Courses of Study

(Detailed Course Contents)

Under-graduate, & Post-graduate Programmes

(2022-2023)

Shri Mata Vaishno Devi University

Kakryal, Katra 182320 Jammu & Kashmir

VISION

Establishment of a Scientific & Technical University of Excellence to nurture young and talented human resources for the service of Indian Society & world at large and preserving the integrity and sanctity of human values.

MISSION

The mission of the University is the pursuit of Education, Scholarship and Research at the highest International level of excellence.

OBJECTIVES

- Provide education and training of excellent quality, both at undergraduate and postgraduate level.
- Ensure that the University achieves and maintains an international standing in both teaching and research
- Promote study and research in new and emerging areas and encourage academic interaction of the faculty and the students at national and international levels.
- Encourage close collaboration with industry and facilitate the application of research for commercial use and for the benefit of society.

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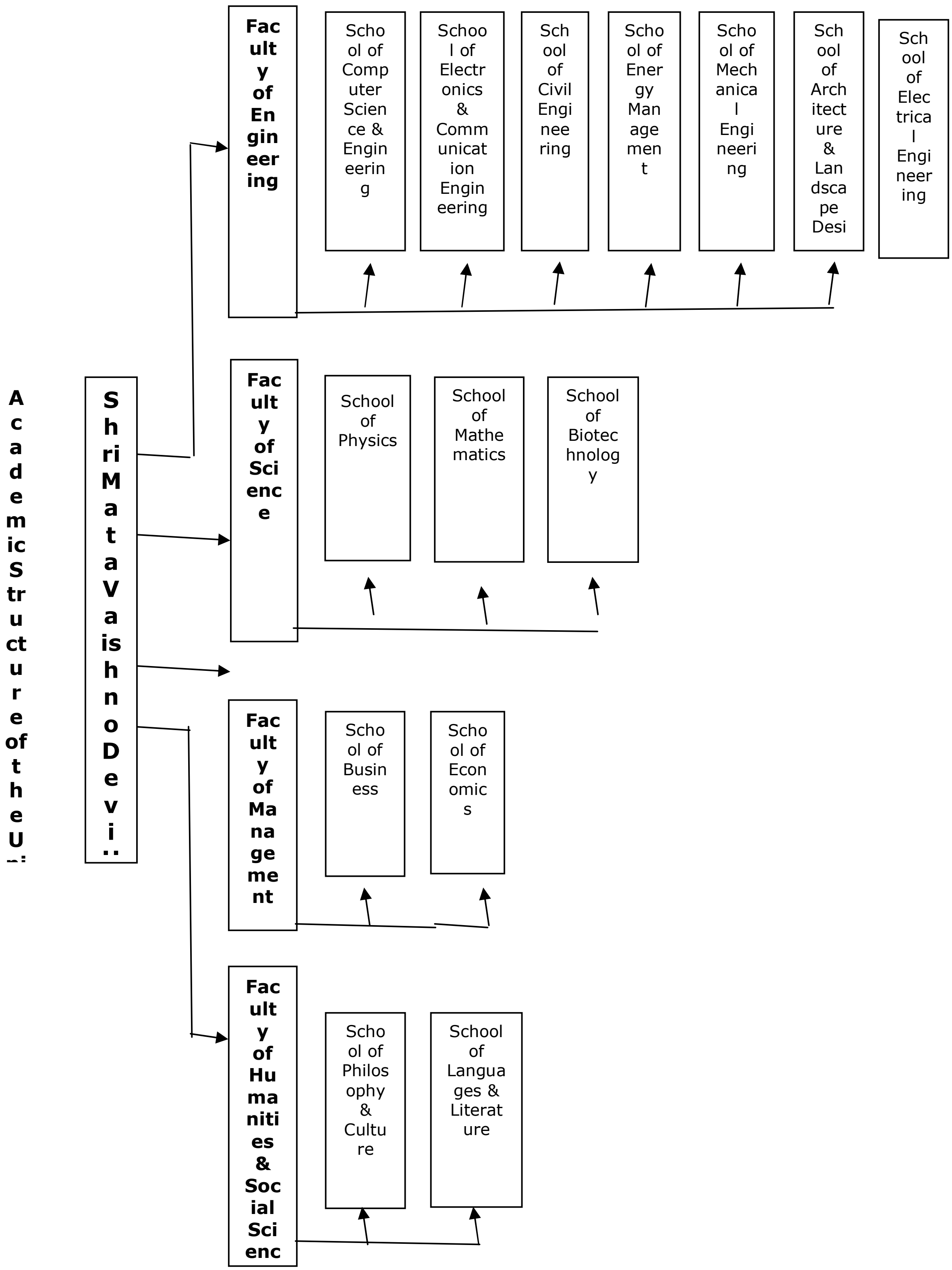
CONTENTS



Academic Structure of the Uni
Shri Mata Vaishno Devi
Faculty of Engineering
School of Computer Science & Engineering
School of Electronics & Communication Engineering
School of Civil Engineering
School of Energy Management
School of Mechanical Engineering
School of Architecture & Landscape Desi
School of Electrical Engineering
Faculty of Science
School of Physics
School of Mathematics
School of Biotechnology
Faculty of Management
School of Business
School of Economics
Faculty of Humanities & Social Scienc
School of Philosophy & Culture
School of Languages & Literature

Details of

Programme of Study

&

Syllabus of Courses

Offered by

School of Electronics & Communication Engineering

Introduction
The field of electronics is the fastest growing and the most rapidly changing area of technology in the current times. Electronics has become the all-pervasive technology, which finds application in all spheres of engineering including computers, communication, defense, mechatronics, instrumentation, automation, robotics, artificial intelligence, computer networks, satellites, education etc. The use of electronics has brought about a drastic change in the way human civilization exists today.

The School currently offers a 4 Year (8 Semester) B.Tech(Electronics & Communication Engineering) program, M.Tech(Electronics & Communication Engineering) program and PhD.The field of communication has benefited significantly because of the growth of electronics technology. Currently it is possible to communicate using computers and mobile phones across cities, deserts, and oceans via satellites orbiting in space but there is more to come. Latest technologies in the communication field are entirely dependent on the field of electronics.

Objectives
The school of Electronics & Communication engineering has been set up to impart training of the highest standards to the students, in the field of electronics, thus preparing them to meet the exacting demands of the highly competitive global industrial market. The objectives of the B.Tech Programme are:

- The progressively impart training starting from the basic fundamentals of electronics and covering the entire spectrum of current technologies being used in the field of communication, digital design, chip design and industry in general.
- To instill in the students a sense of curiosity about the field of electronics and make them confident to explore and innovate.

