Department of Telecommunication Engineering

BMS College of Engineering, Bangalore

Scheme and Syllabus: III to VIII

2015-2016

Institute Vision

Promoting Prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training

Institute Mission

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

Program Vision

Our graduates shall be globally competent Engineering professionals

Program Mission

The department will achieve the Vision through: Framing suitable curriculum; followed by effective implementation of the framed curriculum; Execute industry relevant projects; Pursue Research leading to International Journal/ Conference publications and Provide due emphasis on Professional Ethics and Social/Environmental Concerns

Program Educational Objectives

The Program Educational Objectives (PEOs) describe the professional accomplishments of our graduates about four-five years after having completed the under-graduate program in Telecommunication Engineering. We describe the progress of our graduates through four PEOs. The first PEO reflects their professional career pursued through the knowledge acquired, the second PEO is focussed on their desire to upgrade their technical skills, the third PEO describes their communication skills and team skills, while the fourth PEO describes their attitude through their concern for environment and society. The PEOs of the program is as under:

PEO1	Graduates will compete on a global platform to pursue their professional career in Telecommunication Engineering and allied disciplines
PEO2	Graduates will pursue higher education and/or engage in continuous up gradation of their professional skills
PEO3	Graduates will communicate effectively and will demonstrate professional behaviour while working in diverse teams
PEO4	Graduates will demonstrate high regard for human rights, have concern for society and environment

Program Outcomes (POs)

Program Outcomes (POs), are attributes acquired by the student at the time of graduation. The POs given in the Table below, are identical to the Graduate Attributes (GAs) specified by National Board of Accreditation (NBA), and are common across all branches of engineering. These attributes are measured at the time of Graduation, and hence computed every year for the outgoing Batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum, and help in the attainment of the PEOs.

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage :**Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
PO8	**Ethics :** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes (PSOs)

The Program Specific Outcomes (PSOs), are defined by the stakeholders of the program, and describe the skills in addition to the POs (defined by NBA), expected by the Telecommunication Engineering student at the time of graduation. Similar to the POs, they are addressed through the outcomes of the courses, however, they are exclusive to the branch. The PSOs are developed through the teaching-learning process of various courses of the curriculum. The National Board of Accreditation (www.nbaind.org), recommends having 2-4 PSOs for a program. After series of discussions with the stakeholders of the program, the Department of Telecommunication Engineering has arrived at three PSOs. Through these PSOs, we attempt to develop the ability to: (i) Build Electronic Systems, (ii) Build Communication Systems and (iii) Simulate systems using Engineering Tools.

At the time of graduation, the Telecommunication Engineers will have the ability to	
PSO1	implement, analyze and demonstrate applications using electronic components
PSO2	implement, analyze and demonstrate basic concepts of communication systems
PSO3	develop, analyze and demonstrate algorithms to simulate concepts related to Electronic Systems/ Telecommunication Systems/ Multimedia streaming/ Networking Protocols using suitable Engineering Tools

III Semester Scheme

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
15MA3 GC ADM	Advanced Mathematics	3:1:0:0	4	5	50	50	100
15ES3 GC LCA	Linear Circuit Analysis	3:1:0:0	4	5	50	50	100
15ES3 GC AMC	Analog Microelectronics	3:0:1:2	6	5	50	50	100
15ES3 GC DEC	Digital Electronics	3:0:1:2	6	5	50	50	100
15ES3 GC FAW	Fields and Waves	3:1:0:0	4	5	50	50	100
15TE3 DC SL1	Simulation Laboratory-I	0:0:1:0	1	2	50	50	100
Total		**15:3:3:4**	**25**	**27**	**300**	**300**	**600**

IV Semester Scheme

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
15MA4GC DMP	Discrete Mathematics and Probability	3:1:0:0	4	5	50	50	100
15TE4 DC HDL	Fundamentals of HDL	3:0:1:0	4	5	50	50	100
15ES4 GC AIC	Analog Integrated Circuits	3:0:1:2	6	5	50	50	100
15ES4 GC MCS	Microcontrollers	3:0:1:2	6	5	50	50	100
15TE4 DC CTS	Continuous Time Signal Processing	3:1:0:0	4	5	50	50	100
15TE4 DC SL2	Simulation Laboratory-II	0:0:1:0	1	2	50	50	100
Total		**15:3:3:4**	**25**	**27**	**300**	**300**	**600**

V Semester Scheme

Course Code		Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16TE5 DC ACM		Analog Communication	3:0:1:2	6	5	50	50	100
16TE5 DC DTS		Discrete Time Signal Processing	3:0:1:2	6	5	50	50	100
16TE5 DC CN1		Computer Communication Networks – I	3:0:0:0	3	3	50	50	100
16TE5 DC LCS		Linear Control Systems	2:1:0:0	3	4	50	50	100
16TE5 DC VLI		Fundamentals of VLSI	3:0:0:0	3	3	50	50	100
16TE5 DC SL3		Simulation Laboratory-III	0:0:1:0	1	2	50	50	100
16TE5 DE 1	DS	Digital System Design	3:0:0:0	3	3	50	50	100
	OS	Operating Systems						
	DA	DSP Architecture						
Total			**17:1:3:4**	**25**	**25**	**350**	**350**	**700**

VI Semester Scheme

Course Code		Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16TE6 DC DCM		Digital Communication	3:0:1:2	6	5	50	50	100
16TE6 DC CN2		Computer Communication Networks –II	3:0:1:2	6	5	50	50	100
16TE6 DC TLA		Transmission Lines and Antennas	2:1:0:0	3	4	50	50	100
16TE6 DC ITC		Information Theory and Coding	2:1:0:0	3	4	50	50	100
16TE6 DC SL4		Simulation Laboratory-IV	0:0:1:0	1	2	50	50	100
16TE6 DE 2	FP	System Design using FPGA	3:0:0:0	3	3	50	50	100
	OP	OOPS and Data Structures						
	IP	Image Processing						
16TE6 GE 1	XX	Electrical Cluster Elective -I	3:0:0:0	3	3	50	50	100
Total			**13:2:4:4**	**25**	**26**	**350**	**350**	**700**

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Program: TELECOMMUNICATION ENGINEERING Semester: VII

Course Code		Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16TE7 DC MWR		Microwaves and Radar	3:0:0:0	3	3	50	50	100
16TE7 DC MMC		Multimedia Communication	3:0:1:0	4	5	50	50	100
16TE7 DC WCM		Wireless Communication	3:0:1:2	6	5	50	50	100
16TE7 DC PW1		Project for Community Service	0:0:3:0	3	6	50	50	100
16TE7 DE 3	AD	ASIC Design	3:0:0:0	3	3	50	50	100
	FS	Optical Fiber and Satellite Communication						
	SP	Speech Processing						
	AC	Advanced coding theory						
16TE7 GE 2	XX	Electrical Cluster Elective -II	3:0:0:0	3	3	50	50	100
16TE7 IE 1	XX	Institute Elective – I	3:0:0:0	3	3	50	50	100
Total			**18:0:5:2**	**25**	**28**	**350**	**350**	**700**

DC- Department Core , GC- Group Core, GE: Group Elective; IE- Institute Elective; L – Lecture Hours / week; T- Tutorial Lecture Hours / week; P-Practical Lecture Hours/week. CIE- Continuous Internal Evaluation; SEE- Semester End Examination (of 3 Hours duration)

BMS COLLEGE OF ENGINEERING, BANGALORE
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Program: TELECOMMUNICATION ENGINEERING Semester: VIII

Course Code		Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16TE8DC STN		Sustainable Telecommunication Networks	2:0:0:1	3	2	50	50	100
16HS8 DC PMF		Project Management and Finance	2:0:0:1	3	2	50	50	100
16TE8 DC MPJ		Project Work	0:0:10:0	10	20	50	50	100
16TE8 DC SMR		Seminar: Based on Internship/ Training/ Technical paper	0:0:2:0	2	2	50	50	100
16HS8 IE XXX		**HSS-Institute Elective** : NSS/ NCC/ Yoga/sports/Cultural/ Internship with NGO	0:0:1:0	1	2	50	50	100
16HS8 GC IPL		HSS- Cluster Core: IPR & Cyber Law	2:0:0:1	3	2	50	50	100
16TE8 IE 2	**XX**	Institute Elective – II	3:0:0:0	3	3	50	50	100
Total			**9:0:13:3**	**25**	**33**	**400**	**400**	**800**

DC- Department Core , GC- Group Core, GE: Group Elective ; IE- Institute Elective; L – Lecture Hours / week; T- Tutorial Lecture Hours / week; P-Practical Lecture Hours/week. CIE- Continuous Internal Evaluation; SEE- Semester End Examination (of 3 Hours duration)

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Semester: VI

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16**TE6** GE 1DE	Displays for Embedded System	3-0-0-0	3	3	50	50	100
16**TE6** GE 1CN	Cryptography and Network Security	3-0-0-0	3	3	50	50	100
16ML6GE1BM	Bio-Mems	3-0-0-0	3	3	50	50	100
16ML6GE1FL	Fiber Optics and Laser Medicine	3-0-0-0	3	3	50	50	100
16EC6GE1DA	Data Structures and algorithm	3-0-0-0	3	3	50	50	100
16EC6GE1ST	Sensor Technology	3-0-0-0	3	3	50	50	100
16EC6GE1VT	VLSI Testing and Design for Testability	3-0-0-0	3	3	50	50	100
16EC6GE1PD	Physical Design	3-0-0-0	3	3	50	50	100
16EC6GE1PR	Probability & Random process *(Except TE)*	3-0-0-0	3	3	50	50	100
16EC6GE1AM	Advanced Microcontrollers & Applications	3-0-0-0	3	3	50	50	100
16EC6GE1NE	Nano Electronics	3-0-0-0	3	3	50	50	100
16EE6GE1EM	Electrical & Electronic Engineering Materials	3-0-0-0	3	3	50	50	100
16EE6GE1MT	Modern Control Theory *(Except EE)*	3-0-0-0	3	3	50	50	100
16EE6GE1EC	Electromagnetic Compatibility *(Except EC and IT)*	3-0-0-0	3	3	50	50	100
16EI6GE1II	Industrial IOT	3-0-0-0	3	3	50	50	100
16EI6GE1RT	Robotics	3-0-0-0	3	3	50	50	100

Group II Electrical Cluster Electives (Programs: EC/TE/IT/EE/ML) Semester: VII

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16TE7GE 2CP	Cyber Physical Systems	3:0:0:0	3	3	50	50	100
16TE7GE2RT	Real Time Systems	3:0:0:0	3	3	50	50	100
16TE7GE2LC	Low Power Microcontroller	3:0:0:0	3	3	50	50	100

Institute Elective: Group I Semester: VII

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16TE7IE SDE	System Design and Optimization using Engineering tools	3:0:0:0	3	3	50	50	100
16TE7IE SDG	System Design using Graphical Programming	3:0:0:0	3	3	50	50	100

Institute Elective: Group II Semester: VIII

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16TE8IE NTM	Network Management	3:0:0:0	3	3	50	50	100
16TE7IESPA	Satellites: Principles & Applications	3:0:0:0	3	3	50	50	100

Course Title	ADVANCED ENGINEERING MATHEMATICS (Common to EC, TE, EE, IT, ML)				
Course Code	**15MA3GCAEM**	**Credits**	4	**L-T-P-S**	3:1:0:0
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Pre-requisites

Trigonometric formulas, methods of differentiation, methods of integration, partial derivatives, matrices, Fourier Series, Fourier Transforms

UNIT I **[9 hours]**

MATRICES

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of system of linear equations and solution. Solution of a system of non-homogenous linear algebraic equations: Gauss elimination method, LU decomposition method, Gauss-Seidel method. Eigenvalues and eigenvectors of matrices. Reduction of a matrix to diagonal form.

(7L+2T)

Suggested Reading: Inverse of a matrix using Gauss-Jordan method. Largest eigenvalue and corresponding eigenvector using Rayleigh power method.

UNIT II **[10 hours]**

NUMERICAL METHODS

Solution of algebraic and transcendental equations: Newton-Raphson method.

Finite Differences and interpolation: Forward differences, backward differences. Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Simpson's $1/3^{rd}$, $3/8^{th}$ rule, Weddle's rule. Numerical solution of ordinary differential equations: Euler's modified method, Runge-Kutta method of fourth order**.**

(8L+2T)

Suggested Reading: Milne's method to solve ordinary differential equations. Solution of simultaneous differential equations by Runge-Kutta fourth order method.

UNIT III **[10 hours]**

PARTIAL DIFFERENTIAL EQUATIONS

Formation of Partial differential equations-elimination of arbitrary constants, elimination of arbitrary functions. Equations of first order- Solution of the linear equation $P\,p + Q\,q = R$ **(**Lagrange's partial differential equation).

Applications: One-dimensional heat equation and wave equation (without proof), Transmission line-telegraph equations, various possible solutions of these by the method of separation of variables.

(7L+3T)

Suggested Reading: Direct integration method, method of separation of variables, D'Alembert's solution of wave equation.

UNIT IV **[9 hours]**

COMPLEX ANALYSIS 1

Function of a complex variable, limits, continuity and differentiability of a complex valued

function. Analytic functions, properties of analytic functions, Cauchy-Riemann equations in Cartesian and polar form, construction of analytic functions by Milne-Thomson method.

Conformal mapping-Transformations: $w = z^2$ and $w = z + \frac{a^2}{z}$ $(z \neq 0)$.Bilinear transformations.

(7L+2T)

Suggested Reading: Standard transformations $w = c + z$, $w = cz$, $w = 1/z$, properties of bilinear transformations.

UNIT V	**[10 hours]**

COMPLEX ANALYSIS 2

Complex integration: Line integral, Problems on line integral, Cauchy's theorem, Cauchy's integral formula.

Complex series: Taylor's series, Maclaurin's series and Laurent's series (without proof).

Zeros, Poles and Residues: Residue theorem (without proof). Evaluation of real definite integrals using residues.

(7L+3T)

Suggested Reading: Power series, radius of convergence. Removable and essential singularities, improper real integrals with singular points on real axis.

Applications: Use of harmonic function to a heat transfer problem. Analysing AC circuits, Current in a field- effect transistor.

Mathematics Lab

- Solution of system of algebraic equations using Gauss Seidel method.
- LU decomposition of matrices.
- Eigenvalues and eigenvectors of matrices.
- Largest eigenvalue, smallest eigenvalue and corresponding eigenvectors of a matrix.
- Solution of algebraic and transcendental equations using Newton- Raphson method.
- Numerical integration.
- Numerical solution of ordinary differential equations

Text Books:

1.	Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers
2.	Advanced Engineering Mathematics, 5th edition, 2011, by Dennis G. Zill and Cullen, Jonesand Bartlett India Pvt. Ltd.

Reference Books:

1.	Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill.
2.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley-India.
3.	Numerical Methods for Scientific and Engineering Computation. M.K. Jain, S.R.K Iyengar, R.K. Jain, 6th edition, 2010, New Age International (P) Limited Publishers

E books

1.	Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
2.	Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3.	http://ocw.mit.edu/courses/mathematics/ (online course material)
MOOCs	
1.	http://nptel.ac.in/courses.php?disciplineId=111
2.	https://www.khanacademy.org/
3.	https://www.class-central.com/subject/math (MOOCS**)**
4.	E-learning: www.vtu.ac.in

CO1: Obtain numerical solution a system of algebraic equations, algebraic and transcendental equations and ordinary differential equations.
CO2: Formulate boundary value problems involving one dimensional heat and wave equation.
CO3: Solve partial differential equations with appropriate boundary conditions using the method of separation of variables**.**
CO4: Construct analytic functions and simple conformal mappings.
C-5: Evaluate real and complex integrals using the calculus of residues.

Course Title	DIGITAL ELECTRONICS (Common to EC, TE, EE, IT, ML)				
Course Code	**15ES3GCDEC**	**Credits**	**6**	**L-T-P-S**	**3:0:1:2**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes
At the end of the course, the student will have the

CO1: Ability to **understand, define and explain** the fundamental concepts of Digital circuits	----
CO2: Ability to **apply** the knowledge of simplification methods to optimize a digital circuit	PO1
CO3: Ability to **analyze** digital circuits and arrive at suitable conclusions	PO2
CO4: Ability to **design** a digital circuit for given specifications	PO3
CO5: Ability to **conduct experiments** using digital ICs for a given application/problem statement	PO5 PO9
CO6: Ability to **conduct investigations** to validate a given IC	PO4
CO7: Ability to perform in a team to implement an **open-ended experiment**	**PSO1** PO5 PO9 PO10 PO12

Pre-requisites
Elements of Electronics Engineering

UNIT I	**[8 hours]**

Introduction: Review of Boolean algebra, logic gates.
Simplification of Boolean functions : Three Variable K – Maps, Four Variable K – Maps, The Tabulation Method, Determination of Prime Implicants, Selection of prime implicants
Combinational Logic Circuits: Introduction, Carry Look Ahead Adder, Parallel Adder, Decimal Add Code conversion, , Magnitude Comparator, Decoders, Multiplexers, Read Only memories (ROM), Programmable Logic Arrays(PLAs).

UNIT II	**[7 hours]**

Flip-Flops:
The Basic Flip-flop circuit, Clocked Flip-flops, Triggering of Flip-flops: Master Slave Flip-Flops, Edge Triggered Flip Flops, Characteristic Equations.

UNIT III	**[7hours]**

Sequential Logic Circuits:
Shift Registers, Ripple Counters, Design of Synchronous Counters

UNIT IV	[7 hours]
Sequential systems: Analysis of Clocked Sequential circuits, State Reduction and Assignment, Design Procedure, Design with State Equations	
UNIT V	**[7 hours]**
Logic Families: Characteristic of Digital ICs, Transistor – Transistor Logic, Complementary MOS (CMOS) Logic, Comparison of TTL and CMOS families	
Text Books:	
1.	Digital Logic and Computer Design- M. Morris Mano, Prentice Hall – Pearson Education
2.	Fundamental of Logic Design- Charles Roth Jr., Thomas Learning
Reference Books:	
1.	Digital Principles and Design- Donald Givone, Tata Mc Graw Hill
2.	Digital Logic Applications and principles- John Yarbrough, Pearson Education
E – Book	
1.	http://www.free-engineering-books.com/2014/11/digital-fundamentals-by-thomas-l-floyd.html
2.	https://books.google.co.in/books/about/Fundamentals_of_Digital_Circuits.html?id=BOVkrtiLUcEC
MOOCs	
1.	http://freevideolectures.com/blog/2010/11/130-nptel-iit-online-courses/
2.	http://freevideolectures.com/Course/2319/Digital-Systems-Design#
3.	www. Pyroelectrom.com/edu
4.	Nptel.ac.in/courses/117106086
5.	http://nptel.ac.in/courses/117105080
6.	**Digital Circuits and Systems** Youtube – S. Srinivasan, IIT Madras
7.	**Digital Integrated Circuits** Youtube – AmitavaDasgupta, IIT Madras

Laboratory Experiment List

Sl.No	Title of the Experiments
1	Applications of IC 7483 (Adders, Subtractors and Comparators) (Unit-I)
2	Multiplexers (using Gates and IC) and their applications (Unit-I)
3	Decoders/DeMultiplexers (using Gates and IC) and their applications (Unit-I)
4	BCD to Decimal decoder using 7-segment display (Unit-I)
5	Verification of MSJK Flip-flop (using Gates and IC 7476) (Unit-II)
6	Asynchronous counters (using ICs 7476,7490,7493) (Unit-III)
7	Synchronous Counters (using ICs 7476, 74190/74192) (Unit-III, IV)
8	Shift registers and their applications (using ICs 7476, 7495) (Unit-III)
9	Verification of few parameters of the IC specifications (Unit-V)

Course Title	ANALOG MICROELECTRONICS (Common to EC, TE, EE, IT, ML)				
Course Code	**15ES3GCAMC**	**Credits**	**6**	**L-T-P-S**	**3:0:1:2**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes
At the end of the course, the student will have the

CO1: Ability to **define, understand and explain** concepts related to diodes and Transistors(BJTs, MOSFETs)	–
CO2: Ability to **apply** the knowledge of network theorems to analog electronic circuits	PO1
CO3: Ability to **analyze** given analog electronic circuits to compute required parameters	PO2
CO4: Ability to **design** analog electronic circuits for given application	PO3
CO5: Ability to **conduct investigations** to validate the data sheet of a given electronic component	PO4
CO6: Ability to **conduct experiments** to demonstrate an application of analog electronics using components/Multisim	PO4 PO5 PO9
CO7: Ability to perform in a team to implement **an open-ended experiment**	**PSO1** PO5 PO9 PO10 PO12

Pre-requisites
Elements of Electronics Engineering

UNIT I	**[7 hours]**

Diodes: - Introduction , **Limiting and clamping circuits** --- Limiter circuits, The Clamped capacitor or DC restorer. **Bipolar Junction Transistor (BJTs)**:- Introduction, **Single stage BJT amplifiers** --- The basic structure , characterizing BJT Amplifiers, The common emitter amplifier **Frequency Response of the CE amplifier**---The 3 frequency bands, The high frequency response , The low frequency response.

UNIT II	**[8 hours]**

MOSFETS:-Introduction ,**Device structure and physical operation** ---- Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDs, Operation as VDs is increased, Derivation of the id – V_{DS} relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the subthreshold region .
Current voltage Characteristics---Circuit symbol, id – V_{DS} characteristics, characteristics of the

P-Channel MOSFET

MOSFET Circuits at DC

The MOSFET as an amplifier and as a switch --- Large – signal operation , Graphical derivation of the transfer characteristic, operation as a switch, operation as a linear amplifier.

Biasing in MOS amplifier circuits---Biasing by fixing V_{GS}, Biasing by fixing V_G and connecting a resistor in the source , Biasing using a drain to gate feedback resistor, biasing using a current source

UNIT III	**[7 hours]**

Small – signal operation and models of MOSFETs---The DC bias point, the signal current in the drain terminal ,the voltage gain, separating dc analysis and the signal analysis, small signal equivalent circuit models, the transconductance g_m, the T equivalent circuit model.

Single stage MOS amplifiers---The basic structure, characterizing amplifiers, The CS amplifier, The CS amplifier with a source resistance.

IC Biasing :– **Current sources, current mirror and current steering circuits**---

The basic MOSFET current source, MOS current steering circuits

Current mirror circuit with improved performance --- The Wilson current mirror

UNIT IV	**[7 hours]**

Feedback:-

Introduction ,the general feedback structure, S**ome properties of negative feedback**---Gain density, bandwidth extension, noise reduction, reduction in non linear distortion, **The four basic feedback topologies---** Voltage amplifiers, current amplifiers, transconductance amplifiers , practical feedback circuits for current series and voltage series feedback

UNIT V	**[7 hours]**

Power Amplifiers:-

Introduction, The classification of output stages .

C**lass A output stage** – transfer characteristic, signal w/Fs, power dissipation, power conversion efficiency, transformer coupled power amplifiers, class B transformer coupled amplifier

Class B output stage – Circuit operation , transfer characteristic, power conversion efficiency, power dissipation, reducing crossover distortion, single supply operation

Class AB output stage – Circuit operation, output resistance

Power BJTs – Junction te**mperatur**e, thermal resistance, power dissipation versus temperature, transistor case and heat sink

Text Books:

1.	Microelectronic Circuits-Theory and applications by Adel S. Sedra and Kenneth C.Smith, Fifth Edition , (Oxford International Student Edition)
2.	Electronic Devices and Circuit Theory-Robert L.Boylestad and Louis Nashelsky (Pearson Education)

Reference Books:

1.	Electronic Devices and Circuits- Millman and Halkias, TMH
2.	Electronic Devices and Circuits- David A Bell - PHI 4th edition

On-line Reference

1.	www.pyroelectro.com/edu/analog

2.	http://freevideolectures.com/Course/3020/Circuits-for-Analog-System-Design
MOOCs	
1.	https://www.mooc-list.com/course/electronic-systems-and-digital-electronics-uninettuno?static=true
2.	http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-spring-2009/
3.	Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware | Reviews and Ratings

Sl.No	Title of the Experiments
1	Performance analysis of Diode and Transistor as a switch (Unit-I)
2	Zener diode characteristics and Zener as regulator.
3	Diode clipping circuits- Single/Double ended (Unit-I)
4	Diode clamping Circuits – positive clamping/negative clamping. (Unit-I)
5	Performance analysis BJT as RC coupled amplifier. (Unit-I)
6	Design and analysis of BJT as RC phase shift oscillator
7	To obtain the characteristics of MOSFET, using Multisim (Unit-II)
8	To study MOSFET as an amplifier, using Multisim (Unit-III)
9	To study voltage series feedback amplifier using BJT, using Multisim (Unit-IV)
10	Design and analysis of Crystal Oscillators
11	Performance analysis of Class –B Power Amplifier (Unit-V)
12	Compare the performance of the practical circuit with the corresponding simulation

Course Title	LINEAR CIRCUIT ANALYSIS (Common to EC, TE, EE, IT, ML)				
Course Code	**15ES3DCLCA**	**Credits**	**4**	**L-T-P-S**	**3:1:0:0**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes

At the end of the course, the student will have the

CO1: Ability to **understand, define and explain** the concepts of loop and node analysis, network topology and resonant circuits	___
CO2: Ability to **apply** the knowledge of Network theorems , Laplace transformation and state –space analysis to two port networks to obtain desired parameters	PO1
CO3: Ability to **analyze** two port networks	PO2
CO4: Ability to **conduct experiments** to comprehend and analyze networks and theorems	PO4 PO5
CO5: Ability to make an **effective oral presentation** on E-waste norms, hazards of e-waste, effect on environment	PO6 PO7 PO8 PO10 PO12

Pre-requisites

Elements of Electronics Engineering

UNIT I	**[7L+1T]**

Basic Concepts:

Practical sources, Source transformations, Network reduction using Star Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC and AC networks, Concepts of super node and super mesh.

UNIT II	**[7L+3T]**

Network Topology:

Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set, tie-set & cut- set schedules, Formulation of equilibrium equations, Principle of duality.

