MODEL CURRICULUM

for

UNDERGRADUATE DEGREE COURSES

in

Electronics & Communication Engineering

(Engineering & Technology)

ELECTRONICS & COMMUNICATION ENGINEERING

CONTENTS

ELECTRONICS & COMMUNICATION ENGINEERING

Total Credits: 180

General, Course structure & Theme

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Semester-wise credit distribution

DefinitionofCredit:

1Hr.Lecture(L) perweek	1credit
1Hr.Tutorial(T) perweek	1credit
1 Hr.Practical(P)perweek 2 LecturesPractical (Lab)/week	0.5 credits 1 credit

Rangeofcredits-

Arangeofcreditsfrom170to180forastudenttobeeligibletogetUnderGraduatedegreeinEngineering.

StructureofUndergraduateEngineeringprogram:

S. No.	Category	SuggestedBreakupofCredits (AICTE)	SuggestedBreakupofCredits (Proposed)
1	HumanitiesandSocialSciencesincluding Managementcourses	12*	9
2	BasicSciencecourses	25*	22
3	EngineeringSciencecourses includingworkshop,drawing,basicsofelectrical/mechanical/computeretc	24*	24
4	Professionalcorecourses	48*	70
5	ProfessionalElectivecoursesrelevanttochosenspecialization/branch	18*	15
6	Opensubjects – Electives fromother technicaland/oremergingsubjects	18*	12
7	Project work,seminarandinternshipinindustryorel	15*	28
8	MandatoryCourses [Environmental Sciences,InductionProgram,IndianConstitution,EssenceofIndianKnowledgeTradition]	(non-credit)	0
	Total	**160***	**180**

**Minorvariationisallowedasperneedofthediscipline.*

CreditdistributionintheFirstyearofUndergraduateEngineeringprogram:

	Lecture	**Tutorial**	**Laboratory/ Practical**	**Totalcredits**
Chemistry	3	1	3	5.5
Mathematics –I (Calculus and Differential Equations)	3	1	0	4
Programming for Problem Solving	3	0	4	5
Workshop Manufacturing Practices	1	0	4	3
English	2	0	2	3
Physics (Wave and Optics and Introduction to Quantum Mechanics)	3	1	3	5.5
Mathematics –II (Linear Algebra, Transform Calculus and Numerical Methods)	3	1	0	4
Basic Electrical Engineering	3	1	2	5
Engineering Graphics & Design	1	0	4	3

Coursecodeanddefinition:

Coursecode	**Definitions**
EC	CoreCourses
ECEL	ProgramElectives
ECP	Project/ Internship
BS	BasicScience
ES	GeneralEngineeringCourses
HS	Humanities and Social Sciences Including Management
OE	OpenElectives
MC	MandatoryCourses

BASIC SCIENCE COURSES

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	BS101	Mathematics-III	3-0-0	3	III

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	HS101	Cost Management of Engineering Projects	3-0-0	3	VII
2	HS102	Business Analytics	3-0-0	3	VIII

ENGINEERING SCIENCE COURSES

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	ES101	Basic Electronics	3-0-0	3	III
2	ES101P	Basic Electronics Lab	0-0-2	1	III
3	ES102	Electrical and Electronics Materials	3-0-0	3	IV
4	ES102P	Electrical and Electronics Materials Lab	0-0-2	1	IV

MANADATORY COURSES

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	MC101	Stress Management by Yoga	0-0-2	NIL	I
2	MC102	Disaster Management	0-0-2	NIL	II
3	MC103	Constitution of India	0-0-2	NIL	III

PROGRAM CORE COURSES

S. No.	CourseCode	CourseTitle	L:T:P	Credits	PreferredSemester
1	EC101	Network Theory	3:1:0	4	III
2	EC102	Signals and Systems	3:0:0	3	III
3	EC103	Object Oriented Programming	3:0:0	3	III
4	EC103P	Object Oriented Programming Lab	0:0:2	1	III
5	EC104	Digital Circuits	3:1:0	4	IV
6	EC104P	Digital Circuits Lab	0:0:2	1	IV
7	EC105	Analog Circuits	3:0:0	3	IV
8	EC105P	Analog Circuits Lab	0:0:2	1	IV
9	EC106	Semiconductor Physics and Devices	3:0:0	3	IV
10	EC106P	Semiconductor Physics and Devices Lab	0:0:2	1	IV
11	EC107	Analog Communication	3:0:0	3	IV
12	EC107P	Analog Communication Lab	0:0:2	1	IV
13	EC108	Electromagnetic Theory	3:1:0	4	IV
14	EC109	Digital Signal Processing	3:0:0	3	V
15	EC109P	Digital Signal Processing Lab	0:0:2	1	V
16	EC110	Microprocessors and Microcontrollers	3:0:0	3	V
17	EC110P	Microprocessors and Microcontrollers Lab	0:0:2	1	V
18	EC111	Linear Control Systems	3:1:0	4	V
19	EC112	Linear Integrated Circuits and Applications	3:0:0	3	V
20	EC112P	Linear Integrated Circuits and Applications Lab	0:0:2	1	V
21	EC113	Probability Theory and Stochastic Processes	3:0:0	3	V
22	EC114	Computer Networks and Security	3:0:0	3	V
23	EC115	Digital Communication	3:1:0	4	VI
24	EC115P	Digital Communication Lab	0:0:2	1	VI
25	EC116	Electronics Instruments and Measurement	3:1:0	4	VI
26	EC116P	Electronics Instruments and Measurement	0:0:2	1	VI
27	EC117	Computer Organization and Architecture	3:0:0	3	VI
28	EC118	Wireless Communication	3:0:0	3	VII

PROGRAMELECTIVECOURSES

Sr. No.	CourseCode	CourseTitle	L:T:P	Credits	Preferred Semester
1	ECEL1011	Digital Image & Video Processing	3:0:0	3	VI
2	ECEL1012	Digital CMOS VLSI Design	3:0:0	3	VI
3	ECEL1013	Scientific computing	3:0:0	3	VI
4	ECEL1021	Antennas and Wave Propagation	3:0:0	3	VII
5	ECEL1022	Optical Fiber Communications	3:0:0	3	VII
6	ECEL1023	Micro- and Nano-electronics	3:0:0	3	VII
7	ECEL1024	Embedded System	3:0:0	3	VII
8	ECEL1031	High Speed Electronics	3:0:0	3	VII
9	ECEL1032	Digital System Design	3:0:0	3	VII
10	ECEL1033	VLSI Technology	3:0:0	3	VII
11	ECEL1034	Information and Coding Theory	3:0:0	3	VII
12	ECEL1041	Microwave Theory and Techniques	3:0:0	3	VIII
13	ECEL1042	Error correcting codes	3:0:0	3	VIII
14	ECEL1043	Speech and Audio Processing	3:0:0	3	VIII
15	ECEL1044	Satellite Communication	3:0:0	3	VIII
16	ECEL1051	Wireless Sensor and Networks	3:0:0	3	VIII
17	ECEL1052	Adaptive Signal Processing	3:0:0	3	VIII
18	ECEL1053	Analog CMOS VLSI Design	3:0:0	3	VIII
19	ECEL1054	Bio-Medical Instrumentation	3:0:0	3	VIII

OPEN ELECTIVE COURSES

S.No.	Course Code	CourseTitle	L:T:P	Credits	Preferred Semester
1	OE101	MOOC/SWAYAM Courses	2:0:0	2	IV
2	OE102	MOOC/SWAYAM Courses	2:0:0	2	VI
3	OE103	MOOC/SWAYAM Courses	2:0:0	2	VII
4	OE1041	Machine Learning	3:0:0	3	VII
5	OE1042	Introduction to MEMS	3:0:0	3	VIII
6	OE1043	Internet of Things	3:0:0	3	VIII
7	OE1044	Power Electronics	3:0:0	3	VIII
8	OE1051	Big Data Analytics	3:0:0	3	VIII
9	OE1052	Transducers and Sensors	3:0:0	3	VIII
10	OE1053	Bio and Smart Materials	3:0:0	3	VIII

INTERNSHIP/PROJECT/DISSERTATION

Sr. No.	Course Code	CourseTitle	L:T:P	Credits	Preferred Semester
1	ECP1	Internship (4 Weeks)	0:0:8	4	III
2	ECP2	Internship (4 Weeks)	0:0:8	4	V
3	ECP3	Internship (6 Weeks)	0:0:12	6	VII
4	ECP4	Project WorkI	0:0:10	5	VII
5	ECP5	Project WorkII&Dissertation	0:0:18	9	VIII

SECTION 3:

4-yearCurriculumstructure for undergraduate

Degree in Engineering & Technology

Branch/course:Electronics&CommunicationEngineering

I. Semester-wise structure of curriculum
[L=Lecture, T=Tutorials, P=Practical&C=Credits]

SemesterIII(Secondyear)
Branch/CourseElectronics&CommunicationEngineering

Sr. No.	Course Code	CourseTitle	L	T	P	Contact Hrs./wk.	Credits
1	EC101	Network Theory	3	1	0	4	4
2	EC102	Signals and Systems	3	0	0	3	3
3	BS101	Mathematics-III	3	0	0	3	3
4	EC103	Object Oriented Programming	3	0	0	3	3
5	EC103P	Object Oriented Programming Lab	0	0	2	2	1
6	ES101	Basic Electronics	3	0	0	3	3
7	ES101P	Basic Electronic Science Lab	0	0	2	2	1
8	ES102	Electrical and Electronic Material	3	0	0	3	3
9	ES102P	Electrical and Electronic Material Lab	0	0	2	2	1
10	ECP1	1. Language Lab. (1 Week) 2. Industrial Visit/Internship (2 Weeks) 3. Fundamental Electronics Lab Training (1 Week)	0	0	12	12	4
	TOTAL					37	**26**

Semester IV(Second year)
Branch/Course Electronics & Communication Engineering

Sr. No.	Course Code	CourseTitle	L	T	P	Contact hrs./wk.	Credits
1	EC104	Digital Circuits	3	1	0	4	4
2	EC104P	Digital Circuits Lab	0	0	2	2	1
3	EC105	Analog Circuits	3	0	0	3	3
4	EC105P	Analog Circuits Lab	0	0	2	2	1
5	EC106	Semiconductor Physics and Devices	3	0	0	3	3
6	EC106P	Semiconductor Physics and Devices Lab	0	0	2	2	1
7	EC107	Analog Communication	3	0	0	3	3
8	EC107P	Analog Communication Lab	0	0	2	2	1
9	EC108	Electromagnetic Theory	3	1	0	4	4
10	OE101	OpenElective-1 / MOOC/SWAYAM Courses	3	0	0	3	2
11	MC101	Stress Management by Yoga (Non-Credit)	2	0	0	2	0
	Total					30	**23**

Semester V(Third year)
Branch/Course Electronics & Communication Engineering

Sr. No.	Course Code	CourseTitle	L	T	P	Contact Hrs./wk.	Credits
1	EC109	Digital Signal Processing	3	0	0	3	3
2	EC109P	Digital Signal Processing Lab	0	0	2	2	1
3	EC110	Microprocessors and Microcontrollers	3	0	0	3	3
4	EC110P	Microprocessors and Microcontrollers Lab	0	0	2	2	1
5	EC111	Linear Control Systems	3	1	0	4	4

6	EC112	Linear Integrated Circuits and Applications	3	0	0	3	3
7	EC112P	Linear Integrated Circuits and Applications Lab	0	0	2	2	1
8	EC113	Probability Theory and Stochastic Processes	3	0	0	3	3
9	EC114	Computer Networks and Security	3	0	0	3	3
10	ECP2	1. Software Skills(1 Week) 2. Industrial Visit (1 Week) 3. Internship (Outside) (2 Weeks)	0	0	6	6	4
	TOTAL					31	26

Semester VI(Third year)

Branch/CourseElectronics&CommunicationEngineering

Sr.	Course Code	CourseTitle	L	T	P	Contact hrs./wk.	Credit
1	EC115	Digital Communication	3	1	0	4	4
2	EC115P	Digital Communication Lab	0	0	2	2	1
3	EC116	Electronics Instruments and Measurement	3	1	0	4	4
4	EC116P	Electronics Instruments and Measurement Lab	0	0	2	2	1
5	EC117	Computer Organization and Architecture	3	0	0	3	3
6	ECEL101*	ProgramElective-1	3	0	0	3	3
7	OE102	OpenElective-2/ MOOC or SWAYAM Courses	3	0	0	3	2
8	MC102	Disaster Management (Non-Credit)	2	0	0	2	0
9		Workshop/heads on Training/Soft Skill	-	-	-	8	0
	TOTAL					31	**18**

* means that this course has more than one alternative choice as listed in the course list

Semester VII (Fourth year)