To ensure that the students develop strong work ethics, organizational skills, team work and understand the importance of being a thorough professional.

<u>POs & PEOs of Programs</u>

Program Outcomes:

1. Apply Knowledge of mathematics, science and engineering fundamentals in the domain of Electronics and Communication
2. Identify, formulate, and analyze complex engineering problems to achieve appropriate solutions.
3. Design systems and processes that meet the requirements of public safely and offer solutions for societal and environmental issues.
4. Apply research knowledge to formulate, and analyze complex engineering problems by synthesizing mathematical principles and engineering fundamentals for valid conclusions.
5. Construct, select, and apply the appropriate techniques and modern engineering tools for the system design and analysis.
6. Apply the contextual knowledge to assess the contemporary issues and the impact of engineering solutions on the society.
7. Examine the impact of engineering solutions in environmental context and utilize the knowledge for sustainable development.
8. Develop consciousness and commitment towards professional ethics, responsibilities and norms of engineering practices so as to become good citizens
9. Ability to perform effectively, individually and in a team
10. Proficiency in communication, both verbal and written forms, to be able to compete globally, and communicate effectively on complex engineering activities.
11. Demonstrate the knowledge gained in lifelong learning, and hence participate and succeed in competitive examinations, higher studies, and broader context of technological change.
12. Willingness and ability to take up administrative responsibilities involving both project and financial management confidently.

Program Educational Objectives (PEOs)

1. To progressively impart training starting from the fundamentals of electronics and covering the entire spectrum of current technologies being used in the field Electronics and Communication Engineering
2. To inculcate a sense of curiosity in the students, about the field of E&C and make them confident to explore and innovate
3. To ensure that the students develop strong work ethics, organizational skills, team work and understand the importance of being a thorough professional

4. To develop integrality, human and Ethical values

Training Methodology

The emphasis of the program is on practical, hands-on learning. Significant part of the curriculum is dedicated to ensuring that the students get to work with latest equipment and explore the implementation of the knowledge learnt through the class-work. Besides regular class-work, skills of the students are honed by their participation in group discussions, presentations, group assignments and project work which is mandatory 5th semester onwards. The students face continuous evaluation based on these activities. The students are also required to undergo summer training in an industrial environment to learn industrial standards of project management, teamwork, quality considerations and documentation.

Infrastructure

State-of-the-art laboratories, containing the latest equipment have been set up to ensure that the students get complete facilities to thoroughly understand and explore the concepts of electronics as learnt in the class-room. Specifically keeping in mind, the fact that the University is located in a region where day-to-day industrial interaction is not feasible, the latest equipment is provided in the laboratories itself to ensure that the students are kept abreast of the newer technologies being used in the industry. The school has established laboratories in collaboration with Multi-national companies like Xilinx Inc., USA & Freescale Semiconductors Ltd., USA. The School has also established the **"Center for Embedded Instrumentation & Networked Controls"** with funding from UGC. The following laboratories have been established to provide the students with the best possible facilities for enhancing the value of the learning process:

1. **Analog Electronics Lab**
   - Basic Electronics &Electrical Engg.Lab
   - Linear Integrated circuits Lab
   - Electronics Circuits Lab
2. **SMVDU Xilinx Lab - Established with support from M/s Xilinx Inc., USA**
   - Digital Electronics Lab
   - VHDL & FPGA Lab
   - Electronic Measurement & Instrumentation Lab
   - Control Systems Engineering Lab
3. **SMVDU Freescale Systems Lab - Setup in collaboration with Freescale Semiconductors Inc.(Erstwhile Motorola Semiconductor)**
   - Microprocessor Lab
   - Microcontrollers Lab
   - Embedded Systems Lab
4. **Communication Engineering Lab**
   - Analog Communication Lab
   - Digital Communication Lab
   - Microwave Lab
   - Optical Fiber Communication Lab
   - Switching Networks Lab
5. **Electrical Machines Lab**
   - Power Electronics Lab
   - Electrical Machines Lab
6. **PCB Fabrication & Project Lab**
7. **Center for Embedded Instrumentation & Networked Controls (Research Lab)**
   - Embedded Systems Lab
   - Image processing
   - Wireless Networks Lab
   - Signal Processing Lab
8. **Microelectronics Lab (Research Lab)**
   - VLSI Lab
   - MEMS Lab

Program Structure of the
B. Tech (Electronics & Communication Engineering) Program,2022 - 26

Semester I **First Year**

Course Code	Course Title	L	T	P	C
PHL 1012	Engineering Physics	3	0	0	3
PHP 1012	Engineering Physics Lab	0	0	2	1
ECL 1010	Basic Electronics	3	0	0	3
ECP 1010	Basic Electronics Lab	0	0	2	1
MTL 1025	Engineering Mathematics-I	3	0	0	3
CSL 1022	Introduction to 'C' Programming	3	0	0	3
CSP 1022	'C' Programming Lab	0	0	2	1
LNL 1411	Professional Communication	2	0	0	2
LNP 1411	Professional Communication Lab	0	0	2	1
MEP 1114	Workshop	0	0	2	1
	Induction Program				NC
PCN 1010	NSS				NC
	Total Credits				**19**

Semester II **First Year**

Course Code	Course Title	L	T	P	C
MTL 1026	Engineering Mathematics II	3	0	0	3
MEL 1039	Engineering Graphics with CAD	1	0	2	2
CSL 1028	Programming using Python	2	0	0	2
CSP 1028	Python Programming Lab	0	0	4	2
ECL 1030	Electronic Circuits & Simulation	3	0	0	3
ECP 1030	Circuit & Simulation Lab	0	0	2	1
ECL 1022	Network Analysis & Synthesis*	3	0	0	3
PCL 1067	Discourse on Human Virtues	3	0	0	3
LNP 1142	Language Lab	0	0	2	1
	Total Credits				**20**

Semester III **Second Year**

Course Code	Course Title	L	T	P	C
PCL 2042	Introduction to Logic	3	0	0	3
ECL 2070	Digital Electronics*	3	0	0	3
ECP 2070	Digital Electronics Lab	0	0	2	1
ECL 2130	Signal & Systems*	3	0	0	3
ECL 2151	Analog Communication Engineering	3	0	0	3
ECP 2151	Analog Communication Engineering Lab	0	0	2	1
CSL 2031	Data Structure	3	0	0	3
CSP 2031	Data Structure Lab	0	0	2	1
ECP 2201	Electronics Workshop Lab	0	0	2	1
ECC 2001	Summer Internship - I				1
BTL 2304	Environmental Studies	3	0	0	NC
	Total Credits				**20**