Resonant Circuits: Series and parallel resonance, frequency response of series and Parallel circuits, Q factor, Bandwidth

UNIT III	[6L+3T]
Network Theorems : Superposition, Reciprocity, Millman's, Thevinin's and Norton's theorems; Maximum Power transfer theorem	
UNIT IV	**[9L+3T]**
Transient behavior and initial conditions: Behavior of circuit elements under switching condition and their representation, evaluation of initial and final conditions in RL, RC and RLC circuits Review of Laplace transforms, Laplace Transformation & Applications, , waveform Synthesis, initial and final value theorems, step, ramp and impulse responses, convolution theorem, solution of simple R-L, R-C, R-L-C networks for AC and DC excitations using Laplace transforms.	
UNIT V	**[7L+2T]**
Two port network parameters and State Variable analysis: Definition of z, y, h and transmission parameters, modeling with these parameters, relationship between parameters sets. Writing state equations and solution using Laplace transforms.	
Lab Experiments: • Transient behavior of circuit, Network theorems • Resonance circuits, Steady state response, Obtaining Two – port parameters	
Text Books:	
1.	"Network Analysis", M. E. Van Valkenburg, PHI / Pearson Education, 3rd Edition. Reprint 2002.
2.	"Networks and systems", Roy Choudhury, 2nd edition, 2006 re-print, New Age International Publications
3.	Theory and Problems of Electric Circuits (Schaum Series), 2nd Edition McGraw Hill
Reference Books:	
1.	"Engineering Circuit Analysis", Hayt, Kemmerly and Durbin,TMH 6th 2002
2.	"Network analysis and Synthesis", Franklin F. Kuo, Wiley Edition
3.	"Analysis of Linear Systems", David K. Cheng, Narosa Publishing House, 11th reprint, 2002
4.	"Circuits", Bruce Carlson, Thomson Learning, 2000. Reprint 2002
E-Books	
1.	Nptel.ac.in/courses/108105065- Networks signals and systems by Prof T.K. Basu, IIT Kharagpur

2.	Nptel.ac.in/courses/108102042- Circuit Theory by Prof Dutta Roy S.C, IIT Delhi
3.	www.electrodiction.com/circuit-theory
MOOCs	
1.	http://elearning.vtu.ac.in/06ES34.html
2.	https://www.coursera.org/course/circuits

Course Title	**FIELDS AND WAVES** (Common to TE and EC)				
Course Code	**15ES3GCFAW**	**Credits**	**4**	**L-T-P-S**	**3:1:0:0**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes

At the end of the course, the student will have the

CO1: Ability to **define, understand**, and **explain** concepts on electrostatics and magnetostatics, Time varying fields and Maxwell's equations, wave propagation in different media, concepts on reflection and dispersion of plane waves	———
CO2: Ability to **apply** various properties/ laws/theorems/ Maxwell's equations of electrostatics, magnetostatics to solve/derive **examples** in different media of time varying fields and uniform plane waves.	PO1-3
CO3: Ability to **analyze** the given specifications of static and time varying Electric, Magnetic fields, uniform plane waves in various configurations/ distributions	PO2-3
CO4: Ability to make an **effective oral presentation** on Electromagnetic transmission norms, radiation hazards, effect on environment	PO6-2 PO7-2 PO8-2 PO10-1 PO12-1
CO5: Ability to listen and comprehend audio/video lectures related to the electromagnetic fields and waves	PO10-2

Pre-requisites

Engineering Physics
Engineering Mathematics

UNIT I	**[8L +2T]**

Introduction to electrostatics: Introduction to line integral, surface integral, volume integral of vectors, Coulomb's Law(vector form), Electric Field Intensity (vector form), Electric Flux Density (EFD), Gauss' Law and Divergence Theorem

Energy and Potential: Energy spent in moving charge, Definition of Potential Difference (PD), PD due to Point Charge ,Energy Density **Current and current density:** Current and Current Density, Continuity of Current, Conductor, Dielectric materials, Properties, and Boundary Conditions, capacitance-parallel plate ,co-axial, spherical.	
UNIT II	**[6L+2T]**
Introduction to Magnetostatics: Biot-Savart Law, Ampere's circuital law, curl, Magnetic Flux, Flux Density, Scalar and Vector Magnetic Potentials, Force on a moving charge, Force on different current element, Magnetic Boundary Condition.	
UNIT III	**[7+3T]**
Time varying fields and Maxwell's equations: Faraday's Law, Displacement Current, Maxwell's Equations in Point and Integral Form, retarded potentials,	
UNIT IV	**[7+3T]**
Uniform plane waves: Wave equations, solution of wave equation, wave propagation through good dielectric, good conductor, skin effect, Poynting Theorem, wave polarization.	
UNIT V	**[8 + 2T]**
Plane wave reflection and dispersion: Reflection of uniform plane waves at normal incidence SWR ,Wave reflection from multiple interfaces, plane wave propagation in general directions, plane wave reflection at oblique incidence angles, total reflection and total transmission of obliquely incident waves, wave propagation in dispersive media, pulse broadening in dispersive media	
Text Books:	
1.	**Engineering Electromagnetics,** W H Hayt ,J A Buck,M Jaleel Akhtar Tata McGraw-Hill, 8e Edition, 2014.
2.	**Electromagnetics,** Schaum's Outline series Joseph A Ediminister Tata McGraw-Hill, revised second Edition, 2014.
Reference Books:	
1.	Electromagnetics with Applications, John Krauss and Daniel A Fleisch, McGraw-Hill, 5th Edition, 1999.
2.	"Field and wave electromagnetic, David K Chary, Pearson Education Asia, Second Edition – 1989, Indian Reprint – 2001
On-line Reference	
1.	http://nptel.ac.in/courses/108106073/
2.	http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/
3.	Transmission%20Lines%20and%20EM%20Waves/Course%20Objective.htm
MOOCs	
1.	http://emt-iiith.vlabs.ac.in/
2.	http://emt-iiith.vlabs.ac.in/Experiment.php?code=C001 to C010
3.	http://nptel.ac.in/courses/108106073/ 1 to 108106073/42

Course Title	SIMULATION LABORATORY – I (TE only)				
Course Code	**15TE3DCSL1**	**Credits**	**1**	**L-T-P-S**	**0:0:1:0**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes

At the end of the course, the student will have the

CO1: Ability to **understand** basic programming concepts of the engineering tools Multisim	---
CO2: Ability to **develop Multisim code** to simulate concepts related to analog electronics, two port electronic networks, electronic instruments	PO1-3 PO5-3
CO3: Ability to **obtain** specified parameters of the developed electronic circuit (analog/digital)	PO2-3 PO5-3
CO4: Ability to **interpret** and **compare** simulation results with that of the corresponding physical realization of the electronic circuit (analog/digital) for a given application	PO5-3
CO5: Ability to **formulate, implement** and **demonstrate** an application of electronic circuits through an **open-ended experiment**	PO5-3 PO9-2 PO10-2 PO12-2

Introduction to Multisim:
Circuit Window, Placing component, Using basic functional components like resistors, capacitors and inductors, Basic Oscilloscope, Probes, Simple example

Digital Electronics circuits
Adders, Magnitude comparator, Flip flops

Analog Microelectronics circuits
MOSFET V–I characteristics, Common Source MOSFET amplifier
Clippers, CE Voltage Series Feedback amplifier

Linear Circuit Analysis circuits
Transient behavior of circuit, Network theorems

Linear Circuit Analysis circuits
Resonance circuits, Steady state response, Obtaining Two – port parameters

Implementation of Electronics Instruments
AC Voltmeter using FWR, ADC, DAC, Digital Voltmeter
Function Generator, SMPS

Open Ended Experiments through Multisim

Course Title	DISCRETE MATHEMATICS AND PROBABILITY (Common to EC, TE, EE, IT, ML)				
Course Code	15MA4GCDMP	Credits	4	L-T-P-S	3:1:0:0
CIE	100 marks (50% weightage)	SEE	100 marks (50% weightage)		

Pre-requisites
Basic concepts of set theory, relations and functions. Matrices. Basic concepts of probability, addition theorem, conditional probability, Bayes' theorem, discrete random variable, Binomial distribution

UNIT I	[12 hours]

SET THEORY AND RELATIONS
Introduction to sets and subsets, operations on sets, laws of set theory. Duality, Principle of duality for the equality of sets. Countable and uncountable sets. Addition Principle. Introduction to Relations. Definition, Types of functions, operations on relations, matrix representation of relations, composition of relations, properties of relations, equivalence relations, partial orders, Hasse diagram. Posets- extremal elements on posets.

(9L+3T)

Suggested Reading: Some particular functions- Floor and ceiling functions, Projection, Unary and Binary operations.

UNIT II	[10 hours]

ALGEBRAIC STRUCTURES- Groups, properties of groups. Some particular groups- The Klein 4-group, additive group of integers modulo *n*, multiplicative group of integers mod *p*, permutation groups. Subgroups, Cyclic groups, Coset decomposition of a group, homomorphism, isomorphism.

(7L+3T)

Suggested Reading: Lagrange's theorem and its consequences.

UNIT III	[9 hours]

GRAPH THEORY Basic concepts: Types of graphs, order and size of a graph, in-degree and out-degree, connected and disconnected graphs, Eulerian graph, Hamiltonain graphs, subgraphs, dual graphs, isomorphic graphs. Matrix representation of graphs: adjacency matrix, incidence matrix. Trees: spanning tree, breadth first search. Minimal spanning tree: Kruskal's algorithm, Prim's algorithm, shortest path-Dijkstra's algorithm.

(7L+2T)

Suggested Reading: Konigsberg bridge problem, Utility problem.

UNIT IV	[8 hours]
PROBABILITY Theoretical distributions: Poisson distribution, Normal distribution: Error function, Central limit theorem. Two dimensional random variables: Discrete random variable, Mathematical expectation, Covariance and Correlation. **(6L+2T)** Suggested Reading: Exponential distribution, Uniform distribution. Continuous two dimensional random variables.	

UNIT V	[9 hours]
MARKOV CHAIN AND QUEUING THEORY Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chains. Queuing models: Concept of Queue, M/M/1 queuing systems. **(7L+2T)** Suggested Reading: Power supply model, Economic cost profit model.	

Mathematics Lab

- Probability distributions
- Minimal spanning tree- Kruskal's algorithm, Prim's algorithm.
- Shortest Path- Dijkstra's algorithm

Text Books:	
1.	Discrete Mathematical Structures, Dr. DSC, 4th edition, 2011-12, Prism Engineering Education Series.
2.	Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2013, Khanna Publishers.
3.	Discrete Mathematics, Seymour Lipschutz. M. Lipson, 2005, Tata Mc Graw Hill.
Reference Books:	
1.	Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill.
2.	Discrete Mathematics, J K Sharma, 3rd edition, 2013, Macmillan India Ltd.
3.	Queuing Theory and Telecommunications, Networks and applications, Giovanni Giambene, 2005, Springer
4.	Data Networks, Dimitri Bertsekas, Robert Gallager, 2nd edition, 1992, Prentice India
5.	Schaum's Outline of Probability and Statistics, John J Schiller, Murray R Speigel, 4th edition, 2013, Schaum's Outlines
E books	
1.	Discrete Mathematics for Computer Science, Gary Haggard, John Schlipf, Sue Whitesides, Thomson Brooks/Cole, 2006
2.	http://www.khanacademy.org/math/probability/random-variablestopic/random_variables_prob_dist/v/random-variables
3.	http://ocw.mit.edu/courses/mathematics/ (online course material)
MOOCs	
1.	www.nptelvideos.in/2012/11/discrete-mathematical-structures.html
2.	www.cs.berkeley.edu/~daw/teaching/cs70-s05
3.	https://www.khanacademy.org/

Course Outcomes **At the end of the course, the student will have the**
CO1: Understand the notation of set theory, relations and functions.
CO2: Construct a Hasse diagram for partial orderings, Use many terms associated with graphs and prove whether two graphs are isomorphic.
CO3: Obtain the probability of an event using discrete and continuous distributions, including the n-step transition probability.
CO4: Analyse and classify simple states (recurrent/transient)
CO5: Understand, derive and apply the properties of the M/M/m queuing model (properties like stationary probability, average waiting and system time, expected number of customers in the queue)

Course Title	**FUNDAMENTALS OF HDL** (Only TE)

Course Code	**15TE4DCHDL**	**Credits**	**4**	**L-T-P-S**	**3:0:1:0**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes **At the end of the course, the student will have the**	
CO1: Ability to **understand, define and explain** the fundamental concepts of VHDL and VERILOG for modeling Digital Circuits	--
CO2: Ability to **apply** the knowledge of Digital Electronics fundamentals to describe the VHDL and VERILOG behaviour of a digital circuit using data flow, Behavioral and structural modelling	**PO1**
CO3: Ability to **analyse** the given specifications for a digital circuit to describe the behaviour in VHDL and VERILOG	**PO2**
CO4: Ability to **design** a digital circuit through VHDL and VERILOG for given specifications	**PO3**
CO5: Ability to **synthesize** a digital circuit for given VHDL and VERILOG behaviour	**PO**
CO6: Ability to **conduct experiments** using modern engineering CAD tool to: (i) perform simulation (ii) perform synthesis (iii) Implement using FPGA kit, for a given digital circuit	**PO2** **PO3** **PO4** **PO5**

Pre-requisites Digital Electronics Elements of Electronics Engineering	
UNIT I	**[7 hours]**
Introduction: Why HDL, A Brief History of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, Simulation and Synthesis, Brief comparison of VHDL and Verilog	
UNIT II	**[8 hours]**
Data –Flow Descriptions: Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type **Structural Descriptions**: Highlights of structural Description, Organization of the structural Descriptions, Binding, State Machines, Generate, Generic, and Parameter statements	
UNIT III	**[7 hours]**
Behavioral Descriptions: Behavioral Description highlights, structure of HDL Behavioral Description, The VHDL variable –Assignment Statement, sequential statements. **Procedures, Tasks, and Functions:** Highlights of Procedures, tasks, and Functions, Procedures a tasks, Functions	
UNIT IV	**[7 hours]**
Mixed-Type Descriptions: Why Mixed-Type Description? VHDL User-Defined Types, VHDL Packages, Examples	
UNIT V	**[7 hours]**
Synthesis Basics: Highlights of Synthesis, Synthesis information from Entity and Module, Mappi Process and Always in the Hardware Domain	
Text Book:	
1.	HDL Programming (VHDL and Verilog)- Nazeih M.Botros- Dreamtech Press
2.	Digital Design by Morris Mano, Michael Ciletti, Pearson Education
Reference Books:	
1.	Verilog HDL –Samir Palnitkar-Pearson Education
2.	VHDL -Douglas perry-Tata McGraw-Hill
3.	A Verilog HDL Primer- J.Bhaskar – BSPublications
4.	Circuit Design with VHDL-Volnei A.Pedroni-PHI
E Books	
1.	http://access.ee.ntu.edu.tw/course/dsd_99second/2011_lecture/W2_HDL_Fundamentals_2011-03-02.pdf
2.	http://www.ics.uci.edu/~alexv/154/VHDL-Cookbook.pdf
3.	http://ece.niu.edu.tw/~chu/download/fpga/verilog.pdf
MOOCs	
1.	Electronic Design Automation http://nptel.ac.in/courses/106105083/
2.	Digital system design with PLDs and FPGAs http://nptel.ac.in/courses/117108040/
3.	Fundamentals of HDL (Lecture #008) https://www.youtube.com/watch?v=rdAPXzxeaxs&index=8&list=PLE3BC3EBC9CE15FB0

Laboratory Experiment List

Sl. No	Title of the Experiment
1	Write a HDL (VHDL and VERILOG) for the following combinational circuits using Dataflow, Behavioral and Structural modeling a)Adders (Ripple carry Adder, carry look ahead adder) b)Multiplexers c)Decoders d)Comparators
2	Write a HDL (VHDL and VERILOG) for the following Sequential circuits using Behavioral modeling a)Flip-Flops b)Counters c)registers d)state machine
3	Write a HDL (VHDL and VERILOG) code for the following using mixed type descriptions a)up-down counter b)Gray code counter c)register

Course Title	**ANALOG INTEGRATED CIRCUITS** (Common to EC, TE, EE, IT, ML)				
Course Code	**15ES4GCAIC**	**Credits**	**6**	**L-T-P-S**	**3:0:1:2**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		
CO1: Ability to **define, understand and explain** concepts related to Operational amplifiers, timers and regulators					
CO2: Ability to **apply** the knowledge of network theorems to analog integrated circuits					PO1
CO3: Ability to **analyze** given analog electronic circuits to compute required parameters					PO2
CO4: Ability to **design** analog electronic circuits for given application					PO3
CO5: Ability to **conduct investigations** to validate a given electronic integrated circuit					PO4

CO6: Ability to **conduct experiments** to demonstrate an application of analog integrated circuits using components or the simulation tool (Multisim)	PO4 PO5 PO9
CO7: Ability to perform in a team to **implement a mini-project**	**PSO1** PO5 PO9 PO10 PO11 PO12

Pre-requisites

Elements of Electronics Engineering
Analog Microelectronics

UNIT I	**[8 hours]**

Operational Amplifier Characteristics:
Introduction, DC Characteristics, AC Characteristics, Analysis of data sheets of an OP-AMP
Operational Amplifier Applications:
Review of basic Opamp applications, Instrumental Amplifier, V to I and I to V converter, Op-amp circuits using Diodes – Half wave rectifier, Full wave rectifier, Sample and hold circuit, Multiplier and Divider.

UNIT II	**[7 hours]**

Comparators and Waveform Generators:
Introduction, comparator, Regenerative comparator (Schmitt Trigger), Square wave generator (Astable Multivibrator), Monostable Multivibrator, Triangular wave generator. (RC and wein bridge oscillators only)

UNIT III	**[7 hours]**

Voltage Regulators:
Introduction, Series op-amp regulator, IC Voltage regulators, 723 General purpose Regulator, Switching Regulator.
Active Filters:
Introduction, RC Active Filters, First order low pass filter, second order active filter, Higher order l pass filter, High pass active filter, All pass filter-phase shift lead and lag circuit

UNIT IV	**[7 hours]**

Timers :
Introduction to 555 timer, Description of Functional diagram, monostable operation, astable operation.
Phase locked loops : Introduction, Basic principles, phase detector/comparator, voltage controlled oscillator (VCO)

UNIT V	**[7 hours]**

D-A and A-D Converters:
Introduction, Basic DAC Techniques- Weighted Resistor DAC, R-2R Ladder DAC.
A-D Converters: Direct type ADCs- The parallel Comparator (Flash) A/D converter, Successive Approximation Converter, DAC/ADC Specification, Sigma – delta ADC

Text Book:

1.	Linear Integrated Circuits-D.Roy Choudhury & Shail B.Jain (New age Publication)
2.	Op-Amps and Linear Integrated Circuits- Ramakanth A.Gayakwad,4th ed,PHI
Reference Books:	
1.	Linear Integrated Circuits-S.Salivahanan & V.S.Kanchana Bhaaskaran (Tata McGraw-Hill Publication)
2.	Opamps and Linear Ics-David A.Bell (Prentice-Hall Publications)
E Books	
1.	http://freevideolectures.com/Course/2321/Electronics-for-Analog-Signal-Processing-I
2.	http://freevideolectures.com/Course/2322/Electronics-for-Analog-Signal-Processing-I
MOOCs	
1.	http://ocw.tudelft.nl/courses/microelectronics/analog-integrated-circuit-design/course-home/
2.	Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware | Reviews and Ratings
3.	http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/

Laboratory Experiment List

Sl. No	Title of the Experiment
1	Design and Analyze amplifiers, voltage follower, summing Amplifier, Differentiator and integrator (Unit-I)
2	Design and Analyze Precision half wave and full wave rectifier (Unit-I)
3	Design and Analyze Zero crossing detector and Schmitt trigger (Unit-II)
4	Design and Analyze Weinbridge Oscillator (Unit-II)
5	Design and Analyze IC 723 as low voltage and high voltage regulators (Unit-III)
6	Design and Analyze Active Low-Pass/High Pass filter (Unit-III)
7	Design and Analyze 555 as multivibrators (Unit-IV)
8	Design and Analyze R-2R D to A convertor (Unit-V)
9	Design and Analyze Flash ADC (Unit-V)

Course Title	MICROCONTROLLERS (Common to EC, TE, EE, IT, ML)				
Course Code	**15ES4GCMCS**	**Credits**	**6**	**L-T-P-S**	**3:0:1:2**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes
At the end of the course, the student will have the

CO1: Ability to **understand** and **explain** architecture, pipelining, addressing modes, data types in Embedded C, serial communication, timer configuration and interrupt handling of microcontroller	_____
CO2: Ability to **calculate** instruction execution time, delay, baud rate, and **write** assembly and C Code**, identify** the timer mode, serial communication mode and interrupt priorities	PO1
CO3: Ability to **debug**/**analyze** the code in assembly as well as Embedded C	PO2
CO4: Ability to **develop** the code in assembly as well as Embedded C for a given application	PO3
CO5: Ability to identify the IDE to **conduct experiments by** simulating, interfacing, debugging and executing the assembly and Embedded C code	PO5 PO9
CO6: Ability to formulate and implement an application of microcontroller through an **Mini- project** using the controller or a simulation tool	**PSO3** PO4 PO5 PO9 PO10 PO11 PO12

Pre-requisites
Elements of Electronics Engineering
Digital Electronics

UNIT I	**[7 hours]**

INTRODUCTION TO MICROCOMPUTER AND MICROCONTROLLER Introduction to Microprocessors, Internal organization of computer- Bus Structures, Harvard & Von-Neumann CPU architecture, **The 8051 Architecture:** Introduction, 8051 Microcontroller Hardware, Input / Output Pins, External Memory Interface.

UNIT II	**[8 hours]**

MICROCONTROLLER PROGRAMMING
Instruction set architecture-RISC & CISC CPU Architectures, Pipelining, Execution of an instruction, Addressing Modes and Instruction set. Example programs using 8051 instruction set, Data transfer instructions, Arithmetic instructions, Logical instructions, Branching and Subroutines

UNIT III	[8 hours]
CONCEPTS OF EMBEDDED 'C' PROGRAMMING Data types, examples in 8051 C, program structures, logical operations, Memory and I/O access, Programming peripherals (Examples: Timer / Counter), Programming serial communication (serial da input/output) - example programs using 8051	
UNIT IV	**[7 hours]**
INTERRUPTS AND INTERRUPT PROGRAMMING Concept of Interrupts, Interrupts in 8051. Programming Timer Interrupts, Programming External Hardware Interrupts, Programming Serial Communication Interrupts	
UNIT V	**[6 hours]**
INTERFACING AND APPLICATIONS Interfacing 8051 to LCD, DAC, ADC Stepper motor interfacing. Applications of microcontrollers	

LABORATORY EXPERIMENTS:

- ALP to perform addition, subtraction, multiplication and division of 8 bit numbers (Unit-II)
- ALP to perform addition, subtraction, multiplication and division of 8 bit numbers and store the result in external memory (Unit-II)
- ALP to clear 16 RAM locations starting from 60h, ALP to demonstrate the usage of movc and movx instructions (Unit-II)
- ALP to swap the contents of r7 & r6 using different addressing modes (Unit-II)
- ALP to get the X value from P1 and send X2 to P2 continuously, Block transfer and exchange, Addition of 2 16 bit numbers, BCD numbers, to count number of 1's, check whether 4th bit of a byte is 0 (Unit-II)
- Implement counter0-9, 0-99,99-00,data conversion (Unit-II)
- Embedded C programs-to monitor bit P1.5, toggle all bit of P0 and P2,get the I/P via P1.0 and send it to P2.7 after inverting it, send the value 44h serially, toggle only P1.5 continuously. (Unit-III)
- Transfer A serially, convert Packed BCD to ASCII, Hex to decimal conversion and display the digits on P0, P1 and P2 (Unit-IV)
- Interface Stepper motor, DAC, Keyboard, LCD Display, 7-segment display, logic controller (Unit-V)

Text Books:

1.	"The 8051 Microcontroller Architecture, Programming & Applications", Kenneth J. Ayala 2e, Thomson Learning 2005
2.	"The 8051 Microcontroller and Embedded Systems – using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006

Reference Books:

1.	'Computer Organization and Architecture', Carl Hamacher, McGrawHill, 5th Edition
2.	http://cnx.org/contents/dadb4fd5-8390-4323-a056-f6381587e89a@1/Microcontroller%288051%29-Lab

E Books	
1.	nptel.ac.in/courses/Webcourse-contents/IIT.../microcontrollers
2.	http://freevideolectures.com/Course/3018/Microprocessors-and-Microcontrollers
MOOCs	
1.	**Embedded Systems – Shape The World**-https://www.edx.org/course/embedded-systems-shape-world-utaustinx-ut-6-02x
2.	**Electronic Interfaces: Bridging the Physical and Digital Worlds-** https://www.edx.org/course/electronic-interfaces-bridging-physical-uc-berkeleyx-ee40lx-0

Course Title	**CONTINUOUS TIME SIGNAL PROCESSING** (TE Only)				
Course Code	**15TE4DCCTS**	**Credits**	**4**	**L-T-P-S**	**3:1:0:0**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

Course Outcomes
At the end of the course, the student will have the

CO1: Ability to **define, understand**, and **explain** continuous time signals, systems, their time and frequency domain representation, equalizers, ideal and physically realizable filters	____
CO2: Ability to **classify** signals and systems, **obtain** the output for LTI systems using the time domain and the frequency domain representation, **obtain** the frequency domain representation for continuous time signals, **obtain** the transfer function, pole-zero plot of the Butterworth filters	PO1
CO3: Ability to **analyze** the given specifications for physical realizability, stability, **analyze** the designed system (compare with the desired specifications), **analyze** systems	PO2
CO4: Ability to **design** equalizers for a given system, **design** filters for given specifications	PO3
CO5: Ability to **conduct experiments** on concepts related analog signals, systems, system classification, design of analog filters, time and frequency domain representation **using the engineering tool: Matlab/Multisim**	PO3 PO4 PO5
CO6: Ability to make an **effective oral presentation** on contribution of signal processing to society, communication protocols, effect on environment	PO6 PO7 PO8 PO10 PO12

Pre-requisites

Basic Electronics
Network Analysis
Engineering Mathematics

UNIT I	**8L+4T**

INTRODUCTION

Signal definition; signal classification;
Signal transformation of independent, dependent variable;
Elementary signals; transformation of elementary signals;
System definition; system classification;
The Linear Time Invariant (LTI) system; properties of the LTI system

UNIT II	**7L+2T**

TIME-DOMAIN REPRESENTATION & ANALYSIS OF LTI SYSTEMS

Impulse response;
The convolution integral;
Methods of evaluating the convolution integral;
Properties of impulse response;
Measurement techniques for impulse response of practical circuits;
The constant coefficient differential equation; (solution of differential equation excluded)
Block diagram representation of LTI systems

UNIT III	**7L+2T**

FREQUENCY-DOMAIN REPRESENTATION OF NON-PERIODIC SIGNALS

Fourier Transform of continuous time non-periodic signals;
Properties of Fourier Transform (statement, proof and application);
Relating the Fourier Transform to the Laplace Transform;
The Frequency response of an LTI system;

UNIT IV	**7L+2T**

FREQUENCY-DOMAIN REPRESENTATION PERIODIC SIGNALS

Fourier series of continuous time periodic signals;
Parseval's theorem for periodic signals (other properties not included)
The Fourier transform of periodic signals;

REPRESENTATION OF LTI SYSTEMS

Representation of a given LTI system using: Impulse response, Laplace Transform, Block Diagram, Differential Equation, Pole-Zero plot, Frequency Response

Classification of a given LTI system using: Impulse response, Laplace Transform, Block Diagram, Differential Equation, Pole-Zero plot, Frequency Response

UNIT V	**7L+2T**

EQUALIZERS:

Condition for Distortion-less transmission;
Definition of equalizer.