Branch/Course Electronics & Communication Engineering

Sr.No.	CourseCode	CourseTitle	L	T	P	Contact Hrs./wk.	Credits
1	EC118	Wireless Communication	3	0	0	3	3
2	ECEL102*	ProgramElective-2	3	0	0	3	3
3	ECEL103*	ProgramElective-3	3	0	0	3	3
4	OE103	Open Elective – 3 / MOOC or SWAYAM Courses	3	0	0	3	2
5	HS101	Cost Management of Engineering Projects	3	0	0	3	3
6	ECP3	1. Application Oriented Software (Hands-on) (2 Weeks) 2. Industrial Visit (4 Weeks)	0	0	12	12	6
7	ECP4	ProjectStage-I	0	0	10	10	5
8	MC103	Constitution of India	2	0	0	2	0
	TOTAL					39	**25**

SemesterVIII [Fourthyear]

Branch/CourseElectronics&CommunicationEngineering

Sr.	CourseCode	CourseTitle	L	T	P	Contact hrs. /wk.	Credits
1	ECEL104*	ProgramElective-4	3	0	0	3	3
2	ECEL105*	ProgramElective-5	3	0	0	3	3
3	OE104*	Open Elective – 4	3	0	0	3	3
4	OE105*	Open Elective – 5	3	0	0	3	3
5	HS102	Business Analytics	3	0	0	3	3

6	ECP5	ProjectStage-II	0	0	18	18	9
7		Employability Skill Training	-	-	-	2	0
	TOTAL					35	**24**

1. Humanities and Social Sciences including Management

HS101	Cost Management of Engineering Projects	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	Unit 1:(8 Lectures)Introduction and Overview of the Strategic Cost Management Process: Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Databasefor operational control	8
2	Unit 2:(8 Lectures) Provision of data for Decision-Making: Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre-project execution main clearances and documents	8
3	Unit 3:(6 Lectures) Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram.	6
4	Unit 4:(12 Lectures) Project commissioning: Mechanical and process Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.	10
5	Unit 5:(10 Lectures) Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management. Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	10
	Total	42

Sl. No.	Name of Authors / Books /Publishers
1	Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2	Charles T. Horngren and George Foster, Advanced Management Accounting
3	Robert S Kaplan Anthony A. Alkinson, Management and Cost Accounting
4	. Ashish K. Bhattacharya, Principles and Practices of Cost Accounting A. H. Wheeler publisher
5	.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

HS102	Business Analytics	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	Unit 1: (8 Lectures) Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	8

2	Unit 2: (8 Lectures) Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	8
3	Unit 3: (8 Lectures) Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predictive Modelling Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	8
4	Unit 4: (10 Lectures) Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	10
5	Unit 5: (8 Lectures) Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent trends:In Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	8
	Total	42

Sl. No.	**Name of Authors / Books /Publishers**
1	Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2	Business Analytics by James Evans, persons Education

2. Engineering Science Courses

ES101	**Basic Electronics**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**PN junction diode :** Depletion layer, Barrier potential, Forward and Reverse bias, Breakdown voltage, I-V characteristics of PN junction diode, Knee voltage, Ideal PN junction diode, Diode capacitances, Breakdown diodes (Avalanche and Zener diode). Photodiode and Light Emitting Diode.	8
2	**Rectifiers and filters :** Half wave and Full wave rectifiers (Centre-tap and Bridge), Regulation, Ripple factor, R-C, L-C and Pi filters. Clipping and Clamping circuits, Voltage multiplier.	8
3	**BJT :** Basic theory and Operation of PNP and NPN transistors, Characteristics of C-B, C-E and C-C configuration. Biasing : Base bias, Emitter feedback bias, Voltage divider bias, Load line, Operating point, Incremental analysis using hybrid model.	10
4	**FET :** Introduction, Operation, I-V characteristics, JFET parameters, JFET amplifiers. **MOSFET :** Introduction, Operation, MOSFET parameters.	8

5	**Integrated circuit :** Characteristics of an ideal Operational Amplifier. Application as inverting, non inverting amplifiers. Summer, Difference Amplifier, Differentiator, Integrator. Feedback Amplifiers.	8
	Total	42

Sl. No.	Name of Authors / Books /Publishers
1	"Electronic devices and circuit theory" by Boylestead and Nashelsky, Pearson
2	"Electronic principle" by Albert Malvino and Davis J Bates, TMH
3	"Integrated Electronics", By Jacob Millman and Christos Halkias

Basic Electronics Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

ES102	**Electrical & Electronic Material**	**3L:0T:0P**	3 Credits

Sl. No.	Contents	Contact Hours
1	Atomic structure and bonding in materials. Crystal structure of materials, Crystal systems, Unit cells and space lattices, Determination of structures of simple crystals by X-ray diffraction, Miller indices of planes and directions, Packing geometry in Metallic, Ionic and Covalent solids. Concept of amorphous, single and polycrystalline structures and their effect on properties of materials. Crystal growth techniques. Imperfections in crystalline solids and their role in influencing various properties.	8
2	**Band theory of Solids :** Energy band diagram, E – K Diagram, Reduced E – K Diagram, Insulators, Semiconductors & Conductors.	5
3	**Semiconductor :** Single Crystal, Polycrystalline and Amorphous, Fermi – Dirac Distribution, Hall effect, Intrinsic & Extrinsic, N type & P type, Crystal growth – (1) Preparation of electronic grade polycrystal in Siemens reactor,(2) Czochrarlski Method & Float Zone method of bulk single crystal ingot preparation (3) Mirror finished wafer preparation (4) Epitaxial film growth – Chemical Vapor phase Deposition & Liquid Phase Epitaxy (5) Molecular Beam Epitaxy.	10
4	**Dielectric behavior of materials :** Polarization, Dielectric constant at low frequency & high frequency, Dielectric loss, Piezoelectricity & FerroElectricity	5
5	**Magnetic Properties :** Origin of magnetism in metallic and ceramic materials, Paramagnetism, Diamagnetism, Antiferromagnetism, Ferromagnetism, Ferrimagnetism, magnetic hysteresis, Influence of temperature on magnetic behaviour, domains and Hysteresis.	5
6	**Superconductors :** Low and High temperature (YBaCuO) superconductors, Meissner effect, Applications.	4
7	**Printed Circuit Board :** Manufacturing process, Single- & Double-sided boards, surface mounted devices	3
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Solid State Physics", by Kittel, McGraw Hill.
2	"Principles of Electric Engineering Materials & Devices", by S.O. Kasp, McGraw Hill.
3	"Structure & properties of materials (VOL VI), Electronic Properties", by Robert M. Rose, Lawrence A.Shepherd & John Wulf, Wiley Eastern Ltd.

Electrical and Electronics Materials Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

3. Basic Science Courses

BS101	Mathematics III	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	Unit1 (6 Lectures): Polynomials: Orthogonal Polynomials –Lagrange's, Chebysev Polynomials; Trigonometric Polynomials; Wavelet transforms : properties, methods, inverses and their applications.	6
2	Unit2 (10 Lectures): Sets, relations and functions: Basic operations on sets, Cartesian products, disjoint union (sum), and power sets. Different types of relations, their compositions and inverses. Different types of functions: Ber and Bei functions; recurrence relations, orthogonality properties.	10
3	Unit3 (6 Lectures): Introduction to Graphs: Graphs and their basic properties – degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, trees.	6
4	Unit4 (10 Lectures): Basic Statistics: Measures of Central tendency: Moments, skewness and Kurtosis ; Probability distributions - Binomial, Poisson and Normal ; evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.	10
5	Unit5 (10 Lectures): Applied Statistics: Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.	10
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley and amp; Sons, 2006.
2	2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
3	4. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010
4	C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.

4. Program Core Courses

EC101	Network Theory	3L:1T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction** to signals, their classification and properties, different types of systems, LTI systems and their properties, periodic waveforms and signal synthesis, properties and applications of Laplace transform	8
2	**System modeling** in terms of differential equations and transient response of R, L, C, series and parallel circuits for impulse, step, ramp, sinusoidal and exponential signals by classical method and using Laplace transform.	8
3	**Graph theory :** Concept of tree, Tie-set matrix, Cut-set matrix and application to solve electric networks. Two port networks – Introduction of two port parameters and their interconversion, Interconnection of two 2-port networks, Open circuit and Short circuit impedances and ABCD constants, Relation between image impedances and Short circuit and Open circuit impedances.	10
4	Network functions, their properties and concept of transfer impedance, Hurwitz polynomial ,Positive real function and synthesis of LC, RC, RL Networks in Foster's I and II, Cauer's I and II forms.	10
5	Introduction of passive filter and their classification, frequency response, Characteristic impedance of low pass, high pass, Band Pass and Band reject prototype section	4
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Engineering Circuit Analysis", by W H Hayt, TMH Eighth Edition
2	"Network analysis and synthesis", by F F Kuo, John Weily and Sons, 2nd Edition
3	"Circuit Theory", by S Salivahanan, Vikas Publishing House 1st Edition, 2014
4	"Network analysis", by M. E. Van Valkenburg, PHI, 2000
5	"Networks and Systems", by D. R. Choudhary, New Age International, 1999
6	"Electric Circuit", Bell Oxford Publications, 7th Edition.

EC102	Signals and Systems	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction to Signal and System :** Definition, classification of systems, standard test signal, properties of system, properties of linear system, Properties: linearity: additivity and homogeneity, Shift-invariance, Causality	10
2	Linear time-invariant (LTI) systems, impulse response and step response, convolution, Characterization of causality and stability of linear time-invariant systems. System representation through differential equations and difference equations.	7

3	**Laplace transformation :** Laplace transform of some important function, Shift theorem and its application, Laplace transform of periodic signals, Functional analysis of response, Initial and Final value theorems, Response to periodic sinusoidal excitation, Region Of Convergence, Poles and Zeros of system, Laplace domain analysis, Solution to differential equations.	9
4	**Analysis of Fourier Methods :** Fourier series expansion, Functional symmetry condition, Exponential form of Fourier series, Fourier integral and Fourier transform, Multiplication and their effect in the frequency domain, Magnitude and Phase response, DTFT, Parseval's Theorem	9
5	**Z-transformation :** Z transform of Discrete time signal, LTI system, solution of difference equation, Application of Z transform to open loop system, Region Of Convergence, z-domain analysis.	5
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Signal and System", A.V Oppenheim, A.S Willsky and I.T Young, Prentice Hall
2	"Signals and Systems - Continuous and Discrete", R.F. Ziemer, W.H. Tranter and D.R. Fannin, 4th edition, Prentice Hall
3	"Analysis of Linear System" by D.K Cheng, Narosa pub. House
4	"Signal & system" by H.P Hsu, Tata McGraw Hill

EC103	**Object Oriented Programming**	**3L:0T:0P**	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction to C++ :** Object Oriented Technology, Advantages of OOP, Input-output in C++, Tokens, Keywords, Identifiers, Data Types C++, Derives data types. The void data type, Type Modifiers, Typecasting, Constant, Operator, Precedence of Operators, Strings.	3
2	**Control Structures :** Decision making statements like if-else, Nested if-else, goto, break, continue, switch case, Loop statement like for loop, nested for loop, while loop, do-while loop.	3
3	**Functions :** Parts of Function, User-defined Functions, Value-Returning Functions, void Functions, Value Parameters, Function overloading, Virtual Functions.	3
4	**Classes and Data Abstraction :** Structure in C++, Class, Build-in Operations on Classes,Assignment Operator and Classes, Class Scope, Reference parameters and Class Objects (Variables), Member functions, Accessor and Mutator Functions, Constructors, default Constructor, Destructors.	15
5	**Overloading and Templates :** Operator Overloading, Function Overloading, Function Templates, Class Templates.	5
6	**Inheritance :** Single and Multiple Inheritance, virtual Base class, Abstract Class, Pointer and Inheritance, Overloading Member Function.	5
7	**Pointers and Arrays :** Void Pointers, Pointer to Class, Pointer to Object, The this Pointer, Void Pointer, Arrays.	6
8	**Exception Handling :** The keywords try, throw and catch. Creating own Exception Classes, Exception Handling Techniques (Terminate the Program, Fix the Error and Continue, Log the Error and Continue), Stack Unwinding.	5
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Thinking in C++", Volume 1 and 2 by Bruce Eckel, Chuck Allison, Pearson Education
2	"Mastering C++", 1/e by Venugopal, TataMcGraw Hill.
3	"Object Oriented Programming with C++", 3/e by E. Balaguruswamy, Tata McGraw Hill.
4	"Starting Out with Object Oriented Programming in C++", by Tony Gaddis, Wiley India.