Semester IV **Second Year**

Course Code	Course Title	L	T	P	C
ECL 2030	Linear Integrated Circuits & Applications	3	0	0	3
ECP 2030	Linear Integrated Circuits & Applications Lab	0	0	2	1
ECL 2152	Digital Communication Engineering	3	0	0	3
ECP 2152	Digital Communication Engineering Lab	0	0	2	1
ECL 2040	Electromagnetic Field Theory	3	0	0	3
ECL 2061	Microprocessor & Interfacing	3	0	0	3
ECP 2061	Microprocessor & Interfacing Lab	0	0	2	1
ECL 1200	MATLAB Programming	1	0	2	2
ECL 3182	Probability Theory & Stochastic Process	3	0	0	3
	Total Credits				**20**

Semester V **Third Year**

Course Code	Course Title	L	T	P	C
ECE XXXX	School Elective - I	3	0	0	3
ECL 4202	Digital Signals Processing	3	0	0	3
ECP 4202	Digital Signals Processing Lab	0	0	2	1
ECL 3090	*Control Systems	3	0	0	3
ECL 3081	Embedded Systems & Microcontrollers	3	0	0	3
ECP 3081	Embedded Systems & Microcontrollers Lab	0	0	2	1
ECL 2071	*Digital System Design using Verilog	3	0	0	3
ECP 2071	Verilog Lab	0	0	2	1
ECL 2041	Antenna & Wave Propagation	3	0	0	3
ECD 3990	Minor Project-I (Hardware Based Project)	0	0	0	2
ECC 3002	Summer Internship - II				1
PCN 3079	Constitution of India	1	0	0	NC
	Total Credits				**24**

Semester VI **Third Year**

Course Code	Course Title	L	T	P	C
ECE XXXX	School Elective - II	3	0	0	3
	Open Elective I	3	0	0	3
ECL 3130	IC Fabrication & VLSI	4	0	0	4
ECP 3130	IC Fabrication & VLSI Lab	0	0	2	1
ECL 3181	Internet of Things	3	0	0	3
ECP 3181	Internet of Things Lab	0	0	2	1
ECL 3050	*Microwave Engineering	3	0	0	3
ECP 3050	Microwave Engineering Lab	0	0	2	1
ECL 3100	Communication & Data Network	3	0	0	3
ECD 3991	Minor Project-II (Hardware Based Project)				3
	Total Credits				**25**

Semester VII **Fourth Year**

Course Code	Course Title	L	T	P	C
ECC 4982	Summer Internship - III				2
	Open Elective -II	3	0	0	3
BUL 4011	Entrepreneurship Management	3	0	0	3
ECE XXXX	School Elective-III	3	0	0	3
ECE XXXX	School Elective-IV	3	0	0	3
ECL 4180	Mobile Cellular Communication& 5G Communication Lab	3	0	0	3
ECP 4180	Advanced Communication Lab	0	0	2	1
ECD 4996	Minor Project -III				4
	Total Credits				**22**

Semester VIII **Fourth Year**

Course Code	Course Title	L-T-P	Credit
ECD 4992 / ECC 4982	(Major Project + **Open Elective-IV**) (NC) / Internship		10
	Total Credits		**10**

Total Credits **160 Credits**

***The Tutorial Classes will be additional in the following subjects and extra slot in the table will be allocated for the same.**

***As approved in the 31st Meeting of Academic Council "2018 Batch onwards Students are required to clear comprehensive Exam in the 7th semester is eligible for B.Tech degree**

List of School Electives for B. Tech. Students

LIST OF SCHOOL ELECTIVES I, II ,III , IV						
S. No.	Course Code	Course Title	L	T	S	C
1	ECE 3101	Introduction to Wireless Networks	3	0	0	3
2	ECE 4191	Speech Processing	3	0	0	3
3	ECE 4192	Image & Video Processing	3	0	0	3
4	ECE 4190	Multimedia Communications	3	0	0	3
5	ECE 4140	Introduction to MEMS Design	3	0	0	3
6	ECE 4171	Optoelectronic Devices	3	0	0	3
7	ECE 4251	Object Oriented Programming	3	0	0	3
8	ECE 4082	Advanced Embedded Systems	3	0	0	3
9	ECE 4160	Satellite Communication	3	0	0	3
10	ECE 3100	Pervasive Computing & WSN	3	0	0	3
11	ECE 4161	Radar & Navigational Guides	3	0	0	3
12	ECE 3091	Virtual Instrumentation using LAB View	3	0	0	3
13	ECE 4041	Digital Integrated Circuits	3	0	0	3
14	ECE 4193	Digital Signal Processing	3	0	0	3
15	ECE 4194	Deep learning	3	0	0	3
16	ECE 3091	Electronic Measurement and Instrumentation	3	0	0	3
17	ECE 4041	Digital Integrated Circuits	3	0	0	3

18	ECE 4193	Digital Signal Processing	3	0	0	3
19	ECE 4195	Social Networks	3	0	0	3
20	ECE 4196	Information Theory & Coding	3	0	0	3
21	ECE 4252	Machine Learning	3	0	0	3
22	ECE 4142	Analog VLSI Design	3	0	0	3
23	ECE 4103	Mobile Ad hoc Network	3	0	0	3
24	ECE 4171	Optoelectronics Device	3	0	0	3
25	ECE 4071	Modeling and analysis of nanoscale devices	3	0	0	3
26	ECE 4083	Industry 5.0 & Industrial Internet of Things	3	0	0	3
27	ECE 6231	Modelling of Nanodevices	3	0	0	

Basic Electronics

ECL 1010 **3-1–2=5**

Course Outcomes

CO1	To learn basic concepts of Semiconductor Devices
CO2	Able to understand and use BJT and MOS Devices.
CO3	Learn and able to apply small signal BJT and FET analysis.
CO4	To analyze and design rectifiers and amplifiers.
CO5	Able to understand advanced semiconductor devices and oscillators.

Introduction:- Semiconductor Classification ,Semiconductor bonds, Energy band description ,Semiconductor types, Hall effect.
Diodes:- P-N junction-I/V characteristics, diode equivalent circuits, semiconductor diodes, rectifiers-(efficiency, ripple factor),filters,clipers,clampers.
Transistors:-BJT construction, characteristics (cb,ce,cc), load line. BJT biasing. FET, JFET, MOSFET (Depletion and enhancement), FET biasing.
Transistor Modeling:-BJT small signal model, hybrid equivalent model,FET small signal model.
Amplifiers:- Single stage amplifiers, voltage gain, effect of frequency on Gain, multistage amplifier.
Other Semi-conductor devices- SCR'S , Diacs, triacs, and other thyristors, basic theory of operation, characteristics,Theory and operation of UJT,
Oscillators:-Feedback BH criteria, oscillator types, sinusoidal oscillator, Hartley oscillator,Collpitts Oscillator, Phase shift,Wein bridge oscillator, crystal oscillator.