ANALOG FILTER DESIGN:

Ideal filters characteristics.
Design of Low-Pass Butterworth filters;
Frequency transformation for LP to HP, BP, BP, BE filters;
OP-AMP realization of Butterworth filters, introduction to chebyshev filter

Lab Experiments using Matlab/Multisim:

- To observe elementary deterministic signals (Unit-I)
- To observe random signal (Unit-I)
- To perform addition, multiplication of different signals (Unit –I)
- To test a given system for linearity (Unit-I)
- To verify the convolution result of a given LTI system (Unit-II)
- To observe and verify the step response of a given LTI system (Unit-II)
- To observe and verify the impulse response of a given LTI system (Unit-II)
- To obtain and verify the frequency response of a given LTI system (Unit-III)
- To obtain and observe the truncated Fourier series representation of periodic signals: one term, two term, three term (Unit-IV)
- To design an equalizer for a given system (Unit-V)
- To design and implement the analog Butterworth filter for given specifications, compare the designed filter with the desired filter (Unit-V)

Text Books:	
1.	'Signals & Systems', Simon Haykin and Barry Van Veen, John Wily and Sons
2.	'Signals and Systems', Schaum's Outline series
Reference Books:	
1.	'Signals & Systems', Allan V Oppenheim, Alan S Willsky, and A Hamid Nawab, Pearson Education Asia/ PHI
2.	'Linear systems and signals', B P Lathi, Oxford University Press
E Books	
1.	http://cnx.org/contents/a80b2905-e6aa-4f4e-8460-f2e13980c389@1/Laboratory-measurement-of-impu
2.	http://cnx.org/contents/72f90f3a-f72c-4459-b439-1d27bf9d14d2@1/Fourier-Series:--Square-wave
3.	"Introducing signals and systems concepts through analog signal processing first", IEEE Signal processing society: 14th DSP Workshop & 6th SPE Workshop, Enchantment Resort, Sedona, Arizona, 4th -7th January, 2011 DOI: 10.1109/DSP-SPE.2011.5739191 Publication Year: 2011 , Page(s): 84 – 89
4.	file:///C:/Users/B%20Kanmani/Downloads/introduction-to-digital-signal-and-system-analysis.pdf
MOOCs	
1.	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-0
2.	https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-0

Course Title	SIMULATION LABORATORY – II (TE only)				
Course Code	**15TE4DCSL2**	**Credits**	**1**	**L-T-P-S**	**0:0:1:0**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

CO1: Ability to **understand** basic programming concepts of the engineering tools Matlab	---
CO2: Ability to **develop Matlab code** to implement mathematical concepts like integration, differentiation, solution to linear equation, mean, roots of equation, statistical parameters	PO1 PO5
CO3: Ability to **obtain** the pole-zero plot, frequency response, of a given system, and to **obtain** the frequency domain representation of a given signal using Matlab	PO2 PO5
CO4: Ability to **test** and **classify** a given LTI system using the simulation tool Multisim	PO2 PO5
CO5: Ability to **obtain** the step response and impulse response of the given LTI system	PO2 PO5
CO6: Ability to **analyze** the given LTI system for specified parameters	PO4 PO5
CO7: Ability to **design, implement** and **validate** analog Butterworth filters to meet the specifications	PO3 PO4 PO5

Part A: Using Matlab

1. Introduction to Matlab
2. Integration and differentiation
3. To obtain system transfer function, pole zero plot and frequency response of a given LTI system
4. To obtain Fourier transform of a given signal/audio signal/speech signal
5. To obtain the Fourier series of a given periodic signal
6. To design Butterworth filter for the given specifications/analog to analog transformations

Part B: Using Multisim

1. To simulate Butterworth filters for the given specifications and analyze the bode plot using Multisim
2. To test the system for linearity using superposition

Part C: Using Hardware

1. To observe the random phase of TWO independent signal generators.
2. To observe the ADDITION of two signals
3. To observe the MULTIPLICATION of two signals
4. To test the given system for linearity
5. To obtain step and impulse response of a system

MANDATORY MATHEMATICS COURSES FOR LATERAL ENTRY STUDENTS

Course Title	**Mathematics-I** (All Branches)				
Course Code	**15MA3IMMAT**	**Credits**	**0**	**L-T-P-S**	**0:0:0:0**
CIE	100 marks (100% weightage)				

Pre-requisites
Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration

UNIT I	**[9 hours]**

DIFFERENTIAL AND INTEGRAL CALCULUS
List of standard derivatives including hyperbolic functions, rules of differentiation. Differentiation of product of two functions using Leibnitz rule (direct problems). Taylor's and Maclaurin's series expansion for functions of single variable. List of standard integrals, integration by parts. Definite integrals – problems.

(7L+2T)

UNIT II	**[10 hours]**

POLAR COORDINATES AND PARTIAL DERIVATIVES
Polar curves: Polar coordinates, angle between radius vector and tangent, angle between two polar curves. Partial differentiation. Total differentiation-Composite and Implicit functions. Taylor's and Maclaurin's series expansion for functions of two variables. Jacobians and their properties (without proof) – Problems. **(7L+3T)**

UNIT III	**[08 hours]**

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS
Introduction to first order differential equations. Linear equation and its solution. Bernoulli's equation and its solution. Exact differential equation and its solution. Orthogonal Trajectories. **(6L+2T)**

UNIT IV	**[9 hours]**

SECOND AND HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS

Ordinary differential equations with constant coefficients: Homogeneous differential equations, non-homogeneous differential equations – Particular integral for functions of the type f (x) = e^{ax}, sin(ax), cos(ax), x^n, e^{ax} sin(bx), e^{ax} cos(bx). Method of variation of parameters. Cauchy's and Legendre differential equations. **(7L+2T)**

UNIT V	**[8 hours]**

VECTOR CALCULUS AND ORTHOGONAL CURVILINEAR COORDINATES (OCC)
Recapitulation of scalars, vectors and operation on scalars and vectors. Scalar and vector

point functions. Del operator, gradient-directional derivative, divergence, curl and Laplacian operator. Vector identities (without proof). Cylindrical and Spherical polar coordinate systems. Expressing a vector point function in cylindrical and spherical systems. Expressions for gradient, divergence, curl and Laplacian in OCC. **(6L+2T)**	
Text Books:	
1.	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
2.	Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata Mc. Graw Hill.
Reference Books:	
1.	Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers
2.	Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.
E Books	
1.	Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
2.	Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3.	http://ocw.mit.edu/courses/mathematics/ (online course material)
MOOCs	
1.	https:// www.khanacademy.org/Math
2.	https:// www.class-central.com/subject/math (MOOCS)
3.	E-learning: www.vtu.ac.in
Course Outcomes **At the end of the course, the student will have the**	
CO-1: Understand the basic concepts of differentiation and integration.	
CO-2: Apply the concepts of polar curves and multivariate calculus.	
CO-3: Apply analytical techniques to compute solutions of first and higher order ordinary differential equations.	
CO-4: Apply techniques of vector calculus to engineering problems.	
CO-5: Comprehend the generalization of vector calculus in curvilinear coordinate system.	

Course Title	Mathematics-II (All Branches)				
Course Code	15MA4IMMAT	Credits	0	L-T-P-S	0:0:0:0
CIE	100 marks (100% weightage)				

Pre-requisites
Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration

UNIT I	[8 hours]

LAPLACE TRANSFORMS
Laplace transforms of standard functions. Properties and problems. Laplace Transform of Periodic functions with plotting. Unit step function. **(6L+2T)**

UNIT II	[9 hours]

INVERSE LAPLACE TRANSFORMS
Inverse Laplace transforms of standard functions. Properties and problems. Solution of ODE-Initial and Boundary value Problems. **(7L+2T)**

UNIT III	[11 hours]

DOUBLE INTEGRAL
Evaluation of double integral. Change of order of integration. Change of variables to polar coordinates. Application: Area. **(8L+3T)**

UNIT IV	[8 hours]

TRIPLE INTEGRALS AND IMPROPER INTEGRALS
Evaluation of triple integral. Application: Volume. Gamma and Beta functions-definition Relation between Gamma and Beta functions. Properties and Problems. **(6L+2T)**

UNIT V	[8 hours]

VECTOR INTEGRATION
Line integral. Green's theorem. Stokes' theorem. Gauss divergence theorem. **(6L+2T)**

Text Books:

1.	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
2.	Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd

Reference Books:

1.	Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers.
2.	Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata Mc. Graw Hill.

E Books

1.	(1) Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.

2.	Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3.	http://ocw.mit.edu/courses/mathematics/ (online course material)
MOOCs	
1.	https:// www.khanacademy.org/Math
2.	https:// www.class-central.com/subject/math (MOOCS)
3.	E-learning: www.vtu.ac.in
Course Outcomes At the end of the course, the student will have the	
CO-1: Use Laplace transforms to solve differential equations.	
CO-2: Apply double integrals to compute areas.	
CO-3: Learn to use triple integrals in computing volumes.	
CO-4: Use Gamma and Beta functions to evaluate integrals.	
CO-5: Ability to understand the use of integral calculus in scalar and vector fields.	

ANALOG COMMUNICATION
16TE5DCACM (L:T:P:S ::3:0:1:2)

Course Outcomes: At the end of the course, the student will be able to have the	
CO1: Ability to **define, understand and explain** concepts of convolution, correlation, random variables, time and frequency domain representation of analog communication systems	–
CO2: Ability to **apply** the knowledge of signal processing to **obtain** the time and frequency domain representation, Figure of Merit of analog communication systems	PO1
CO3: Ability to **analyze** the waveforms related to analog communication	PO2
CO4: Ability to **design** analog communication systems to meet given specification	PO3
CO5: Ability to **conduct experiments** to demonstrate concepts related to analog communication using suitable electronic components/ Engineering Tool (Matlab)	PO5 PO9
CO6: Ability to make an **effective oral presentation** on broadcast standards, contribution to society, impact on health, effect on environment	PO6 PO7 PO8 PO10 PO12
CO7: Ability to perform in a team to build **an AM/FM receiver** using discrete components **and** simulation tool (Matlab)	**PSO2** PO5 PO9 PO10 PO11 PO12

Prerequisites:

11MA**3**ICMAT	Engineering Mathematics –III
11MA**4**ICMAT	Engineering Mathematics –IV
11ES**3**GCASP	Analog Signal Processing

UNIT I	**[07 hours]**

SIGNAL REPRESENTATION: Convolution, Auto correlation, cross correlation, and their properties, Hilbert transform, band pass signals, in-phase and quadrature-phase components, canonical representation of band pass signals, natural, pre and complex envelop of band pass signals.

UNIT II	**[07 hours]**

RANDOM PROCESS: Random variables: Several random variables. Statistical averages: Function of Random variables, moments, Mean, Correlation and Covariance function: Central limit theorem, Properties of Gaussian process. Transmission of random signals through linear systems.

NOISE: Introduction, shot noise, thermal noise, white noise, Noise equivalent bandwidth, Noise Figure, Equivalent noise temperature.

UNIT III	**[7 hours]**

AMPLITUDE MODULATION:

Introduction, AM: Time-Domain description, Frequency – Domain description. Generation of AM wave: square law modulator, switching modulator. Detection of AM waves: square law detector, envelop detector. Receiver model, Figure of merit of AM.

Double side band suppressed carrier modulation (DSBSC): Time-Domain description, Frequency-Domain representation, Generation of DSBSC waves: balanced modulator, ring modulator. Coherent detection of DSBSC modulated waves, Figure of merit of DSB-SC

UNIT IV	**[7 hours]**

SINGLE SIDE-BAND MODULATION (SSB): Quadrature carrier multiplexing, Canonical representation of SSB, Single side-band modulation, Frequency-Domain description of SSB wave. Phase discrimination method for generating an SSB modulated wave. Demodulation of SSB waves, Figure of merit of SSB

VESTIGIAL SIDE-BAND MODULATION (VSB): Frequency – Domain description, Generation of VSB modulated wave, Time – Domain Canonical representation of VSB, Envelop detection of VSB wave plus carrier, Frequency translation, **FDM**: Frequency division multiplexing, Applications.

UNIT V	**[8 hours]**

ANGLE MODULATION (FM): Basic definitions, FM, narrow band FM, wide band FM, transmission bandwidth of FM waves, generation of FM waves: indirect FM and direct FM. Demodulation of FM waves, FM stereo multiplexing, Phase-locked loop Noise in FM receivers, FM threshold effect, Pre-emphasis and De-emphasis in FM. Figure of merit of FM

Design of a basic AM/FM receiver.

LAB Experiments
Part A: **Using discrete components**

- Analog filters;
- Generation and demodulation of AM, DSB-SC, (Unit-III)
- Generation FM, pre-emphasis and de-emphasis; (Unit-V)
- Generation of SSB (using Multisim); (Unit-IV)

Part B: Using Matlab

- Generation and demodulation of AM, DSB-SC (Unit – III)
- Generation and demodulation FM, PM; (Unit – V)
- QAM, SSB (Unit – IV)
- Correlation, Convolution, Hilbert Transform (Unit – I)
- Central Limit Theorem, Gaussian Process (Unit – II)

TEXT BOOKS:

1. **Communication Systems**, Simon Haykins, 3rd Edition, John Willey, 1996.
2. **An Introduction to Analog and Digital Communication**, Simon Haykins, John Wiley, 2003.

REFERENCE BOOKS:

1. **Modern digital and analog Communication systems** B. P. Lathi, 3rd ed 2005 Oxford University press.
2. **Communication Systems**, Harold P.E, Stern Samy and A Mahmond, Pearson Edn, 2004.
3. **Communication Systems**: Singh and Sapre**:** Analog and digital TMH 2nd , Ed 2007**.**

Reference:

1. DOI: 10.1109/ICECS.2008.4675044 , Publication Year: 2008 , Page(S): 1079 - 1082
2. DOI: 10.1109/DSP.2009.4786027, Publication Year: 2009 , Page(S): 780 - 785
3. DOI: 10.1109/DSP.2009.4786028 , Publication Year: 2009 , Page(S): 786 - 790
4. Volume 52, April 2009, ISSN 2070-3724, Page(S): 330-334
5. Volume 52, April 2009, ISSN 2070-3724, Page(S): 325-329
6. DOI: 10.1109/MITE.2013.6756376, Publication Year: 2013 , Page(S): 399 - 404
7. LABORAORTY GENERATION OF AM AND DSB-SC (M32038 At Cnx.Org)
8. THE 'PHASE-REVERSAL' IN DSB-SC (M32165 At Cnx.Org)
9. Transformer-Less Generation Of The DSB-SC (M32046 At Cnx.Org)
10. Transformer-Less Generation Of AM (M32040 At Cnx.Org)

DISCRETE TIME SIGNAL PROCESSING 16TE5DCDTS (L:T:P:S::3:0:1:2)	
Course Outcomes	
At the end of the course, the student will have the	
CO1: Ability to **define, understand and explain** concepts related to discrete time signals and systems	–
CO2: Ability to **apply** the knowledge of signal processing to **obtain** the time and frequency domain representation of linear discrete time signals and systems (LTI)	PO1
CO3: Ability to **analyze** the given LTI system for stability, and realizability	PO2
CO4: Ability to **design** discrete LTI systems to meet given specifications	PO3
CO5: Ability to **conduct experiments** to demonstrate concepts related to discrete LTI systems using the engineering tool: Matlab	PO5 PO9
CO6: Ability to **conduct experiments** to demonstrate concepts related to discrete LTI systems using the Digital Signal Processors	PO5 PO9
CO7: Ability design, formulate, implement and demonstrate an application of discrete time system concepts through an **Open-Ended experiment** for an audio/image/video/data signal	**PSO3** PO5 PO9 PO10 PO11 PO12
Prerequisites: Continuous Signal Processing	

UNIT I	**[7 hours]**
Introduction: Discrete Time Signal definition; signal classification; signal transformation: independent, dependent variable; elementary signals; transformation of elementary signals. Discrete Time System definition; system classification; the Linear Time Invariant (LTI) system; properties of the LTI system. **Time Domain Analysis of Discrete time systems:** Impulse response; the convolution sum; methods of evaluating the convolution sum; overlap-save and overlap-add method; Properties of impulse response	
UNIT II	**[7 hours]**
Discrete Fourier Transform: The Discrete Fourier Transform: periodic and non-periodic signals; Properties of DFT, multiplication of two DFTs- the circular convolution, additional DFT properties, Radix-2 **Fast Fourier Transform**: FFT algorithm for the computation of DFT and IDFT–Decimation-in-Time. **Z-Transforms**	

Properties of Z transform, Unilateral Z-Transform; Solution to difference equation; Obtaining the impulse response, step response of the given system, The pole-zero plot; Stability criteria

UNIT III	[8 hours]

IIR Filters:

Design of IIR filters from analog Butterworth filters using: impulse invariance method, Mapping of transfer functions: Approximation of derivative (backward difference and bilinear transformation) method, Matched z transforms. IIR filter realization.

UNIT IV	[07 hours]

FIR filters:

Introduction to FIR filters, Design using the window technique, FIR filter realization, Design using frequency sampling technique; Frequency sampling structure for FIR filters, Introduction to design of optimal FIR filters.

UNIT V	[7 hours]

Finite word length effects in digital filters:

Introduction, types of arithmetic in digital systems, fixed point arithmetic, floating point arithmetic, block floating point, types of quantization in digital filters, truncation, rounding, round off noise in recursive structures-fixed point, dynamic range constraints-fixed point case.

Introduction to wavelet transforms; approximation and detail coefficients of a given discrete time sequence.

Lab Experiments:

- Generation of discrete time signals (Unit-I)
- To obtain the impulse response of the given system (Unit-I)
- Linear Convolution, Circular Convolution (Unit-I)
- DFT, IDFT, DIT-FFT (Unit-II)
- Pole-zero plot, solution of difference equation (Unit-II)
- Spectral Analysis of a given signal (Unit-II)
- Design of IIR filters (Unit-III)
- Design of FIR filters (Unit-IV)
- Comparison of the performance of FIR filters for different window functions (Unit IV)
- Comparison of the performance of FIR and IIR filters (Unit III, IV)
- Filtering of real signals (audio, signals with noise) (Unit-III, IV)
- To obtain the wavelet transform of audio/image (Unit-V)
- Comparison of computation of an algorithm using Fixed-point and Floating point representation (Unit-V)
- Convolution, Impulse response, Filter design, spectral analysis using processor (TMS6713/ UTLP/ Arduino/ any other) (Unit-V)

TEXT BOOKS:

1. **Theory and application of Digital signal processing**, Lawrence R Rabiner and Bernard Gold, Prentice Hall, Easter Economy Edition

2 **Digital signal processing** – **Principles Algorithms & Applications**, Proakis & Monalakis, Pearson education, 4th Edition, New Delhi, 2007
REFERENCE BOOKS:
1. **Discrete Time Signal Processing**, Oppenheim & Schaffer, PHI, 2003. 2. **Digital Signal Processing**, S. K. Mitra, Tata Mc-Graw Hill, 3rd Edition, 2010. 3. **Digital Signal Processing**, Lee Tan: Elsevier publications, 2007 4. **Schaum's Outline of Digital Signal Processing ,Monson Hayes**

MOOCS	
1.	http://nptel.ac.in/courses/117102060/ (NPTEL DSP Course)
2.	http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/ (MIT Open courses)

COMPUTER COMMUNICATION NETWORKS-I

16TE5DCCN1 (L:T:P:S :: 3:0:0:0)

Course Outcomes

At the end of the course, the student will have the

CO1: Ability to **define, understand and explain** concepts related to Telecommunication Networks	–
CO2: Ability to **apply** the knowledge of engineering fundamentals to **obtain** the Traffic parameters (Grade of Service, Blocking probability, congestion) of the network	PO1
CO3: Ability to **analyze** the given network parameters	PO2
CO4: Ability to **design** a switching network to meet given specifications	PO3
CO5: Ability to **conduct experiments** to demonstrate concepts related to telecommunication networks using the engineering tool: Matlab	PO5 PO9
CO6: Ability to perform in **a team** to prepare a report and make an **effective oral presentation** of the study on topics related to Networks protocols, effect on environment, contribution to society	PO6 PO7 PO8 PO9 PO10 PO12
UNIT I	**[07 hours]**

EVOLUTION OF SWITCHING SYSTEMS: Introduction, Developments of telecommunications, Network structure, Network services, terminology, Regulation, Standards, Telecommunications transmission, power levels, four wire circuits. FDM, TDM, WDM concepts, overview of WDM operation principles, Circuit switching, Packet Switching, Functions of switching systems, Digital Switching Systems. OSI Model, Layers in OSI model, TCP/IP Suite, Addressing

UNIT II	[07 hours]

TELECOMMUNICATIONS TRAFFIC: Introduction, Unit of traffic, Congestion, Mathematical model, lost call systems, Queuing systems.

SWITCHING NETWORKS: Switching: circuit switched networks, Datagram networks, Virtual circuit networks, structure of a switch, Link Systems, GOS of Linked systems, SDS, TDS , Non blocking networks

UNIT III	07 hours

PHYSICAL LAYER: Basics of data communication, Transmission media, telephone network, Dial up modems, DSL, SONET/SDH, SONET/SDH rings

UNIT IV	08hours

DATA LINK CONTROL: Framing, Flow and error control, CRC, Protocols, Noiseless channels: Simplest protocol, Stop and wait protocol, Noisy channels: Stop and wait protocol ARQ, piggy backing, Go-Back-N ARQ, sliding window protocol, Selective repeat ARQ, HDLC, Point to point protocol.

UNIT V	07 hours

MEDIUM ACCESS SUB LAYER: Channel allocation problem, Multiple access protocols. IEEE standard for LANs ands MANs,

TEXT BOOKS:

1. Telecommunication and Switching, Traffic and Networks - J E Flood: Pearson Education, 2002.
2. Computer Networks - Andrew. S. Tannenbaum

REFERENCE BOOK:

1. Digital Telephony - John C Bellamy: Wiley India, 3rd Ed, 2000
2. Data communication and networking– Behrouz A. Forouzan, 4th Ed, TMH 2006.

E-BOOK:

1. Digital Switching System – K.Chandrashekar, first edition 2008, Technical Publications Pune.
2. Communication Networks by Anish Arkatkar, et al, wikibooks2012

Web Link: http://ieee802.org/
https://www.itu.int/en/Pages/default.aspx
http://www.youtube.com/watch?v=xGkp-AnWV (NPTEL Video lecture 3)

Linear Control Systems
(TE Only)
16TE5 DCLCS (L:T:P:S ::2:1:0:0)

Course Outcomes
At the end of the course, the student will have the

CO1: Ability to **define, understand and explain** concepts related to linear control systems	–
CO2: Ability to **apply** the knowledge of signal processing to obtain the Bode plot, Nyquist plot, Polar plot, Root locus, state-space representation of the given system	PO1
CO3: Ability to **analyze** the given linear control system for realizability and stability	PO2
CO4: Ability to **design** controllers to meet desired specifications using time and frequency domain representation	PO3
CO5: Ability to **conduct experiments** to demonstrate concepts related to linear control systems using the engineering tool: Matlab/ LabVIEW	PO4 PO5

UNIT I	**5L+3T**
Control System Components: Feedback principle; Transfer function; Block diagram representation; Signal flow graph for electrical systems. Mathematical modeling of physical system: translational , rotational systems, electrical circuits and analogous circuits	

UNIT II	**5L+2T**
Time response design and analysis: Transient and steady-state analysis of LTI systems; step response of first order, second order systems, response specifications, steady state error and error constants. Design specifications of a second order system	

UNIT III	**5L+3T**
Frequency response design and analysis: Bode plot, Polar plot, Nyquist plot, Series, parallel, series- parallel compensators-Lead, Lag, and Lead Lag Compensator, Controllers	

UNIT IV	**5L+3T**
Stability Analysis: Stability, RH criteria, root-locus plots, Nyquist Stability Criterion- Relative stability,	

UNIT V	**4L+1T**
State variable Analysis: State variable model and solution of state equation of LTI systems	

List of experiments:

- Determine the overall transfer function of the a control system
- Determine rise time, peak time, peak overshoot and settling time for the given transfer function.
- To obtain and plot the Unit step, Unit ramp response of a closed loop control system.
- To obtain Nyquist diagram for given transfer function.
- Determine the root locus of the given characteristic equation for the given control system.
- Determine gain margin, phase margin, gain crossover frequency and phase crossover frequency for the given control system.