Object Oriented Programming Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC104	Digital Circuits	3L:1T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Digital Principle :** Analog vs Digital, Number system, Computer Codes, Digital Signals, Waveforms Positive and Negative logic, Logic Gate : basic, universal and others, Truth Table, Logic functions, IC Chips, Timing Diagram, Electrical analogy.	5
2	**Boolean laws and theorems :** Logic functions, Conversion of logic functions into truth table and vice versa. SOP and POS forms of representation, Canonical form, minterms and maxterms, Simplification of logic functions by theorems and Karnaugh's map, don't care conditions.	5
3	**Analysis and synthesis of Combinational logic circuits:** Comparators, Multiplexers, Encoder, Decoder, 7 Segment Display, Half Adder and Full Adder, Subtractors, Serial and Parallel Adders, BCD Adder	6
4	**Sequential circuit blocks and latches :** Flip-Flops-Race around condition, Master-Slave and Edge triggered SR, JK, D and T Flip Flop, Shift registers, Counters-Synchronous and Asynchronous: Design of ripple counter	10
5	**Timing circuit :** Multivibrators, Monostable and Astable timer: LM555	4
6	**Integrated circuit logic families :** RTL, DTL, TTL, CMOS, IIL/I2L (Integrated Injection logic and Emitter Coupled logic).	5
7	**Use of building blocks :** Designing larger systems such as Digital-to-Analog Converters (DAC) : Weighted resistors and R-2R, Analog-to-Digital(ADC)-converter, counter and succession.	5
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Digital Fundamentals", Floyd and Jain., Pearson
2	"Digital Logic and Computer Design", M.Morris Mano, Pearson
3	"Fundamentals of Digital Circuits", A.Anand Kumar, PHI
4	"Digital Systems", Ronald J.Tocci, Neal S.Widmer, Pearson

Digital Circuits and Systems Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC105	**Analog Circuits**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**Small signal amplifiers :** CB, CE, CC configurations, hybrid model for transistor at low frequencies, RC coupled amplifiers, mid band model, gain and impedance, comparisons of different configurations, Emitter follower, Darlington pair (derive voltage gain, current gain, input and output impedance). Hybrid-model at high frequencies (pi - model).	7
2	**Multistage Amplifiers :** Cascade and Cascode amplifiers, Calculations of gain, impedance and bandwidth. Design of multistage amplifiers. Feedback Amplifiers: Feedback concept, Classification of Feedback amplifiers, Properties of negative Feedback amplifiers, Impedance considerations in different configurations. Analysis of feedback Amplifiers.	11
3	**Field Effect Transistor :** Introduction, Classification, FET characteristics, Operating point, Biasing, FET small signal Model, Enhancement and Depletion type MOSFETs, FET Amplifier configurations (CD,CG and CS).	7
4	**Oscillators :** Barkhausen criterion , Sinusoidal Oscillators, the RC phase-shift oscillator, resonant circuit Oscillators, a general form of oscillator circuit, the Wien -bridge oscillator, Crystal oscillators, Hartley, Colpitt's and Clapp's Oscillator.	8
5	**Power Amplifiers :** Power dissipations in transistors, Amplifiers Classification, (Class-A, Class-B, Class-C, Class-AB) Efficiency analysis, Push-Pull and Complementary Push-pull amplifiers, Cross over distortion and Harmonic distortion in Push-Pull amplifier. Tuned amplifiers (single, double and stagger tuned amplifier).	6
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**
1	"Electronic Devices and Circuit Theory", Boylestad and Nashelsky, PEARSON PUBLICATION.
2	"Electronic devices and circuits", Salivahanan, Suresh Kumar, Vallavaraj, TMH, 1999
3	"Integrated Electronics, Analog and Digital Circuits and Systems", J. Millman and Halkias, TMH, 2000
4	"Micro Electronic Circuits", Sedra and Smith, Oxford University Press, 2000
5	"Electronic Devices and Circuits", David A Bell, Oxford University Press, 2000

Analog Circuits Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC106	Semiconductor Physics and Devices	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Basics of Semiconductor Physics :** Semiconductor carrier modelling-Bonding model, Energy band model, Carriers, Band gap, Carrier properties (Effective mass, Intrinsic carrier concentration, Doping), Density of states, Fermi function, Equilibrium carrier concentration (formula for n and p and np product), Charge neutrality relationship, Determination of Fermi level, Carrier concentration, Temperature dependence. **Carrier Action -** Drift, Mobility, Drift Current, Resistivity, Diffusion Current, Total current, Relation between the diffusion constants and mobility (Einstein's relationship), Recombination-Generation (Band- to-Band, R-G Centres, Auger, Impact Ionization). Equation of state, Continuity equation, Minority Carrier Diffusion Equation.	10
2	**PN Junction Diode :** Step junction, Built-in potential, Depletion width, Depletion Approximation, Electrostatic relationship (Charge density, Depletion width, Potential, Electric field) for Va = 0, Va ¡ 0 and Va ¿ 0, Ideal Diode Equation (Qualitative and Quantitative derivation : Band Model, Assumptions, Approximation, Boundary condition), Deviation from Ideal (R-G Current, Series resistance, High Level Injection), Junction Breakdown (Avalanche and Zener), Reverse Bias Junction Capacitance, forward Bias Diffusion Capacitance, Qualitative understanding of Turn on and Turn-off transients. Zener Diode, Tunnel diode, Varactor diode, Schottky diode.	10
3	**Physics and technologies of BJT :** Operational considerations, Modes and Configurations, Performance Parameters (Emitter Efficiency, Base Transport Factor, Common Base Current Gain, Common Emitter Current Gain and their derivation for an ideal transistor, Deviation from ideal (Base Width Modulation Punch Through, Avalanche Breakdown, Geometrical effects, R-G current), Small signal modelling.	6
4	**Physics and technologies of FET :** JUNCTION FET (Theory of operation, I-V relationship), MOS CAPACITOR (Energy Band diagram, Gate-Voltage relationship, Capacitance-Voltage characteristics), MOSFET (Theory of operation, Threshold voltage, I-V characteristics), NON IDEAL MOS (M-S work function difference, oxide charges, threshold adjustment and considerations)	6
5	Introduction to UJT, SCR, Triac and Diac (Construction, Working, Characteristics and Application), UJT Relaxation oscillator. **Optoelectronic Devices :** Photo diodes (PIN and Avalanche), Solar cell, LED, Solid State LASER diodes.	8
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Semiconductor Device Fundamentals", by R. F. Pierret, Addison-Wesley publishing company, 1996
2	"Semiconductor Physics and Devices: Basic Principles", by Donald A. Neamen, 3rd Edition, 2003
3	"Physics of Semiconductor Devices" S. M. Sze, 2nd edition, 1981

Semiconductor Physics Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC107	Analog Communication	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction to the communication system :** Block diagram of communication system and comparative study of analog and digital communication.	3
2	Modulation(upward frequency translation) and demodulation (downward frequency translation) and the need for modulation: broad classification of modulation [linear (amplitude-AM) and exponential (frequency-FM and phase-PM)]	7
3	Generation of double side band (DSB) with carrier, double side band with suppressed carrier (DSB-SC) and single side band with suppressed carrier: Demodulation of double side band with carrier –incoherent detector or envelope detector, peak diode detector, coherent or synchronous detection of DSBSC and single side band with suppressed carrier.	8
4	**Superhetrodyne Receivers :** Characteristics , Intermediate Frequency and its advantages, image rejection of the Receiver.	5
5	Generation of FM signals(direct and indirect methods) and Demodulation.	5
6	Noise: Different types of Noise, SNR in AM, FM and PM System and use of emphasis Circuit in FM for SNR optimization.	4
7	**Analog pulse modulation :** PAM, PWM, PPM and demodulation; comparative study of various analog pulse modulation	8
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Electronic Communication system", by Kennedy. TMH.
2	"Communication system", by Haykin, Wiley
3	"Communication system", by Bruce carison . TMH.
4	"Modern Digital And Analog Communication", B.P.LATHI Oxford

Analog Communication Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC108	Electromagnetic Theory	3L:1T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	Introduction to Vector Algebra, Coordinate Systems and Transformation, Vector Calculus. **Electrostatics :** Coulomb's law, Gauss's law and its applications, the potential functions, Equipotential surface, Poisson's and Laplace's equation, Applications (solution for some simple cases), Capacitance, Electrostatic energy, Conductor properties and boundary conditions between dielectricS and dielectric-conductor interface, Uniqueness Theorem.	10
2	**Magnetostatics :** Biot-Savart law, Ampere's circuital law, Curl, Stoke's theorem, Magnetic flux and magnetic flux density, Energy stored in magnetic field, Ampere's force law, Magnetic vector potential, Analogy between electric and magnetic field.	6

3	Maxwell's equations, Equation of Continuity for time varying field. Inconsistency of Ampere's circuital law, Maxwell's equations in differential and integral form. **Electromagnetic waves :** Solution of wave equation in free space, Uniform plane wave propagation, Uniform plane waves, the wave equation for conducting medium, Wave propagation in lossless medium and in conductive medium, Conductors and dielectrics, Polarization	10
4	**Reflections and Refractions :** Reflection by a perfect conductor with normal as well as oblique incidence. Reflection and refraction by perfect dielectrics with normal and oblique incidence. Surface impedance. **Poynting vector :** Poynting theorem, Instantaneous, Average and Complex Poynting vector, Power loss in a plane conductor.	8
5	**Transmission Lines :** Transmission line theory, low loss radio-frequency and UHF transmission line. UHF line as a transformer, voltage step up of the quarter wave transformer. Transmission line chart (Smith Chart).	8
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Time-harmonic Electromagnetic Fields", R. F. Harrington, Wiley-IEEE Press, 2001
2	"Fields and Waves in Communication Electronics", Ramo, S., Whinnery, J.R., and Van Duzer, T., 3rd Ed., John Wiley and Sons, 1994
3	"Advanced Engineering Electromagnetics", Balanis, C.E., Wiley India Pvt. Ltd., Reprint, 2008
4	"Microwave Engineering", Pozar, D.M., 3rd Ed., John Wiley and Sons, 2004

EC109	Digital Signal Processing	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	Overview of DSP, Basic Elements of DSP system, Advantages of DSP over Analog, Classification of signals, Concept of frequency in continuous time and discrete time, Continuous time and Discrete time sinusoidal signals.	7
2	**Discrete time systems :** Linear time invariant, Response of LTI system – convolution sum, description of discrete time system by difference equation and complete solution of difference equation, Implementation ofdiscrete time systems, Correlation of discrete time signals	6
3	Transform and its applications to the analysis of LTI Systems	3
4	Discrete Time Fourier Transform, Properties of DTFT	4
5	Frequency domain representation of LTI Systems	5
6	Sampling and reconstruction of Analog signals	5
7	Discrete Fourier series, Discrete Fourier transform, Properties of DFT, FFT	5
8	**Digital filter structure :** FIR and IIR designs	5
	Total	40

Sl. No.	Name of Authors / Books /Publishers

1	"Digital Signal Processing" by Proakis and Manolakis, Pearson
2	"Digital Signal Processing" by Ingle and Proakis, Thomson
3	"Digital Time Signal Processing" by Oppenheim and Schafer, Pearson
4	"Digital Signal Processing : Computer Based Approach" by Mitra, TMH

Digital Signal Processing Lab	0L: 0T: 2P	1 Credit

Sl. No.	**List of Experiments**
1	To represent basic signals (Unit step, unit impulse, ramp, exponential, sine and cosine).
2	To develop program for discrete convolution
3	To develop program for discrete correlation
4	To understand stability test
5	To understand sampling theorem
6	To design analog filters (low-pass, high pass, band pass, band stop)
7	To design digital filters (low-pass, high pass, band pass, band stop)
8	To design fir filters using windows techniques

EC110	**Microprocessors and Microcontrollers**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction to Microprocessor Systems :** Architecture and Pin diagram of 8085, Timing Diagram, Memory organization, Addressing modes, Interrupts. Assembly Language Programming, 8085 interrupts, Additional I/O concepts and processes.	8
2	Interfacing of 8085 with 8255, 8254/ 8253, 8251, 8259: Introduction, Generation of I/O Ports, Programmable Peripheral Interface (PPI)-Intel 8255, Sample-and-Hold Circuit and Multiplexer, Keyboard and Display Interface, Keyboard and Display Controller (8279), Programmable Interval timers (Intel 8253/8254), USART (8251), PIC (8259), DAC, ADC, LCD, Stepper Motor.	12
3	Introduction to 8086, 80286, 80386 and 80486 Microprocessor: 8086 Architecture, Generation of physical address, Pin diagram of 8086, Minimum Mode and Maximum mode, Bus cycle, Memory Organization, Memory Interfacing, Addressing Modes, Assembler Directives, Instruction set of 8086, Assembly Language Programming, Hardware and Software Interrupts. Introduction of 80286, 80386, and 80486 microprocessor	9
4	**Overview of Microcontroller 8051 :** Introduction to 8051 Microcontroller, Architecture, Memory organization, Special function registers, Port Operation, Memory Interfacing, I/O Interfacing, Programming 8051 resources, interrupts, Programmer's model of 8051, Operand types, Operand addressing, Data transfer instructions, Arithmetic instructions, Logic instructions, Control transfer instructions, Timer and Counter Programming, Interrupt Programming.	11
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Microprocessors and Microcontrollers", Muhammad Ali Mazidi, Pearson, 2006
2	"Microprocessors and Interfacing, Programming and Hardware", Douglas V Hall, Tata McGraw Hill, 2006
3	"MicroProcessor Architecture, Programming and Applications with the 8085", Ramesh Gaonkar, PHI
4	"The 8051 Microcontroller and Embedded Systems", Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. MCKinlay, 2nd Edition, Pearson Education, 2008
5	"The 8086 Microprocessor: Programming and Interfacing The PC", Kenneth J. Ayala, Delmar Publishers, 2007
6	"Advanced Microprocessors and Peripherals", A K Ray, K M Bhurchandi, Tata McGraw Hill, 2007

