Between C and Java	
2		**Fundamental Of Java Programming**	**08**
	2.1	Features of Java, JDK Environment & Tools, Structure of Java Program	
	2.2	Java Keywords, Super Keyword, Final Keyword, Abstract Class	
	2.3	Data Types, Variables, Operators,Expressions	
	2.4	Input Output Using Scanner Class	
	2.5	Exception Handling, Object-Oriented Containers	
3		**Method, Constructors, Destructors And Arrays**	**04**
	3.1	Passing and Returning Parameters to Methods	
	3.2	Constructor and Types, Destructor	
	3.3	Arrays and Types**:** Create, One Dimensional Arrays, Two Dimensional Array, Multidimensional Array, String Array	
4		**Inheritance, Interface And Package**	**04**
	4.1	Types of Inheritance: Single, Multilevel, Hierarchical	
	4.2	Method Overloading and Method Overriding	
	4.3	Interface	
	4.4	Packages	
5		**Multithreading And Applet**	**04**
	5.1	Life Cycle Of Thread	
	5.2	Priority In Multithreading	
	5.3	Applet Life Cycle	
	5.4	Creating Applet, Applet Tag	

Textbooks :

1. Herbert Schidt, "*The Complete Reference*", Tata McGraw-Hill Publishing Company Limited, Ninth Edition
2. D.T. Editorial Services ,"*Java 8 Programming Black Book*", Dreamtech Press, Edition: 2015
3. Yashwant Kanitkar,"*Let Us Java*", BPB Publications; 2nd Edition edition.

Reference Books:

1. Java: How to Program, 8/e, Dietal, Dietal, PHI
2. Grady Booch, James Rumbaugh, Ivar Jacobson, "*The Unified Modeling Languageser Guide*", Pearson Education
3. Sachin Malhotra, Saurabh Chaudhary "*Programming in Java*", Oxford University Press, 2010

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:

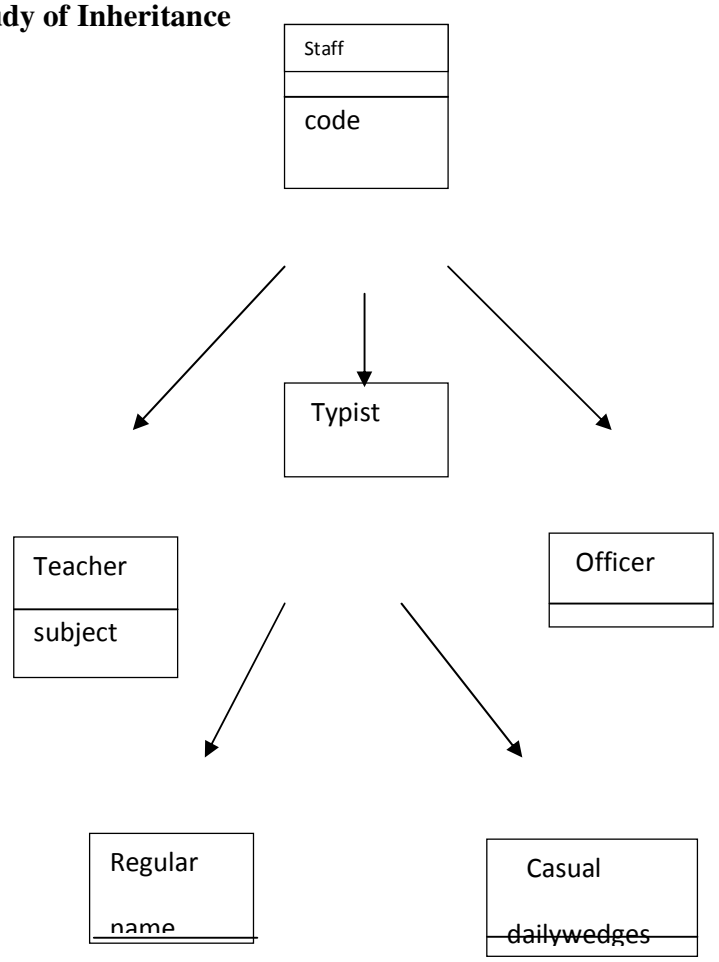
1. Google Drive
2. GitHub
3. Code Guru

Laboratory plan

Maximum of 8 practicals including **minimum 2 simulations** should be conducted based on following topics