- Design and analysis of lead-lad compensators using time domain specifications
- Design and analysis of lead-lad compensators using frequency domain specifications

TextBook:

- Control Engineering by Nagrath & Gopal, New Age International Publishers
- Automatic Control systems- B C Kuo, John Wiley and sons

Reference Books:

- Modern Control Engineering- Ogata, Prentice Hall
- Schaum's OutlineSeries,"Feedback and control system" Tata Mc Graw- Hill, 2007
- Richard C Dorf and Robert H Bishop. " Modern Control systmes" Addison-Wesley, 1999.

MOOCs and e-content:

- https://www.mooc-list.com/tags/control-system?static=true
- https://www.class-central.com/mooc/2078/upv-x-dynamics-and-control
- http://nptel.ac.in/courses/108102043/
- https://www.youtube.com/watch?v=PT8D_ITgqzw

Fundamentals of VLSI
16TE5DCVLI (L:T:P:S :: 3:0:0:0)

Course Outcomes

At the end of the course, the student will have the

CO1: Ability to **define, understand** and **explain** concepts of nMOS and CMOS technology.	--
CO2: Ability to **apply** the knowledge of VLSI to fabricate the MOS circuits, **illustrate** different CMOS logic structures, subsystems and memory elements, **calculate** rise time and fall time estimations.	PO1
CO3: Ability to **analyze** the monochrome layout and stick diagrams of MOS technology and CMOS logic structures and subsystems, **deduce** appropriate testability vectors for the given parameters.	PO2
CO4: Ability to **conduct experiments** using VLSI tools for a given application/problem statement.	PO5 PO9
CO5: Ability to **listen** and **comprehend** audio/video lectures related to VLSI concepts	PO10 PO12
UNIT I	**[7 hours]**

Basic MOS technology: Enhancement and depletion mode MOS transistors. nMOS fabrication, pMOS fabrication, CMOS fabrication, BiCMOS fabrication, Thermal aspects of processing.

Circuit design processes: MOS layers. Stick diagrams: CMOS design style. Basic physical design of simple logic gates

UNIT II	[7 hours]

CMOS logic structures : Complementary Logic, Pseudo-nMOS Logic, Dynamic CMOS Logic, Clocked CMOS Logic, Pass Transistor Logic, CMOS Domino Logic, Cascaded Voltage Switch Logic (CVSL), BiCMOS Logic, The Transmission Gate, Tri-state Inverter

UNIT III	[7 hours]

Basic circuit concepts: Sheet resistance, Area capacitance, Rise time and fall time calculations.

CMOS subsystem design: Architectural issues. Switch logic. Gate logic. Design examples: Multiplexer and its applications.

UNIT IV	[8 hours]

CMOS subsystem design processes: General considerations. Process illustration: 4-bit Arithmetic Processor, Design of 4-bit Shifter.

Adders: Manchester Carry chain, Carry Select Adders, Carry Skip adders, Carry Look-ahead adder.

Multipliers: Serial-Parallel multiplier, Braun Array multiplier, Baugh – Wooley multiplier, Modified Booth's multiplier, Wallace tree multiplier.

UNIT V	[7 hours]

Memory, registers, and clock: Timing considerations. Memory elements. Memory cell arrays.
Testability: Performance parameters, Ground rules for design, Test and testability.

Lab Experiments

1. Stick diagrams of digital circuits(Unit I)
2. Complementary Logic structures (Unit II)
3. Pseudo-nMOS Logic (Unit II)
4. Dynamic CMOS Logic (Unit II)
5. Clocked CMOS Logic (Unit II)
6. CMOS Domino Logic (Unit II)
7. Tri-state Inverter (Unit II)
8. Sub system design of digital circuits (Unit III and Unit IV)
9. Sub system design of ALU (Unit III and Unit IV)
10. Test benches (Unit V)

TEXT BOOKS:

1. **Douglas A. Pucknell & Kamran Eshraghian**, "Basic VLSI Design" PHI 3rd Edition (original Edition – 1994), 2005.
2. **John P. Uyemura**, "Introduction to VLSI Circuits and Systems", Wiley Publications, 2002.

REFERENCE BOOKS:

1. **Neil H. E. Weste and K. Eshragian**," Principles of CMOS VLSI Design: A Systems Perspective," 2nd edition, Pearson Education (Asia) Pvt. Ltd., 2000.
2. **John P. Uyemura**, "CMOS Logic Circuit Design", Wiley Publications.

Course Title	SIMULATION LABORATORY – III (TE only)				
Course Code	**16TE5DCSL3**	**Credits**	**1**	**L-T-P-S**	**0:0:1:0**
CIE	100 marks (50% weightage)	**SEE**	100 marks (50% weightage)		

CO1: Ability to **understand** basic programming concepts of the engineering tool Simulink, Mentor Graphics	---
CO2: Ability to **develop Simulink code** to implement basic mathematical concepts, signal processing concepts	PO1 PO5
CO3: Ability to **obtain** the pole-zero plot, frequency response, transient response of a given system and hence classify the system	PO2 PO5
CO4: Ability to **design, implement** and **validate** the VLSI circuits using Mentor Graphics / Multisim Tool	PO3 PO4 PO5
CO5: Ability to **analyze** the given LTI system for specified parameters	PO4 PO5
CO6: Ability to perform in a team to develop a tool-box using Matlab for a course (Mathematics/ control systems/ signal processing/ analog communication)	**PSO3** PO5 PO9 PO10 PO11 PO12
CO8: Ability to perform in a team to develop the Analog Communication Link using Simulink	**PSO3** PO5 PO9 PO10 PO11 PO12

Control System Experiments (Matlab/Simulink)

- Determine the overall transfer function of the a control system
- Determine rise time, peak time, peak overshoot and settling time for the given transfer function.
- To obtain and plot the Unit step, Unit ramp response of a closed loop control system.
- To obtain Nyquist diagram for given transfer function.
- Determine the root locus of the given characteristic equation for the given control system.
- Determine gain margin, phase margin, gain crossover frequency and phase crossover frequency for the given control system.

- Design and analysis of lead-lad compensators using time domain specifications
- Design and analysis of lead-lad compensators using frequency domain specifications

VLSI Experiments

- Stick diagrams of digital circuits
- Complementary Logic structures
- Pseudo-nMOS Logic
- Dynamic CMOS Logic
- Clocked CMOS Logic
- CMOS Domino Logic
- Tri-state Inverter
- Sub system design of digital circuits
- Sub system design of ALU
- Test benches

Development of a Tool Box using Matlab

Implement Analog Communication Link using Simulink
Experiments on operating systems/ Digital System Design /DSP Architecture

DIGITAL COMMUNICATION
16TE6DCDCM (L:T:P:S :: 3:0:1:2)

CO1: Ability to **define, understand and explain** concepts related to digital communication	–
CO2: Ability to **apply** the knowledge of mathematics and signal processing to various blocks of the digital communication system	PO1-3
CO3: Ability to **analyze** the given block/waveform of the digital communication system	PO2-1
CO4: Ability to **conduct experiments** to demonstrate concepts related to digital communication using discrete electronic components	PO5-3 PO9-3
CO5: Ability to **conduct experiments** to demonstrate concepts related to digital communication using the engineering tool: LabVIEW	PO4-1 PO5-1 PO9-1
CO6: Ability to perform in a team to build **the complete digital communication system** for transmitting audio/data/image and obtain the performance parameters (using discrete components or an engineering tool)	**PSO2-2** PO3-2 PO4-2 PO5-2 PO9-2 PO10-2 PO11-2 PO12-2

UNIT I	**[07 hours]**
Block Diagram of Digital Communication System Pulse Analog Modulation: Sampling theorem, sampling of band-pass signals, Practical aspects of sampling, Reconstruction of message from its samples, PAM, PWM, PPM, TDM, PAM-TDM, TDM and FDM comparison	
UNIT II	**[07 hours]**
Pulse-Digital Modulation: Elements of PCM, Noise in PCM systems, Quantization, Companding, A-law and u-law of companding, Differential PCM, Delta modulation, Adaptive delta modulation, Typical multiplexed systems: T1 and E1 digital Hierarchy.	
UNIT III	**[07 hours]**
Base-band Data transmission: Elements of binary PAM, Baseband shaping, Optimum transmitting and receiving filters, Correlative coding, Baseband M-ary PAM, Adaptive equalization, Eye pattern, Examples: Line coding	

UNIT IV	[08 hours]
Gram-Schmidt orthogonalization procedure, Matched filters, Properties of matched filters. Band-pass data transmission: Time and frequency domain representation of ASK, FSK, PSK, QPSK; generation and detection; Performance analysis: power and bandwidth, bit error rate	

UNIT V	[07 hours]
Need for Spread Spectrum Modulation. PN sequence and its properties, Direct sequence SS system- DS/BPSK Transmitter & Receiver, Frequency hopping, Processing gain, Jamming margin, Introduction to OFDM, MSK, GMSK, MQAM	

Part A: Using suitable components

- Sampling Theorem verification (Unit-I)
- Generation of PAM, PWM, PPM, PAM-TDM (Unit-I)
- Generation of Line-Codes (Unit-III)
- Generation of ASK, PSK, FSK (Unit-IV)
- Demodulation of ASK, FSK, PSK (Unit-IV)

Part B: Using LabVIEW

- Sampling Theorem verification (Unit-I)
- Generation of DM, ADM (Unit-II)
- Generation of Line-Codes (Unit-III)
- Obtaining the eye-pattern (Unit-III)
- Generation ASK, PSK, FSK, QPSK, (Unit-IV)
- Obtain the BER, Bandwidth, Signal Constellation diagram for the modulation scheme (Unit-IV)
- PRBS sequence generation (Unit-V)
- Properties of Matched Filters (Unit-IV)
- Generation and demodulation of OFDM symbol (Unit-V)
- Generation and demodulation of SS, DS-BPSK symbol (Unit-V)

TEXT BOOK:

Digtal Communications By Simon Haykins –John Wiley 2003

REFERENCE BOOKS:

1. Digital and Analog Communication by K Sam Shanmugham, John Wiley
2. Analog and Digital communications by Simon Haykins –John Wiley

Computer Communication Networks – II

16TE6DCCN2 (L:T:P:S ::3:0:1:2)

CO1: Ability to **define, understand and explain** concepts related to network, transport and application layer	–
CO2: Ability to **apply** the knowledge of communication and coding to telecommunication networks	PO1-2
CO3: Ability to **analyze** the given network systems parameters	PO2-2
CO4: Ability to **conduct experiments** to demonstrate networking concepts using the engineering tool: Qualnet / Matlab	PO5-3 PO9-3
CO5: Ability to perform in **a team** to prepare a report and make an **effective oral presentation** of the study on application of communication protocols to Railways/ Landing Systems/ Power Systems/ Automotives/ Positioning Systems / any other	PO6-1 PO7-1 PO8-2 PO9-3 PO10-2 PO12-2

Unit 1 **07H**

Network layer: Logical Addressing, IPV4 addresses, Address space, Notations, Classful Addressing, Classless Addressing, Network Address Translations(NAT).IPv6 Addresses, Structure ,Address space. IPV4, Datagram Fragmentation, Checksum, Options .Ipv6, Advantages, Packet Format, Extension Headers. Transition from Ipv4 to Ipv6Delivery Forwarding, Unicast Routing Protocols, Optimization, Intra and Inter domain Routing, Distance Vector Routing, Link State Routing, Path Vector Routing Multicast Routing Protocols, Unicast, Multicast and Broadcast (without applications)

Unit 2 **08H**

Label Switching, Flows, and MPLS

Switching Technology , Flows And Flow Setup, Large Networks, Label Swapping, And Paths Using Switching With IP , IP Switching Technologies And MPLS, Labels And Label Assignment Hierarchical Use Of MPLS And A Label Stack , MPLS Encapsulation , Label Semantics , Label Switching Router, Control Processing And Label Distribution , MPLS And Fragmentation , Mesh Topology And Traffic Engineering

Unit 3 **07H**

Transport layer: Process to process delivery, Client/Server Paradigm, Multiplexing and Demultiplexing , Connection Versus Connection – Oriented service, Reliable Versus Unreliable, Three Protocols. User Datagram Protocol(UDP), Well known ports for UDP, User Datagram, Checksum, UDP operation, Use of UDP.TCP, services, features, segment, A TCP connection, SCTP, SCTP services, features, Packet Format, An SCTP Association, Congestion control & QOS: Data traffic, Congestion, Congestion control

Unit 4 **07H**

Application layer: Name space, DNS, Email, FTP

Network Security: IP Security, Two modes, Two security protocols, security association, Internet key exchange SSL/TLS, Firewalls, packet filter firewall, proxy firewall

Unit 5 **07H**

Cryptography: Symmetric –Key Cryptography , Traditional Ciphers, simple modern ciphers, Modern round ciphers, mode of operation . Asymmetric –key cryptography, RSA, Diffie-Hellman.

Lab experiments:

Part A: Hardware

- Study of different types of network cables and practically implement the cross over cable and straight through cable
- Study of network devices such as Switches, Router, Modem (Unit-II)
- Study of network IP (Unit-II)
- Study and setting up Local Area Network (LAN) (Unit-III)

Part B: Qualnet

- Configure network with the following topologies and analyze i) BUS ii) RING iii) Fully connected mesh topology, disable a node in each of the topologies and find the changes. (Unit-I)
- Simulate Ethernet LAN with 4 nodes , apply relevant TCP and UDP applications and determine
    - the number of data packets sent by UDP and TCP
    - Average jitter of UDP and TCP
    - Number of periodic updates sent by the routing algorithm
    - number of ACK packets sent (Unit-III)

- Simulate a network of N nodes with point to point connection; apply TCP and UDP applications vary the queue size and bandwidth and find (Unit-III)
    - Number of packets dropped due to queue overflow
    - Average hop count for data packets
    - Average delay and jitter.
    - apply FTP and TELNET traffic between the nodes of the above network and analyze the throughput.
- Simulate Ethernet LAN with N nodes , configure multicast traffic and Determine (Unit-I)
    - the total multicast data bytes received
    - Total multicast data bytes transmitted
    - Multicast average delay at the transport layer for UDP
    - Packets sent by DVMRP
    - Neighbors for every node as determined by DVMRP
    - packets dropped due to expired TTL
    - Packets dropped due to no route.
- Apply multiple UDP and TCP applications between any 2 nodes of N (N=4)node Ethernet LAN and compare it with experiment number 4.(compare multiple unicast with multicast) (Unit-III)
- Simulate a wireless ad hoc network apply relevant TCP and UDP applications between any 2 nodes and determine
    - Number of packets dropped due to retransmission limit
    - Number of CTS packets sent by the node
    - Number of RTS packets sent and ACK packets sent by the node
    - Determine the number of RTS retransmission due to timeout
    - Packet retransmission due to ACK time out
    - Signals received with error
- Simulate a network having 2 LANs connected by a switch. Apply relevant TCP and UDP applications between nodes across the LANS (send data from a node in one LAN to a node in another LAN) and determine application layer, transport layer, network layer and MAC layer parameters. (Unit-III)
- Simulate a network with the topology as shown in the figure, apply TCP and UDP applications between nodes shown in the figure. Modify the network to make communication happen between node 1 and 9 and node 6 and 16 (Unit-III)
- DNS, FTP (Unit-IV)
- Encryption and Decryption of a message (Unit-V)

TEXT BOOKS:

1. Data Communication and Networking, Behrouz Forouzan, 4th Edition, Tata Mcgraw Hill

2. Internetworking with TCP/IP Principles, Protocols, and Architecture, Douglas E Comer, 6th Edition, PHI

REFERENCE BOOKS:

1. Computer Networks, Andrew S Tanenbaum, 3rd Edition, PHI
2. Cryptography and Network Security- Principles and Practice: William Stallings, Third Edition

TRANSMISSION LINES & ANTENNAS

16TE6DCTLA (L:T:P:S ::2:1:0:0)

Course Outcomes

At the end of the course, the student will have the

CO1: Ability to define, understand, and explain concepts of transmission lines involving primary and secondary constants ,Time varying fields to obtain the radiation pattern and related parameters of different antennas	-
CO2: Ability **to apply** various properties/laws/theorems/ to **solve/derive** transmission line problems and **obtain** parameters of different antennas.	PO1-2
CO3: Ability to **analyze** the given specifications of different types of transmission lines and antennas in various configurations/ distributions.	PO2-2
CO4: Ability to **design** solutions to meet the given specifications of transmission lines and antennas.	PO3-1
CO5: Ability to **conduct experiments** to design and analyze concepts related to transmission lines and antennas using HFSS	PO4-2 PO5-3
CO6: Ability to perform in **a team** to prepare a report and make an **effective oral presentation** of the study on topics related to antenna applications/ radiation hazards/ transmission lines/ broadcast standards/ EMC-EMI/ any other	PO6-1 PO7-1 PO8-1 PO9-3 PO10-3 PO12-3

Prerequisites:

09MA**2**ICMAT	Engineering Mathematics
11ES**4**GCFTH	Field and Waves

UNIT I	[06 hours+4T]
TRANSMISSION – LINE THEORY: The transmission Line-general solution, The distortion less Line, Reflection on a Line not terminated in Z_0, Open and short circuited Lines, Losses, Standing waves. **THE LINE AT RADIO FREQUENCIES:** Input impedance of open and short circuited Lines, The quarter wave Line; Smith chart: single stub impedance matching on a Line, Double stub impedance, Open and Short circuit impedances when considering dissipation.	
UNIT II	**[06 hours+2T]**
ANTENNA BASICS: Introduction, Basic Antenna parameters, Friss transmission formula and antenna field zones. **POINT SOURCES AND ARRAYS:** point sources, Two element array, N-element array: Uniform amplitude and spacing, broadside array; ordinary end fire array; phased array, planar arrays, principles of pattern multiplication.	
UNIT III	**[04 hours+2T]**
WIRE ANTENNAS: Short electric dipole, fields of short electric dipole, radiation resistance of short dipole, loop antennas-small loop, general case, comparison of far fields of small loop and short dipole, radiation resistance and directivity of Loop antennas, ground effects, Yagi-Uda modifications.	
UNIT IV	**[04 Hours+2T]**
APERTURE ANTENNAS: E-plane sectoral Horn: aperture fields; radiated fields, directivity, H-plane sectoral Horn: aperture fields, radiated fields, directivity, plane reflector, Parabolic reflector: front-fed parabolic reflector; cassegrain reflectors,	
UNIT V	**[04 Hours+2T]**
MICROSTRIP AND SMART ANTENNAS: Introduction, Basic characteristics; Feeding Methods; Methods of analysis; Rectangular patch: Transmission line model; cavity model; directivity; Circular patch: electric and magnetic fields-TMZmnp; Resonant frequencies; design; equivalent current densities and fields radiated; conductance and directivity; resonant input resistance; Quality factor, bandwidth and efficiency, input impedance, arrays and feed networks.	

Lab Experiments:

- To measure the impedance of the given transmission line (Unit-I)
- To design and plot radiation pattern for various antennas using hardware / Matlab (Unit-II)
- To design and measure antenna parameters for dipole antenna using HFSS (Unit-III)
- To design and measure antenna parameters for horn antenna using HFSS (Unit-IV)
- To design and measure antenna parameters for patch antenna using HFSS (Unit-V)
- To obtain the radiation pattern for antenna arrays using Matlab (Unit-II, V)

TEXT BOOKS:

1. Network Lines and Fields - John D Ryder, 2e, PHI, 2003.

2. Antenna Theory Analysis and Design - C A Balanis, 2nd ED, John Wiley, 1997.

REFERENCE BOOKS:

1. Antennas, John D. Krauss, III (SEI) edition, McGraw-Hill International edition,2006.

2. Antennas Theory and Design – Warren.L.Stutzman,Garry.A.Thiele, 2nd edition,Wiley,

E-Books

1. Antennas: Theory and Practise – S.A Schelkunoff, J. Wiley 1952
2. Advancement in Microstrip Antennas with Recent Applications – Ahmed Kishk, InTech 2013, ISBN-13:9789535110194

INFORMATION THEORY & CODING

16TE6DCITC (L:T:P:S :: 2:1:0:0)

CO1: Ability to **define, understand and explain** concepts related to information theory and coding	–
CO2: Ability to **apply** the knowledge of probability and source encoding algorithms to **obtain** the information of analog and discrete message sources	PO1-3
CO3: Ability to **analyze** Convolution codec	PO2-2
CO4: Ability to **design** the Block and Convolution codes for a given channel	PO3-3
CO5: Ability to **conduct experiments** to demonstrate concepts related to information theory and coding using the engineering tool: LabVIEW/ Matlab	PO5-3 PO9-3
CO6: Ability design, formulate, implement and demonstrate an application of coding theory through an **Open-Ended experiment** for transmission of audio/data signal using LabVIEW/ Matlab/ VHDL/ any other	PO5-3 PO9-3 PO10-2 PO11-2 PO12-2

Prerequisites: 11ES**3**GCDEC Digital Electronics 11MA**4**ICMAT Engineering Mathematics –IV	
UNIT I	**5L+3T**
INFORMATION THEORY: Introduction, Measure of information, (Entropy) Average information content of symbols in long independent sequences, Joint Entropy and conditional entropy, Mutual information, Relationship between entropy and mutual information, Mark-off statistical model for information source, Entropy and information rate of mark-off source. Problems.	
UNIT II	**4L+2T**
SOURCE CODING: Encoding of the source output, Kraft inequality, Noiseless coding Theorem, Shannon's encoding algorithm, Shannon's Fano encoding algorithm. Huffman coding, problems.	
UNIT III	**5L+2T**
COMMUNICATION CHANNELS: Discrete communication channels: Representation of channels, Channel Capacity, Shannon's Theorem on channel capacity, Channel efficiency, Binary channel, Binary symmetric channel, Binary Erasure channel, Cascaded channel, Problem **Continuous channels**: Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity Theorem and its implications	
UNIT IV	**5L+3T**
ERROR CONTROL CODING: Irreducible polynomials in Galois Field**,** Introduction, Types of errors, Types of codes : Linear Block Codes: Matrix description, Encoding and Syndrome calculating circuit, Hamming Weights and Minimum distance, Error detection and correction, CRC Codes, Error Correcting Hamming Codes, Standard arrays and look up table for decoding, Decoding Circuit for Linear Block Code. Binary Cyclic Codes: Algebraic structures of cyclic codes, Encoding using an (n-k) bit register, Syndrome calculation- Error Detection and Correction, Expurgated Hamming Code. .	
UNIT V	**5L+2T**
CONVOLUTION CODES: Encoder for Convolution Codes: Using Time domain approach, Using Transform domain approach, State Diagram and code trees, Trellis Diagram and Viterbi Decoding, RS codes, Golay codes, shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes. Introduction to Turbo Codes	

Lab Experiments using LabVIEW/Matlab:

- Polynomial Multiplication/Division
- Testing for Irreducibility of a given polynomial
- Generation and detection of CRC Codes
- Generation and detection of Block Hamming Codes
- Generation of Convolution Codes

TEXT BOOK:

1. Digital and analog communication systems – K. Sam Shanmugam, John Wiley, 1996.
2. Digital communication – Simon Haykin, John Wiley, 2003

REFERENCE BOOKS:

1. Concepts of Information Theory and Coding – Dr.P.S.Satyanarayana, Dynaram, 2005.
2. Elements of information theory – Thomas M. Cover, John Wiley, 2006

E-NOTES:

1. http://www.rejinpaul.com/2013/06/anna-university-IT2302-Information-Theory-and-Coding-ITC-Notes.html

Web Link:

1. http://nptel.ac.in/courses/117101053/1

2. https://www.youtube.com/watch?v=nvmo9voRiSs

<table>
<tr><td colspan="2">Course Title</td><td colspan="5">SIMULATION LABORATORY – IV
(TE only)</td></tr>
<tr><td colspan="2">Course Code</td><td>16TE6DCSL4</td><td>Credits</td><td>1</td><td>L-T-P-S</td><td>0:0:1:0</td></tr>
<tr><td>CIE</td><td colspan="2">100 marks (50% weightage)</td><td>SEE</td><td colspan="3">100 marks (50% weightage)</td></tr>
<tr><td colspan="6">CO1: Ability to understand basic programming concepts of the High Frequency Structure Simulation (HFSS) Tool and LabVIEW</td><td>---</td></tr>
<tr><td colspan="6">CO2: Ability to develop HFSS program to implement basic antennas structures</td><td>PO1-3
PO5-3</td></tr>
<tr><td colspan="6">CO3: Ability to obtain the radiation pattern, antenna gain, S-parameters, return loss of the antenna, antenna array</td><td>PO2-3
PO5-3</td></tr>
<tr><td colspan="6">CO4: Ability to design, implement and validate the antenna structures using HFSS</td><td>PO3-3
PO4-3
PO5-3</td></tr>
<tr><td colspan="6">CO5: Ability to design, implement and demonstrate the Block/Convolution codes using Matlab/Multisim/LabVIEW</td><td>PO3-3
PO4-1
PO5-3</td></tr>
<tr><td colspan="6">CO6: Ability to formulate, implement and demonstrate an application of coding theory through an open-ended experiment</td><td>PO5-3
PO9-3
PO10-2
PO12-2</td></tr>
<tr><td colspan="7">Introduction to LabVIEW:

• Block diagram and Front Panel, Control Panel,
• Function palettes, Basic Operations of control and indicators,
• Loop functions: While loop, For loop;
• Case structures, Enum constant, Select functions, Strings.
• Basic function generator, Spectrum Analyzer,

Transmission Lines and Antenna Experiments

• To design and plot radiation pattern for various antennas using hardware / Matlab
• To design and measure antenna parameters for dipole antenna using HFSS
• To design and measure antenna parameters for horn antenna using HFSS
• To design and measure antenna parameters for patch antenna using HFSS
• To obtain the radiation pattern for antenna arrays using Matlab</td></tr>
</table>

Information Theory and Coding Experiments

- Polynomial Multiplication/Division
- Testing for Irreducibility of a given polynomial
- Generation and detection of CRC Codes
- Generation and detection of Block Hamming Codes
- Generation of Convolution Codes

Linear Algebra Experiments

MICROWAVE AND RADAR 16TE7DCMWR (L:T:P:S :: 3:0:0:0)	
Course Outcomes	
CO1: Ability to **define, understand and explain** concepts related to microwave and RADAR	-
CO2: Ability to **apply** the knowledge of electromagnetic theory for propagation/transmission of microwaves	PO1
CO3: Ability to **analyze** the behavior of microwave active devices and passive devices using S parameters	PO2
CO4: Ability to **conduct experiments** to measure the losses, power, VSWR, coupling factor, isolation, directivity, S-parameters (using microwave bench/simulation tool)	PO5 PO9 PSO2
CO5: Ability to engage in independent learning, submit a report and use ICT for **effective presentation** on the study on topics related to microwave link / standards / radiation hazards / specifications / applications / impact on society/environment	PO7 PO8 PO9 PO10 PO12

Prerequisites: Field Theory, Transmission lines and Antennas

UNIT I **[7 hours]**

EM Wave Propagation and Microwave Transmission Lines : Introduction, Wave Propagation, EM Wave equation, Equivalent circuit parameters of propagation line, Boundary conditions, Polarisation of waves, Plane waves in different media, Propagation of microwaves in Ferrite, Faraday rotation, Transmission line equations, Characteristic and Input Impedances, Reflection and Transmission co-efficients, Standing wave, Smith Chart, Ideal co-axial line, Planar Transmission lines, Rectangular waveguides, Circular waveguides, Power handling capability of Microwave transmission lines

UNIT II **[8 hours]**

Microwave Network Theory and Microwave Passive Devices : Scattering parameters, Symmetrical Z and Y parameters for reciprocal Networks, S matrix representation of multi-port networks, Properties of S matrix

Microwave Passive devices: Waveguide terminations, Construction, Operation and Parameters of Tee junctions, Directional coupler, Isolator, Phase shifter, Attenuators, Microstrip resonators, Microwave filters

UNIT III **[7 hours]**

Microwave Solid-state Devices and Circuits: Reflex Klystron, Magnetron Oscillator, Transferred electron devices(TED)-Gunn diode, Avalanche transit time devices(ATTD), Varactor diode, Parametric Amplifier, Analogy between Parametric Amplifier and Super heterodyne Mixer , Microwave Transistor and Circuits

UNIT IV **[7 hours]**

Radar : Basic Radar, The simple form of the Radar equation, Radar block diagram, Radar frequencies, application of Radar, Introduction to Doppler and MTI Radar, delay line Cancellers, digital MTI processing, Moving target detector, Pulse Doppler Radar, FMCW RADAR, Search acquisition and Tracking RADAR, Methods of acquiring track data by tracking RADARS.