Microprocessors and Microcontrollers Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC111	**Linear Control System**	**3L:1T:0P**	3 Credits

Sl. No.	Contents	Contact Hours
1	**Control Systems :** Basics & Components, Introduction to basic terms, Classifications and types of Control Systems, Block diagrams & Signal flow graphs. Transfer function, Determination of transfer function using Block diagram reduction techniques and Mason's Gain formula. Control system components: Electrical, Mechanical, Electronic, AC/DC Servo Motors, Stepper Motors, Tacho Generators, Synchros, Magnetic Amplifiers, Servo Amplifiers	8
2	**Time-Domain Analysis :** Time domain performance specifications, Transient response of first and second order systems, Steady state errors and Static error constants in unity feedback control systems, response with P, PI and PID controllers, Limitations of time domain analysis.	8
3	**Frequency Domain Analysis :** Polar and inverse polar plots, Frequency domain specifications and Performance of LTI systems, Logarithmic plots (Bode plots), Gain and Phase Margins, Relative stability. Correlation with time domain performance, Closed loop frequency responses from Open loop response. Limitations of frequency domain analysis, Minimum/Non-minimum phase systems	8
4	**Stability and Compensation Techniques :** Concepts, absolute, Asymptotic, Conditional and Marginal stability, Routh–Hurwitz and Nyquist stability criterion, Root locus technique and its application. Concepts of compensation, series/parallel/ series-parallel/feedback compensation, Lag/ Lead/Lag-Lead networks for compensation, Compensation using P, PI, PID controllers	8

5	**Control System Analysis using State Variable Methods** Control Systems Engineering Syllabus State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.	8
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Automatic control system", B. C. Kuo, Prentice Hall of India, 7th edition, 2001
2	"Control Systems Engineering -Principles and Design", Nagraath and Gopal New Age Publishers
3	"Control systems engineering", Norman S. Nise, John Wiley and Sons (Asia) Singapore
4	"Design of Feedback Control System", Raymond T. Stefani, Oxford University Press
5	"Modern control engineering", K. Ogata, Pearson, 2002

EC112	Linear Integrated Circuits and Applications	3L:1T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**IC Fabrication :** IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities. Realization of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance and FETs	9
2	**Characteristics of OPAMP :** Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Basic applications of Op-Amp – Inverting and Non-inverting Amplifiers, V/I and I/V converters, Summer, Differentiator and Integrator	9
3	**Applications of OPAMP :** Instrumentation amplifier, Log and Antilog Amplifiers, first and second order active filters, comparators, multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types), A/D converters using Op-Amps.	9
4	**Special ICs :** Functional block, characteristics and application circuits with 555 Timer IC-566 voltage controlled oscillator IC; 565-phase lock loop IC, Analog multiplier ICs.	9
5	**Application ICs :** IC voltage regulators –LM78XX, 79XX Fixed voltage regulators - LM317, 723 Variable voltage regulators, switching regulator- SMPS-LM 380 power amplifier- ICL 8038 function generator IC.	9
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Op-amp and Linear ICs", David A.Bell, Oxford, 2013

2	"Linear Integrated Circuits", D. RoyChoudhary, Sheil B. Jani, II edition, New Age, 2003
3	"Op-amps and Linear Integrated Circuits", Ramakant A.Gayakward, IV edition, Pearson Education, PHI, 2000
4	"Opamps and Linear Integrated Circuits Concepts and Applications", Fiore, Cengage, 2010
5	"Fundamentals of Analog Circuits", Floyd and Buchla, Pearson, 2013
6	"Integrated Electronics - Analog and Digital circuits system", Jacob Millman, Christos C.Halkias, Tata McGraw Hill, 2003
7	"Op-amp and Linear ICs", Robert F.Coughlin, Fredrick F. Driscoll, PHI Learning, 6th edition, 2012

Linear Integrated Circuits and Applications Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC113	**Probability Theory and Stochastic Processes**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.	4
2	Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions;	6
3	Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds.	8
4	Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.	10
5	Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density, Markov chain and Markov processes.	10
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**
1	"Probability and Random Processes with Applications to Signal Processing," H. Stark and J. Woods, Third Edition, Pearson Education
2	"Probability, Random Variables and Stochastic Processes", A.Papoulis and S. Unnikrishnan Pillai, Fourth Edition, McGraw Hill.
3	"Introduction to Probability Theory with Stochastic Processes", K. L. Chung, Springer International

EC114	Computer Networks and Security	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Data communication Components :** Representation of data and its flow Networks , Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum	10
2	**Data Link Layer and Medium Access Sub Layer :** Error Detection and Error Correction -Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back - N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA	10
3	**Network Layer :** Switching, Logical addressing – IPv4, IPv6; Address mapping –ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols. **Transport Layer:** Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.	8
4	**Application Layer :** Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography	6
5	**Network Security :** Passive and Active Attacks, Symmetric Encryption, Encryption Algorithms, Key Distribution, Traffic Padding, Message Authentication, Hash function, Secure Hash function, Public-key Encryption, Digital Signature, RSA Public Key Encryption algorithm, Key Management, Secure Socket Layer and Transport layer Security, SSL Architecture, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol, handshake Protocol, IP level security IPSEC, Application layer security PGP, Firewall, Virtual Private Networks.	8
	Total	42

Sl. No.	Name of Authors / Books /Publishers
1	"Data Communication and Networking", 4th Edition, Behrouz A. Forouzan, McGraw-Hill
2	"Data and Computer Communication", 8th Edition, William Stallings, Pearson Prentice Hall India
3	"Computer Networks", 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
4	"Internetworking with TCP/IP", Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
5	"TCP/IP Illustrated", Volume 1, W. Richard Stevens, Addison-Wesley, United States of America
6	"Network Security Bible", by Cole, Krutz and Conley, Wiley dreamtech

EC115	Digital Communication	3L:1T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction :** Block Diagram of Digital Communication System, Advantages of Digital communication system over Analog communication systems, Sampling theorem, Signal reconstruction in time domain, Practical and Flat Top Sampling, Sampling of Band-pass Signal, Aliasing Problem, Uniform and Non-uniform quantization. Signal to Quantization ratio of Quantized Signal.	7
2	**Baseband Transmission :** Line Coding and its properties, Various types of PCM waveforms. Attributes of PCM waveforms, M-ary Pulse Modulation waveforms, Differential Pulse Code Modulation, Multiplexing of PCM signals, Delta modulation, Idling noise and slope overload, Adaptive Delta Modulation, Adaptive DPCM, Comparison of PCM and DM	9
3	**Baseband Detection :** Error performance degradation in communication systems, Eb/NO parameter, Matched filter and its derivation, Inter-Symbol Interference (ISI), Nyquist criterion for zero ISI and raised cosine spectrum, Correlation detector : Decision threshold and Error probability for Binary, Unipolar (on-off) signalling	7
4	**Band-pass Modulation and Demodulation :** Types of digital modulation, Waveforms for Amplitude, Frequency and Phase Shift Keying, Method of generation and detection of coherent and non-coherent binary ASK, FSK and PSK, Differential phase shift keying, Quadrature modulation techniques, M-ary FSK, Minimum Shift Keying (MSK), Probability of error and comparison of various digital modulation techniques	9
5	**Error :** A base band signal receiver, Probability of error, The Optimum filter, Matched Filter, Probability of error in Matched filter, Coherent reception, Coherent reception of ASK, PSK and FSK, Non-Coherent reception of ASK, FSK, PSK and QPSK, Calculation of bit error probability of BPSK and BFSK, Error probability for QPSK	6
6	**Multiple Access Techniques :** Time division multiplexing, Frequency division multiplexing, Code division multiplexing, Introduction to upcoming techniques of transmission	2
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Communication Systems", Simon Haykin, Wiley publication, 4th Edition, 2004
2	"Digital Communication-Fundamentals and Applications", Bernard Sklar, Pearson Education India, 2nd Edition, 2009
3	"Modern Electronic Communication", Miller Gary M, Prentice-Hall, 6th Edition, 1999
4	"Digital Communications", John Proakis, Tata Mc Graw Hill, 5th Edition, 2007
5	"Electronic Communication Systems, Fundamentals Through Advanced", Wayne Tomsi, Pearson Education, 4th Edition, 2001

Digital Communication Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC116	Electronics Instruments and Measurements	3L:1T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	Introduction to Standards of Measurement, Errors and their evaluation. Calibration, Accuracy, Precision Sensitivity, Resolution, Noise, etc.	3
2	**Measurements of voltage, current, power and energy :** Moving iron, moving coil, thermal, Induction and Rectifier type. **Measurements of power factor and frequency:** Dynamometer and moving iron single and three phase power factor meters, Resonance, moving coil and moving iron frequency meters. Range extension of voltmeter, ammeter, Wattmeter and Energy meter: Voltmeter multipliers, Ammeter shunt, Current and Potential Transformers	10
3	**Galvanometer :** D'Arsonval, Vibration and Ballistic galvanometers	5
4	**Bridges :** D.C. bridges: Kelvin double bridge, Wheatstone bridge and Carey-Foster bridge; A.C. bridges: Maxwell Bridge, Hay and Owen bridges, Anderson Bridge, Wien Bridge, Schering Bridge and Heaviside-Campbell Bridge	7
5	Potentiometer's Principle, Standardization and application: D.C. Potentiometers: Crompton and Vernier potentiometers, A.C. Potentiometers: Coordinate type and Polar type	5
6	**Magnetic measurements :** Measurement of magnetic flux by ballistic galvanometer and fluxmeter, Determination of B-H curve and hysteresis loop, Separation of iron loss into hysteresis and eddy current losses, Measurement of iron loss and its separation on Lloyad-Fisher squares	5
7	**Digital measurements :** Digital voltmeter and multimeter. Universal counter and its uses for measurements of frequency, ratio of two frequencies, Time period and Pulse width.	5
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Measurement System, Application and Design", E O Doeblin, TMH
2	"Course in Electrical and Electronic Measurement and Instrumentation", A K Sawhney, Dhanpat Rai and Sons
3	"Electronic Measurements and Instrumentation", Rajendra Prasad, Khanna Publishers
4	"Basic Electrical Measurements", M.B. Stout, Prentice Hall

Electronic Instruments and Measurement Lab are according to the theory mentioned above.	0L: 0T: 2P	1 Credit

EC117	Computer Organization and Architecture	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction:** Computer Arithmetic, Instruction sets, Introduction to computer organization, CPU Design. Micro programmed Control: Control Memory, Address sequencing, Micro programming, sequencing and execution of microinstructions	10
2	**Memory system:** Hierarchical memory structure, Cache memories, Set Associative memory, Virtual Memory, Paging, Segmentation, Input-Output Interface, Asynchronous Data Transfer, Programmed I/O, Interrupts, Direct Memory Access	8

3	**Input-Output Organization:** Basic Input/Output Structure of Computers, serial and parallel communications, Asynchronous Data Communication, Programmed I/O, Interrupt Driven I/O, Interrupt Controller, DMA, Device Drivers, Buses.	10
4	**Introduction to Parallel Processing:** Evolution of computer systems (RISC vs. CISC), Parallelism in uniprocessor systems, Architectural classification schemes.	5
5	**Principles of Pipelining and Vector processing:** Pipeline strategy, Pipeline performance, Controls and Data paths, Overlapped parallelism, Principles of designing pipelined processors, Vector processing requirements	7
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	Computer system architecture by M. Morris Mano
2	Computer Architecture and parallel processing by Kai Hwang, Briggs, McGraw Hill
3	Computer Architecture by Carter, Tata McGraw Hill.
4	Computer System Organization and Architecture by John D. Carpinelli, Pearson Education