Section	Experiment Name	Module
1.	**Write a program using command line argument in java.** • Echoing Command-Line Arguments. • Parsing Numeric Command-Line arguments.	Module 1
2.	**Study of simple java programs** • WAP to calculate area & circumference of circle • WAP to swap given two strings • WAP to separate out digits of a number • WAP to convert temperature from Fahrenheit to Celsius • WAP to find a square , squarroot, and Cube of a given no. using abstraction	Module 1
3.	**Study of different operators in java** • WAP to compare two numbers. • WAP to print truth table for java logical operators • WAP to read the number & shift left & right by 3 bits.	Module 1
4.	**Write a program for various ways of accepting data through keyboard & display its content.** • Read through DataInputstream. • Read input through Scanner. • Read input through BufferedReader.	Module 2
5.	**Study of Arrays** Write a program for addition, subtraction and multiplication of two matrices.	Module 3
6.	**Study of Objects and Classes** • Define a class to represent a bank account. Include the following members: Data: name of the depositor account number	Module 3

	type of account balance amount in the account Methods: 1.to assign initial values 2.to deposit an amount 3.to withdraw an amount after checking balance. 4.to display the name & balance • WAP using this keyword	
7.	**Study of Strings**. Accept the two strings from user & do the following operations • convert to lowercase • convert to uppercase • Replace all appearance of one character by another • Compare two strings • Derive the substring of a string • Derive the position of a character in a string • Calculate the length of a string • Derive the nth character of a string	Module 2
8.	**WAP to implement following constructors** • Default constructor • Parameterized constructor	Module 3
9.	**Study of Interface**. Create an interface Area & implement the same in different classes Rectangle ,circle ,triangle.	Module 4
10.	**Study of utility package** • WAP to generate a year using random class and check whether it is leap or not. • Write a program to display current date. Also display Time in hours &	Module 4

	Minutes using Date class.	
11.	**Study of Inheritance** 	Module 4
12.	**Study of Exception Handling in java**. Write a program to use throw finally and try catch to handle exception.	Module 2

13.	**Study of Multithreading.** WAP to illustrate function yield(), isAlive(), sleep(), join(). Create three threads as P,Q,R. Thread P has maximum priority, thread Q has minimum priority, thread R has normal priority.	Module 5
14.	**Study graphics using applet.** WAP to draw all geometric shapes and fill them with different colors.	Module 5

Minimum One project
Suggested list of mini projects

1. Inventory Control System
2. Develop Calculator
3. Develop Editor (Example: Notepad)
4. Devlop Multimedia App to teach primary students (Sahpes, Colors, etc.)
5. Create an audio or video applet or swing based application with play, pause and stop options.

Note : Small project should be considered as a part of term-work.

Term Work:

At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion.

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 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/mini project codes on online repository.

Practical from any 10 sections out of 14 sections is compulsory . Practical exam slip should cover all at least 10 sections.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC401	Applied Mathematics-IV	04	--	@2	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC401	Applied Mathematics-IV	20	20	20	80	25	--	--	125

@2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Mathematics I
- Applied Mathematics II
- Applied Mathematics III

Course Objectives:

1. To build the strong foundation in Mathematics of students needed for the field of Electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects

Course Outcome:

After successful completion of the course student will be able to

1. Demonstrate basic knowledge of Calculus of variation, Vector Spaces, Matrix Theory, Random Variables, Probability Distributions, Correlation and Complex Integration.
2. Demonstrate an ability to identify and Model the problems in the field of Electronics and Telecommunication and solve it.
3. Apply the application of Mathematics in Telecommunication Engineering.