UNIT V **[7 hours]**

Microwave Measurements , Applications and Hazards: Measurement of microwave power, frequency, losses, VSWR and Impedance using waveguides /microstrip lines, Measuring instruments-VSWR meter, Spectrum Analyser, Network Analyser, Power meter, Microwave communication, Other applications, Microwave communication, Industrial and Medical Applications, Hazards of EM radiation, Radiation hazard levels for personnel, limits and protection

TEXT BOOKS

1. Microwave Engineering, Annapurna Das, Sisir.K.Das, Second Edition, McGraw Hill
2. Introduction to RADAR Systems: Merril I.Skolnik, second edition, McGrawHill

REFERENCE BOOKS

1. Microwave Devices and Circuits, Samuel Y.Liao, Third Edition, PHI.
2. Concepts and Applications of Microwave Engineering, Sanjay Kumar, Saurabh Shukla, PHI Learning Pvt. Ltd, Delhi.

MOOCs

1. http://accessengineeringlibrary.com/browse/microwave-transmission-networks-planning-design-and-deployment-second-edition
2. http://accessengineeringlibrary.com/browse/radar-handbook-third-edition

MULTIMEDIA COMMUNICATION 16TE7DCMMC (3:0:1:0)	
Course Outcomes	
CO1: Ability to **understand** and **explain** concepts of multimedia communication.	--
CO2: Ability to **apply** knowledge of analog and digital communication to multimedia data.	PO1
CO3: Ability to **analyze** various communication networks, **derive** text encoding, **evaluate** different image compression schemes and **analyze** audio/speech/video frames.	PO2
CO4: Ability to function effectively as an individual and as a team member to **conduct experiments** using MATLAB for a given multimedia application/problem statement.	PO5 PO9
CO5: Ability to work as an individual/ in a team to **identify, test, analyze** and **demonstrate** Multimedia protocols as a mini-project using modern engineering tools.	PO5 PO9 PO10 PO12 PSO3

Prerequisites: Digital Communication, Discrete time signal processing

UNIT I **[8 hours]**

Fundamentals of Multimedia Communication: Introduction, multimedia information representation, multimedia networks: telephone networks, data networks, broadcast television networks, ISDNs, broadband multiservice networks, multimedia applications: interpersonal communications, interactive applications over internet, entertainment applications.

Multimedia Information Representation: Media types, communication modes, network types, multipoint conferencing: centralized, decentralized and hybrid modes, basic digital principles for multimedia

UNIT II **[7 hours]**

Text Representation and Compression: Text representation, unformatted text, formatted text, Hypertext, Introduction to compression techniques in multimedia, Text compression principles, Entropy encoding, Source encoding, Static Huffman coding, Arithmetic coding, Basics of LZW coding.

UNIT III **[7 hours]**

Image Representation and Compression: Image representation, Graphics, Digitized documents, Digitized Pictures, Raster scan principles, three color image capture methods,

Image compression principles, Image compression techniques: Graphics Interchange Format, JPEG: Image Preparation, Block Preparation, DCT, Quantization, Entropy encoding, Frame builder, Basics of JPEG decoder, Introduction to TIFF and JPEG 2000

UNIT IV **[7 hours]**

Audio Processing and Compression: PCM Speech, CD quality audio, Synthesized audio, MIDI, MIDI versus Digital Audio, Adding sound to multimedia projects, Music CDs, Adaptive predictive coding, Linear predictive coding, Dolby Audio coders.

UNIT V **[7 hours]**

Video Processing and Animation: Introduction to Video compression: Broadcast TV, Color signals, Luminance and Chrominance, Signal bandwidth, digital video: 4:2:2 format, 4:2:0 format, HDTV format, Video compression techniques: Video Compression principles: Frame Types, Introduction to MPEG.

Principles of Animation, Computer based animation.

Laboratory Component:

The lab sessions would include experiments based on basics of multimedia processing using tools such as MATLAB/LABVIEW which subsequently would conclude in a mini-project. A batch of THREE students is required to undertake a mini project to showcase the knowledge acquired during the course of this study. The mini-project may be pursued with respect to the following sub – domains (but not limited to):

1. Image processing techniques such as enhancement, restoration, segmentation etc.
2. Image compression techniques such as JPEG, JPEG 2000, TIFF etc.
3. Text processing techniques like Huffman coding etc.
4. Text Compression techniques such as LZW coding, ZIP, RAR etc.
5. Audio / Speech compression techniques.
6. Video processing / compression techniques such as MPEG etc.

Implementation of the mini-project including the project report would carry 15 out of 25 of the lab component marks.

TEXT BOOKS

1. Multimedia Communications: Applications, Networks, Protocols, and Standards – Fred Halsall, Pearson Education, Fourth Impression 2009.
2. Multimedia: Making It Work – Tay Vaughan, Tata McGraw-Hill, Seventh Edition, 2010.

REFERENCE BOOKS

1. Data Compression: The Complete Reference – David Salomon, Springer, Fourth Edition, 2007.
2. Multimedia in Practice: Technology and Applications – Judith Jeffcoate, Pearson Education, Fifth Impression 2011.

MOOCs

1. http://nptel.ac.in/courses/117105083/
2. http://nptel.ac.in/downloads/117105083/

WIRELESS COMMUNICATION 16TE7DCWCM (3:0:1:2)	
Course Outcomes	
CO1: Ability to **define, understand** and **explain** concepts related to wireless communication	--
CO2: Ability to **apply** the knowledge of communication and coding to wireless communication	PO1
CO3: Ability to **analyze** the given parameters for different propagation models of wireless networks	PO2
CO4: Ability to **conduct experiments** to demonstrate concepts of wireless communication using the engineering tool such as QUALNET / MATLAB	PO5 PO9
CO5: Ability to perform in a team to prepare a report and make an effective **oral presentation** of the study on topics related to Networks protocols, contribution of wireless systems to the society and its effect on environment	PO6 PO7 PO8 PO9 PO10 PO12

Prerequisites: Analog Communication, Digital Communication

UNIT I [8 hours]

Introduction to Wireless Communication System: Mobile Radio systems around the world, Examples of wireless communication systems, Modern wireless Communication systems: 2G Cellular networks, 3G wireless networks, **The Cellular Concept-System Design fundamentals:** Introduction, Frequency reuse, Channel assignment strategies, Handoff Strategies, interference and system capacity, trunking and Grade of Service, Improving coverage and capacity in cellular systems

UNIT II [7 hours]

Mobile Radio Propagation: Large scale Path loss-introduction to radio wave propagation, free space propagation model, The three basic propagation mechanisms, Reflection, ground reflection model, Diffraction, Scattering, **Outdoor propagation model:** Okumura model, Hata model.

UNIT III [7 hours]

Small Scale fading and multipath: small scale multipath propagation, types of small scale fading, Rayleigh and Ricean distributions.

UNIT IV **[7 hours]**

GSM: system overview, the Air interface, Logical and physical channels, Synchronization, Coding, Establishing a connection and handover, Services and Billing

UNIT V **[7 hours]**

IS-95 and CDMA 2000: system overview, Air interface, Coding, spreading and Modulation, Logical and physical channel Handover.

Laboratory Component:

The lab sessions would include experiments

1.Simulate simple BSS with transmitting nodes in wire-less LAN by simulation and determine the performance with respect to transmission of packets.

2.Simulate simple Wi-fi and Wimax with transmitting nodes in wire-less LAN by simulation and determine the performance with respect to transmission of packets.

a) WIFI b)WIMAX

3) MANET (Mobile Adhoc Networks) simulation using Omni-directional Antenna model and Analysis

4)To find S-parameters of the given passive device.

5)To find impedance of a given load using slotted line method.

6)To find insertion loss, VSWR, output power and frequency of Operation of the given passive device.

7)To verify the characteristics of the given micro strip antenna

8)) Setting up of optical analog link

9)Setting up of optical digital link

10)To find various Fibre losses of the given optical fibre

11)To find the Numerical Aperture of the given optical fibre

TEXTBOOKS

1. Wireless communications- Principles and Practice, Theodore S Rappaport, Pearson, 2nd Edition
2. Wireless Communications, Andreas F Molisch, Wiley, 2012

REFERENCES

1. Wireless Communications, Andrea Goldsmith, Cambridge University Press, 2007
2. Wireless & Cellular Telecommunications, William C Y Lee, Mc Graw Hill, 3rd Edition

MOOCs

1. http://nptel.ac.in/courses/117104099/
2. https://www.edx.org/course/understanding-wireless-technology-notredamex-eg240x

Project for Community Service **Course code:16TE7DCPW1 (0:0:3:0)**	
Course Outcomes	
CO1: Ability to **apply and analyze** the engineering concepts to solve the identified research work through literature survey.	**PO1** **PO2**
CO2: Ability to arrive at an exhaustive list of available **modern engineering tools,** and select the tool for implementing the identified research work	**PO5**
CO3: Ability to **design** systems using hardware components/ software tools considering health, safety and societal needs and **validate** the results of the identified work leading to publications	**PO3** **PO4** **PO6** **PO7**
CO4: Ability to abide by the norms of **professional ethics** and meet societal and environmental needs	**PO8**
CO5: Ability to perform in the **team**, contribute to the team and mentor/lead the team	**PO9**
CO6: Ability to **communicate effectively** through presentation and demonstration of the project and preparation of the report and video.	**PO10**
CO7: Ability to apply the principles of **project management and finance** during the implementation of the project	**PO11**
CO8: Ability to function effectively as an individual to engage in **independent learning**	**PO12**

VIII SEMESTER

SUSTAINABLE TELECOMMUNICATION NETWORKS **16TE8DCSTN(2:0:0:1)**	
Course Outcomes	
CO1: Ability to **understand** and **explain** the need for sustainability, role of regulatory bodies, radiation hazards and revenue models for telecommunication networks	-
CO2: Ability to **apply** the knowledge of radiation hazards to minimize the effect on human health and environment	**PO1**
CO3: Ability to apply the Knowledge of finance management to arrive at effective revenue models for telecommunication networks	**PO11**
CO4: Ability to engage in independent learning, submit a report and use ICT for **effective presentation** on the study on topics related to, Awareness on Mobile Tower Radiation & Its Impacts On Environment, human health and protection from radiation hazards	**PO9** **PO10** **PO12**

UNIT- I **[4hours]**

Sustainability: Need for transformation, understanding today's telecommunication industry, business and sustainability, sustainability factors, green products, drivers of sustainability

UNIT-II **[5hours]**

Energy Efficiency and Management in Wireless Networks: Peer-to-Peer content sharing techniques for Energy Efficiency in Wireless Networks , Foraging-Inspired Radio-Communication Energy Management for Green Multi-Radio Networks, Intelligent Future Wireless Networks for Energy Efficiency, The telecom commercial communication, Internet of Things and data analytics in the cloud-sustainability, communication networks in IOT applications, Digital services and sustainable solutions, bandwidth management, energy management

UNIT-III **[5hours]**

Regulatory bodies: Telecom Regulations- Telecom Evolution, Role of regulatory bodies-The Indian Perspective, TRAI Regulation 2002,The telecommunication Interconnection usage charges regulation , Access to Information Regulations on QoS for VOIP based ILD service,

Broadcasting and cable services Interconnection, DTH services, Mobile number regulations,

UNIT- IV **[5hours]**

Radiation standards: Regulation of cellular service and RF radiation safety levels, SAR for cell phones, ,RFID standards, Wireless devices, ICNIRP,IEEE,CENELEC standards for controlled and occupational and military environments, Myths and Realities

UNIT – V **[5hours]**

Revenue models through Telecommunication Networks : Constant Revenue Model for Telecommunication Networks, .Business Model Requirements and Challenges in the Mobile Telecommunication Sector, A Novel Dynamic Pricing Model for the Telecommunications Industry

TEXTBOOKS

1. The Telecommunications Handbook, Kornel Terplan, Patricia A. Morreale, CRC Press
2. The Telecom Regulatory Authority of India Act, 1997, Georg Thieme Verlag
3. Telecommunication: New Signposts to Old Roads, Paul Slaa
4. Telecom Management in Emerging Economies: Evolutionary and Contemporary Perspectives, Murali Krishna Medudula, Mahim Sagar, Ravi Parkash Gandhi

REFERENCE BOOKS

1. Green Networking and Communications: ICT for Sustainability, Shafiullah Khan, Jaime Lloret Mauri
2. Internet of Things and Data Analytics Handbook, Hwaiyu Geng,John Wiley & Sons

PROJECT MANAGEMENT AND FINANCE 16HS8DCPMF (2:0:0:1)	
Course outcomes	
CO1: Ability to **define, understand** and **explain** concepts related to Project management and Finance.	-
CO2: Ability to **apply** the knowledge of project Management and Finance for success of projects	**PO1**
CO3: Ability to **analyze** financial feasibility ,cost estimation and financing of projects	**PO2**

CO4: Ability to **design** project work system	**PO3**
CO5: Ability to **use modern tools** for project scheduling and monitoring aspects of project management.	**PO5**
CO6: Ability to engage in independent learning, submit a report and use ICT for effective presentation on the study on topics related to Management of telecommunication based Projects.	**PO8** **PO9** **PO10** **PO11** **PO12**

Pre-requisites: Personality development course, soft skills

UNIT-I **[5 hours]**

Concepts of Project Management - Concepts of project , Categories of project , Project life cycle phases, Project management concepts, Tools and techniques for project management, The project manager, Basic education for a project manager, Roles and responsibilities of project manager ,Project manager as profession, Summary

UNIT-II **[5 hours]**

Establishing the Project - Scope, Time , Cost and performance goals, Feasibility report, Financing Arrangements, Preparation of cost estimates, Finalization of project implementation schedule, Evaluation of the project profitability, Appointing a project manager, Fixing the Zero date, Summary

UNIT-III **[5 hours]**

Organizing Human Resources and Contracting - Delegation , Project manager's authority, Project organization , Accountability in Project Execution , Contracts , R's of contracting, Tendering and Selection of Contractors, Team building, Summary

UNIT-IV **[4 hours]**

Organizing Systems and Procedures for Project Implementation -Working of systems, Design of Systems, Project work system design , Work breakdown structure, Project execution plan, Project procedure manual, Project control system, Planning, Scheduling and Monitoring,

Monitoring contracts, Project diary , Summary.

UNIT-V **[5 hours]**

Financing of Projects - Capital structure, Menu of financing , Internal accruals , Equity capital, Preference capital , Debentures (or bonds) , Methods of offering term loans , Working capital advances, Miscellaneous sources , Raising venture capital, Project financing structures, Financial closure , Financial institutions ,Summary.

TEXT BOOKS

1. Project Management – S Choudhury, Tata McGRAW Hill Publishing Company Limited
2. Projects- Planning , Analysis , Selection, Financing ,Implementation and Review –Dr. Prasanna Chandra McGRAW Hill Publishing Company Limited

REFERENCE BOOKS

1. Project Management – David I Cleland – Mcgraw Hill International edition
2. Project Management – Gopalakrishnan – Mcmillan India Ltd
3. Project Management – harry – Maylor- Pearson Publication

MOOCS

1. Nptel lecture on Introduction to project management by prof. Arun Kanda
2. https://www.youtube.com/watch?v=5pwc2DYlKQU

INTELLECTUAL PROPERTY RIGHTS AND CYBER LAW 16HS8GCIPL (2:0:0:1)	
Course Outcomes	
CO1: Apply technical concepts of IPR and Cyber Law to access societal, health, safety issues and continue responsibilities relevant to the professional engineering practices	**PO6**
CO2: Understand the impact of Patents, Copyright & Trademarks and demonstrate the knowledge of Cyber Law	**PO7**
CO3: Ability to apply ethical principle to obtain Intellectual property Rights like Patents, Copyright & Trademarks and Action taken due to unethical Telecom practices in Cyber law	**PO8**

CO4: Ability to work as an individual / in a team to effectively communicate Intellectual Property rights and Cyber Law leading to improvement in team work and leadership qualities.	**PO9** **PO10** **PO12**

UNIT – I **[5 hours]**

Basic principles of IP laws & Patents: Introduction, Concept of property, Constitutional aspects of IP, Evolution of the patent system in UK, US and India, Basis for protection, Origin and meaning of the term patent, Objective of a patent law, principles underlying the patent law in India, the legislative provisions regulating patents, Non – patentable inventions.

UNIT-II [5 **hours]**

Procedure for obtaining patent: Submission of application, Filing provisional and complete specification, Examination of the application, advertisement of the acceptance, opposition, Grant and sealing of patent, Term of the patent, compulsory license.

Provisional and complete specification: Definition of Specification, Kinds of specification, provisional specification, complete specification, Claims, Conditions for amendment.

Rights conferred on a patentee: Patent rights, Exception and limitations, Duties of a Patentee.

Transfer of patent: Forms of transfer of Patent rights, Assignment, kinds of assignment, License, kinds of license, Rights conferred on a licensee, Transmission of patent by operation of law.

Infringement of patents: Construction of claims and infringement, patents held to be infringed, patents held to be not infringed.

Action for Infringement: Where a suit is to be instituted, procedure followed in the suit, Onus of establishment infringement, Defence by the defendant, The Relief's, Injunction, Damages or account of profits, patent agents, patent drafting, database searching, and Case studies.

UNIT-III **[5 hours]**

Copy Right: Meaning and characteristics of copy right, Indian copy right law, requirement of copy right, Illustrations copy right in literary work, Musical work, Artistic work, work of architecture, Cinematograph film, sound recording.

Author and Ownership of copy right: Ownership of copy right, Contract of service, Contract for service, rights conferred by copy right, terms of copy right, license of copy right.

Infringement of copy right: Acts which constitute infringement, general principle, direct and indirect evidence of copying, Acts not constituting infringements, Infringements in literary, dramatic and musical works, Remedies against infringement of copy right, Case studies

Trade Marks: Introduction, Statutory authorities, procedure of registration of trademarks, rights conferred by registration of trademarks, licensing in trade mark, infringement of trade mark and action against infringement

UNIT-IV **[5 hours]**

Cyber Law: An introduction, Definition, why cyber law in India, Evolving cyber law prctices-for corporates, privacy in Indian cyber space. Terrorism & Cyber Crime. Cyber theft and Indian telegraph act, Cyber Stalking

UNIT-V **[4 hours]**

Indian Cyber law: Protecting Indian children online, Spam, contempt in cyber space, Indian consumers & cyber space, E-courts of India.

TEXT BOOKS

1. Dr. T Ramakrishna, "Basic principles and acquisition of Intellectual Property Rights", CIPRA, NSLIU -2005.
2. Dr.B.L.Wadehhra, " Intellectual Property Law Handbook", Universal Law Publishing Co. Ltd., 2002.
3. Cyberlaw-The Indian perspective by Pavan Duggal, 2009 Edition.

REFERENCES

1. Dr. T Ramakrishna, "Ownership and Enforcement of Intellectual Property Rights", CIPRA, NSLIU -2005.
2. "Intellectual Property Law (Bare Act with short comments)",Universal Law Publishing Co. Ltd. 2007.
3. "The Trade marks Act 1999 (Bare Act with short comments)", Universal Law Publishing Co. Ltd., 2005.

PROJECT WORK II 16TE8DCMPJ (0:0:10:0)		
Course Outcomes		
CO1	Ability to **apply** and **analyze** the engineering concepts to solve the identified research work through literature survey.	**PO1** **PO2**
CO2	Ability to arrive at an exhaustive list of available **engineering tools,** and select the tool for implementing the identified research work	**PO5**
CO3	Ability to **design** systems using hardware components/ software tools considering **health, safety** and **societal needs** and **validate** the results of the identified work leading to publications	**PO3** **PO4** **PO6** **PO7**
CO 4	Ability to abide by the norms of **professional ethics** and meet societal and environmental needs	**PO8**
CO 5	Ability to perform in the **team**, contribute to the team and mentor/lead the team	**PO9**
CO 6	Ability to **communicate effectively** through presentation and demonstration of the project and preparation of the report and video.	**PO1 0**
CO7	Ability to apply the principles of **project management and finance** during the implementation of the project	**PO11**
CO8	Ability to function effectively as an individual to engage in **independent learning**	**PO1 2**

SEMINAR 16TE8DCSMR (0:0:0:2)	
Course Outcomes	
CO1: Ability to develop written and oral **communication skills** in both technical and non-technical environment, and use ICT for effective presentation of the study / internship	**PO10**
CO2: Ability to function effectively as an **individual** to identify the mathematical concepts, science concepts, engineering concepts and **modern engineering tools** necessary to communicate the identified study / internship	**PO5** **PO9**
CO3: Ability to engage in **independent study** to research literature and understand Telecommunication engineering trends in the identified study	**PO12**
CO4: Ability to **apply** and **analyze** the knowledge of Telecommunication and Electronics engineering concepts to effectively communicate the results from various publications	**PO1** **PO2**
CO5: Ability to emphasize the need and abide by **professional ethics**	**PO8**
CO6: Ability to emphasize the role of Telecommunication and Electronics concepts on **environmental, cultural** and **societal** aspects.	**PO6** **PO7**

V Semester Department Elective

DIGITAL SYSTEM DESIGN

16TE5 GE1DD (L:T:P:S :: 3:0:0:0)

Course Outcomes	
CO1: Ability to understand, define the concepts and advanced features of VHDL to design a digital circuit	---
CO2: Ability to apply PLD concept to design a digital system	PO1
CO3: Ability to design a digital system for arithmetic operations	PO3
CO4: Ability to realize and analyze digital circuits using SM charts	PO4
CO5: Ability to conduct experiments to simulate, synthesize and implement digital systems using industry standard CAD tools	PO3 PO4 PO5
UNIT I	**[8 hours]**
Introduction: VHDL description of combinational networks, Modeling flip-flops using VHDL, VHDL models for a multiplexer, Compilation and simulation of VHDL code, Modeling a sequential machine, Variables, Signals and constants, Arrays, VHDL operators, VHDL functions, VHDL procedures, Packages and libraries, VHDL model for a counter. **Additional Topics in VHDL**: Attributes, Transport and Inertial delays, Operator overloading, Multi-valued logic and signal resolution, IEEE-1164 standard logic, Generics, Generate statements, Synthesis of VHDL code, Synthesis examples, Files and Text IO.	
UNIT II	**[07 hours]**
Designing With Programmable Logic Devices: Read-only memories, Programmable logic arrays (PLAs), Programmable array logic (PLAs), Other sequential programmable logic devices (PLDs), Design of a keypad scanner.	
UNIT III	**[07 hours]**
Designing With Programmable Gate Arrays And Complex Programmable Logic Devices: Xlinx 3000 series FPGAs, Designing with FPGAs, Xlinx 4000 series FPGAs, using a one-hot state assignment, Altera complex programmable logic devices (CPLDs), Altera FELX 10K series CPLDs.	

UNIT IV	[07 hours]
Design Of Networks For Arithmetic Operations: Design of a serial adder with accumulator, State graphs for control networks, Design of a binary multiplier, Multiplication of signed binary numbers, Design of a binary divider.	
UNIT V	**[07 hours]**
Digital Design with SM Charts: State machine charts, Derivation of SM charts, Realization of SM charts. Implementation of the dice game, Alternative realization for SM charts using microprogramming, Linked state machines.	