EC118	**Wireless Communication**	**3L:0T:0P**	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction to Wireless Communication Systems:** Evolution of mobile radio communications; examples of wireless comm. systems; paging systems; Cordless telephone systems; overview of generations of cellular systems, comparison of various wireless systems.	4
2	**Introduction to Personal Communication Services (PCS):** PCS architecture, Mobility management, Networks signalling. The Cellular Concept and Multiple Access Techniques: A basic cellular system, Frequency Reuse basic theory of hexagonal cell layout, spectrum efficiency, FDM/TDM, Cellular System, channel allocation schemes, Handover Analysis, cellular CDMA, Soft capacity, Erlang capacity comparison, multiple access techniques: FDMA, TDMA, CDMA.	9
3	**2G Networks: Second generation, digital, wireless systems:** GSM, IS_{136} (D-AMPS), IS-95 CDMA. Global system for Mobile Communication (GSM) system overview: GSM Architecture, Mobility Management, Network signalling, mobile management, voice signal processing and coding. Spread Spectrum Systems- Cellular code Division Access Systems-Principle, Power Control, effects of multipath propagation on code division multiple access.	11
4	**2.5G Mobile Data Networks:** Introduction to Mobile Data Networks, General Packet Radio Services (GPRS): GPRS architecture, GPRS Network nodes, EDGE, Wireless LANs, (IEEE 802.11), Mobile IP. Third Generation (3G) Mobile Services: Introduction to International Mobile Telecommunications 2000 (IMT 2000) vision, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000, Quality of services in 3G, Introduction to 4G.	11

5	**Introduction to Wireless Channels and Diversity:** Fast Fading Wireless Channel Modelling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Introduction to Diversity modelling for Wireless Communications.	5
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	Theodore S. Rappaport, "Wireless Communications: Principles and Practice" 2nd Edition (2008), 2008
2	Andrew J Viterbi, "CDMA Principles of spread spectrum communications", Addition Wesley, 1995
3	J S Lee and L E Miller, "CDMA systems engineering handbook", Artech House,1998
4	Marvin K Simon, Jim K Omura, Robert A Scholtz, Bary Klevit, "Spread Spectrum Communications", 1995
5	Sergio Verdu, "Multiuser Detection", Cambridge University Press, 1998
6	Andrew S Tanenbaum, "Computer Network", Pearson/ PHI, 4th edition, 2009

5. Program Elective Courses

ECEL1011	Digital Image & Video Processing	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Digital Image Fundamentals:** Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels –neighborhood, adjacency, connectivity, distance measures	8
2	**Image Enhancements and Filtering:** Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters –low-pass and high-pass.	8
3	**Color Image Processing:** Color models–RGB, YUV, HSI; Color transformations– formulation, colorcomplements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation.	8
4	**Image Segmentation:** Detection of discontinuities, edge linking and boundary detection, thresholding– global and adaptive, region-based segmentation.	6
5	**Wavelets and Multi-resolution image processing:** Uncertainty principles of FourierTransform, Time frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Subband filter banks, wavelet packets. Image Compression-Redundancy–inter-pixel and psycho-visual; Losslesscompression – predictive, entropy; Lossy compression-predictive and transform coding; Discrete Cosine Transform; Still image compression standards–JPEG and JPEG-2000	8

6	**Fundamentals of Video Coding:** Inter-frame redundancy, motion estimationtechniques – full-search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy–Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X. Video Segmentation-Temporal segmentation–shot boundary detection, hard-cuts and soft-cuts; spatial segmentation–motion-based; Video object detection and tracking.	12
	Total	42

Sl. No.	Name of Authors / Books /Publishers
1	R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008
2	Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2^{nd} edition 2004
3	Murat Tekalp , Digital Video Processing" Prentice Hall, 2nd edition 2015.

ECEL1012	Digital CMOS VLSI Design	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**MOS transistor theory and modelling :-** The Metal Oxide Semiconductor (MOS) Structure, MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), Current-Voltage Characteristics, Scaling and Small-geometry Effects, MOSFET modelling, Small-signal model.	8
2	**Fabrication and Layout of CMOS ICs :-** Fabrication Process Flow: Basic Steps, CMOS nWell Process, Layout Design Rules, Full-Custom Mask Layout Design.	8
3	**MOS INVERTERS Static characteristics :-** Resistive-Load Inverter, Inverters with n-Type MOSFET Load, CMOS Inverter. Switching characteristics and interconnect effects :- Delay-Time definitions, Calculation of Delay times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.	10
4	**Combinational MOS logic circuits :-** MOS Logic Circuits with Depletion nMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates)	8
5	**Sequential MOS logic circuits :-** Behaviour of Bistable elements, The SR Latch Circuit, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop.	8
	Total	42

Sl. No.	Name of Authors / Books /Publishers
1	"CMOS: Digital Integrated Circuits", by Sung-Mo Kang and Yusuf Leblibici, 3rd edition, McGraw-Hill Higher Education, 2003

2	"CMOS Logic Circuit Design", by John P. Uyemura, Kluwer Academic Publishers, 2001
3	"CMOS VLSI Design:A Circuits and Systems Perspective", by Neil Weste and David Harris 4th Edition,
4	"CMOS: Circuit Design, Layout and Simulation", by R. Jacob Baker, 3rd edition, IEEE press, 2010

ECEL1013	**Scientific Computing**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction:** Sources of Approximations, Data Error and Computational, Truncation Error and Rounding Error, Absolute Error and Relative Error, Sensitivity and Conditioning, Backward Error Analysis, Stability and Accuracy Computer Arithmetic: Floating Point Numbers, Normalization, Properties of Floating Point System, Rounding, Machine Precision, Subnormal and Gradual Underflow, Exceptional Values, Floating- Point Arithmetic, Cancellation	8
2	**System of liner equations:** Linear Systems, Solving Linear Systems, Gaussian elimination,Pivoting, Gauss-Jordan, Norms and Condition Numbers, Symmetric Positive Definite Systems and Indefinite System, Iterative Methods for Linear Systems Linear least squares: Data Fitting, Linear Least Squares, Normal Equations Method, Orthogonalization Methods, QR factorization, Gram-Schmidt Orthogonalization, Rank Deficiency, and Column Pivoting	8
3	**Eigenvalues and singular values:** Eigenvalues and Eigenvectors, Methods for Computing All Eigenvalues, Jacobi Method, Methods for Computing Selected Eigenvalues, Singular Values Decomposition, Application of SVD Nonlinear equations: Fixed Point Iteration, Newton's Method, Inverse Interpolation Method Optimization: One-Dimensional Optimization, Multidimensional Unconstrained Optimization, Nonlinear Least Squares	8
4	**Interpolation:** Purpose for Interpolation, Choice of Interpolating, Function, Polynomial Interpolation, Piecewise Polynomial Interpolation Numerical Integration And Differentiation: Quadrature Rule, Newton-Cotes Rule, Gaussian Quadrature Rule, Finite Difference Approximation, Initial Value Problems for ODES, Euler's Method, Taylor Series Method, Runga-Kutta Method, Extrapolation Methods, Boundary Value Problems For ODES, Finite Difference Methods, Finite Element Method, Eigenvalue Problems	8
5	Partial Differential Equations,Time Dependent Problems, Time Independent Problems, Solution for Sparse Linear Systems, Iterative Methods Fast Fourier Transform, FFT Algorithm, Limitations, DFT, Fast polynomial Multiplication, Wavelets,Random Numbers And Simulation, Stochastic Simulation, Random Number Generators, Quasi-Random Sequences	8
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**
1	Heath Michael T., "Scientific Computing: An Introductory Survey", McGraw-Hill, 2ndEd., 2002

2	Press William H., Saul A. Teukolsky, Vetterling William T and Brian P. Flannery,"Numerical Recipes: The Art of Scientific Computing", Cambridge University Press, 3rd Ed., 2007
3	Xin-she Yang (Ed.)., "Introduction To Computational Mathematics", World Scientific Publishing Co., 2nd Ed., 2008
4	Kiryanov D. and Kiryanova E., "Computational Science", Infinity Science Press, 1st Ed.,2006
5	Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, "Scientific Computing With MATLAB And Octave", Springer, 3rd Ed., 2010

ECEL1021	**Antennas and Wave Propagation**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**Fundamental Concepts :** Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions. **Radiation :** Potential function and electromagnetic fields, a small current element radiation, Power radiated by current element and radiation resistance, Radiation from quarter wave monopole and half wave dipole	10
2	**Antenna Arrays** : Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.	7
3	Aperture and Reflector Antennas-Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas. **Broadband Antennas :** Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas. **Microstrip Antennas :** Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.	12
4	**Basic Concepts of Smart Antennas :** Concept and benefits of smart antennas, fixed weight beam forming basics, Adaptive beam forming. Different modes of Radio Wave propagation used in current practice.	8
5	**Guided waves and waveguides :** Waves between parallel planes. TM and TE waves, Their propagation and attenuation in parallel plane guides, Rectangular wave guides – TE and TM waves in rectangular guides, Wave impedance, Circular wave guides, Introduction to resonators.	5
	Total	42

Sl. No.	**Name of Authors / Books /Publishers**
1	"Antennas", J.D. Kraus, McGraw Hill, 1988
2	"Antenna Theory - Analysis and Design", C.A. Balanis, John Wiley, 1982
3	"Antenna Engineering Handbook", McGraw hill, 1984
4	"Micro Strip Antennas", I.J. Bahl and P. Bhartia, Artech House, 1980
5	"Electromagnetic Waves", R.K. Shevgaonkar, Tata McGraw Hill, 2005

6	"Electromagnetic Waves and Radiating Systems", (Prentice-Hall Electrical Engineering Series) by Edward C. Jordan, 2006
7	"Antennas and Radio Wave Propagation", R.E. Collin, McGraw Hill, 1985

ECEL1022	**Optical Fiber Communication**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction :** Optical Fiber :-Structures, Wave guiding and Fabrication – Nature of light, Basic optical laws and Definition, Optical fiber modes and Configuration, Mode theory for circular waveguides, Single mode fibers, Graded index fiber, Fiber materials, Fabrication and mechanical properties, Fiber optic cables, Basic Optical Communication System, Advantage of Optical Communication System	10
2	**Attenuation in Optical Fibers :** Introduction, Absorption, Scattering, Very Low Loss Materials, All Plastic and Polymer-Clad-Silica Fibers. Wave Propagation: Wave propagation in Step-Index and Graded Index Fiber, Overall Fiber Dispersion-Single Mode Fibers, Multimode Fibers, Dispersion-Shifted Fiber, Dispersion, Flattened Fiber, Polarization	10
3	**Source and Detectors :** Design and LED's for Optical Communication, Semiconductor Lasers for Optical Fiber Communication System and their types, Semiconductor Photodiode Detectors, Avalanche Photodiode Detector and Photo multiplier Tubes. Source to fiber power launching - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling. Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors. Optical receiver operation- Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of error, Quantum limit, Analog receivers	10
4	**Optical Fiber Communication Systems :** Data Communication Networks – Network Topologies, Mac Protocols, Analog System. Advanced Multiplexing Strategies – Optical TDM, Sub carrier Multiplexing, WDM Network. Architectures: SONET/SDH. Optical Transport Network, Optical Access Network, Optical Premise Network. Applications-Military Applications, Civil, Consumer and Industrial Applications.	10
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**
1	"Optical Communication System", Gowar, IEEE Press – 2nd Edition
2	"Fiber Optics and Opto Electronics", R.P.Khare, Oxford Publication
3	"Optical Information Processing", F. T. S. Yu, Wiley, Newyork, 1983
4	"Fiber optic Communication Systems", John Wiley and sons, New York, 1992
5	"An Introduction to Fiber Optics", A. Ghatak, K. Thyagarajan, Cambridge University Press.
6	"Optical Communication Components and Systems", J. H. Franz and V. K. Jain, Narosa Publish, 2013
7	"Optical Fiber Communications", John M. Senior, PEARSON, 3rd Edition,2010

PECEL1023	Micro and Nano Electronics	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**EVOLUTION OF NANOELECTRONICS** Moore's Law, Silicon Electronics, Limitations, Discussion of the International Technology Roadmap characteristics: Need for new concepts in electronics, Silicon MOS Transistor from Micro to Nano, Future Opportunities, Nanocomputing	10
2	**TUNNEL JUNCTIONS AND APPLICATIONS OF TUNNELING** Tunneling Through a Potential Barrier, Potential Energy Profiles for Material Interfaces – Metal -Insulator, Metal - Semiconductor, and Metal – Insulator-Metal Junctions , Applications of Tunneling, Field Emission, Gate - Oxide Tunneling and Hot Electron Effects in MOSFETs, Double Barrier Tunneling and the Resonant Tunneling Diode	10
3	**BALLISTIC AND SPIN TRANSPORT** Coulomb Blockade , Tunnel Junction Excited by a Current Source , Coulomb Blockade in a Quantum Dot Circuit , Single Electron Transistor, Ballistic Transport , Electron Collisions and Length Scales, Ballistic Transport Model, Quantum Resistance and Conductance, Transport of Spin and Spintronics Devices ,Applications	10
4	**MOLECULAR ELECTRONICS** Introduction to molecular electronics - An atomistic view of electrical resistance, Schrodinger equation, Self - consistent field, Bandstructure, Level broadening, Coherent transport, Non-coherent transport in molecular electronics devices , Molecular Devices, Logic Switches, Interface Engineering - Issues	10
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 2007
2	K a r l Goser et.al, "Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum devices", Springer, 2005
3	Mark. A. Reed and Takhee, "Molecular Electronics", American Scientific Publishers, 2003
4	Mitin V., V. Kochelap, and M. Stroscio, "Introduction to", Cambridge University Press, 2008
5	Michael C. Petty, "Molecular Electronics: From Principles to Practice", John Wiley and Sons, Ltd, 2007.
6	Ramachandran K. I. et.al, "Computational Chemistry and Molecular Modeling",Springer, 2008.
7	J. H. Franz and V. K. Jain, "Optical Communication Components and Systems", Narosa Publish, 2013
8	John M. Senior, "Optical Fiber Communications", PEARSON, 3rd Edition, 2010.