Module No.	Unit No.	Detailed Content	Hours
1		**Calculus of Variation:**	**06**
	1.1	Euler's Langrange equation, solution of Euler's Langrange equation (only results for different cases for Function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	1.2	Isoperimetric problems, several dependent variables	
	1.3	Functions involving higher order derivatives: Rayleigh-Ritz method	
2		**Linear Algebra: Vector Spaces**	**06**
	2.1	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Vector spaces over real field, properties of vector spaces over real field, subspaces	
	2.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process	
3		**Linear Algebra: Matrix Theory**	10
	3.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors.	
	3.2	Cayley-Hamilton theorem (without proof), examples based on verification of Cayley- Hamilton theorem.	
	3.3	Similarity of matrices, Diagonalisation of matrices.	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices.	
4		**Probability**	**10**
	4.1	Baye's Theorem (without proof)	
	4.2	Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function, expectation, variance.	
	4.3	Moments, Moment Generating Function.	

	4.4	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
5		**Correlation**	**04**
	5.1	Karl Pearson's coefficient of correlation, Covariance, Spearman's Rank correlation,	
	5.2	Lines of Regression.	
6		**Complex integration**	**12**
	6.1	Complex Integration:Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	6.2	Taylor's and Laurent's Series	
	6.3	Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem.	
	6.4	Applications of Residue theorem to evaluate real Integrals of different types.	

Note: Term Work should be based on Tutorials.

Textbooks :

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication
4. P.N.Wartilar&J.N.Wartikar, "*A Text Book of Applied Mathematics*" Vol. I & II, Vidyarthi Griha Prakashan, Pune

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Seymour Lipschutz "*Beginning Linear Algebra*" Schaum's outline series, Mc-Graw Hill Publication
5. SeymourLipschutz "*Probability*" Schaum's outline series, Mc-Graw Hill Publication

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Electronic Devices & Circuits-II	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC402	Electronic Devices & Circuits-II	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Electronic Devices & Circuits-I

Course Objectives:

1. To understand the operation of the various bias circuits of MOSFET and Analyze and design MOSFET bias circuits.
2. To understand the operation and design of multistage amplifier for a given specification.
3. To understand the operation and design of transformer coupled various types of power amplifier circuits.
4. To understand the effects of negative feedback on amplifier circuits.
5. To analyze the different *RC* and *LC* oscillator circuits to determine the frequency of oscillation.

Course Outcome:

After successful completion of the course student will be able to

1. Design and analyse the basic operations of MOSFET.
2. Know about the multistage amplifier using BJT and FET in various configuration to determine frequency response and concept of voltage gain.
3. Know about different power amplifier circuits, their design and use in electronics and communication circuits.
4. Know the concept of feedback amplifier and their characteristics.
5. Design the different oscillator circuits for various frequencies

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction to MOSFET**	**08**
	1.1	MOSFET - Symbol, Types of MOSFET - Depletion and Enhancement type MOSFET (N channel and P channel),	
	1.2	Construction, Operation, and V-I characteristics of MOSFET	
	1.3	MOSFET biasing - Types of Depletion & enhancement MOSFET biasing,	
	1.4	MOSFET as amplifier	
2		**Introduction of Multistage amplifiers**	**06**
	2.1	RC coupled, transformer coupled, direct coupled,	
	2.2	Low and high frequency considerations of cascade amplifier, cascode amplifier (CE-CB), Darlington pair amplifier.	
3		**Design of Multistage amplifiers**	**10**
		Analysis and design considerations of multistage amplifiers (CE-CE, CS-CS, CS-CE,), effect of source and load resistance	
4		**Large signal amplifiers**	**08**
	4.1	Harmonic distortion and power efficiency of Class A, B, AB, and C amplifiers	
	4.2	Design of Class A, Class B, and Push-Pull Power amplifier design.	
	4.3	Thermal considerations and design selection of heat sinks.	
5		**Feedback amplifiers**	**08**
	5.1	Feedback concept, ideal feedback amplifier, classification of feedbacks, Various topologies	
	5.2	Analysis and design of different types of negative feedback.	
6		**Oscillators**	**08**
	6.1	Principle of oscillation, RC oscillator, twin T oscillator	
	6.2	Oscillator with LC feedback. Colpitts oscillator, Hartley oscillator, Crystal controlled oscillator.	
	6.3	Design of different oscillator circuits.	