Recommended Books:
- Basic Electronics: Devices, Circuits & IT Fundamentals, Kal,PHI
- Basic Electronics for Scientists
- Electronic Devices & Circuits: An Introduction, Mottershead,
- Electronic Devices & Circuits, Boylestad, Nashelky, PHI
- Semiconductor Devices , NanditaDass, PHI
- Electronic Devices & Circuits, Milman&Halkias
- Electronic Devices & Circuits, Theodore Bogart, Jr

Basic Electrical Engineering

ECL 1020 **3 – 0 – 2 = 4**

Course Outcomes

CO1	To learn basic concepts of electrical engineering and be able to understand their applications.
CO2	To apply basic circuit analysis concept to solve basic electrical circuits.
CO3	To apply the network theorems to practical problems.
CO4	To study resonance behaviour of electrical circuits.
CO5	To learn basic operating principle of transformer.

UNIT - I

Introduction to Electrical Engineering: Essence of electricity, Conductors, semiconductors and insulators (elementary treatment only); Electric field; electric current, potential and potential difference, electromotive force, electric power, ohm's law, basic circuit components, electromagnetism related laws, Magnetic field due to electric current flow ,force on a current carrying conductor placed in a magnetic field, Faradays laws of electromagnetic induction. Types of induced EMF's, Kirchhoff's laws. Simple problems.

UNIT-II

Network Analysis : Basic definitions, types of elements , types of sources, resistive networks, inductive networks, capacitive networks, series parallel circuits, star delta and delta star transformation , Network theorems- Superposition , Thevenins's, Maximum power transfer theorems, Norton theorem and simple problems.

UNIT-III

Alternating Quantities : Principle of ac voltages , waveforms and basic definitions, relationship between frequency, speed and number of poles, root mean square and average values of alternating currents and voltage, form factor and peak factor, phasor representation of alternating quantities, the J operator and phasor algebra, analysis of ac circuits with single basic network element, single phase series circuits, single phase parallel circuits, single phase series parallel circuits, power in ac circuits. Fundamentals of AC- Average value, RMS value, form factor, crest factor, AC power and power factor, phasor representation of sinusoidal quantities.Simple series, parallel & series-parallel circuits containing R-L, R-C, R-L-C parameters.Active, Apparent & Reactive power, Resonance in series & parallel circuits.

UNIT-IV

Transformers : Principles of operation, Constructional Details, Ideal Transformer and Practical Transformer, Losses, Transformer Test, Efficiency and Regulation Calculations.

Recommended Books:

- Electrical & Electronic Technology, Hughes, Pearson Education
- Basic Electrical Engineering, Cathey, Nasar, TMH
- Basic Electrical Engineering, Mittal, TMH
- Basic Electrical Engineering, B. L. Theraja
- Electrical Engineering Fundamentals, Vincent Deltoro, PHI
- Network & Systems, D Roy Choudhary
- Circuit Analysis, A.K. Chakrabarti

Linear Integrated Circuits and Applications

ECL 1030 **4 – 0 – 0 = 4**

Course Outcomes

CO1	To understand the concept of differential amplifiers	
CO2	To understand the basics of Operational amplifiers and its applications	
CO3	To be able to perform the Frequency response analysis of Op-amp	
CO4	To be able to design active filters and oscillators using Op-amp	
CO5	To be introduced about some specialized IC applications of OP-amp	

Unit I: Introduction: Differential Amplifiers

Basics of Differential Amplifier, Transistorized Differential Amplifier, Configurations of Differential Amplifier, Analysis of Dual Input Balanced Output Differential Amplifier, Constant Current Bias, Current Mirror Circuit, Cascading of Differential Amplifiers.

Unit II: Introduction to Operational Amplifiers

The Ideal Op-Amp, Block diagram Representation of Op-Amp, Voltage Transfer Curve of Op-Amp, Integrated Circuit: Package Types, Pin Identification and Temperature- Ranges, Interpretation of Data sheets and Characteristics of an Op-Amp, Inverting and Non-Inverting Configuration, Ideal Open-Loop and Closed-Loop Operation of Op-Amp, Block diagram Representation of Feedback Configurations, Voltage-Series Feedback Amplifier, Voltage-Shunt Feedback Amplifier, Differential Amplifiers with One & Two Op-Amps.

Unit III: Frequency Response of an Op-Amp

Introduction, Frequency Response, Compensating Networks, Frequency Response of Internally Compensated Op-Amp, Frequency response of Non-compensated Op-Amp, Closed-Loop Frequency Response, Circuit Stability, Slew Rate.

Unit-IV: General Linear Applications

DC & AC Amplifiers, Peaking Amplifier, Summing, Scaling and Averaging amplifier, Instrumentation Amplifier, Voltage-to-Current Converter, Current-to-Voltage Converter, The Integrator, The Differentiator, Log and Antilog Amplifier, Peak Detector, Precision Rectifiers, Comparator, Zero Crossing Detector, Schmitt Trigger, Sample and Hold Circuit, Clippers and Clampers, A/D and D/A Converters.

Unit V: Active Filters and Oscillators

Active Filters:- Butterworth Filters, Band-Pass Filters, Band Reject Filters, All-Pass Filters. Oscillators and Wave Generators:- Phase Shift Oscillator, Wien Bridge Oscillator, Voltage-Controlled Oscillator(VCO), Square Wave Generator, Triangular Wave Generator, Saw-tooth Wave Generator.

Unit VI: Specialized IC Applications

Introduction, Universal Active Filter, The 555 Timer, Monostable and Astable Multivibrator using IC 555, Phase-Locked Loop(PLL), Voltage Regulators.