ECEL1024	Embedded System	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours

1	**Introduction to Embedded Systems:** Definition of Embedded System. Embedded Systems Vs General Computing Systems. History of Embedded Systems. Classification, Major Application Areas. Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems. Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM. RAM. Memory according to the type of Interface. Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators. Communication Interface: Onboard and External Communication Interfaces, Programming.	10
2	**Embedded Firmware:** Reset Circuit. Brown-out Protection Circuit. Oscillator Unit. Real lime Clock. Watchdog Timer, Embedded firmware Design Approaches and Development Languages. RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks. Process and Threads. Multiprocessing and Multitasking, Task Scheduling.	7
3	**Task Communication:** Shared Memory. Message Passing. Remote Procedure Call and Sockets.Task Synchronization: Task Communication / Synchronization Issues. Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.	4
4	**Introduction to ARM:** ARM Architecture ARM Design Philosophy, Registers, Program Status Register. Instruction Pipeline Interrupts and Vector Table. Architecture Revision, ARM Processor Families.	4
5	**ARM Programming:** Instruction Set: Data Processing Instructions. Addressing Modes. Branch. Load. Store Instructions, PSR Instructions. Conditional Instructions. Thumb Instruction Set: Register Usage, Other Branch Instructions. Data Processing Instructions. Single-Register and Multi Register Load-Store Instructions. Stack. Software Interrupt Instructions.	9
6	**ARM Programming in C:** Simple C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation. Conditional Execution and Loops	6
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	Embedded System Design -Frank Vahid, Tony Givargis, John Wiley.
2	C -Michael J. Pont, 2nd Ed., Pearson Education, 2008.
3	ARM Systems Developer's Guides-Designing and Optimizing System Software Andrew N.
4	Sloss. Dominic Symes. Chris Wright, 2008. Elsevier.
5	Introduction to Embedded Systems -Shibu K.V, Mc Graw Hill.

ECEL1031	**High Speed Electronics**	**3L:0T:0P**	3 Credits

Sl. No.	Contents	Contact Hours

1	**Transmission line theory :** Basics, Crosstalk and non ideal effects, Signal integrity, Impact of packages, Vias, Traces, Connectors, Non-ideal return current paths, High frequency power delivery, Methodologies for design of high speed buses, Radiated emissions and minimizing system noise, Noise Analysis, Sources, Noise Figure, Gain compression, Harmonic distortion, Inter modulation, Cross-modulation, Dynamic range	12
2	**Devices :** Passive and active, Lumped passive devices (models), Active (models, low vs. high frequency).	8
3	RF Amplifier Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed) Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages.	10
4	Mixers, Up conversion Down conversion, Conversion gain and spurious response, Oscillators Principles, PLL Transceiver architectures.	8
5	Printed Circuit Board Anatomy, CAD tools for PCB design, Standard fabrication, Microvia Boards, Board Assembly, Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.	12
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**
1	"High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", Stephen H. Hall, Garrett W. Hall, James A. McCall, Wiley-IEEE Press,2000
2	"The Design of CMOS Radio-Frequency Integrated Circuits", Thomas H. Lee, Cambridge University Press, 2004
3	"RF Microelectronics", Behzad Razavi, Prentice-Hall, 1998
4	"Microwave Transistor Amplifiers", Guillermo Gonzalez, 2nd Edition, Prentice Hall
5	"RF and Microwave Wireless systems", Kai Chang, Wiley
6	"Electronic Product design", R.G. Kaduskar and V.B.Baru, Wiley India, 2011

ECEL1032	**Digital System Design**	**3L:0T:1P**	4 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction to Digital Design Concepts:** Review of digital design fundamentals, minimization and design of combinational circuits, sequential machine fundamentals	6
2	**Clocked Sequential Finite State Machines:** State diagram, analysis of synchronous circuits, derivation of state graphs and tables, reduction of state tables, state assignment, design of sequence detectors, serial data code conversion, design of synchronous sequential state machine, design and applications of counters and shift registers	7
3	**Multi-input System Controllers Design:** System controller, controller design principles, timing and frequency considerations, DFD development, controller architecture design, asynchronous input handling, state assignment concepts, flip-flop level implementation using VEM's	7

4	**Sequential Design using LSI** & **MSI circuits:** Using decoders, multiplexers in sequential circuits, sequential network design using ROMs, PLAs and PALs, Programmable gate Arrays (PGAs)	5
5	**Asynchronous Sequential Finite State Machines:** Introduction, analysis of asynchronous networks, races and cycles, derivation of primitive flow tables, reduction of primitive flow tables, state assignments, hazards, asynchronous sequential network design	8
6	**VHDL:** Why VHDL? Basic Language Elements, Data objects, classes and data types, operators, overloading, logical operators, VHDL representation of Digital design entity and architectural declarations, introduction to behavioral, dataflow and structural models	7
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	(1) William I Fletcher "An Engineering Approach to Digital Design", PHI, 3rd Indian reprint, (1994)
2	(2) Z Navabi "VHDL-Analysis and Modelling of Digital Systems", McGraw Hill, 2nd Edition (1997)
3	(3) Kevin Skahill "VHDL for Programmable Logic", Pearson Education, 1st Indian Reprint (2004)
4	(4) Jr. Charles H. Roth, "Fundamentals of Logic Design", Jaico Publishers, 4th Edition, (2002).
5	(1) M Morris Mano "Digital Design", Pearson Education, 3rd Edition (2002)

ECEL1033	VLSI Technology	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction to MOS technology :** Introduction to IC technology, MOS and related VLSI technology, Basic MOS transistors (Enhancement mode and depletion mode), NMOS process, CMOS process (P – Well, N – Well, Twin – tub processes), Bi CMOS process flow, aspects of CMOS and Bi CMOS devices.	5
2	**Brief introduction of VLSI:** Architecture Definition, Functional Design, Logic Design, Circuit Desig and Physical Design	3
2	**Crystal growth and doping :** Starting materials, Czochralski technique, Gradient freeze technique, Considerations for proper crystal growth (role of point defects, thermal gradients, turbulences, pull and spin rate, crystal orientation, crystal hardening techniques), Doping (rapid stirring conditions, partial stirring conditions, radial doping variations), Zone processes (Zone refining, Zone leveling, neutron transmutation doping)	5
3	**Diffusion :** Diffusion in a concentration gradient, Diffusion equation, Impurity behavior in Silicon, diffusion systems for Silicon, redistribution during oxide growth, diffusion during oxide growth, cooperative diffusion, evaluation techniques for diffused layers in Silicon.	4
4	**Epitaxy :** Nucleation and growth, doping, dislocation, thermally induced strain, Molecular Beam exitaxy, Vapor phase epitaxy for Silicon, Liquid phase epitaxy.	5

5	**Ion-Implantation :** Penetration range (nuclear and electronic stopping, Transverse effects), Implantation damage, annealing, Ion – Implantation systems, process consideration, high energy and high current implants.	4
6	**Native Films :** Thermal Oxidation of silicon (kinetics of oxide growth, oxidation systems, oxidation induced stacking faults, properties of thermal oxides), Thermal nitridation of Silicon, Plasma.	4
7	**Deposited Films :** Films deposition methods (vacuum evaporation, sputter deposition, Chemical vapor Deposition), Film characteristics (step coverage, grown habit, mechanical stress, electromigration)	5
8	Etching and Cleaning : wet chemical etching in silicon based processes, Dry physical etching, Dry chemical etching, Reactive Ion etching, Etch induced damage, Cleaning (wet and dry).	5
9	**Lithography :** Photoreactive materials, pattern generation and mask making, pattern transfer- optical printing, advanced techniques (short wavelength, multilayer resist, phase shifting masks, Electron beam techniques, Xray printing), Mask defects, Pattern transfer defects.	3
10	**Process integration :** Isolation, (P-N junction, Mesa, Oxide), self alignment, local oxidation, planarization, metallization, gettering, Process flow for CMOS	2
	Total	45

Sl. No.	Name of Authors / Books /Publishers
1	'Basic VLSI Design by Pucknell and Eshraghian.
2	VLSI Fabrication Principles by Sorab Gandhi.
3	The science and engineering of Microelectronic Fabrication by Stephen Campbell.
4	VLSI Design by Sujata Pandey and Manoj Pandey.
5	CMOS VLSI design by Wolfe.

ECEL1034	Information and Coding Theory	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Information Theory:** Definition of Information, Entropy, Mutual Information, Properties of Mutual Information, Fundamental Inequality, I.T. Inequality, Divergence, Properties of Divergence, Divergence Inequality, Relationship between entropy and mutual information, Chain Rules for entropy, relative entropy and mutual information.	4
2	**Channel Capacity:** Uniform Dispersive Channel, Uniform Focusing Channel, Strongly Symmetric Channel, Binary Symmetric Channel, Binary Erasure Channel. Channel Capacity of the all these channels, Channel Coding Theorem, Shannon-Hartley Theorem.	6
3	**Data Compression:** Kraft inequality, Huffman codes, Shannon-Fano coding, Arithmetic Coding.	7

4	**Linear Block Codes:** Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the MacWilliams identities; Perfect codes. Cyclic Codes, BCH codes; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes.	8
5	**Decoding of BCH codes:** Berlekamp's decoding algorithm, Massey's minimum shift-register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm.	8
6	**Convolution codes:** Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm, Turbo Codes, Concatenated Code	8
	Total	41

Sl. No.	Name of Authors / Books /Publishers
1	Simon Haykin, "Communication Systems", 4th Edition, John Wiley and Sons, 2001
2	ArijitSaha, "Information Theory, Coding and Cryptography", Pearson Education, 2013
3	Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory", Wiley India Pvt. Ltd, 2nd Edition, 2013
4	J.Mary Jones, "Information and Coding Theory", Springer, 2000
5	Ranjan Bose, "Information Theory, Coding and Cryptography", Tata Mc-Graw Hill, 2nd Edition, 2008

ECEL1041	Microwave Theory and Techniques	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Microwave oscillators and amplifiers :** Introduction to Microwaves-History of Microwaves, Microwave Frequency bands;Applications of Microwaves: Civil and Military, Medical, , advantages and uses of microwave, limitations of conventional vacuum tubes at UHF and microwave frequency, UHF.	7
2	**Passive and Active Microwave Devices :** Microwave passive components: Directional Coupler, Magic Tee, Phase Shifters, Isolators , circulators. Attenuator, Microwave active components: Diodes, Transistors, Oscillators, Mixers	8
3	**Microwave Tubes:** Klystron, TWT, Magnetron; Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes	12
4	**Microwave measurement :** Measurement of power, Standing wave detectors and its uses, Impedance measurement, Measurement of frequencies by wave meters, Attenuation Measurement, Noise factor measurement.	8
5	**Microwave receiver :** Block Diagram representation, Varactor Diode as mixer, antenna noise and noise temperature.	4
6	**Microwave Systems:** Introduction to Radar, MTI Radar Effect of Microwaves on human body.	4
	Total	43

Sl. No.	Name of Authors / Books /Publishers
1	Microwave devices and circuits by Samuel Y. Laio.
2	Microwave and Radar Engineering by M. Kulkarni, Umesh Publications.
3	Foundations of Microwave Engineering by R.F. Collins, McGraw Hill.
4	Microwave Engineering by David M .Pozar, Wiley.

ECEL1042	ERROR CORRECTING CODES	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Linear block codes:** Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels.	10
2	**Hamming codes:** Weight enumerators and the McWilliams identities; Perfect codes	6
3	Introduction to finite fields and finite rings;factorization of $(x^(n-1))$ over a finite field; Cyclic Codes.	5
4	BCH codes; Idempotents and Mattson-Solomon polynomials; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes;Spectral properties of cyclic codes. ;Decoding of BCH codes:Berlekamp's decoding algorithm, Massey's minimum shift register Synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp – Massey algorithm.	12
5	Convolution codes; Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm.	8
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	F.J. McWilliams and N.J.A. Slone, The theory of error correcting codes.
2	R.E. Balahut, Theory and practice of error control codes, Addison Wesley.