Textbooks :

1. D. A. Neamen, *"Electronic Circuit Analysis and Design,"* Tata McGraw Hill, 2nd Edition.
2. R. L. Boylestad,"Electronic Devices and Circuit Theory," Pearson, 11th Edition.
3. T. F. Bogart,"Electronic Devices And Circuit," Merrill, 6th Edition.
4. R. S. Dudhe and M. Farhan, "Electronic Devices and Circuits," Synergy Knowledgeware, 1st Edition

Reference Books:

1. Salivahanan, N. Suresh Kumar,"*Electronic Devices and Circuits*," Tata McGraw Hill, 3rd Edition
2. J. Millman, Christos CHalkias, and Satyabratatajit, Millman's,"*Electronic Devices and Circuits*," McGrawHill, 3rd Edition
3. Muhammad H. Rashid, "*Microelectronics Circuits Analysis and Design*," Cengage Learning, 2nd Edition.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC403	Linear Integrated Circuits	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC403	Linear Integrated Circuits	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Basic Electrical Engineering
- Electronic Devices & Circuits-I

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. Understand the fundamentals and areas of applications for the integrated circuits.
2. Analyze important types of integrated circuits.
3. Demonstrate the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical, practical & simulated results in integrated circuits.
5. Select the appropriate integrated circuit modules to build a given application.

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction to operational amplifiers**	**08**
	1.1	Analysis of differential amplifier circuit configurations using FETs, Effect of Swamping resistor, Current sources using FETs, Widlar current source, Wilson current source, Voltage sources and references, DC level shifters.	
	1.2	Ideal & Practical Operational Amplifiers, Operational amplifier characteristics, Operational amplifier parameters, Operational amplifier open loop and closed loop configurations.	
2		**Applications of Operational Amplifier**	**08**
	2.1	Amplifiers: Inverting, non-inverting, buffer, summing & difference amplifiers, integrator & differentiator (ideal & practical), current amplifier, instrumentation amplifier, log and antilog amplifiers..	
	2.2	Converters: Current to voltage converters, voltage to current converters, voltage to frequency converter, frequency to voltage converter.	
	2.3	Active Filters: Second order active low pass, high pass, band pass and band reject filters, Introduction to switch capacitor filters.	
	2.4	Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3		**Non-Linear Applications of Operational Amplifier**	**08**
	3.1	Comparators: Inverting comparator, non-inverting comparator, zero crossing detector, window detector, peak detector, sample & hold circuits.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator.	
	3.4	Precision Rectifiers: Half wave and full wave precision rectifiers.	
4		**Analog to Digital and Digital to Analog Convertors**	**08**
	4.1	Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.	
	4.2	Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.	
5		**Special Purpose Integrated Circuits**	**08**
	5.1	Functional block diagram and working of IC 555, design of astable and monostable multivibrator using IC 555, application	

		of IC 555 as pulse position modulator, pulse width modulator and Schmitt Trigger.	
	5.2	Functional block diagram and working of VCO IC 566 and application as frequency modulator, Functional block diagram and working of PLL IC 565 and application as FSK Demodulator, Functional block diagram and working of multiplier IC 534andapplication as a phase detector, Functional block diagram and working of waveform generator XR 2206 and application as sinusoidal FSK generator.	
6		**Voltage Regulators**	**08**
	6.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	6.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator.	

Textbooks :

1. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition.
2. K. R. Botkar, "*Integrated Circuits*", Khanna Publishers (2004)
3. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition.

Reference Books:

1. Sergio Franco, "*Design with operational amplifiers and analog integrated circuits*", Tata McGraw Hill, 3rd Edition.
2. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition.
3. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition.
4. "J. Millman, Christos CHalkias, and Satyabratatajit, Millman's,"Electronic Devices and Circuits," McGrawHill, 3rdEdition".