Recommended Books:

- OP-AMP and Linear IC's By Ramakant A. Gayakwad, Prentice Hall
- Digital Integrated Electronics, By Taub and Schilling, McGraw Hill

- Integrated Electronics, By Millman J. and Halkias C.C., McGraw Hill.
- Op-Amp and Linear IC's, By Caughlier and Driscoll, PHI

Communication and Data Network

ECL 3100 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To understand signal flow on physical layer.
CO2	Able to understand behavior network layer.
CO3	Able to understand behavior Data-link layer.
CO4	Able to understand behavior Transport layer.
CO5	To apply knowledge in the data communication systems

Unit I: Physical Layer
Communication Medium (Copper, OFC, Wireless), Connectors and Cables (RJ11, RJ45, 8P8C, Cat5, Cat6, UTP, Coax, 10baseT etc.) Baseband and Passband Communications, Modulation schemes, Source coding, Channel coding, Line coding
Unit II: Data link Layer
Framing and Error Detection, Packet Multiple Access, Packet Switching, Aloha, CSMA (CA, CD), RTS CTS, Hidden/Exposed Terminals, ARQ Protocols, ARP, LAN, Ethernet, 802.11, 802.15.1, 802.15.4
Unit III: Network Layer
Network Addressing, Subnets, Packet Routing, Packet Fragmentation, Routing Protocols, WAN, IP, ICMP
Unit IV: Transport Layer
Datagrams, Segments, Bit Streams, Connection Oriented and Connectionless Protocols, Reliability, Error Detection and Correction, Flow Control, Congestion Control, TCP, UDP, RTP, Host to Host Communication

Recommended Books:

- 1. D E Comer and M S Narayanan. Computer Networks and Internets 4th ed : Pearson Education: ISBN: 9788177589276
- 2. Peterson and Davie. Computer Networks (2nd Edition). San Francisco, CA: Morgan Kaufmann Publishers, 1999. ISBN: 1558605142 .
- 3. Tanenbaum, A. S. Computer Networks. 4th ed. Upper Saddle River, NJ : Prentice Hall, 2003. ISBN: 0130661023.
- 4. Stevens. TCP/IP Illustrated. Reading, MA: Addison-Wesley Pub. Co., c1994-c1996. ISBN: 0201633469.
- 5. Saltzer, J., D. Reed, and D. Clark. "End-to-end Arguments in System Design." ACM Transactions on Computer Systems (TOCS) 2, no. 4 (1984): 195-206.
- 6. Cerf, V., and R. Kahn. "A Protocol for Packet Network Interconnection." IEEE Transactions on Communications COM-22 (1974): 637-648.
- 7. Clark, D. "Design Philosophy of the DARPA Internet Protocol." Proc ACM SIGCOMM (August 1988): 106-114. Stanford, CA.
- 8. Paxson, V. "End-to-End Routing Behavior in the Internet." IEEE/ACM Transactions on Networking 5, no. 5 (October 1997): 601-615.
- 9. Jacobson, V., and M. Karels. "Congestion Avoidance and Control." Proc ACM SIGCOMM (August 1988). Stanford, CA.
- 10. Bharghavan, V., A. Demers, S. Shenker, and L. Zhang. "MACAW: A Media Access Protocol for Wireless LANs." ProcACM SIGCOMM (September 1994): 212-225. London, UK.

Engineering Mathematics II

MTL 1026 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Understand the concepts of vector calculus like directional derivative, gradient, divergence and curl, and their applications.
CO2	learn and apply the concepts of vector integral calculus for the computation of work done, circulation, and flux.
CO3	formulate the differential equations concerning physical phenomena like electric circuits, wave motion, heat equation etc.
CO4	learn various methods of solution of ordinary and partial differential equations.
CO5	solve various partial differential equations arising in heat conduction problems and wave propagation problems.

Unit -I
Vector Calculus: Beta & Gamma functions. Differentiation of vector functions of scalar variables. Gradient of a scalar field, Divergence & Curl of a vector field and their properties. Line & surface integrals. Green's theorem, Stokes' theorem & Gauss' theorem both in vector & Cartesian forms (statement only) with simple applications.
Unit-II
Ordinary Differential Equation(ODE): Formation of ODE, definition of order and degree of ODE and solution, ODE's of first order, method of separation of variables, homogenous and non-homogenous

differential equations and their solution, exactness and integrating factor, Bernoulli's equation, linear ODE's of nth order, operator method, method of undetermined coefficients, method variation of parameters, solution of simple simultaneous ODE's.

Unit-III

Partial Differential Equation(PDE): Formation of (PDE), Solution of PDE by direct integration, Lagrange's linear equation, Non-linear PDE of first order, Method of separation of variables, Heat, Wave & Laplace's equations (Two dimensional Polar & Cartesian Co-ordinates).

Recommended Books:

- E. Kreysig, Advanced Engineering Mathematics, Wiley 10th edition 2011.
- Frank Ayres , Vector Analysis, Mc Graw Hills, 6th edition 2011.
- T. Marsden and W.H. Freeman,VectorCalclus, Freeman, 6 edition 2011.
- G. Simons, Differential Equations with Applications, TMH, McGraw-Hill Higher Education; 2 edition 1991.
- S.L. Ross, Differential Equations, Wiley 3rd edition 1984.
- R. Zalman, A Course in Ordinary and PDEs, Academic Press, 1st edition 2014.

Electronic Circuits& Simulation

ECL 1030 **4 – 0 – 0 = 4**

Course Outcomes

CO1	To learn basic concepts of Semiconductor Devices
CO2	Able to understand and use BJT and MOS Devices.
CO3	Learn and able to apply small signal BJT and FET analysis.
CO4	To analyze and design rectifiers and amplifiers using SPICE.
CO5	Able to understand advanced semiconductor devices and oscillators.

Bias stability: - Operating point, Q point variation due to changes in β & temperature, Stability factor, stability factor analysis (variation of Ico, V_{be})

Small signal Analysis:-BJT small signal analysis, h parameters, FET small signal analysis, small signal high frequency model (π model), Millers theorem.

Large Signal Amplifiers: Classification of power amplifiers (Class A,B, C& D), push pull amplifier,

Multistage Amplifier:-General cascade system, configuration of RC coupled, transformer coupled, direct couple multistage amplifier, General frequency consideration, Effect of cascading on the bandwidth of an amplifier.

Frequency response of Amplifier:-Frequency response characteristics, the high frequency response of CE stage, the gain bandwidth product, common source stage at high frequency, Emitter and source followers at high frequency, the time constant method of obtaining the response.

Feedback Amplifiers:-Feedback concepts, the transfer gain with feedback, general characteristics of feedback amplifier. Input resistance, output resistance, voltage series feedback pair, current series feedback, current shunt feedback, voltage shunt feedback.

Regulated power supplies:- ordinary DC power supply, voltage regulators,Zener as voltage regulator, series voltage regulators, principle of switching voltage regulator, IC voltage regulator, its specification and performance characteristics

Circuit Simulation using PSPICE: SPICE and its types, limitations; Circuit Descriptions: Input files, Element values, Nodes, Circuit elements, Sources, Types of Analysis, Output Variables and commands; Format of circuit and output files, simulation of simple DC circuits.