ECEL1043	Speech and Audio Processing	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours

1	**Introduction :** Speech production and modeling - Human Auditory System;General structure ofspeech coders; Classification of speech coding techniques – parametric, waveform and hybrid ; Requirements of speech codecs –quality, coding delays, robustness. Speech Signal Processing:Pitch-period estimation, all-pole and all-zero filters ,convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.	10
2	**Linear Prediction of Speech :** Basic concepts of linear prediction; LinearPrediction Analysis of nonstationarysignals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction. **Speech Quantization :** Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.	10
3	**Scalar Quantization of LPC :** Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions,quantization based on LSF.	6
4	**Linear Prediction Coding :** LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.	6
5	**Code Excited Linear Prediction :** CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search: state-save method, zero-input zero-state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP. **Speech Coding Standards :** An overview of ITU-T G.726, G.728 and G.729standards	8
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Digital Speech" by A.M.Kondoz, Second Edition (Wiley Students? Edition), 2004
2	"Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W.C. Chu, WileyInter science, 2003

ECEL1044	Satellite Communication	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction to Satellite Communication:** Principles and architecture of satellite Communication,Brief history of Satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication.	7
2	**Orbital Mechanics:** Orbital equations, Kepler's laws, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day	9
3	**Satellite sub-systems:** Study of Architecture and Roles of various subsystems of a satellite system such as Telemetry, tracking, command and monitoring (TTC and M), Attitude and orbit control system (AOCS), Communication sub-system.	10

4	**Typical Phenomena in Satellite Communication:** Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift Phenomena and expression for Doppler shift	8
5	Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, C/N ratio calculations in clear air and rainy conditions	6
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**
1	Timothy Pratt Charles W. Bostian, Jeremy E. Allnutt: Satellite Communications; Wiley
2	Tri T. Ha: Digital Satellite Communications: Tata McGraw Hill
3	Dennis Roddy: Satellite Communication: 4th Edition, McGraw Hill

ECEL1051	**Wireless Sensor and Networks**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction:** Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks.	8
2	**Sensor Node Hardware and Network Architecture:** Single-node architecture, Hardware components and design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.	9
3	**Deployment and Configuration:** Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, self configuring localization systems, sensor management.	8
4	**Network Protocols:** Issues in designing MAC protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network. Department of Electronics and Communication Engineering Routing protocols: Issues in designing routing protocols, Classification of routing protocols, Energy-efficient routing, Unicast, Broadcast and multicast, Geographic routing.	9
5	**Data Storage and Manipulation:** Data centric and content based routing, storage and retrieval in network, compression technologies for WSN, Data aggregation technique.	3
6	**Applications:** Detecting unauthorized activity using a sensor network, WSN for Habitat Monitoring.	3
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**

1	Holger Kerl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Network", John Wiley and Sons, 2005
2	Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, "Wireless Sensor Network", Springer 1st Ed, 2004
3	Feng Zhao, Leonidas Guibas, " Wireless Sensor Network",Elsevier, 1st Ed, 2004
4	Kazem, Sohraby, Daniel Minoli, Taieb Zanti, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed, 2007
5	B. Krishnamachari, " Networking Wireless Sensors", Cambridge University Press.
6	N. P. Mahalik, "Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications" Springer Verlag.

ECEL1052	**Adaptive Signal Processing**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**
1	General concept of adaptive filtering and estimation, applications and motivation, Review of probability, random variables and stationary random processes, Correlation structures, properties of correlation matrices.	8
2	Optimal FIR (Wiener) filter, Method of steepest descent, extension to complex valued The LMS algorithm (real, complex), convergence analysis, weight errorcorrelation matrix, excess mean square error and mis-adjustment	8
3	**Variants of the LMS algorithm:** the sign LMS family, normalized LMSalgorithm, block LMS and FFT based realization, frequency domain adaptive filters, Sub-band adaptive filtering. Signal space concepts - introduction to finite dimensional vectorspace theory, subspace, basis, dimension, linear operators, rank and nullity, inner product space, orthogonality, Gram- Schmidt orthogonalization, concepts of orthogonal projection,orthogonal decomposition of vector spaces.	8
4	Vector space of random variables, correlation as inner product, forward andbackward projections, Stochastic lattice filters, recursive updating of forward and backward prediction errors, relationshipwith AR modeling, joint process estimator, gradient adaptive lattice.	6
5	Introduction to recursive least squares (RLS), vector space formulation of RLSestimation, pseudoinverseof a matrix, time updating of inner products, development of RLS lattice filters, RLStransversal adaptive filters. Advanced topics: affine projection and subspace based adaptive filters, partial update algorithms, QR decomposition and systolic array.	8
	Total	42

Sl. No.	**Name of Authors / Books /Publishers**
1	S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
2	C.Widrow and S.D. Stearns, Adaptive signal processing, Prentice Hall, 1984.

ECEL1053	Analog CMOS VLSI Design	3L:0T:4P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Basic MOS Device Physics :** MOSFET - Thoery, Operation and I-V characteristics, Second order effects, MOS Capacitances, Small-signal model, etc. Single stage amplifiers : Common Source stage, Source Follower, Common Gate stage, Cascode stage.	6
2	**Differential Amplifiers :** Single-ended and Differential operation, Basic Differential pair, Common-Mode response, Differential pair with MOS loads, Gilbert cell. Current Mirrors : Basic current mirrors, Cascode current mirror, Wilson current mirror.	10
3	**Frequency response of Amplifiers :** Miller effect, CS stage, Source follower, CG stage, Cascode stage, Differential Pair. Noise : Statistical characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single-stage amplifiers, Noise in Differential pairs.	10
4	**Operational Amplifiers :** Performance parameters, One-stage Op Amps, Two-stage Op Amps, Gain boosting, Common-mode feedback, Input range limitations, Slew rate, Power Supply rejection, Noise in Op Amps.	8
5	**Introduction to Switched Capacitor circuits :** Sampling switches, Switched-Capacitor Amplifiers, Switched-Capacitor integrator. Phase-Locked Loops : Simple PLL, Charge-Pump PLLs, Applications.	8
	Total	42

Sl. No.	Name of Authors / Books /Publishers
1	"Design of Analog CMOS Integrated Circuits", by Behzad Razavi, McGraw Hill.
2	"Analysis and Design of Analog Integrated Circuits", by Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, Wiley

ECEL1054	Biomedical Instrumentation	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Biomedical signals and Physiological transducers :** Source of biomedical signal, Origin of bioelectric signals, recording electrodes, Electrodes for ECG, EMG and EEG Physiological transducers: Pressure, Temperature, photoelectric and ultrasound Transducers. Measurement in Respiratory system: Physiology of respiratory system, Measurement of breathing mechanics Spiro meter, Respiratory therapy equipments Inhalators ventilators and Respirators, Humidifiers, Nebulizers Aspirators, Biomedical recorders: ECG, EEG and EMG.	11
2	**Patient Monitoring systems and Audiometers :** Cardiac monitor, Bedside patient monitor, measurement of heart rate, blood pressure, temperature, respiration rate, Arrhythmia monitor, Methods of monitoring fatal heart rate, Monitoring labor activity. Audiometers: Audiometers, Blood cell counters, Oximeter, Blood flow meter, cardiac output measurement, Blood gas analyzers.	11

3	**Modern Imaging systems :** Introduction, Basic principle and Block diagram of x-ray machine, x- ray Computed Tomography (CT), Magnetic resonance imaging system (NMR), ultrasonic imaging system. Eco-Cardiograph, Eco Encephalography, Ophthalmic scans, MRI. Therapeutic Equipments: Cardiac pacemakers, cardiac defibrillators, Hemodialysis machine, Surgical diathermy machine.	11
4	**Patient's safety :** Precaution, safety codes for electro medical equipment, Electric safety analyzer, Testing of biomedical equipment, Ultrasound therapy unit. Electrotherapy Equipments, Ventilators.	7
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	"Hand book of Biomedical Instrumentation", R.S.Khandpur, TMH
2	"Biomedical Instruments: Theory and Design", Walter Welko- Witiz and Sid Doutsch, Wiley
3	"Biomedical Instrumentation and Measurements", Lesile Cromwell, Fred J. Weibell and Erich A. Pfeiffer, PHI
4	"Introduction to Biomedical Equipment Technology", Joseph J. Carr and John M. Brown, Pearson
5	"Textbook of Biomedical Instrumentation System", Shakti Chatterjee, Cengage Learning

6. Open Elective Courses

OE1041	**Machine Learning**	**3L:0T:0P**	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction:** Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, overfitting	8
2	Instance based learning, Feature reduction, Collaborative filtering based recommendation. Probability and Bayes learning.	8
3	Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM	8
4	Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network	8
5	Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning. Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model.	8
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997, 1997
2	Introduction to Machine Learning Edition 2, by Ethem Alpaydin

OE1042	Introduction to MEMS	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	Introduction to Microelectromechanical Systems (MEMS) and MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes for Micromachining - Basic Process Tools, Advanced Process Tools	8
2	**MEMS Structure and Systems:** General Design Methodology, Techniques for Sensing and Actuation, Passive MEM Structures, Sensors. Actuators, Mechanical Vibrations, Computer-Aided Design of MEMS and tools	7
3	**Applications of MEMS in RF/Microwave:** The MEMS Switch and its Design Consideration. The MEM Resonator and its Design Considerations, Micromachining-Enhanced Planar Microwave Passive Elements. Other MEMS Based RF/Microwave Circuits and System	15
4	**Packaging and Reliability for MEMS:** Key Design and Packaging Considerations. Die-Attach Processes. Wiring and Interconnects. Types of Packaging Solutions. Reliability and Failure Analysis	10
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	Nadim Maluf and Kirt Williams, "An Introduction to Microelectromechanical Systems Engineering", Artech, 2nd Edition (2004).
2	Hector J. De Los Santos " Introduction to Microelectromechanical Microwave Systems", Artech, 2 nd Edition (2004).

OE1043	Internet of Things	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	**Introduction:** Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device	9

2	**SEVEN GENERATIONS OF IOT SENSORS TO APPEAR:** Industrial sensors – Description & Characteristics–First Generation – Description & Characteristics–Advanced Generation – Description & Characteristics–Integrated IoT Sensors – Description & Characteristics–Polytronics Systems – Description & Characteristics–Sensors Swarm – Description &Characteristics–Printed Electronics – Description & Characteristics–IoT Generation Roadmap	9
3	**TECHNOLOGICAL ANALYSIS:** Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sensing Module	9
4	**IOT DEVELOPMENT EXAMPLES:** ACOEM Eagle – EnOcean Push Button – NEST Sensor – Ninja Blocks -Focus on Wearable Electronics	9
5	**PREPARING IOT PROJECTS: Creating the sensor project:** Preparing Raspberry Pi - Clayster libraries - Hardware- Interacting with the hardware - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data - Creating the actuator project- Hardware - Interfacing the hardware - Creating a controller - Representing sensor values - Parsing sensor data - Calculating control states - Creating a camera - Hardware -Accessing the serial port on Raspberry Pi - Interfacing the hardware - Creating persistent default settings - Adding configurable properties - Persisting the settings - Working with the current settings -Initializing the camera	9
	Total	45

Sl. No.	Name of Authors / Books /Publishers
1	Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',Yole Développement Copyrights, 2014
2	Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
3	Editors OvidiuVermesan Peter Friess,'Internet of Things – From Research and Innovation to Market
4	Deployment', River Publishers, 2014
5	N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014

OE1044	**Power Electronics**	**3L:0T:0P**	3 Credits

Sl. No.	Contents	Contact Hours
1	**Semiconductor Switching Devices:** Review of Thyristor, two transistor Model of SCR, classification and V-I characteristics, junction temperature, gate circuit ratings, triggering process, UJT and characteristics, UJT as a relaxation oscillator, triggering UJT using SCR, turn off methods, fast recovery diodes, schottky diodes, Series and parallel connections of SCR, DIAC, TRIAC, Power MOSFETS, application of SCR.	7
2	**Power Rectification:** Classification of rectifiers, half, full, three-phase rectifier, semi converters, full converters, freewheeling diodes, circuits using SCR, voltage multiplying rectifier circuits, transformer utility factor	5

3	**Regulated Power Supplies:** Classification of voltage regulators, short period and long period accuracy of voltage regulator, D.C. voltage regulators, complete series voltage regulator circuit with ICs, SMPS basic principles, step up and step down circuits, UPS.	5
4	**Inverters:** Introduction, simple Inverters and Power Inverter using SCR, output voltage control in inverter waveform control, PWM inverters, reduction of harmonies with the help of PWM inverters.	5
5	**Induction and Dielectric Heating:** Induction heating effect of frequency power requirements, merits and application of induction heating, Dielectric heating, dielectric properties of a few typical materials, thermal losses, application of dielectric heating, skin effect, high frequency sources for induction and dielectric heaters.	6
6	**Electronic Control of D.C. Motors:** Introduction, control of D.C. shunt motor, full wave D.C. shunt motor control overload projection, universal motor control, electronic control for reversing motor control using SCR, choppers, their classifications and applications.	6
7	**Electronic Control of A.C. Motors:** Instability of D.C. motors, variable speed induction motor drives, T.N. characteristics of I.M. invertors for driving the motor, speed control of I.M. using various methods, cyclo-converters, their classifications and applications.	6
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	M H Rashid, "Power electronics", PHI, 2nd Edition (1998).
2	G K Mithal, "Industrial electronics", Khanna Publishers, Delhi, 18th Edition (1998).
3	S N Biswas, "Industrial electronics", Dhanpat Rai and Company, Delhi, 3rd Edition (2000).
4	P S Bhimbra, "Power electronics", Khanna Publishers, Delhi, 3rd Edition (2002).
5	M D Singh, Khanchandani K B, "Power electronics", TMH, 6th reprint (2001).