Lab Experiments:

- To develop a sub-program for a given digital circuit
- To develop multiplier circuit
- To develop Divider circuit
- To develop and implement Dice Game circuit
- To develop and implement Interfacing circuits like waveform generation, stepper motor control, DC motor

TEXT BOOK:

1	Charles H. Roth. Jr:, **Digital Systems Design using VHDL**, Thomson Learning
2	John F. Wakerly, **Digital Design ,** Pearson Education

REFERENCE BOOKS:

	1.	Stephen Brown & ZvonkoVranesic, **Fundamentals of Digital Logic Design** with VHDL, Tata McGrw-Hill, New Delhi, 2nd Ed., 2007
	2.	Mark Zwolinski, **Digital System Design with VHDL**, 2 Ed, Pearson Education., 2004
	3.	Volnei A Pedroni, **Digital electronics and Design with VHDL**. Elsevier

V Semester Department Elective

DSP Architecture

16TE5 GE1DA (L:T:P:S :: 3:0:0:0)

CO1	Ability to **understand** and **explain** the data formats for the DSP processor, architecture, fixed and floating point processor, addressing modes , bus structure, pipelining, parallelism, overflow and underflow, directives, I/O interfaces, DMA	-
CO2	Ability to **identify** the addressing modes, **write** and execute assembly and C codes for DSP applications.	PO1
CO3	Ability to **debug** and **analyze** the assembly and embedded C code for TMS320C54xx processor	PO2
CO4	Ability to **conduct experiments** using assembly and embedded C in CCS environment for implementing signal processing algorithms on the TMS32054XX DSP Processor	PO5 PO9

UNIT I **8 Hours**

INTRODUCTION TO DIGITAL SIGNAL PROCESSING: Introduction, A Digital Signal-Processing Systems and applications, software development tools, hardware issues, system consideration, Fixed and floating point DSP,

Implementation considerations-data representations and arithmetic, Dynamic range, resolution and precision, Decimation and Interpolation, Programmable Digital Signal Processors, Major features of Programmable digital Signal Processors,

UNIT II **8 Hours**

ARCHITECTURES FOR PROGRAMMABLE DIGITAL SIGNAL-PROCESSING DEVEICES: Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing..

UNIT III **8 Hours**

PROGRAMMABLE DIGITAL SIGNAL PROCESSORS- Data Addressing Modes of TMS32OC54xx., Memory space of TMS 320C54xx processors, Program control, Assembler directives , Detail Study of TMS320C54X & 54xx Instructions and Programming, On- Chip peripherals, Interrupts of TMS32OC54XX Processors, Pipeline Operation of TMS32OC54xx Processor.

UNIT IV **6 Hours**

IMPLEMENTATION OF BASIC DSP ALGORITHMS : Introduction, implementation of FIR filter, steps involved in designing IIR Filters, Interpolation and Decimation Filters, Overflow and Scaling, and optimum scaling factor in FFT

UNIT V **6 Hours**

INTERFACING MEMORY AND PARALLEL I/O PERIPHERALS TO PROGRAMMABLE DSP DEVICE AND DSP APPLICATIONS - Introduction, memory space organization, external bus interfacing signals, memory interface, parallel I/O interface, programmed I/O, interrupts and I/O, direct Memory Access (DMA), Applications using DSP Processor

TEXT BOOK:

1. **Digital Signal Processing** – Avatar Singh and S. Srinivasan, Thomson Learning, 2004.

REFERENCE BOOKS:

1. Texas Instruments Reference manual
2. **Digital Signal Processing**, Shaila D Apte, Wiley India, 2009.
2. **Digital Signal Processors** – B Venkataramani and M Bhaskar TMH, 2002.
3. **Architectures for Digital Signal Processing** – Peter Pirsch John Weily, 2007.

V Semester Department Elective

OPERATING SYSTEMS 16TE5 DE1OS (L:T:P:S :: 3:0:0:0)	
Course Outcomes	
CO1: Ability to **understand** and **explain** the structures of operating system, file-system, inter-process communication and memory management	**--**
CO2: Ability to **identify** different scheduling policies and threads for process operations;	**PO2**
CO3: Ability to **analyze and obtain** solution for prevention and avoidance of deadlock in system	**PO3**
CO4: Ability to **conduct experiments** on scheduling, memory management, file system using C/Unix	**PO5**

UNIT – I **7hr**

Introduction to Operating Systems, System structures: What operating systems do; Computer System organization; Operating system structure; Operating System operations; Process Management; Memory management; Storage management; Special-purpose systems; Computing environments. System Structure: Operating System Services; User - Operating System interface; System calls; Types of system calls; System programs; Operating System design and implementation; Operating system structures;

PROCESS MANAGEMENT: Process concept; Process scheduling; Operations on processes;

UNIT – II **7hr**

PROCESS MANAGEMENT: Multi-Threaded Programming: Overview; Multithreading models; Thread Libraries; Threading issues.

SCHEDULING: Scheduling Terminology and Concepts, Nonpreemptive Scheduling Policies, Preemptive scheduling policies, **Scheduling in practices:** Long-term, Medium and short term scheduling; Real time scheduling

UNIT – III **8hr**

MEMORY MANAGEMENT: Execution of programs, Memory allocation to a process, Heap Management Contiguous memory allocation, Non-contiguous memory allocation, Paging, Segmentation

VIRTUAL MEMORY: Virtual memory basics, **Demand paging:** Preliminaries; The Virtual Memory Manager, Page replacement policies

UNIT – IV **7hr**

MESSAGE PASSING: Overview of message passing, Implementing message passing, Mailboxes

DEADLOCKS: Definition of deadlock, Deadlock in resource allocation, Handling deadlocks, Deadlock detection and resolution, Deadlock prevention, Deadlock avoidance

UNIT – V **7hr**

FILE SYSTEM, IMPLEMENTATION OF FILE SYSTEM: File System: File concept; Access methods; Directory structure; File system mounting; File sharing; Protection. Implementing File System: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management

TEXT BOOK:

1. Operating System Principles – Silberschatz, Galvin, Gagne, Wiley**,** Seventh Edition
2. "Operating Systems - A Concept based Approach", D. M. Dhamdhare, TMH, 3rd Ed, 2012.

REFERENCE BOOK:

1. Operating System – Internals and Design Systems, Willaim Stalling, Pearson Education, 4th Ed, 2006.

Lab Experiments:

WEEK	Unit #	Title
1		Introduction to Unix Platform
		Understanding of expr, test and basic operators if statement, While loop, For loop and Case structure, Until, Select , Break and Continue statements, string operators using examples
2	4	Study and implement Banker's Algorithm
	2	The program demonstrates how to create a new process using fork system call
3	2	The program demonstrates how to create a thread and passing value from thread
	2	Implement the multithread application to create Two child threads with normal priority.
4	2	Simulate the following CPU scheduling algorithms a) FCFS b) Round Robin

VI Semester Department Elective

System Design using FPGA

16TE6DE2SD (L:T:P:S :: 3:0:0:0)

Unit-1 **7 Hours**

FPGA-Based Systems: Introduction, Basic Concepts, Digital Design and FPGAs, FPGA-Based System Design

Unit-2 **7 Hours**

FPGA Fabrics: Introduction, FPGA Architectures, SRAM-Based FPGAs, Permanently Programmed FPGAs, Chip I/O, Circuit Design of FPGA Fabrics, Architecture of FPGA Fabrics

Unit-3 **7 Hours**

Combinational Logic: Introduction, the Logic Design Process, Combinational Network Delay, Power and Energy Optimization,

Unit-4 **7 Hours**

Arithmetic Logic, Logic-Implementation for FPGAs, Physical Design for FPGAs

Unit-5 **8 Hours**

Sequential Machines: Introduction, The sequential Machine Design Process, Sequential Design Styles, Rules for Clocking, performance Analysis, Power Optimization

Text Book:

1. Wayne Wolf , "FPGA-Based System Design" , Prentice Hall International, Inc. Pearson Education
2. M.J.S .Smith, - "**Application - Specific Integrated Circuits**" – Pearson Education,

Reference Books:

1. Steve Kilts, "Advanced FPGA Design Architecture, Implementation, and Optimization", John Wiley & Sons, Inc.,
2. Bob Zeidman, "Design with FPGAs and CPLDs", Elsevier publications

VI Semester Department Elective

C++ AND DATA STRUCTURES 16TE6DE2OP (L:T:P:S :: 3:0:0:0)	
Course Outcomes	
At the end of the course, the student will have the	
CO1: Ability to **understand** the programming concepts for data structures	--
CO2: Ability to **apply** the knowledge of Engineering mathematics and programming skills to develop efficient codes in C++	PO1
CO3: Ability to **analyze** abstract object and real object using class	PO2
CO4: Ability to **design** programming solutions with operator overloading and memory management	PO3
CO5: Ability to work as an individual and thereby **conduct experiments** using any C compiler for a given application/problem statement.	PO5 PO9
CO6: Develop, test, analyze and demonstrate applications using C++ and Data structures through an **Open-Ended Experiment**	PSO3

Prerequisites: C Programming

UNIT I	**[7 hours]**
Introduction to OOPS: OOP Concepts, structure of C++ program, Function prototype, argument passing, recursion, inline functions, friend and virtual functions Classes and objects: Class definition and declaration, member functions, static data members and member functions, arrays of objects, returning objects.	
UNIT II	**[7 hours]**
Constructors, Destructors, Operator overloading Constructors, parameterized constructors, multiple constructors in a class, copy constructor, dynamic constructors, and destructors. Operator overloading and type conversions: Overloading unary and binary operators, overloading using friends, rules for overloading.	
UNIT III	**[8 hours]**
Inheritance and Templates Inheritance, public, private and protected inheritance. Private member inheritance. Types of inheritance: Single, Multilevel, multiple, hierarchical, hybrid. Pointers, virtual functions and polymorphism. Class templates, function templates, overloading template functions, member function templates and non-type template arguments.	
UNIT IV	**[07 hours]**
Stacks and Queues **Stacks:** ADT, derived classes, formula based representation and linked list based representation,	

Applications
Queue: ADT, derived classes, formula based and linked representation, Applications

UNIT V **[7 hours]**

Hashing and Trees
Skip lists and hashing: linear representation, skip list and hash table representation
Trees: Binary trees, properties and its representation, operations, binary tree traversal, ADT
Priority queues: Linear list, heaps.

LAB Experiments:

1. Program to implement classes and objects (unit 1)
2. Program to implement inline functions (unit1)
3. Program to implement friend and virtual functions(unit 1)
4. Program to implement Constructors, parameterized constructors, multiple constructors in a class, copy constructor, dynamic constructors, and destructors. (unit 2)
5. Program to implement Operator overloading and type conversions: Overloading unary and binary operators, overloading using friends, rules for overloading. (unit 2)
6. Program to implement public, private and protected inheritance. Types of inheritance: Single, Multilevel, multiple, hierarchical, hybrid. (unit 3)
7. Program to implement Pointers, virtual functions and polymorphism.(unit 3)
8. Program to implement Class templates, function templates, overloading template functions(unit 3)
9. Program to implement stacks and ques using data structures (unit 4)
10. Program to implement hashing and trees using data structures (unit 5)

TEXT BOOKS:

1. **Object oriented Programming with C++,** -E Balagurusamy (TMH Publications, 4th edn)
2. D.S. Malik, "Data Structures using C++" India edition, CENGAGE Learning, 2003.

REFERENCE BOOKS:

1.	**Object oriented Programming in turbo C++,**Robert Lafore (GALGOTIA Publications)
2.	**Let Us C++--**Yashavanth P. Kanetkar (BPB Publications)
3.	Gray Litwin, "Programming with C++ and Data Structures ", Vikas publications,2003 .

MOOCS

1.	c++ tutorial at spoken-tutorial (http://spoken-tutorial.org/tutorial-search/?search_foss=&search_language=English)
2.	Introduction to data structures and algorithms (http://nptel.ac.in/courses/106102064/)

VI Semester Department Elective

Image Processing

16TE6DE2IP (L:T:P:S :: 3:0:0:0)

Course Outcomes **At the end of the course, the student will have the**	
CO1: Ability to **understand** and **explain** concepts of digital image processing.	--
CO2: Ability to **apply** the knowledge of image processing techniques to enhance the quality of gray scale and colour image, restore the degraded image, **illustrate** different segmentation principles, **solve** problems based on different image processing transforms.	PO1
CO3: Ability to **analyze** the distance relationship between pixels, **evaluate** Histogram equalization on gray scale and colour image, **deduce** filter operations on the image, **analyze** image segmentation and image transforms.	PO2
CO4: Ability to **conduct experiments** using MATLAB for a given application/problem statement.	PO5 PO9
CO5: Ability to listen and comprehend audio/video lectures related to image processing concepts.	PO10 PO12

UNIT I	**[7 hours]**
Introduction to Image Processing: Introduction, Fundamental steps in DIP, Components of DIP system, A simple image formation model, Image sampling and quantization, Basic relationship between pixels, Arithmetic and Logical operations on images, Image file formats.	
UNIT II	**[8 hours]**
Image Enhancement: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Gray level slicing, Bit plane slicing, Histogram processing – Histogram equalization. Spatial Domain Smoothening filters. **Enhancement in Frequency Domain:** Properties of Gaussian filters, Gaussian LPF and HPF, Homomorphic filter.	
UNIT III	**[7 hours]**
Image Restoration and De-noising: Image degradation/restoration model, Inverse filter, Pseudo Inverse filter, Noise models, Restoration using spatial filtering – Mean filters, Geometric mean filters, Harmonic mean filters, Median filter, Max & min filters, Midpoint filter, Wiener filter	
UNIT IV	**[7 hours]**
Color Image Processing: Fundamentals of color image processing, Color models, Conversion of color models from one form to other form, Pseudo color image processing, Chromaticity diagram, Color Image Quantization, Histogram of color Image, Color Image Filtering	

UNIT V	[7 hours]

Image Segmentation: Classification, Region approaches to segmentation, Edge Detection basics: Roberts Kernel, Prewitt Kernel and Sobel Kernel, Canny edge detector.
Basic Image Transforms: K-L Transform, Singular Value Decomposition: Basics, properties of SVD.

Image Processing Experiments

1. Arithmetic and Logical Operations on an image (Unit I)
2. Average of an image, Zooming and Pixel replication of an image (Unit I)
3. Transformations of an image (Unit II)
4. Gaussian Low Pass and High Pass filters (Unit II)
5. Inverse Filter and Pseudo Inverse filter (Unit III)
6. Wiener filter (Unit III)
7. Color Median filter (Unit IV)
8. Color histogram equalization (Unit IV)
9. Pseudo – color image processing (Unit IV)
10. Image Segmentation (Unit V)

TEXT BOOKS:

1. Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition, Pearson education, 2009.
2. Digital Image Processing by S.Jayaraman, S.Esakkirajan, T.Veerakumar, MacGraw Hill, 2009.

REFERENCE BOOKS:

1. Digital Image Processing Using MATLAB by Rafael C. Gonzalez, Richard E. Woods & Steven L. Eddins, Second Edition, Pearson education, 2010.
2. Digital Image Processing by Kenneth R. Castleman, Pearson education, 2007.

DEPARTMENT ELECTIVE COURSES SEMESTER: VII

ASIC DESIGN **16TE7 DE 3AD (3:0:0:0)**	
Course Outcomes	
CO1: Ability to **define**, **understand** and **explain** ASIC systems	--
CO2: Ability to **apply** the knowledge of VLSI to design digital integrated circuits	PO1
CO3: Ability to **analyze** a system using different VLSI design methodologies such as Full custom and Semi-custom approaches	PO2
CO4: Ability to the **design** and **interpret** performance of VLSI systems	PO3
CO5: Ability to function effectively as an individual and as a team member to **conduct experiments** using modern engineering tools for a given ASIC problem statement.	PO5 PO9

Prerequisites: Fundamentals of HDL, Fundamentals of VLSI, Digital System Design

UNIT I [7 hours]

Introduction to ASICs : Types of ASICs**:--** Full Custom with ASIC, Standard Cell based ASIC, Gate array based ASIC, Channeled gate array, Channel less gate array, structured gate array, Programmable logic device, Field programmable gate array, Design flow, ASIC cell libraries

UNIT II [8 hours]

CMOS LOGIC: Data path Logic Cells**: -** Data Path Elements, Adders, Multiplier, I/O cell, Cell Compilers

ASIC LIBRARY DESIGN: Logical effort: - practicing delay, logical area and logical efficiency logical paths, multi stage cells, optimum delay, optimum no. of stages, library cell design.

UNIT III [7 hours]

PROGRAMMABLE ASICS: The Antifuse, Static RAM, EPROM and EEPROM Technology. Programmable ASIC logic cells

UNIT IV [7 hours]

Programmable ASIC I/O cells, Programmable ASIC interconnect.

UNIT V **[7 hours]**

Low-level Design Entry: Schematic Entry: -Hierarchical design. The cell library, Names, Schematic Icons & Symbols, Nets, schematic entry for ASICs, connections, vectored instances and buses, Edit in place, attributes, Netlist screener, Back annotation.

TEXT BOOKS

1. M.J.S .Smith, - "Application - Specific Integrated Circuits" – Pearson Education, 2003
2. Vikram Arkalgud Chandrasetty, VLSI Design A practical Guide for FPGA and ASIC implementations , Springer

REFERENCE BOOKS

1. Jose E. France, Yannis Tsividis, "Design of Analog-Digital VLSI Circuits for Telecommunication and Signal Processing", Prentice Hall, 1994.
2. Malcolm R. Haskard, Lan. C. May, "Analog VLSI Design - NMOS and CMOS" Prentice Hall, 1998.
3. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", McGraw Hill, 1994.

MOOCs

1.www.udemy.com/vlsi-academy-physical-design-flow/

2.nptel.ac.in/courses/117108040

3.nptel.ac.in/courses/117101004

4.www.cmosedu.com/jbaker/courses/ece5410/s08

OPTICAL FIBER AND SATELLITE COMMUNICATION 16TE7DE3 FS(3:0:0:0)	
Course Outcomes	
CO1: Ability to **define**, **understand** and **explain** concepts of Optical Fiber and satellite communication system	-
CO2: Ability to **apply** the knowledge of electromagnetic theory/ray theory to study the technologies of Fiber Optic Communication and satellite communication	PO1
CO3: Ability to **analyse** power budget for a given communication link	PO2
CO4: Ability to **interpret** sample satellite data and arrive at suitable conclusion	PO4
CO5: Ability to function effectively as an individual or as a team member to **conduct experiments** using optical fiber kit.	PO5 PO9

Prerequisites: Analog communication, Digital communication, Transmission lines and Antennas

UNIT I **[8 hours]**

Introduction to Optical fiber: Optical fiber communication system, Basic optical laws, optical fiber modes and configurations, Mode theory for circular waveguides, single mode fibers, graded index fiber structure, Fiber materials, photonic crystal fibers

UNIT II **[7 hours]**

Signal degradation in optical fibers: Attenuation, Absorption, Scattering and bending losses, Dispersion, Polarisation

UNIT III **[7 hours]**

Optical communication: Optical receivers, Analog and digital links, WDM concepts, Optical amplifiers, Optical networks

UNIT IV **[7 hours]**

Satellite Communication: History of satellite communications, Satellite orbits, Earth station, Types of satellite communication system, Friis Transmission equation, Space segment, ground segment, propagation effects

UNIT V **[7 hours]**

Satellite link: Link design, Modulation Techniques, Multiple access, GPS, Indian satellites in space applications

TEXT BOOKS

1. Optical fiber Communication, Gerd Keiser, Tata McGraw Hill

2. Satellite Communications**:** Dennis Roddy, Tata McGraw Hill

REFERENCE BOOKS

1. Optical fiber Communications: Principles and Practice, Senior John M,Third Edition Pearson Education

2. Satellite Communication: Timothy Pratt, Second Edition, John Wiley and sons.

MOOCs

1. http://accessengineeringlibrary.com/browse/optical-communications-essentials

2. http://accessengineeringlibrary.com/browse/electro-optics-handbook-second-edition

3. http://accessengineeringlibrary.com/browse/wireless-security-models-threats-and-solutions/p2000a5429970133001?s.num=10&start=10&q=satellite+communication#p2000a5429970143001

4. https://onlinecourses.nptel.ac.in/noc17_ph01

5. https://onlinecourses.nptel.ac.in/noc16_ec10

SPEECH PROCESSING **16TE7DE3SP (3:0:0:0)**	
Course Outcomes	
CO1: Ability to **define, understand**, and **explain** discrete time model of the speech production and short time processing of the speech	--
CO2: Ability to **solve** LPC equations for speech communication and **obtain** complex Cepstrum of speech for pitch estimation	PO1
CO3: Ability to **analyze** and **synthesize** the speech in frequency domain through short time Fourier transform	PO2
CO4: Ability to function effectively as an individual or as a team member to **conduct experiments** using modern engineering tools for a given Speech processing problem.	PO5 PO9
CO5: Ability to perform in a team to implement an open-ended experiment	PO5 PO9 PO12

Prerequisites: Continuous Time Signal Processing Discrete Time Signal Processing.

UNIT I **[8 hours]**

INTRODUCTION & TIME DOMAIN PROCESSING OF SPEECH SIGNAL: Mechanism of speech production, Acoustic phonetics, General discrete time model for speech production, Time dependent processing of speech, short-time energy and average magnitude, short-time average zero crossing rate, Speech vs. silence detection, short time autocorrelation function, Short time average magnitude difference function, pitch period estimation.

UNIT II **[7 hours]**

FREQUENCY DOMAIN PROCESSING OF SPEECH SIGNAL: Definitions and properties: Fourier transforms interpretation and linear filter interpretation, sampling rates in time and frequency, Filter bank summation and overlap add methods for Synthesis of speech, Spectrographs, Phase vocoder, Channel vocoder.

UNIT III [7 hours]

LINEAR PREDICTIVE CODING OF SPEECH: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis of speech from linear predictive parameters.

UNIT IV [7 hours]

HOMOMORPHIC SPEECH PROCESSING: Introduction, Homomorphic systems for convolution, the complex Cepstrum of speech, pitch detection, formant estimation. The homomorphic vocoder.

UNIT V [7 hours]

APPLICATIONS OF SPEECH PROCESSING IN HUMAN-MACHINE COMMUNICATION: Voice response systems, Speaker recognition systems, Speech recognition systems, Introduction to Blind Source Separation.

TEXT BOOKS

1. Digital processing of speech signals – L. R. Rabiner and R. W. Schafer, Pearson Education Asia, 2004.
2. Fundamentals of Multimedia – Z. Li and M.S. Drew, Pearson Education Ltd., 2004.

REFERENCE BOOKS

1. Discrete time speech signal processing– T. F. Quatieri, Pearson Education Asia, 2004.
2. Speech and audio signal processing: processing and perception of speech and music– B. Gold and N. Morgan, John Wiley, 2004.

MOOCS

1. Sakshat virtual labs by IIIT-H (http://cse16-iiith.virtual-labs.ac.in/indexie.html)
2. Audio signal Processing (https://www.coursera.org/course/audio)

LAB EXPERIMENTS

1. Stationary and non-stationary nature of speech signal.
2. Identification of voiced/unvoiced and silence regions
3. Different sounds in language
4. Short time processing of speech
5. Linear prediction analysis
6. Cepstral analysis of speech
7. Estimation of pitch and formants
8. Voice activity detection

ADVANCED CODING THEORY 16TE7DE3AC (3:0:0:0)	
Course Outcomes	
CO1: Ability to **define, understand** and **explain** concepts related to coding theory	-
CO2: Ability to **apply** the mathematical foundation of coding theory for code compression and error control.	PO1
CO3: Ability to **analyze** the error correction capability of different error control codes and their performances	PO2
CO4: Ability to **design** various error correcting codes for different communication standards and modulation schemes.	PO3
C05: Ability to **conduct experiments** to demonstrate concepts related to coding theory using the engineering tool: MATLAB	PO-5 PO-9

Pre-requisites: Information theory and coding, Digital Communications

UNIT I **[7Hours]**

PRINCIPLES OF CODING THEORY: Error Control Schemes, Modulation, The Channel, Demodulation: Coherent demodulation, Differential demodulation, Soft-decision demodulation, Decoding: Dorsch algorithm decoding, Code Performance and Coding Gain.

UNIT II **[7Hours]**

FINITE FIELD ARITHMETIC: Set, Group, field, vector spaces, elementary properties of Galois fields, Galois field arithmetic, Addition of polynomials, Subtraction of polynomials, Multiplication of polynomials, Division of polynomials, Irreducible polynomial, Primitive polynomial, Construction of GF (2^m).

UNIT III **[7Hours]**

BCH CODES: Non-binary BCH codes, Berlekamp–Massey Algorithm, Chien Search algorithm **REED SOLOMON CODES:** Non-binary RS codes, REED SOLOMON Design, decoding of non-binary codes,Welch—Berlekamp Algorithm.

UNIT IV **[8Hours]**

TURBO CODES: Turbo Encoder, Different Types of Interleavers, Turbo Coding Illustration, Turbo Decoder, The BCJR Algorithm, Performance Analysis of the Turbo Codes, Effect of Number of Iterations on the Performance of the Turbo Codes, Effect of Puncturing on the Performance of the Turbo Codes

UNIT V **[7Hours]**

ITERATIVE DECODING: Low-density Parity-Check (LDPC) codes, properties, representation using Tanner Graph, LDPC encoding, preprocessing method, LDPC decoding, Bit flipping algorithm, Sum Product algorithm, Min Sum algorithm.

LAB Experiments

- Program to compute BER performance of various modulation schemes in AWGN, and Rayleigh fading channels.
- Construction of non-binary Minimal Polynomials Using MATLAB.
- Program to compare the decoding error probability of different RS codes
- Program to compare the decoding error probability of different non-binary BCH codes
- Program to encode and decode the data sequence using Turbo codes.
- Program to program for efficient encoding and decoding of LDPC Codes.

TEXT BOOKS

1. K.DeeragaRao, " Channel Coding Techniques for Wireless Communications", Springer, 1st edition, 2015.
2. Peter Sweeney, “Error Control Coding from Theory to Practice”, John Wiley and Sons, 2002.

REFERENCE BOOKS

1. Shu Lin and Daniel J. Costello. Jr, "Error control coding", Pearson, Prentice Hall, 2nd edition, 2004.

2. Richard B Wells, "Applied Coding and Information Theory for Engineers", Prentice Hall, 1st edition,1998.

MOOCs

1. http://www.ee.iitm.ac.in/~skrishna/ee5160/
2. http://nptel.ac.in/courses/117101053/1

Electrical Science Cluster Elective Group-I:

These set of electives are offered by Electrical Science Cluster and student has an option to choose one among these set of courses, provided he/she has not taken the same course in respective departmental core or departmental electives.