Recommended Books:

- Integrated Electronics, Millman&Halkias,Tata Mc Graw Hill
- Microelectronics, Millman&Grabel, Tata Mc Graw Hill
- Electronics Circuits, Schilling &Belove, McGraw Hill
- Introduction to PSpice using OrCad for Circuits & Electronics, Rashid, Pearson Education

Digital Electronics

ECL 2070 **4 – 0 – 0 = 4**

Course Outcomes

CO1	To provide the skills to efficiently acquire knowledge on digital electronic circuit analysis and design.
CO2	To acquire Knowledge of various number systems and codes from historic point of view.
CO3	To understand the logic families in digital circuits.
CO4	To obtain the ability to analyze various aspects of sequential circuit design.
CO5	To learn the design procedure for Sequential Circuits and data converters.

Basic concepts of Boolean Algebra: Review of number systems - Binary, Hexadecimal, conversion from one to another, complement arithmatic, Signed and unsigned numbers and their arithmetic operations. BCD, Excess-3, Gray and Alphanumeric codes. Review of Boolean algebra, De-Morgan's Theorems, Standard Forms of Boolean Expressions, Minimization-Techniques: K-MAPS, VEM Technique, Q-M (Tabulation) method.

CMOS Logic family : Logic family features, noise margin, setup time, hold time, delay, fan in, fan out, CMOS based logic gates.

Combinational Logic Circuits: Problem formulation and design of Basic Combinational Logic Circuits, Combinational Logic Using Universal Gates. Basic Adders, ALU, Parity-Checkers and Generators, Comparators, Decoders, Encoders, Code Converters, Multiplexer (Data Selector), De-multiplexers
Sequential Circuits: Latches, Flip-flops (SR, JK, T, D, Master/Slave FF,) Edge-Triggered Flip-Flops, Flip-Flop Operating Characteristics, Basic Flip-Flop Applications, Asynchronous Counter Operation, Synchronous Counter Operation, Up/Down Synchronous Counters.
Shift registers & Memories
Shift Register Functions, Serial In - Serial Out Shift Registers, Serial In - Parallel Out Shift Registers, Parallel In - Serial Out Shift Registers, Parallel In - Parallel Out Shift Registers, Bidirectional Shift Registers,Basics of Semiconductor Memories, Random-Access Memories (ROM), Read Only Memories (ROMs), Programmable ROM's (PROMs and EPROM's), PAL, PLA. FPGA introduction, CPLD.

A/D and D/A convertor
Characteristics of ADC, Types of ADC- SAR, Dual Slope, Flash ADC. Characteristics of DAC, R-2R Ladder, Weighted Resistance Type

Recommended Books:
- "Digital Fundamentals" by Thomas L. Floyd, Prentice Hall, Inc
- "Digital Systems - Principles and Applications" by Tocci, R. J. and Widner, Prentice Hall,
- Switching and finite automata theory: Z V Kohavi.–TMH
- Digital Logic Circuit Analysis & Design, by Victor P. Nelson, H. Troy Nagle, Bill D. Carroll and J. David Irwin, Prentice Hall,
- Digital logic and computer design: M Morris Mano –PHI
- Modern digital electronics: R.P. Jain. TMH
- *Digital Design: Principles and Practices, by* Wakerly J F, Prentice-Hall,
- "Digital Experiments Emphasizing Systems and Design," by David Buchla, Prentice Hall, Inc,

Network Analysis & Synthesis

ECL 1022 **3 – 1 – 0 = 4**

Course Outcomes

CO1	Understand basics electrical circuits with nodal and mesh analysis.
CO2	Appreciate electrical network theorems.
CO3	Apply Laplace transform for steady state and transient analysis.
CO4	Determine different network functions.
CO5	Appreciate the frequency domain techniques.

Foundations of Network Analysis
Passive elements and their circuit properties, Voltage & Current Sources, Source Transformations, Network Theorems (Tellegen's, Reciprocity, Compensation Theorem), Duality, Concept of Complex Impedance
Network Graph Theory: Concept of a network graph terminology used in network graph, relation between twigs and links, Properties of a tree in a graph, Formation of incidence matrix, No. of trees in a graph, Cut set matrix and tie set matrix

Laplace Transform
Definition, Inverse L.T, Properties of L.T, Solution of Linear Differential equations, Transformed Circuit Components Representation, Independent Sources, Resistance Inductance and Capacitance Parameters, Transfer Functions
Transient Response
Initial Conditions, Transient and Steady State Responses, Transient responses of RL, RC and RLC Networks
Two-port Networks
Two-port parameters (z, y, h, ABCD), Transfer functions using two-port parameters. Interconnection of two-ports, Analysis of Ladder Networks
Network Synthesis
Causality and Stability, Hurwitz polynomials. Positive real functions, Frequency Response of Reactive One –ports, Synthesis of Reactive One-ports by Foster's method, Synthesis of Reactive One-ports by Cauer's Method.
Filters
Determination of pass and attenuation bands constant K-type, Low pass, High pass, Band pass, Band stop, M-derived filters, Lattice filter

Recommended Books:
- M E Van Valkenburg, "Network Analysis", Prentice Hall of India,
- F FKuo, "Network Analysis and Synthesis", Wiley,
- K.M.Soni, " Circuits &Systems" Kataria& Sons,

Electromagnetic Field Theory

ECL 2040 **4 – 0 – 0 = 4**

Course Outcomes

CO1	Able to understand vector analysis and coordinate systems.	
CO2	Able to learn time varying electromagnetic field.	
CO3	To understand solution of wave equations.	
CO4	Able to understand radiation & reflection in time varying EM field.	
CO5	To understand the basics of transmission line.	

Unit I: Introduction

Vector Analysis, Coordinate System, Gradient, Divergence, Curl, Laplaceian in rectilinear, Cyllindrical, Spherical Coordinate System, Line, surface and volume integrals, Divergence Theorem, Stoke's theorem

Unit II: Time varying fields and Maxwell's equations

Introduction, The Equation of Continuity For Time-Varying Fields, Inconsistency Of Ampere's Law, Maxwell's Equation in Integral and differential form, Physical Significance of Maxwell Equation, Boundary conditions.

ELECTROMAGNETIC WAVES

Solution For Free-Space Conditions, Uniform Plane Waves & Propagation, The Wave Equations For A Conducting Medium, Sinusoidal Time Variations, Conductors And Dielectrics, Polarization, Reflection By A Perfect Conductor Normal Incidence & Oblique Incidence, Reflection By A Perfect Dielectric — Normal Incidence & Oblique Incidence, Reflection At The Surface Of A Conductive Medium.