OE1051	**Big Data Analytics**	**3L:0T:0P**	3 Credits

Sl. No.	Contents	Contact Hours
1	**Simple linear regression:** Fit a simple linear regression between two variables in R; Interpret output from R; Use models to predict a response variable; Validate the assumptions of the model. Modelling data: Adapt the simple linear regression model in R to deal with multiple variables; Incorporate continuous and categorical variables in their models; Select the best-fitting model by inspecting the R output.	10
2	**Many models:** Manipulate nested dataframes in R; Use R to apply simultaneous linear models to large data frames by stratifying the data; Interpret the output of learner models. Classification : Adapt linear models to take into account when the response is a categorical variable; Implement Logistic regression (LR) in R; Implement Generalised linear models (GLMs) in R; Implement Linear discriminant analysis (LDA) in R.	10

3	**Prediction using models:** Implement the principles of building a model to do prediction using classification; Split data into training and test sets, perform cross validation and model evaluation metrics; Use model selection for explaining data with models; Analyse the overfitting and bias-variance trade-off in prediction problems.	10
4	**Deep learning:** Use massive amounts of data to train multi-layer networks for classification; Understand some of the guiding principles behind training deep networks, including the use of autoencoders, dropout, regularization, and early termination; Use sparklyr and H2O to train deep networks.	10
	Total	40

Sl. No.	Name of Authors / Books /Publishers
1	Data Science for Business by F. Provost and T. Fawcett
2	Data Mining for the Masses by M. North

OE1052	Transducers and Sensors	3L:0T:0P	3 Credits

Sl. No.	Contents	Contact Hours
1	GENERALISED CONFIGURATIONS, FUNCTIONAL DISCRIPTION & PERFORMANCE CHARACTERISTICS OF MEASURING INSTRUMENTS: Functional elements of an instrument; active & passive transducers; analog & digital modes of operation ; null & deflection methods; I/O configuration of measuring instruments & instrument system – methods of correction for interfering & modifying inputs. Static characteristics; Meaning of static calibration, accuracy, precision & bias. Combination of component errors in overall system-accuracy calculation. Addition, subtraction, division & multiplication. Static sensitivity, linearity, threshold, resolution, hysteresis and dead space. Scale readability. Span. Generalized static stiffness & input impedance.	5
2	MEASUREMENT OF DISPLACEMENT, FORCE, TORQUE & SHAFT POWER: Principle of measurement of displacement. Resistive potentiometers, variable inductance & variable reluctance pickups, LVDT, capacitance pickup. Principle of measurement of Force, Torque, Shaft power standards & calibration; basic methods of force measurement; characteristics of elastic force transducer-Bonded strain gauge, differential transformer, piezo electric transducer, variable reluctance/FM-oscillator, digital systems. Loading effects; Torque measurement on rotating shafts, shaft power measurement (dynamometers).	5

3	TEMPERATURE MEASUREMENT: Standards & calibration; thermal expansion methods- bimetallic thermometers, liquid-in-glass thermometers, pressure thermometers; thermoelectric sensor (thermocouple) – common thermocouple, reference junction considerations, special materials, configuration & techniques; electrical resistance sensors – conductive sensor (resistance thermometers), bulk semiconductor sensors (thermistors), bulk semiconductor sensors (thermistors); junction semiconductor sensors; digital thermometers. Radiation Methods – radiation fundamentals, radiation detectors, unchopped (dc) broadband radiation thermometers. Chopped (AC) selective band (photon) radiation thermometers, automatic null balance radiation thermometers (optical pyrometers). Two color radiation thermometers., Black body-tipped fibre optic radiation thermometer, IR imaging systems. Fluoroptic temperature measurement.	8
4	PRESSURE MEASUREMENT: Standards & calibration; basic methods of pressure measurement; dead weight gauges & manometer, manometer dynamics; elastic transducers; high pressure measurement; low pressure (vaccum) measurement – Mcleod gage, Knudsen gage, momentum-transfer (viscosity) gages, thermal conductivity gages, ionization gages, dual gage technique	6
5	FLOW MEASUREMENT; Local flow velocity, magnitude and direction. Flow visualization. Velocity magnitude from pilot static tube. Velocity direction from yaw tube, pivoted vane, servoed sphere, dynamic wind vector indicator. Hot wire and hot film anemometer. Hot-film shock-tube velocity sensor. Laser Doppler velocimeter; gross volume flow rate: calibration and standards. Constant-area, variable-pressure-drop meters (obstruction meters). Averaging pitot tubes. Constant pressure drop, variable area meters (rotameters), turbine meters, positive displacement meters. Metering pumps. Electromagnetic flow meters. Drag force flow meters. Ultrasonic flow meters, vortex shedding flow meters.	
6	LEVEL MEASUREMENT: Capacitance probe; conductivity probes; diaphragm level detector, deferential pressure level detector, radiation level sensors, RADAR level gauges, level transmitter, ultrasonic level detector.	
7	LEVEL MEASUREMENT: Capacitance probe; conductivity probes; diaphragm level detector, deferential pressure level detector, radiation level sensors, RADAR level gauges, level transmitter, ultrasonic level detector.	
	Total	40

Sl. No.	**Name of Authors / Books /Publishers**
1	Measurement systems application and design, ERNEST DOEBELIN, IV Edn. (Chapter 1, 2, 3, 4, 5).
2	Instrument Engineers Hand Book (process measurement), LIPTAK (Chapter 6).
3	Electronic Instrumentation – by H S Kalsi TMH 2nd Ed 2004

OE1053	**Bio and Smart Materials**	**3L:0T:0P**	3 Credits

Sl. No.	**Contents**	**Contact Hours**

1	UNIT I : INTRODUCTION [9 Hours] Intelligent / Smart materials – Functional materials – Polyfunctional materials – Structural materials, Electrical materials, bio-compatible materials. – Intelligent biological materials – Biomimetics – Wolff's Law – Biocompatibility – Material response: swelling and leaching, corrosion and dissolution, deformationand failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis – in vitro and in vivo evaluation of biomaterials.	9
2	UNIT II ELECTRO-RHEOLOGICAL AND PIEZOELECTRIC MATERIALS [9 Hours] The principal ingredients of smart materials –microsensors- hybrid smart materials – an algorithm for ynthesizing smart materials – active, passive reactive actuator based smart structures- suspensions 2nd electro-rheological fluids – Bingham body model – principal characteristics of electro-rheological fluids – charge migration mechanism for the dispersed phase – electro- rheological fluid domain – fluid actuators- design parameter – application of Electo-rheological fluids – Basics, Principles and instrumentation and application of Magnetorheological fluids – Piezoelectric materials: polymers and ceramics, mechanism, properties and application. Introduction to electro-restrictive and magneto-restrictive materials	5
3	TEMPERATURE MEASUREMENT: Standards & calibration; thermal expansion methods- bimetallic thermometers, liquid-in-glass thermometers, pressure thermometers; thermoelectric sensor (thermocouple) – common thermocouple, reference junction considerations, special materials, configuration & techniques; electrical resistance sensors – conductive sensor (resistance thermometers), bulk semiconductor sensors (thermistors), bulk semiconductor sensors (thermistors); junction semiconductor sensors; digital thermometers. Radiation Methods – radiation fundamentals, radiation detectors, unchopped (dc) broadband radiation thermometers. Chopped (AC) selective band (photon) radiation thermometers, automatic null balance radiation thermometers (optical pyrometers). Two color radiation thermometers., Black body-tipped fibre optic radiation thermometer, IR imaging systems. Fluoroptic temperature measurement.	9
4	UNIT III SHAPE MEMORY MATERIALS [9 Hours] Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – martensitic transformations – austenitic transformations – thermoelastic martensitic transformations– classification of SMA alloys- mechanism of magnetic SMA – applications of SMA – continuum applications of SMA fasteners – SMA fibers – reaction vessels, nuclear reactors, chemical plant, etc. – micro robot actuated by SMA – SMA memorization process (Satellite Antenna Applications) SMA blood clot filter – Impediments to applications of SMA – Shape memory polymers– mechanism of shapememory-Primary moulding – secondary moulding – types and applications.	9
5	UNIT IV : ORTHOPAEDIC AND DENTAL MATERIALS [9 Hours] Bone and teeth composition, formation and properties – bioresorbable, bioinert, bioactive materials – temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- Fillings and restoration materials – Materials for oral and maxillofacial surgery – ental cements and dental amalgams – dental adhesives- bone tissue engineering	9
6	UNIT V : APPLICATIONS OF BIO MATERIALS FOR CARDIOVASCULAR OPTHALMOLOGY AND SKIN REGENERATION [9 Hours] Blood clotting – blood theology– approaches to thrombo resistance materials development – blood vessels – The heart – aorta and valves – geometry of blood circulation – cardiac pacemakers – blood substitutes – extracorporeal blood circulation devices.The lungs – vascular implants: vascular graft, cardiac valve prostheses, card– Biomaterials in opthalmology –skin grafts -connective tissue grafts – tissue adhesives – drug delivery methods and materials.	9
	Total	451

Sl. No.	**Name of Authors / Books /Publishers**

1	Measurement systems application and design, ERNEST DOEBELIN, IV Edn. (Chapter 1, 2, 3, 4, 5).
2	Instrument Engineers Hand Book (process measurement), LIPTAK (Chapter 6).
3	Electronic Instrumentation – by H S Kalsi TMH 2nd Ed 2004

Project / Internship

ECP1: Internship (4 Weeks)

S.N.	Schedule	Duration	Credits (14-20)	Activities	Sub Activity Head	Proposed Documen t as Evidence	Evaluated by	Performance appraisal/ Maximum points/ activity
1	Summer vacation after 2nd Semester	4 weeks	4	Inter/ Intra Institutional Activities	Inter/ Intra Institutional Workshop/Training/ Communication Skills & English Language	Certificate	Programme Head	Satisfactory/ Good/ Excellent
					Working for consultancy/ research project	Certificate	Programme Head	Satisfactory/ Good/ Excellent
					Festival (Technical / Business / Others) Events/	Certificate	Programme Head	Satisfactory/ Good/ Excellent
					Contribution in Incubation/ Innovation/ Entrepreneurship Cell	Certificate	Cell In-Charge	Satisfactory/ Good/ Excellent
					Learning at Departmental Lab/Tinkering Lab/	Certificate	Cell In-Charge	Satisfactory/ Good/ Excellent

ECP2: Internship (4 Weeks)

S.N.	Schedule	Duration	Credits (14-20)	Activities	Sub Activity Head	Proposed Document as Evidence	Evaluated by	Performance appraisal/ Maximum points/ activity

1	Summer vacation after 4th Semester	4 weeks	4	Inter/ Intra Institutional Activities	Inter/ Intra Institutional Workshop/Training/ Communication Skills & English Language	Certificate	Programme Head	Satisfactory/ Good/ Excellent
					Participation in innovation related completions for eg. Hackathons etc.	Certificate	Faculty Mentor	Satisfactory/ Good/ Excellent
					Development of new product/ Business Plan/ registration of start- up	Certificate	Programme Head	Satisfactory/ Good/ Excellent
					Work experience at family business	Declaration by Parent	TPO	Satisfactory/ Good/ Excellent
					(Internship with Industry/ Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise	Evaluating Report	Faculty Mentor/TPO / Industry Supervisor	Satisfactory/ Good/ Excellent

ECP3: Internship (6 Weeks)

S. N.	Schedule	Duration	Credits (14-20)	Activities	Sub Activity Head	Proposed Document as Evidence	Evaluated by	Performance appraisal/ Maximum points/ activity
1	Summer vacation after 6th	6weeks	6	Inter/ Intra Institutional Activities	Participation in innovation related completions for eg. Hackatho	Certificate	Faculy Mentor	Satisfactory/ Good/ Excellent

	Semester				ns etc.			
					Development of new product/ Business Plan/ registration of start-up	Certificate	Programme Head	Satisfactory/ Good/ Excellent
					Work experience at family business	Declaration by Parent	TPO	Satisfactory/ Good/ Excellent
					(Internship with Industry/ Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise	Evaluating Report	Faculty Mentor/ TPO/ Industry Supervisor	