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	04	--	2@	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC404	Signals and Systems	20	20	20	80	25	--	--	125

@2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Maths-III
- Circuit Theory and Networks

Course Objectives:

1. To introduce students the concept and theory of signals and systems needed in electronics and telecommunication engineering fields.
2. To introduce students to the basic idea of signal and system analysis and its characterization in time and frequency domain

Course Outcome:

After successful completion of the course student will be able to

1. Understand about various types of signals and systems, classify them, analyze them, and perform various operations on them,
2. Understand use of transforms in analysis of signals and system in continuous and discrete time domain.
3. Observe the effect of various properties and operations of signals and systems.
4. Evaluate the time and frequency response of Continuous and Discrete time systems which are useful to understand the behaviour of electronic circuits and communication systems.

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction to signals and systems**	**08**
	1.1	Introduction to signals: Definition, sampling theorem, sampling of continuous time signals, elementary signals: exponential, sine, step, impulse, ramp, rectangular, triangular, signum, sinc, operations on signals,	
	1.2	Classification of signals: Continuous and discrete time, deterministic and non-deterministic, periodic and aperiodic, symmetric (even) and asymmetric (odd), energy and power, causal and anti-causal signal, Case study of different signals from communication and biomedical field	
	1.3	Introduction to systems: Definition, Classification of systems: Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems., communication and control system as examples	
2		**Time domain analysis of continuous time and discrete time systems**	**08**
	2.1	Representation of systems using differential /difference equation, Impulse, step and exponential response, system stability	
	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,PSD with auto-correlation	
3		**Frequency domain analysis of continuous and discrete signals:**	**10**
	3.1	**Review of Fourier series:** Trigonometric and exponential Fourier series representation of signals, Gibbs phenomenon, Discrete Time Fourier Series, properties, analogy between Continuous Time Fourier Series (CTFS) and Discrete Time Fourier Series (DTFS).	
	3.2	**Fourier Transform (FT):** Fourier Transform and Inverse Fourier Transform on periodic and non-periodic signals, limitations of CT/DT Fourier Transform and need for Laplace/Z Transform.	
	3.3	**Overview of Laplace Transform:** Need of Laplace Transform, review of unilateral and bilateral Laplace	

		Transform, properties, inverse of Laplace Transform, concept of Region of Convergence (ROC),poles and zeros, relation between continuous time Fourier Transform and Laplace Transform.	
4		**Z-Transform**	**08**
	4.1	Need of Z-Transform, definition of unilateral and bilateral Z-Transform, Z-Transform of finite and infinite duration sequences, properties, Inverse Z-Transform, relation between discrete time Fourier Transform and Z-Transform, Z-Transform of standard signals, ROC for ZT, plotting poles and zeros of transfer function.	
	4.2	Analysis of discrete time LTI systems using Z-Transform: Transfer Function, causality and stability of systems, frequency response (impulse and step), relation between Laplace Transform and Z–Transform.	
5		**State Space Analysis and Realization Structures**	**08**
	5.1	State Variable Analysis: Introduction to the notion of 'state', systematic procedure for determining state equations, solution of state equations using Laplace transform, definition of $exp(A)$ where A is a matrix, time domain solution of state equations.	
	5.2	Systems with finite duration and infinite duration, impulse response, recursive and non-recursive discrete time system, realization structures: direct form–I, direct form–II, Transpose, cascade, and parallel forms.	
6		**Applications of Signals and Systems**	**06**
	6.1	Signal Processing Applications: Speech and Audio Processing, Multimedia (image & video) processing, Underwater acoustic signal processing, Biological signal analysis	
	6.2	Communication and Control System Application: Modulation (Analog and Digital) process, Feedback/Feedforward Control system	

Textbooks :

1. NagoorKani, "*Signals and Systems"*, Tata McGraw Hill, Third Edition, 2011.
2. B.P. Lathi, "*Principles of Linear Systems and Signals"*, Oxford, Second Edition, 2010.
3. S. L. Nalbalwar, A. M. Kulkarni and S. P. Sheth, "*Signals and Systems"*, Synergy Knowledgeware, 2016.
4. Simon Haykin and Barry Van Veen, "*Signals and Sytems"*, John Wiley and Sons, Second Edition,2004.