RADIATION

Potential Functions And Electromagnetic Field, Potential Functions For Sinusoidal Oscillations, Alternating Current Element, Power Radiated By Current Element, Application To Short Antennas, Radiation From A Monopole Or Dipole.

Transmission Line

Circuit theory analysis of Transmission Line, Loss less and Lossy transmission lines, Reflection coefficient, Transmission Coefficient, VSWR, Input Impedance, Matching of Transmission Line, pulse excitation. Group Velocity and Phase velocity.

Recommended Books:

- Fields & Wave Electromagnetics , DK Cheng
- Electromagnetic Waves and Radiating Systems, Jordan &Balmin
- Elements of Electromagnetics, Sadiku
- Engineering Electromagnetics: W H Hayt& J A Buck
- Advanced Engineering Electromagnetics: C A Balanis

Linear Integrated Circuits

ECL 2030 **4 – 0 – 0 = 4**

Course Outcomes

CO1	To understand the concept of differential amplifiers
CO2	To understand the basics of Operational amplifiers and its applications
CO3	To be able to perform the Frequency response analysis of Op-amp
CO4	To be able to design active filters and oscillators using Op-amp
CO5	To be introduced about some specialized IC applications of OP-amp

Differential Amplifiers

Basics of Differential Amplifier, Transistorized Differential Amplifier, Configurations of Differential Amplifier, Analysis of Dual Input Balanced Output Differential Amplifier, Constant Current Bias, Current Mirror Circuit, Cascading of Differential Amplifiers.

Introduction to Operational Amplifiers

The Ideal Op-Amp, Block diagram Representation of Op-Amp, Voltage Transfer Curve of Op-Amp, Integrated Circuit: Package Types, Pin Identification and Temperature- Ranges, Interpretation of Data sheets and Characteristics of an Op-Amp, Inverting and Non-Inverting Configuration, Ideal Open-Loop and Closed-Loop Operation of Op-Amp, Block diagram Representation of Feedback Configurations, Voltage-Series Feedback Amplifier, Voltage-Shunt Feedback Amplifier, Differential Amplifiers with One & Two Op-Amps.

Frequency Response of an Op-Amp

Introduction, Frequency Response, Compensating Networks, Frequency Response of Internally Compensated Op-Amp, Frequency response of Non-compensated Op-Amp,Closed-Loop Frequency Response, Circuit Stability, Slew Rate.

General Linear Applications

DC & AC Amplifiers, Peaking Amplifier, Summing, Scaling and Averaging amplifier, Instrumentation Amplifier, Voltage-to-Current Converter, Current-to-Voltage Converter,The Integrator, The Differentiator, Log and Antilog Amplifier, Peak Detector, Precision Rectifiers, Comparator, Zero Crossing Detector, Schmitt Trigger, Sample and Hold Circuit, Clippers and Clampers, A/D and D/A Converters.

Active Filters and Oscillators

Active Filters:- Butterworth Filters, Band-Pass Filters, Band Reject Filters, All-Pass Filters. Oscillators and Wave Generators:- Phase Shift Oscillator, Wien Bridge Oscillator, Voltage-Controlled Oscillator(VCO), Square Wave Generator, Triangular Wave Generator, Saw-tooth Wave Generator.

Specialized IC Applications

Introduction, Universal Active Filter, The 555 Timer, Monostable and AstableMultivibrator using IC 555, Phase-Locked Loop(PLL), Voltage Regulators.

Recommended Books:

- OP-AMP and Linear IC's By Ramakant A. Gayakwad, Prentice Hall
- Digital Integrated Electronics, By Taub and Schilling, McGraw Hill
- Integrated Electronics, By Millman J. and Halkias C.C., McGraw Hill.
- Op-Amp and Linear IC's, By Caughlier and Driscoll, PHI

Analog Communication Engineering

ECL 2151 **3 – 1 – 0 = 4**

Course Outcomes

CO1	Able to understand basic concept of signals and Fourier transform.
CO2	Able to learn amplitude modulation and angle modulation.
CO3	Able to learn the basic design concept of communication transmitters and recievers.
CO4	Acquire knowledge of random signal theory.
CO5	Able to learn noise analysis in communication systems.

Introduction: Historical Review, Elements of an Electronic Communication System, Communication Channel and their Characteristics, Mathematical Models for Communication Channels.

Frequency Domain Analysis of Signals and Systems: The Fourier Transform, Properties of the Fourier Transform, Rayleigh`s Energy Theorem, the inverse relationship between time and frequency, Dirac Delta Function, Fourier transform of Periodic signals, transformation of signals through Linear systems, Paley-Wiener Criterion, Hilbert transform, Band Pass signals, Transmission of Band Pass signals, Phase and group delay.

Analog Signals Transmission and Reception: Introduction, Amplitude Modulation, Double side Band Suppressed carrier Amplitude Modulation, Single side band Amplitude Modulation, Vestigial side band Modulation, Implementation of AM Modulators and De-Modulators, Frequency division Multiplexing, Analog Modulation, representation of FM and PM signals, Spectral Characteristic of Analog Modulated Signals, Implementation of Angle Modulators and De-Modulators, AM Radio Broadcasting, FM Radio Broadcasting

Effect of Noise on Analog communication System: White noise, shot noise, thermal noise, noise equivalent bandwidth, Effect of Noise on AM , Effect of Noise on DSB-SCAM, Effect of Noise on SSBAM, Carrier Phase Estimation with Phase Locked loop , Effect of Noise on Angle Modulation, Threshold Effect in Angle Modulation, Pre-emphasis and De-emphasis in FM.

Recommended Books:

- Communication Systems, Simon Haykin, John Willey & Sons
- Communication Systems Engineering, Proakis&Salehi, Pearson Education
- Radio Engineering, G.K. Mithal
- Electronic Communication, Roody&Coolen
- Electronic Communication, Kennedy

Microprocessor Systems

ECL 2060 **3 – 0 – 0 = 3**

Course Outcomes

CO1	The student will be able to analyze, specify, design, write and test assembly language programs of moderate complexity.
CO2	The student will be able to select an appropriate 'architecture' or program design to apply to a particular situation; e.g. an interrupt-driven I/O handler for a responsive real-time machine.
CO3	The student will be able to calculate the worst-case execution time of programs or parts of programs, and to design and build, or to modify, software to maximize its run time memory or execution-time behavior.
CO4	Write programs to run on 8086 microprocessor based systems.
CO5	Design system using memory chips and peripheral chips for 16 bit 8086 microprocessor.