VI Semester Electrical Cluster Elective

DISPLAYS FOR EMBEDDED SYSTEM CLUSTER ELECTIVE 16TE6GE1DE (L:T:P:S :: 3:0:0:0)	
Course Outcomes	
At the end of the course, the student will have the	
CO1: Ability to **understand** the working principle behind various display devices for embedded systems.	--
CO2: Ability to **apply** c programming concepts to program LED and LCDs for embedded displays	PO1-3
CO3: Ability to **analyse** and **investigate** working of GLCDs for both graphic displays and Touch interfaces	PO2-2
CO4: Ability to work as an individual and thereby **conduct experiments** using UTLP for a given application/problem statement.	PO5 – 2 PO9 – 2
CO5: Develop, test, analyze and demonstrate applications of telecommunication using UTLP	PSO3-2

Prerequisites: C Programming	
UNIT I	**[7 hours]**
Introduction: Introduction to display devices, Types of display devices, CRT, vector displays, raster	

displays, character based frame buffer, LED, LCD, GLCD, Touch screen, plasma display panels, FEDs.

UNIT II	[7 hours]

Driving LEDs

Programming LEDs with iterative loops: for, while, do-while, Branching with if, break, continue, switch statements, usage of pointers and arrays in LED programming, Number arrays for LEDs, LED class definition, Macros, Dynamic memory allocation, exception handling, Example programs to turn on/off LED on board, Controlling brightness of LED by changing the parameters of PWM signal.

UNIT III	[7 hours]

Programming with CLCD

Comparison of CRT and LCD, Reflective and backlit LCDs, Active matrix LCDs, Programming with character LCD to display one line, printing values on different lines of CLCD, display a string keep changing the message with delay, shifting the characters right and left on CLCD, example application program on display system for railways on CLCD.

UNIT IV	[07 hours]

Programming with GLCD and Touch screen

Introduction to GLCD, Introduction to touch screen technology, components of touch screen, Types of touch screen technology, resistive, capacitive, saw and infrared touch screen. Loading images of different formats onto GLCD, display an image with four quadrants of different color, program to set the GLCD as touch panel and display the coordinates of touch panel on screen.

UNIT V	[8 hours]

OS mode and DSP for Embedded system

Comparison of non OS mode and OS mode of embedded system, Linux architecture, DSP and C6Accel, Q format data representation ,Using 7 segment LED and LCD in OS mode, Frame buffers, Touch interfaces in OS mode, File system API, Debugging.

TEXT BOOKS:

1. Interfacing with c++, jayantha katupitiya and kim Bentley ,springer publications (unit2)

1.	http://www.slideshare.net/abhishekpal1991/pal-17140724 (unit 1)
2.	http://www.vrarchitect.net/anu/cg/Display/printCG.en.html (unit1)
3.	UTLP practitioner workshop & UTLP Expert workshop training materials from Mission 10x, Wipro Technology. (unit3,unit4,unit5) (http://www.mission10x.com/m10x/technology/learning

Cryptography and Network Security

16TE6GE1CN

CO1: Ability to **define, understand and explain** concepts related to network security	–
CO2: Ability to **apply** the knowledge of mathematics to cryptography	PO1-2
CO3: Ability to **analyze** the given security systems parameters	PO2-2
CO4: Ability to perform as an individual, prepare a report and make an **effective oral presentation** on applications of network security protocols of communication system, satellite systems , any other.,	PO6-1 PO7-1 PO8-2 PO9-3 PO10-2 PO12-2

UNIT – I **7hr**

Introduction, Services, mechanisms and attacks, The OSI security Architecture, A model for network security, A model for network security, Symmetric Ciphers: Symmetric Cipher model, Symmetric Ciphers: Symmetric Cipher model, Substitution techniques Transposition technique,

UNIT – II **7hr**

Simplified DES, Block Cipher Principles, Data encryption Standard, The strength of DES,, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher modes of Operation, Advanced Encryption Standar, Triple DES, Blow fish

UNIT – III **9hr**

Fermat's and Euler's theorem Chinese Remainder Theorem , Principles of public key cryptosystems, The RSA algorithm, Diffe-Hellman key exchange, Elliptic Curve Arithmetic, Elliptic Curve cryptography

UNIT – IV **6hr**

Message Authentication and Hash Functions: Authentication requirements, Authentication functions, Message authentication codes, Hash functions, Security of hash functions and MAC. Digital Signatures, Digital Signature standard, Electronic Mail Security : Pretty Good Privacy,

UNIT – V **8hr**

Intruders, Intruder detection, Password management, Viruses and related threats, Viruses and related threats, Firewalls design principles

TEXT BOOK:

1. Cryptography and Network Security- Principles and Practice: William Stallings, Third Edition

REFERENCE BOOKS:

Data Communication and Networking, Behrouz Forouzan, 5th Edition, Tat

FIBER OPTICS AND LASERS IN MEDICINE
16TE6 GE1FL (L:T:P:S :: 3:0:0:0)

CourseOutcomes

CO1:Ability to apply the knowledge of mathematics science and engineering fundamentals to understand the mechanisms describing the interaction of laser radiation with bodily tissue.
CO2: Ability to analyze the properties of lasers and light delivery systems relevant to applications in medicine.
CO3: Ability to discuss selected applications of lasers and optical techniques which are presently important in medicine

UNIT I	**[7 hours]**

Medical Lasers: Introduction, Laser physics-fundamentals, principles, Medical Laser Systems-solid state laser, gas laser, dye laser, semiconductor laser, Laser safety.

UNIT II	**[7 hours]**

Laser interaction with tissue- photocoagulation, photo thermal ablation, photochemical ablation photo disruption

UNIT III	**8 hours]**

Laser Applications in Medical Therapy- application in dermatology, ophthalmology, general surgery, cardiovascular surgery, tumor surgery, gynecology

UNIT IV	**[10 hours]**

Optical Fibers: Elements of optical fiber transmission link 1Basic Optical Laws and Definations, optical fiber mode and configurations, Fiber materials, Fiber fabrication, signal degradation in optical fibers connectors ,splices and couplers, Optical Fiber Bundles: Introduction, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices- fundamentals & principles, fiberscopes

UNIT V	**[8 hours]**

Intruders, Intruder detection, Password management, Viruses and related threats, Viruses and related thrEndoscopy: Introduction, fundamentals, principles, types of endoscopes, Clinical Applications of Fiber Optic Laser Systems: in gastroenterology, neurosurgery, oncology, ophthalmology/ orthopedics 1 otolaryngology (ENT), urologyeats, Firewalls design principles

TEXT BOOK:

Lasers and Optical Fibers in Medicine by Abraham Katzir, Academic Press, 1998.

Handbook of Biomedical Instrumentation, by R.S.Khandpur, 2nd edition,

Optical Fiber communications/ by Gerd Keiser1 3rd editionMcGraw-Hill International Editions

EFERENCE BOOKS:

Therapeutic Lasers - Theory and practice by G.DavidBaxterr Churchill Livingstone

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DATA STRUCTURES AND ALGORITHMS 16EC6GE1DA (L:T:P:S :: 3:0:0:0)	
UNIT I	**[7 hours]**
Linear Structures: Abstract Data Types (ADT) – List ADT – array-based implementation – linked list implementation –cursor-based linked lists – doubly-linked lists – applications of lists – Stack ADT – Queue ADT circular queue implementation – Applications of stacks and queues	
UNIT II	**[7 hours]**
Tree Structures: Need for non-linear structures – Tree ADT – tree traversals – left child right sibling data structures for general trees – Binary Tree ADT – expression trees – applications of trees – binary search tree ADT	
UNIT III	**7 hours]**
Balanced Search Trees And Indexing :AVL trees – Binary Heaps – B-Tree – Hashing – Separate chaining – open addressing – Linear probing	
UNIT IV	**[9 hours]**
Graphs :Definitions – Topological sort – breadth-first traversal - shortest-path algorithms – minimum spanning tree – Prim's and Kruskal's algorithms – Depth-first traversal – biconnectivity – euler circuits – applications of graphs.	
UNIT V	**[8 hours]**
Chemical and biomedical micro systems: Algorithm Design And Analysis: Greedy algorithms – Divide and conquer – Dynamic programming – backtracking – branch and bound – Randomized algorithms – algorithm analysis – asymptotic notations – recurrences – NP complete problems	
Text Books M. A. Weiss, “Data Structures and Algorithm Analysis in C”, Pearson Education Asia, 2002. 2. ISRD Group, “Data Structures using C”, Tata McGraw-Hill Publishing Company Ltd., 2006. **References:** A. V. Aho, J. E. Hopcroft, and J. D. Ullman, “Data Structures and Algorithms”, Pearson Education, 1983. R. F. Gilberg, B. A. Forouzan, “Data Structures: A Pseudocode approach with C”, Second Edition, Thomson India Edition, 2005. Sara Baase and A. Van Gelder, “Computer Algorithms”, Third Edition, Pearson Education, 2000. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", Second Edition, Prentice Hall of India Ltd, 2001.	

SENSOR TECHNOLOGY 16EC6GE1ST (L:T:P:S :: 3:0:0:0)	
UNIT I	**[6 hours]**
Sensor Characteristics: Transfer function, span, accuracy, calibration, hysteresis, non linearity, saturation, dead band, resolution, special properties, output impedance, excitation, dynamic characteristics, environmental factors, reliability, application characteristics, and uncertainty	
UNIT II	**[8 hours]**
Physical principles of sensing: Electric charges, fields and potentials, capacitance, magnetism, induction, resistance, piezoelectric effect, pyro-electric effect, hall effect, Peltier effect and seebeck effect, sound waves, temp and thermal props of mats, heat transfer, light, dynamic models of sensor elements	
UNIT III	**8 hours]**
Sensors for embedded systems application_1: Photoelectric sensors, detection methods, proximity sensors: Inductive and capacitive, limit switches, LED, microwave sensors, laser sensors, bar code identification systems, OCRs, position sensors	
UNIT IV	**[8 hours]**
Sensors for embedded systems application_2: Displacement and level sensors, velocity and acceleration sensors, force, strain and tactile sensors, pressure sensors	
UNIT V	**[6 hours]**
Digital transducers and applications : Adv of digit ran, shaft encoders, optical encoders, digital tachometer, Hall effect sensors, linear encoders, Moire Fringe displacement sensors, binary transducers	
Text Books: T1: Handbook of modern sensors: Physics, designs, applications by JACOB FRADEN, 3rd edition, Springer. T2: Sensors Handbook by SabrieSoloman, 2nd edition, Mc Graw Hill. T3: Sensors and Actuators control systems Instrumentation by Clarence W de Silva, CRC Press.	

VLSI TESTING AND DESIGN FOR TESTABILITY 16EC6GE1VD (L:T:P:S :: 3:0:0:0)	
UNIT I	**[4 hours]**
Introduction: Testing Philosophy, Role of testing, Digital and Analog VLSI Testing. How to Test chips- types of Testing, Automatic Test equipment (ATE), Electrical parametric testing, Yield, Defects, Errors and Faults.	
UNIT II	**[10 hours]**
Fundamentals of VLSI testing: Fault models, Fault equivalence, Fault collapsing, Automatic test pattern generation: Path sensitization technique, Boolean difference, D-algorithm, PODEM algorithm, Iddq testing, Delay fault testing. Example problems. CAD tool usage for ATPG	
UNIT III	**8 hours]**
Design for testability**:** Controllability and observability, Scan design and scan based testing, Level	

sensitive scan Design (LSSD), Test interface and boundary scan	
UNIT IV	**[6 hours]**
Memory testing : Memory fault models, Test algorithms for RAMs, Detection of pattern sensitive faults Example problems	
UNIT V	**[8 hours]**
Built in self-test (BIST): BIST process, BIST implementation, BIST pattern generation methods, output response analysis	
Reference Books: M. L. Bushnell and V.D. Agrawal, Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits, Springer, 2005 Parag.K.Lala, Digital Circuit Testing and Testability, Academic press Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective", Third Edition, Pearson Education (Asia) Pvt. Ltd, 2006.	

PHYSICAL DESIGN **16EC6GE1PD (L:T:P:S :: 3:0:0:0)**	
UNIT I	**[8 hours]**
Libraries Standard cells, Transistor sizing, input-output pads, ESD and its sources, Library characterization, Timing models: Delay model, NLDM, Polynomial Delay model, Current source model.	
UNIT II	**[8 hours]**
Partitioning and Floor planning Approximation of Hyper Graphs with Graphs, Kernighan-Lin Heuristic Ratio cut partition, Fiduccia &Mattheyses, Technology File, Circuit Description Design Constraints, Design planning, Pad placement, power planning, Macro placement, Clock planning	
UNIT III	**8 hours]**
Placement Global Placement, detail placement, clock tree synthesis, power analysis	
UNIT IV	**[6 hours]**
Routing (clock, power/ground, signal nets): Special routing, Global routing, Detailed routing, Extraction	
UNIT V	**[8 hours]**
Verification Functional Verification, Timing verification (STA), Physical Verification, SI analysis, Power Analysis	
Text Book: KhosrowGolshan,"Physical Design Essentials-An ASIC Design Implementation Perspective", 2007 Springer Science+Business, Media. **Reference books:** F. Nekoogar. Timing Verification of Application-Specific Integrated Circuits (ASICs).Prentice Hall PTR, 1999.	

Sarafzadeh, C.K. Wong, "An Introduction to VLSI Physical Design", McGraw Hill International Edition 1995.
Preas M. Lorenzatti, " Physical Design and Automation of VLSI systems", The Benjamin Cummins Publishers, 1998.

PROBABILITY AND RANDOM PROCESS 16EC6GE1PR (L:T:P:S :: 3:0:0:0)	
UNIT I	**[8 hours]**
Introduction to Probability theory: Experiments and Sample space, Events, Probability definition and Axioms, Joint and conditional probabilities, Baye's theorem- Independent events, Bernoulli Trials	
UNIT II	**[7 hours]**
Random variables, Distribution functions, Density functions: CDF, PDF, Gaussian random variable, Binomial, Poisson, Uniform, Exponential and Rayleigh types of random variable, Probability Mass Function	
UNIT III	**7 hours]**
Operation on a single random variable: Expectation, EV of random variables, EV of functions of random variables, Moments, Central moments, Conditional expected values	
UNIT IV	**[7 hours]**
Random processes. Stationarity and ergodicity. Strict sense and wide sense stationary processes. Mean, Correlation and Covariance functions	
UNIT V	**[7 hours]**
Spectral properties of random processes – power spectral density and its properties, relation with autocorrelation, cross PSD and cross correlation	
Text Books: Peyton Z. Peebles, "Probability, Random variables and random signal principles", TMH, 4th edition, 2015. S.Haykins, An Introduction to Analog and Digial Communications, Wiley, 2003 http://nptel.ac.in/courses/117105085	

ADVANCED MICROCONTROLLERS & APPLICATIONS 16EC6GE1AM (L:T:P:S :: 3:0:0:0)	
UNIT I	**[7 hours]**
Migration from 8051 to 32bit cores, RISC design and ARM Design Approach, Advantages of ARM, ARM Organization, Registers, Pipeline, Exceptions & Interrupts, Introduction to Cortex M3 Processor & its applications.	
UNIT II	**[10 hours]**
Cortex M3 Registers, Operation Modes, Thumb2 Technology & Instruction Set Architecture,	

Exceptions & Nested Vector Interrupt Controller, Memory Systems	
UNIT III	**10 hours]**
Cortex M3 Programming: A typical development flow, Using C, CMSIS, Using Assembly, Exception Programming.	
UNIT IV	**[6 hours]**
Introduction to Firmware, Boot-loader and Embedded Operating Systems, MPU & MMU**,** Working With I2C, SPI, CAN & USB protocols	
UNIT V	**[6 hours]**
Applications of ARM Cortex M3: Robotics & Motion Control, WSN, IoT, ARM Cortex for DSP applications	
TEXT BOOKS: The Definitive Guide to ARM Cortex M3, 2nd Edition by Joseph Yiu. ARM System Developer's Guide By Andrew N Sloss, Dominic Symes, Chris Wright **REFERENCE TEXT BOOKS:** ARM System-On-Chip Architecture By Steve Furber, Addison Wesley, Pearson Education, 2nd edition Jagger (Ed) ARM architectural reference manual, Prentice Hall	
NANO ELECTRONICS **16EC6GE1NE (L:T:P:S :: 3:0:0:0)**	
UNIT I	**[7 hours]**
INTRODUCTION: Overview of nanoscience and engineering, Moore's law and continued miniaturization, Classification of Nano structures, Electronic properties of atoms and solids: isolated atom, bonding between atoms Giant molecular solids, Free electron models and energy bands, crystalline solids, periodicity of crystal lattices, electronic conduction effects of nanometre length scale, Fabrication methods : top down process methods for templating the growth of nanomaterials, ordering of nanosystems.	
UNIT II	**[7 hours]**
CHARACTERIZATION: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques diffraction techniques: bulk, surface spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement; mechanical electron magnetic, thermal properties	
UNIT III	**7 hours]**
INORGANIC SEMICONDUCTOR NANO STRUCTURES: Overview of semiconductor physics, quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super lattices, band offsets, electronic density of states.	
UNIT IV	**[7 hours]**
PHYSICAL PROCESS: Modulation doping ,quantum hall effect, resonant tunnelling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined strark effect, nonlinear effects, coherence and dephasing, characterisation of semiconductor nanostructures: optical electrical structural.	
UNIT V	**[8 hours]**

METHODS OF MEASURING PROPERTIES STRUCTURE: Atomic, crystallography, microscopy, spectroscopy, Properties of nano particles: metal nanoclusters, semiconductor nanoparticles, Rare gases and molecular clusters, Carbon nanostructures and its application (field emission and shielding computers, fuel cells, sensors, catalysis). Self-assembling nanostructured molecular materials and devices: building blocks, principles of self-assembly, methods to prepare and pattern nano particles, template nanostructures, liquid crystal mesophases.

SELF LEARNING: FABRICATION TECHNIQUES

Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching ,cleaved edge growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations , thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.

REFFERENCES

Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale science and technology"
Charles P Poole,Jr Frank J owens "Introduction to nanotechnology"
ED William A Goddard, Donald W Brenner, Sergy Edward Lysheveski, Gerald J Lafrate, "Hand Book of Nanoscience engineering and technology"

Course Title	**Electrical & Electronics Engineering Materials (Group Elective)**				
Course Code	**16EE6GE 1EM**	**Credits**	**3**	**L-T-P-S**	**3-0-0-0**
CIE	**50 Marks(100% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites:
Basics of Physics & Chemistry

Course Description:
This course will enable students to
Know about the basics of kinetics, chemical bonding and structure of materials.
Analyze the facts of conductors, resistors and dielectric materials.
Study different types and properties of semiconductors.
Know about the concept of magnetic materials and their properties.
Measure different electrical and magnetic properties of materials.

UNIT-1		**7 hours**

Introduction, Equilibrium, kinetics and crystal geometry - Materials science & Engineering: Classification of engineering materials, level of structure, structure-property relationship in materials. Crystal geometry: The space lattice, space lattice and crystal structure, crystal direction and planes.

UNIT-2		**9 hours**

Atomic structure, chemical bonding and structure of solid - Atomic structure: Quantum states, ionization potential, electron affinity and electro-negativity. Chemical bonding: bond energy, bond type and bond length, ionic bonding, covalent bonding, metallic bonding, variation of bonding character and properties. Structure of solids: crystalline and non-crystalline states, covalent solids, metal and alloys, ionic solids, the structure of silica and the silicates.

UNIT-3		7 hours
Conductors, Resistors and Dielectric materials - Conductors and resistors: The resistivity range, the free electron theory, conduction by free electrons, conductor and resistor materials, super conducting materials. Dielectric materials: Polarization and dielectric constant, temperature and frequency effects, electric breakdown, ferroelectric materials, piezoelectricity, dielectric losses		
UNIT-4		**8 hours**
Semiconductors - Classifying materials as semiconductor, the chemical bond in Si and Ge, the density of carriers in intrinsic semiconductor; the energy gap, the conductivity of intrinsic semiconductors, extrinsic semiconductors, carrier density in n-type semiconductors, p-type semiconductors, Hall effect and carrier density, photoconductivity, fabrication of integrated circuits		
UNIT-5		**8 hours**
Magnetic Materials, Measurement of Electrical and Magnetic properties - Classification of magnetic materials, diamagnetism, the origin of permanent magnetic dipoles in matter, soft magnetic materials, hard magnetic materials, some properties of ferromagnetic materials, antiferromagnetic materials, Measurement of Electrical and Magnetic properties: Conductivity measurements, dielectric measurements, magnetic measurements, measurements of semiconductor parameters		

Text book	
1	Materials Science and Engineering, V. Raghavan,PHI Learning Private Limited, Fifth Edition. 42nd reprint2013.
2	Electrical Engineering Materials, A.J. Dekker, Prentice Hall of India Private Limited, 13threprint1988.
Reference books:	
1	An Introduction to Electrical Engineering Materials,C.S. Indulkar and S. Thiruvengadam, S. Chand & Company Ltd. 3rd Edition, reprint 1985.
2	Electronic Engineering Materials and Devices, John Allison,Tata McGraw-Hill Publishing Company Ltd. 9th reprint 1990.

Course outcomes

At the end of the course ,the student will have the ability to

CO1: Understand the physics of equilibrium and kinetics and crystal geometry of engineering materials.

CO2: Understand the concept of atomic structure, chemical bonding, and structure of solid.

CO3: Apply the principle of physics and mathematics to understand about the properties of conductors, semiconductors, dielectric and magnetic materials.

CO4: Apply the concept of conductor, semiconductor, dielectric and magnetic materials to measure properties of these materials

Course Title	ELECTROMAGNETIC COMPATIBILITY (Cluster Elective I – Except EC & IT)				
Course Code	16EE6GE 1EC	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Analog Electronic, Digital electronics, Power electronics.

Course Description:

The course covers topics on introduction to EMI/EMC, Cabling, balancing and filtering, grounding, and shielding, Electro static discharge.

UNIT-I		8 **hours**

Introduction - Designing of electromagnetic compatibility, EMC regulation, typical noise path, and Use of network theory, method of noise coupling, miscellaneous noise sources, and method of eliminating Interference.

UNIT-II		**8 hours**

Cabling - Capacitive coupling, effect of shield on magnetic coupling, mutual inductance calculations, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shield transfer impedance, experimental data, example of selective Shielding, co-axial cable versus shielded twisted pair braided shields.

UNIT-III		**7 hours**
Balancing and filtering - Balancing, power supply decoupling, decoupling filters, amplifier Decoupling driving capacitive loads, high frequency filtering, system bandwidth, and modulation and Coding. Introduction to Grounding - Safety grounds, signal grounds, single point ground systems, hybrid grounds, multipoint ground systems, functional ground layout, practical low frequency grounding, hardware grounds		
UNIT-IV		**8hours**
Shielding - Near field and far fields, characteristic and wave impedance's shielding effectiveness, absorption loss, reflection loss, composite absorption and reflection loss, summary of shielding equation, Shielding with magnetic material, experimental data, apertures, wave guide below cut off, conductive gaskets, conductive windows, conductive coatings, cavity resonance, brooding of shields.		
UNIT-V		**8 hours**
Electrostatic discharge - State generation, human body model, static discharge, and ESD Protection in equipment design, software and ESD protection, ESD versus EMC.		

Text books:

1	Noise reduction techniques in electronic systems, Henry W. Ott, John Wiley, 2nd edition, 1988
2	Engineering Electromagnetic Compatibility: Principles, Measurements & Technologies, V. Prasad Kodali, S. Chand & Co. Ltd. Delhi, 2000

Reference books:

1	Electromagnetics Explained – A Hand Book For Wireless/Rf, Emc And High Speed Electronics

Course Outcomes:

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

CO1: Analyze the fundamentals and reason for noise in Analog electronics, Power electronics and Digital electronics circuit**.**

CO2 : Design and development of filters for Analog electronics, Power electronics and Digital circuits for reduction of noise.

CO3 : Design the various types of grounding systems and get familiarised with handling electro static discharge systems

CO4 :Acquire knowledge about testing standards and Regulations.

Course Title	**Modern Control Theory (Cluster Elective I –Except EE)**				
Course Code	**16EE6DCMCT**	**Credits**	**03**	**L-T-P-S**	**3-0-0-0**
CIE	**50 Marks(100% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites:
Control Systems

Course Description:
This course intends to create state models using physical variables, phase variables and canonical variables that are used to solve state equations. It also deals with the various techniques used to analyse the controllability and observability of a system. Basics about nonlinear systems are also dealt with.

UNIT-I	**8 hours**

State variable analysis and design:
Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables & canonical variables

UNIT-II	**8 hours**

Derivation of transfer function from state model, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation ,state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley -Hamilton method

UNIT-III	**7 hours**

Concept of controllability & observability, methods of determining the same, Effect of Pole-Zero cancellation. Duality.

UNIT-IV	**8 hours**

Pole placement techniques - Stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer.

UNIT-V	**8 hours**

Non-Linear systems - Introduction, behavior of non-linear system, common physical non linearity –saturation, friction, backlash, dead zone, relay, multivariable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.

Text books:

1	Digital control & state variable methods- M.Gopal,THM Hill, 2nd edition, 2003
2	Control system Engineering- I.J .Nagarath&M.Gopal, New Age International (P)Ltd, 3rd edition.

Reference books:	
1	State space Analysis of Control Systems- Katsuhiko Ogata- Prentice Hall Inc
2	Automatic Control Systems- Benjamin C. Kuo&FaridGolnaraghi , John Wiley & Sons, 8th edition, 2003
3	Modern Control Engineering- Katsuhiko Ogata-PHI 2003
4	Modern control systems-Dorf& Bishop- pearson education,1998

Course outcomes

At the end of the course ,the student will have the ability to

CO1: Create state models using physical variables ,mathematical variables and to solve the state equation

CO2: Identify appropriate techniques to analyze the system for its controllability and Observability

CO3: Apply relevant concepts to design systems with state feedback to meet the specifications, Comprehend mathematical representation of nonlinear systems and analysis of a few simple models.