Reference Books:

1. Hwei. P Hsu, "*Signals and Systems"*, Tata McGraw Hill, Third edition, 2010
2. V. Krishnaveni and A.Rajeshwari, "*Signals and Systems"*, Wiley-India, First Edition 2012.
3. NarayanaIyer, "*Signals and Systems"*, Cenage Learning, First Edition 2011.
4. Michael J Roberts, "*Fundamentals of Signals and systems*", Tata McGraw Hill, special Indian Economy edition, 2009.
5. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, "*Signals and Systems"*, Pearson Education, Fourth Edition 2009.
6. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, "*Signals and Systems*", Prentice-Hall of India, Second Edition, 2002.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC405	Principles of Communication Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Applied Maths III
- Electronic Devices and Circuits I

Course Objectives:

1. To introduce students to various modulation and demodulation techniques of analog communication.
2. To analyze different parameters of analog communication techniques.
3. To study pulse modulation and demodulation.

Course Outcome:

After successful completion of the course student will be able to

1. Use different modulation and demodulation techniques used in analog communication
2. Identify and solve basic communication problems
3. Analyze transmitter and receiver circuits
4. Compare and contrast design issues, advantages, disadvantages and limitations of analog communication systems

Module No.	Unit No.	Detailed Content	Hours
1		**Basics of Communication System**	**06**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain.	
	1.2	Types of noise, signal to noise ratio, noise figure and noise temperature, Friss transmission formula.	
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concepts, signal representation, need for modulation	
	2.2	Spectrum, waveforms, modulation index, bandwidth, voltage distribution and power calculations	
	2.3	DSBFC: Principles, modulating circuits, low level and high level transmitters DSB suppressed carrier :Multiplier modulator, nonlinear modulator and switching modulator	
	2.4	Amplitude demodulation: Diode detector, practical diode detector, square law detector	
	2.5	Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television	
3		**Angle Modulation and Demodulation**	**12**
	3.1	Frequency modulation (FM): Basic concept, mathematical analysis, spectrum of FM wave, sensitivity, phase deviation and modulation index, deviation and percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio, narrowband FM and wideband FM	
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise emphasis and de-emphasis	
	3.3	Phase modulation (PM): Principle and working of transistor direct PM modulator and relationship and comparison between FM and PM	
	3.4	FM demodulation: Balance slope detector, Foster-Seely discriminator, ratio detector, FM demodulator using Phase lock loop (PLL), amplitude limiting and thresholding, comparison between FM demodulators, comparison between AM, FM and PM	
	3.5	Applications of FM and PM	

4		**Radio Receivers**	**06**
	4.1	TRF, Super - heterodyne receiver, receiver parameters and choice of IF	
	4.2	AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC, and communication receiver	
	4.3	FM receiver circuits, comparison with AM receiver	
	4.4	Single and independent sideband (SSB and ISB) receivers	
5		**Analog Pulse Modulation & Demodulation**	**08**
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria	
	5.2	Sampling techniques, aliasing error and aperture effect	
	5.3	PAM,PWM, PPM generation and detection	
	5.4	Applications of Pulse Communication	
6		**Multiplexing & De-multiplexing**	**04**
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram	
	6.2	Time Division Multiplexing transmitter & receiver block diagram	
	6.3	Examples and applications of FDM and TDM	

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*", Prentice Hall, Third Edition.
5. Louis Frenzel, "*Communication Electronics*", Tata McGraw Hill, Third Edition.
6. Roy Blake, "*Electronic Communication Systems*", Delmar Publication, Second edition