Course Title	**ROBOTICS (Cluster Elective I)**				
Course Code	**16EI6GE1RT**	**Credits**	**3**	**L-T-P-S**	**3-0-0-0**
CIE	**50 Marks(100% weightage)**	**SEE**	**100 Marks(50% weightage)**		

UNIT-1		**5 hours**
Introduction Objectives, Classification of robots, Major components of robot, definitions: Kinematics, Controls, and actuators. Robot history, types and applications current and future with examples. Fixed and flexible automation		
UNIT-2		**9 hours**
Robot Arm Kinematics Introduction, The direct kinematics problem, Rotation Matrices, Composite rotation Matrix, Rotation matrix about arbitrary axis, Rotation matrix with Euler angle representation, Geometric interpretation of rotation matrix, Homogenous coordinates and transformation matrix, Geometric interpretation of Homogenous transformation matrices, Composite homogenous transformation matrices, Links, Joints, and their parameters, The Denavit -		

Hartenberg representation, Kinematic equation for manipulator, Other specifications of the locations of the end effectors, Inverse kinematics problem.		
UNIT-3		**7 hours**
Control of Actuators Objective, Motivation, Closed loop control in position servo, Effect of friction and gravity, Adaptive control, Optimal control, Computed torque technique, Transfer function of single joint, Position control for single joint, Brief discussion on performance and stability criteria.		
UNIT-4		**9 hours**
Sensors Sensor characteristics, Position sensors- potentiometers, Encoders, LVDT, Resolvers, Displacement sensor, Velocity sensor- encoders, tachometers, Acceleration sensors, Force and Pressure sensors – piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, optical, ultrasonic, inductive, capacitive, eddy-current proximity sensors. Hall Effect sensors, Binary sensors, Analog sensors, Force and Torque sensing, Elements of a Wrist sensor.		
UNIT-5		**9 hours**
Vision and Processing : Image acquisition, illumination Techniques, imaging geometry, some basic transformations, perspective transformations. Camera model, camera calibration, stereo imaging, Higher-Level Vision: Segmentation, Edge Linking and Boundary detection, Thresholding. Region-oriented segmentation, Use of motion, Description, Boundary descriptors, Regional descriptors.		
Mini project: Discussion on DC motors with gears, Stepper motor, Servo motor ,Mini projects using Basic sensors, 555 timers, Motors (DC motors with gears, Stepper motor, Servo motor) A batch of TWO students are required to undertake a mini project to showcase the knowledge acquired during the course of this study. Example topics :		

1. Line follower robot 2. Obstacle avoiding robot 3. Face reorganization algorithm 4. MATLAB simulation or Use of robo sim 5. PCB design workshop (Using PCB design software) Note: Carrying out small models / prototypes of projects are mandated which will carry a 20 percent weight in CIE Project report has to be submitted with following chapters followed by a presentation 1. Abstract 2. Introduction 3. Block diagram 4. Materials used with detailed specification 5. Design and Design issues in detail 6. Model testing

Text book	
1	"Robotics – control, sensing, Vision and Intelligence", K.S.Fu, R.C.Gonzalez, C.S.G. Lee, McGraw Hill, 1987.
2	"Robotic Engineering" - Richard D Klafter, PHI
Reference books:	
1	**"Introduction to Robotics Mechanics and control",** John J. Craig, 2nd Edition, Pearson education, 2003

Course outcomes
At the end of the course ,the student will have the ability
CO1: To Deduce kinematic equations for a given robot configuration.
CO2: To Select actuators and sensors for specified tasks.
CO3: To Design and develop manipulators for simple tasks.

Course Title	INDUSTRIAL INTERNET OF THINGS (Cluster Elective I)				
Course Code	16EE6GE1II	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Course Description :

With technological advances in computing power, connectivity and machine learning, the world of manufacturing is expected to undergo a major transformation. Manufacturing will use these advancements and have interconnected smart learning machines improving the productivity and margin to a large extent. This fourth industrial revolution will convert existing manufacturing facilities into smart factories having cyber physical systems communicating with each other and humans in real time taking decentralized and faster decisions. This course is a preamble to the revolution taking you through the Industrial Internet of Things that forms the back bone of cyber physical systems. The various building blocks of IIoT such as Big data, analytics, and cloud will be discussed along with case studies of integrating all these together.

Prerequisites: control systems and process control

UNIT-1		12 Hours

Course Overview :

Introduction to IIoT

IIoT in Process Automation : IT + OT

Building Blocks

Sensors & Wireless communication

Big data & Cloud , Edge / Fog Computing

Analytics

Mobility.

Standards in Industry Automation [Industrie 4.0]

Learning Activity: Pick any real life problem of significance to the individual or industry or society; Formulate / Explain the problem statement and propose a solution using IIOT & all its building blocks. Individuals shall make a 3-minute ‘pitch’ for their idea Good ideas shall be

considered for project work / prototyping and as a candidate for detailed discussions during subsequent units.		
UNIT-2		**8 Hours**
Architectures & Patterns for IIoT Industrial internet consortium reference architecture Reference architecture model industries 4.0 Solution patterns for IIOT Learning Activity: Define a solution architecture for problems identified in Unit I by explaining the rationale behind their decisions – Group activity.		
UNIT-3		**7 Hours**
Challenges with IIoT. Integrating IT & OT Communication - Connectivity, Collaboration with other infrastructure Information Security Data Management (Size, Type & Reliability) Some known ways / best practices to counter / overcome some of these constraints Learning Activity: Refine the solution architecture for problems identified in Unit II.		
UNIT-4		**4 Hours**
Case Study : IIoT for Smart City Building blocks of smart city – candidate applications for SMART CITY. Study of proposed IIoT based solutions for this application, used cases and workshop Learning Activity : Identifying improvements to the proposed SMART CITY Architecture		
UNIT-5		**8 Hours**
Case Study : IIoT for Plant Operations Introduction to plant operations (A day in the refinery / video based sessions) Today / Current Practice vs IIOT impact, IIOT in process industry, Typical IIoT applications based on industry (eg. Power vs Water vs Oil & Gas)		

Case study : Asset Management for Process Industry using IIoT, Building blocks behind the solution An overview of similar applications from the Industry **Learning Activity:** A different area of IIoT application in a process plant shall be identified. The groups will carry out research / present case studies related to this application including study of the market landscape, similar offerings etc.**.**
Learning Material provided from YOKOGAWA Evaluation Criteria: - Grading for individuals / groups based on 1. Understanding of the concepts covered based on relevance in the outcome of learning activities 2. Self-learning exhibited in the outcome of learning activities 3. Justification of decisions based on the learnings 4. Team behavior wherever applicable Top two ideas selected by Yokogawa can be taken for project work/internship.

Text book

1	Designing the Internet of Things by Adrian McEwen, Hakim Cassimally
2	Internet of Things: A Hands-On Approach By Vijay Madisetti, Arshdeep Bahga
3	Internet of things and big data: predict and change the future by Dilin Anand and Anagha P.
4	The silent intelligence the internet of things by Daniel Kellmereit and Daniel Obodovski
5	Enterprise IoT: A definitive Handbook by Naveen Balani and Rajeev Hathi
6	The internet of Things: a look at real world use cases and concerns by by Lucus Darnell
7	Internet of things by Samuel Greengard

Course outcomes At the end of the course ,the student will have the ability
CO1: To understand the building blocks of an IIOT based solution and try applying it to few common problems
CO2: To use one of the ideas of IIOT and propose a solution architecture for the idea in addition to one reference of IIOT in process Automation.
CO3: To understand the challenges of IIOT as a technology, understand its strength, limitations. Solve constraints through alternatives to refine the group proposal of process Automation.
CO4: To understand concepts of IIOT and apply them in the context of plant operations. Also gain an understanding of the operations of a process plant and identify potential applications.

CLUSTER ELECTIVE II **SEMESTER VII**

CYBER PHYSICAL SYSTEMS **16TE7GE 2CP (3:0:0:0)**	
CO1: Ability to **understand** and **explain** the concepts embedded system design process, sensors and actuators, applications, embedded processors, memory architecture and I/O hardware	-
CO2:Ability to **apply** the knowledge of processors/controllers to develop embedded systems	PO1
CO3:Ability to **analyze** embedded systems with emphasis on the techniques used to build concurrent, real-time embedded software, **select** and **use** appropriate I/O hardware to develop embedded applications	PO2
CO4:Ability to perform in a team/individual to prepare a report and make an effective **oral presentation** of the study on application of cyber physical systems	PO9 PO10 PO12

Prerequisites: Digital Electronics and Microcontrollers

UNIT I **[7Hours]**

Introduction to Embedded Systems- Applications, Motivating Example ,The Design Process, modeling, design, analysis

UNIT II **[8Hours]**

Design of Embedded Systems : Models of Sensors and Actuators–Linear and affine models, dynamic range, quantization, noise, sampling, harmonic distortion, signal conditioning, , Common Sensors , Actuators

UNIT III **[7Hours]**

Embedded Processors: Types of Processors-Microcontrollers, DSP processors, PLC, Graphic processors, Parallelism vs concurrency, pipelining, instruction level parallelism, multi core architecture

UNIT IV **[7Hours]**

Memory Architectures -Memory Technologies , Memory Hierarchy , memory maps, register files, scratch pads, caches, Memory Models-memory addresses, stacks, memory protection units, dynamic memory allocation, memory model of C

UNIT V **[8Hours]**

Input and Output :I/O Hardware –PWM, general purpose digital I/O, serial interfaces, parallel interfaces, buses, Sequential Software in a Concurrent World –interrupts and exceptions, atomicity, interrupt controllers, modeling interrupts

TEXT BOOKS

1. Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Edward A. Lee and Sanjit A. Seshia, , Second Edition, http://LeeSeshia.org, ISBN 978-1-312-42740-2, 2015.
2. Introduction to Embedded Systems - A Cyber-Physical Systems Approach,

REFERENCE BOOKS

1. Cyber-Physical Systems: From Theory to Practice, Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, CRC press
2. Principles of Cyber-Physical Systems, Rajeev Alur, MIT press

MOOCs

1. https://www.edx.org/course/cyber-physical-systems-uc-berkeleyx-eecs149-1x

REAL TIME SYSTEMS 16TE7 GE2RT (3:0:0:0)	
Course Outcomes	
CO1: Ability to **understand** and **explain** the structures of embedded system and real time operating system	--
CO2: Ability to **apply** the knowledge of operating systems to identify different scheduling policies and structure of semaphores and process operations.	PO1
CO3: Ability to **analyze** and obtain solutions for different scheduling programs.	PO2
CO4: Ability to **conduct experiments** on shell and system programing using C / Unix / RTlinux.	PO5 PO9

Prerequisites: Operating System

UNIT I **[8Hours]**

Introduction to Embedded systems: what is an embedded system, application area, categories of embedded system, overview of embedded system architecture, specialties of embedded systems **Architecture of Embedded system:** Hardware Architecture, Software architecture, Application software, Communication software, process of generating Executable images. **Programming for Embedded Systems:** Overview of ANSI C, Bit manipulation using C, Memory management, timing of programs, productivity tools, code optimization

UNIT II **[7Hours]**

Operating system Concepts: Embedded operating systems, network Operating Systems (NOS), layers of an operating system, Functions performed by an OS, the kernel, Tasks and processes, scheduling algorithm, threads, interrupt handling, Inter process communication (IPC), Task synchronization, semaphores, priority inversion, device driver, codes/Pseudo code for OS functions RTOS

UNIT III **[7Hours]**

Real Time Operating systems: Real time tasks, real time systems, types of real time tasks, real time operating system, real time scheduling algorithms, Rate monotonic algorithm, The earliest Deadline First Algorithm, Qualities of Good RTOS

UNIT IV **[7Hours]**

Programming in Linux: Overview of Unix/Linux, Shell programming, System programming

UNIT V **[7Hours]**

Programming in RTLinux: Overview of RTLinux, Core RTLinux, programs, Semaphore management, Mutex management, Case study: Appliance Controls by RTLinux System

TEXT BOOKS

1. Embedded/ Real Time systems: Concepts, Design & Programming, DR.K.V.K.K. Prasad, Dream teach - 2011
2. Embedded Systems: An integrated Approach, Lyla B Das, Pearson

REFERENCE BOOKS

1. Real-Time Systems, Jane Liu, Prentice Hall, 2000
2. Embedded systems Architecture, Programming and Design, Raj Kamal, 2nd Edition, TataMcHill

MOOCs:

1. http://nptel.ac.in/courses/106105036/

2. https://www.edx.org/course/embedded-systems-shape-world-multi-utaustinx-ut-6-20x

LOW POWER MICROCONTROLLER 16TE7GE2LC (3:0:0:0)	
CO1: Ability to **understand** and **explain** the concepts of low power microcontroller, architecture, addressing modes, timer modes, displays, low power modes, serial communication	-
CO2: Ability to **identify** the addressing modes, **write** and execute assembly and C codes	PO1
CO3: Ability to **debug** and **analyze** the assembly and embedded C code for variants of MSP430 microcontroller	PO2
CO4: Ability to identify the IDE to **conduct experiments** using assembly and embedded C for implementing low power applications on MSP430 hardware.	PO5 PO9
CO5: Ability to perform in a team/individual to prepare a report and make an effective **oral presentation** of the study on application of low power applications of MSP430	PO9 PO10 PO12

Pre-requisites: Programming language like C / C++ and Digital electronics

UNIT I **[7Hours]**

Introduction - Motivation for MSP430microcontrollers – Low Power embedded systems Main characteristics of a MSP430 microcontroller, Main features of the MSP430X RISC CPU architecture, Address space, Interrupt vector table, Flash/ROM, Information memory (Flash devices only), Boot memory (Flash devices only), RAM, Peripheral Modules, Special Function Registers (SFRs), Central Processing Unit (MSP430 CPU), Arithmetic Logic Unit (ALU), MSP430 CPU registers, Central Processing Unit (MSP430X CPU), MSP430X CPU registers.

UNIT II **[7Hours]**

Addressing modes & Instruction set- Double operand instructions, Single operand instructions, Program flow control – Jumps, Emulated instructions and programming.

UNIT III **[7Hours]**

Device Systems and Operating Modes- System reset, system clock, interrupt management, WDT, WDT+, Basic Timer, Timer_A and Timer_B, low power modes.

UNIT IV **[8Hours]**

On-Chip Peripherals and digital input, output and displays- Hardware multiplier, ADC, DAC, SD16, LCD, DMA, Registers, Interruptible ports.

UNIT V **[7Hours]**

Communications: Communications system model, Transmission mode, Synchronous and asynchronous serial communications, Serial Peripheral Interface (SPI) communication protocol, MSP430 communications interfaces, Case Studies

TEXT BOOKS

1. John H Davies, MSP430 Microcontroller Basics, Newnes Publications, 2008
2. Teaching MSP430, CD provided by Texas Instruments

REFERENCE BOOKS

1. Chris Nagy, Embedded systems Design using TI MSP430 Series, Newnes Publications, 2003
2. Programmable Microcontrollers with Applications: MSP430 Launchpad with CCS and Grace, Cem Unsalan, McGraw-Hill Education - Europe

MOOCS

1. http://nptel.ac.in/courses/117104072/
2. http://nptel.ac.in/courses/106108100/

INSTITUTE ELECTIVE GROUP I **SEMESTER VII**

System Design and Optimization using Engineering Tools 16TE7IE SDE (3:0:0:0)	
Course Outcomes	
CO1: Understand basic programming concepts, data analysis and optimization techniques	PO5
CO2: apply programming skills to **develop** models for a given application	PO1, PO5
CO3: Ability to **analyze** and **validate** the developed models	PO4 , PO3
CO4: Analyze the simulation results compare with given specifications	PO4
CO5: Synthesize an optimal time-domain/frequency domain model	PO4
CO6: Perform in a team to formulate an optimization problem and develop the Graphical User Interfaces (GUI) for the identified problem	PO9

UNIT I **[7 hours]**

Data Analysis and Processing: Model requirements for importing data, import, plot and analyze data, preprocessing of Data, GUI

UNIT II **[7 hours]**

Parameter Estimation: Specifying experiment data, specifying parameters for estimation and initial states, run estimation and model validation

UNIT III **[7 hours]**

Response Optimization: Optimization algorithm to formulate minimization problems, specifying response characteristics and requirements, specify and edit time-domain design requirements

UNIT IV **[7 hours]**

Frequency-domain design: Specifying frequency domain requirements, Specifying design variables and update model, optimization and linearization options, plots using response optimization tool

UNIT V **[8 hours]**

Design Optimization: Design optimization to Meet time and frequency domain requirements, design optimization with uncertain variables, optimizing parameters for robustness and speed, parallel computation for response optimization

TEXTBOOKS

1. SIMULINK Design Optimization User's Guide by MATHWORKS, MATLAB R2015b
2. Multiple Design Optimization, Garret N. Vanderplaats

REFERENCE BOOKS

1. Optimization for Engineering Design, Kalyanmay Deb
2. Engineering optimization: theory and practice / Singiresu S. Rao.

MOOCs

1.https://ocw.mit.edu/courses/sloan-school-of-management/15-057-systems-optimization-spring-2003/

2. https://www.mathworks.com/discovery/design-optimization.html

SYSTEM DESIGN USING GRAPHICAL PROGRAMMING 16TE7IE SDG (3:0:0:0)	
Course Outcomes	
CO1: Ability to **define, understand**, and **explain** graphical system design and virtual instrumentation	--
CO2: Ability to **analyze and synthesize** the graphical program using loops arrays, strings and structures.	PO1
CO3: Ability to **solve** a problem and **analyze** the results using modern engineering tool	PO2
CO4: Ability to function effectively as an individual or as a team member to **conduct experiments** using modern engineering tools for a given problem	PO5 PO9
CO5: Ability to perform in a team to implement an open-ended experiment	PO5 PO9 PO12

UNIT I **[8Hours]**

Graphical system design: GSD model, design flow with GSD, virtual instrumentation, hardware and software in virtual instrumentation, test, control and design, engineering process, virtual instrumentation beyond personal computer, comparison of textual language and graphical programming language.

Introduction to Lab VIEW: Advantages, software environment, creating VI, front panel, block diagram, palettes, short cut menus, property dialog boxes, controls and indicators, data types, data flow, keyboard shortcuts.

UNIT II **[7Hours]**

Modular Programming: Modular programming in LabVIEW, icon and connector plane, creating an icon, building a connector pane, Displaying Sub VIs and express Vis, editing sub VIs, creating standalone application

Repetition and Loops: For loops, while loops, structure tunnels, terminals inside or outside loops, shift registers, feedback nodes, control timing, communication of multiple loops, local and global variables.

UNIT III **[7Hours]**

Arrays: Arrays in LabVIEW, creating 1D and 2D and multi-dimensional arrays, initializing arrays, editing the arrays, array functions, auto indexing, arrays using loops, data structures using wires, auto indexing, matrix operations with arrays, polymorphism.

Clusters: Creating cluster controls and indicators, cluster constant, order of cluster elements, cluster operations, assembling and disassembling clusters, conversion between arrays and clusters, error handling, error cluster.

UNIT IV **[7Hours]**

Plotting data: Types of waveforms, waveform graphs, waveform charts, waveform data type, XY graphs, intensity graphs and charts, digital waveform graphs, 3D graphs, customizing graphs and charts, dynamic formatting of graphs, displaying special planes on XY graph

Structures: Case structures, sequence structures, customizing structures, timed structures, formula nodes, event structure, and LabVIEW mathscript.

UNIT V **[7Hours]**

Strings and File I/O: Creating string control and indicators, string functions, editing and formatting strings, configuring string controls and indicator, basics of file input/output, choosing a file I/O format, File I/O VIs, creating a relative path.

Instrument control: GPIB communication, hardware specifications, software architecture, instrument I/O assistant, VISA, instrument drivers, serial port communications, using other interfaces.

TEXT BOOKS

1. “Virtual Instrumentation using LabVIEW” Jovitha Jerome, PHI publication
2. “LabVIEW for Everyone” JEFFREY TRAVIS JIM KRING, 3rd Edition, Pearson education. Ltd., 2004.

REFERENCE BOOKS

1. "Learning with Lab-View" Robert H. Bishop, PreticeeHall,2009
2. "Virtual Instrumentation, LABVIEW", Sanjay Gupta, TMH,NewDelhi,2003

MOOCs

www.ni.com/tutorial/280L/en/

LAB PROGRAMS

1. Program to build VIs and sub VIs, express Vis
2. Programming with loops: case structure, for loops, while loops
3. Programming with arrays: 1D,2D, multi dimension arrays
4. Programming with strings
5. Programming with sstructures, clusters
6. Programming with waveform graph,waveform chart, multiple graphs, customizing the graphs
7. Programming with File I/O

To build any engineering application

INSTITUTE ELECTIVE GROUP II **SEMESTER VIII**

NETWORK MANAGEMENT **16TE7 IE2RT (3:0:0:0)**	
Course Outcomes	
CO1: Ability to **define, understand and explain** concepts related to network Management	--
CO2: Ability to **apply** the knowledge of computer network and communication to network , telecommunication management applications and models	**PO1**
CO3: Ability to **analyze** the different parameters for SNMP	**PO2**
CO4: Ability to perform in a team/individual to prepare a report and make an effective **oral presentation** of the study on application Network Management	**PO9** **PO10** **PO12**

UNIT I **[8 Hours]**

Introduction: Analogy of Telephone Network Management, Data and Telecommunication Network, Distributed computing Environments, TCP/IP Based Networks: The Internet and Intranets, Communication Protocols and Standards, Networks, Systems and services, Case Histories of Networking and Management,Challenges of IT Managers, Network Management: Goals, Organization, and Functions, Network Management Architecture and Organization.

Review of information Network and Technology: Network Topology , Local Area Networks, Network Node Components, Wide Area Networks, Transmission Technology

UNIT II **[7 Hours]**

SNMP and Network Management: Basic Foundations: Standards, Models and Language: Network Management standards, Network Management Models, Organization model, information model, Communication model, Abstract syntax Notation One ASN.1, Encoding structure, Macros, Fucntional Model

UNIT III **[7 Hours]**

SNMPv1 Network Management - 1 : Managed Network: The History of SNMP Management, Internet Organizations and standards, Internet Documents, The SNMP Model, The Organization Model, System Overview

UNIT IV **[7Hours]**

SNMP Management – RMON: Remote Monitoring, RMON SMI and MIB, RMONI1, RMON2, ATM Remote Monitoring, A Case Study of Internet Traffic Using RMON.

UNIT V **[7Hours]**

Telecommunication Management Network (TMN): Why TMN, operations systems, TMN conceptual model, TMN standards, TMN architecture, TMN Management service architecture, An integrated View of TMN, Implementation issues

Network Management Applications: Configuration Management, Fault Management, Performance management, Event Correlation Techniques

TEXT BOOKS:

1. Mani Subramanian: Network Management- Principles and Practice, 2nd Edition, Pearson Education, 2010.
2. J. Richard Burke: Network management Concepts and Practices: a Hands-On Approach, PHI, 2008.

REFERENCE BOOKS:

1. Alexander Clemm , Network Management Fundamentals 1st Edition, CISCO Press

MOOCs

1. http://nptel.ac.in/courses/106105081/
2. http://nptel.ac.in/courses/106106091/

SATELLITES: PRINCIPLES AND APPLICATIONS 16TE8IESPA (3:0:0:0)	
Course Outcomes	
CO1: Ability to **define, understand** and **explain** Satellite Principles and applications.	**-**
CO2: Ability to **apply** the knowledge of Physics, mathematics, electronics and communication for satellites	**PO1**
CO3: : Ability to **analyze** orbital parameters, modulation schemes, multiple access methods and satellite links	**PO2**
CO4: Ability to use **tools** for studying satellite applications	**PO5**
CO5: Ability to engage in **independent learning**, submit a report and use ICT for effective presentation of the study on assigned topics related to applications of satellite communication/ standards/ related hazards	**PO7** **PO8** **PO9** **PO10** **PO12**

UNIT I **[7Hours]**

Introduction to Satellites and Applications: History of evolution of satellites, Basic principles, Satellite orbits, orbital parameters, Launch vehicles, orbital perturbations, look angles

UNIT II **[7Hours]**

Satellites Hardware: Satellite subsystems, Mechanical structure, Propulsion subsystem, Thermal control subsystem, Attitude and orbit control, Telemetry tracking and command subsystem, Payload, Antenna subsystem

UNIT III **[8Hours]**

Communication Techniques: Types of information signals, AM, FM, Pulse communication, Digital modulation techniques, Multiplexing Techniques, Multiple Access Techniques-FDMA,TDMA,CDMA, Satellite link design fundamentals, Earth station, Networking protocols.

UNIT IV **[7Hours]**

Satellite Applications: Communication satellites, Remote sensing satellites, Weather satellites, Navigation satellites

UNIT V **[7Hours]**

Scientific satellites: satellite based versus ground based scientific Techniques, Applications of scientific satellites-study of earth, Astronomical observations, Military satellites, Emerging trends-Millimeter wave satellite communication, space stations

TEXT BOOKS:

1. **Satellite Technology Principles and Applications: 3rd Edition,** by Anil Maini, Varsha Agrawal, Publisher: John Wiley & Sons
2. **Satellite Communications:** Dennis Roddy, Tata McGraw Hill

REFERENCE BOOK:

1. **Satellite Communication:** Timothy Pratt, Second Edition, John Wiley and sons.
2. **Satellite Communications Systems : systems, techniques and technology**, 5th edition, by G. Maral, M. Bousquet, Z. Sun, Publisher: John Wiley and sons
3. **The Satellite Communication Applications Handbook,** Bruce R. Elbert Artech House, 2004 - Technology & Engineering

MOOCs:

1. https://onlinecourses.nptel.ac.in/noc16_ec10/preview
2. http://nptel.ac.in/courses/106105082/33