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL401	Electronic Devices & Circuits-II Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL401	Electronic Devices & Circuits-II Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Design and Analyze two stage BJT amplifier (Frequency response and performance parameters)
2. Design and Analyze two stage FET amplifier (Frequency response and performance parameters)
3. Design Multistage BJT amplifier and finding its parameters, Verify.
4. Design and Analyze Voltage series feedback amplifier using BJT/FET and verify its effect on frequency response. x
5. Design and Analyze Current series feedback using BJT/FET and verify its effect on frequency response.
6. Design Multistage JFET amplifier and finding its parameters, verify.
7. Design and Analyze RC Phase shift oscillator for different amplitude and frequency.
8. Design and Analyze Colpitt / Hartley oscillator for different amplitude and frequency.
9. Class C power amplifier and its efficiency

Minimum One project based on:

1. Simple Emergency light.
2. DC servo amplifier using MOSFET.
3. Audio tone control circuit.
4. Public address system.
5. Automatic Door Bell

6. Clapp Switch
7. Topic related to syllabus

Note :Small project should be considered as a part of term-work.

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.

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

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL402	Linear Integrated Circuits Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL402	Linear Integrated Circuits Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Discrete Differential Amplifier
2. Inverting, Non inverting, Buffer, Summing & Difference amplifiers
3. Differentiator & Integrator
4. Instrumentation amplifier
5. I to V and V to I converters
6. V to F and F to V convertors
7. Active Filters
8. Wien Bridge Oscillator
9. RC Phase shift Oscillator
10. Inverting & Non inverting Schmitt trigger
11. Square & Triangular wave generator
12. Precision rectifiers
13. Peak detector & Sample & Hold Circuits
14. Analog to Digital converter

15. Digital to Analog converter
16. Multivibrators using IC 555
17. PPM, PWM and Schmitt trigger using 555
18. Frequency modulatorusing VCO IC 566.
19. FSK DemodulatorusingPLL IC 565.
20. Phase detectorusing multiplier IC 534.
21. Sinusoidal FSK generator using XR 2206
22. Voltage Regulators using 78XX/79XX, 317/337, 723

Minimum One project based on:

1. Variable Power Supply
2. Data Acquisition System
3. Function Generator
4. Topic related to syllabus

Note :Small project should be considered as a part of term-work.

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.

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL403	Signals and Systems Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL403	Signals and Systems Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Generation of signals, perform different operation on signals and plot them.
2. Generation of Gibbs phenomenon and observe the behavior of the signal.
3. Simulation of continuous time LTI system using convolution or Simulation of discrete time LTI systems using convolution.
4. Implementation of energy spectral and power spectral density.
5. Perform correlation, auto-correlation operations on different signals.
6. Obtaining impulse response of the systems.
7. Computing FT and DTFT of the CT signals and DT sequences.
8. Observing the effects of lower sampling rate and higher sampling rate on CT signal.
9. Modeling/Simulating Realization Structure of Direct form-I and II.
10. Modeling/Simulating State Space Realization.

Minimum One project based on:

1. Biometric Identification
2. Classification of Audio signal
3. Image Enhancement and Denoising
4. Designing of Feed-forward and Feedback Systems
5. Relevant topics in scope of subject.

Note :Small project should be considered as a part of term-work.

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.

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 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.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL404	Principles of Communication Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL404	Principles of Communication Engineering Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Generation and detection of AM (DSB-FC, DSB-SC,SSB) signal.
2. Generation and detection of FM signal.
3. Study of AM broadcast receiver (Super heterodyne).
4. Generation of PAM signal and verify the sampling theorem.
5. Generation of PPM, PWM signal.
6. Study of TDM and FDM multiplexing techniques.

Suggested list of Minimum projects

1. AM transmitter /receiver.
2. FM transmitter /receiver.
3. PAM,PPM,PWM circuits with IC 555
4. FM remote encoder/decoder circuits,
5. Transistor Intercom circuit
6. Walkie -Talkie Circuit

7. Arduino based communication circuits
8. Electronic voting machine.
9. Electronic Notice Board Using Android.
10. Home security system.

Note :Small project should be considered as a part of term-work.

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.

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 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.