Introduction to 8085 Microprocessor: Functional block diagram – Registers, ALU, Bus systems, Memory & Instruction cycles Timing diagrams, Address Decoding techniques, Addressing modes, Instruction Set, Assembly Language Programming, Interrupts-Types & handling, ISR, Stack architecture

Memory and Peripheral interfacing: Basic interfacing concepts - Memory space partitioning - Buffering of buses – Timing constraints - Memory control signals - Read and write cycles, Interfacing RAM, ROM, 8255PPI, Interfacing applications using 8255. Need for direct memory access - DMA transfer types

Intel 16 bit Microprocessor: Register organization of 8086 – Architecture - Physical Memory organization - I/O addressing capability, Addressing modes of 8086 - Instruction set of 8086 - Assembler directives and operators, Assembly language programming, Interrupt Architecture

Freescale 32 bit ColdFire Processor:-Introduction to ColdFire Core, Comparison with 8085 & 8086 Architecture, Introduction to MCF5223X Microprocessor Architecture & Functional Blocks

Recommended Books:

- Gaonkar R. S, "Microprocessor Architecture: Programming and Applications with the 8085/8086A", New Age International (P) Ltd.,
- K. Ray, K. M. Bhurchandi – Advanced Microprocessors and Peripherals – Architecture, Programming and Interface – Tata McGraw Hill
- "ColdFire Microprocessors & Microcontrollers" – MunirBannoura, Rudan Bettelheim and Richard Soja, AMT Publishing.
- Douglas V. Hall, "Microprocessors and Interfacing Programming and Hardware", Tata McGraw Hill,
- Daniel Tabak, "Advanced Microprocessors", McGraw Hill,
- David A. Patterson, John.L.Hennessey – Computer organization and design-the hardware/software Interface- Elsevier-Morgan Kaufmann Publishers-

Digital System Design using VHDL

ECL 2071 **4-0-0 = 4**

Course Outcomes

CO1	To understand and develop complex digital circuits and system functions based on algorithms.
CO2	To represent complex digital circuits in the form of the hierarchically organized VHDL design/simulation software tools.
CO3	To develop VHDL architectural representations of systems and components using models representing structure, behavior, or data flow concepts describing the internal structure or external behavior of the circuit.
CO4	To develop final technical documentation of a complex digital system using VHDL language descriptions, and their implementations on CPLD and FPGA.

Review: Review of concepts of combinational and Sequential logic circuit design, design of digital systems with help of state machine charts and their realization through Gates, Multiplexers and other discrete digital ICs.

Synchronous and Asynchronous Sequential circuits
Sequential Circuits: Synchronous sequential circuits and finite state machines (FSM); Mealy machine; Moore machine; State table; State diagram; Synchronous Sequential circuit analysis; System design; State minimization; State assignment; ROM implementation; Asynchronous sequential circuits, Threshold functions , Hazards, Pulse Mode Circuits.

Introduction to VHDL: Basic language elements & behavioral modeling, Data flow modeling – structural, Generics and configurations - Subprogram and overloading – Packages and Libraries – Model simulation.
Design of Hardware using VHDL as examples – code converters, multiplexer, de-multiplexer, binary adders and multipliers, counters. Design of sequential circuits using VHDL, counters, shift registers

Basics of FPGA, CPLD and programmable devices in general. FPGA programming, design and implementation of digital system, ASIC design using CAD tools. Overview of ASM's realization through PLDs and design of FSM / simple microprocessor through Algorithmic State Machine concept.

Recommended Books:

- Daniel Gajski: Principles of Digital Design
- Bhasker: A VHDL Primer
- Pedroni: Circuit Design with VHDL
- Perry: VHDL: Programming by examples
- Palnitkar: Verilog HDL,

Antenna & Wave Propagation

ECL 2041 **3 – 0 – 0 =3**

Course Outcomes

CO1	Students would be able to understand the basic operation of e.m. wave based application.
CO2	Students should be able to design and analyze various types of antenna.
CO3	Students should be able to understand the different propagation modes of EM wave.
CO4	Students would be able to find suitability of antennas for different applications.
CO5	To understand the different types of antennas and their applications

Unit I: Antenna Fundamentals
Radiation pattern, Antenna gain, Effective joint of an antenna, Antenna aperture, relation between antenna gain and antenna aperture, elementary idea of self and mutual impedances in antenna, Antenna terminal impedance, reciprocity theorem of an antenna.
Unit II: Antenna arrays

Arrays of two point source, linear arrays of n-point sources, broad side and End fire arrays, Pattern multiplication Binomial arrays.

Unit III: Special purpose antennas

Loop antenna traveling wave antenna, Rhombic antenna, Yagi antenna, Horn and reflector type antennas, Helix antenna, and Lens antenna, Log Periodic antenna, Microstrip patch antenna

Unit IV: Ground wave propagation

Introduction to different region of the atmosphere. Various propagation paths, Basic ideas of ground wave propagation, space wave and surface wave, True Tropospharic refraction, radius of curvature of a ray in the troposphere. Concept of modified earth, Duct propagation.

Unit V: Sky wave propagation

Structure of the ionosphere, effective permittivity & conductivity of an ionized region. Effect of earth magnetic field. Critical frequency. MUF and OPWF. Virtual height, skip distance fading.

Recommended Books:

- Fields & Wave Electromagnetics , DK Cheng
- Fields & Wave in Communication Electronics, RamoWhinnery&Duzer
- Electromagnetic Waves and Radiating Systems, Jordan &Balmin
- Antenna Theory:Analysis& Design, A. Balanis
- Elements of Electromagnetics, Sadiku
- Antenna & Wave Propagation, K.D. Prasad

Digital Communication

ECL 2152 **4 – 0 – 0 = 4**

<u>Course Outcomes</u>

CO1	Understand the theoretical aspects of digital communication system, useful for today's multidisciplinary applications.
CO2	Learn the elements of digital communications systems, fundamental concepts of sampling theorem, quantization and coding.
CO3	Understand the different types of digital pulse and band pass modulation techniques.
CO4	Able to calculate probability of error for method filter Receiver and various Digital
CO5	Modulation techniques to analyze the performance of Digital Communications Systems in the pressure of noise.
CO6	Able to do the source coding problems and understand the compact description of sources.
CO7	Able to solve the various channel coding problems and analyze the performance of vicarious coding techniques.

Introduction: A historical perspective in the development of Digital Communication, elements of a digital communication system, analog versus digital communication system.

Pulse modulation: Introduction, sampling process, pulse amplitude modulation, TDM, PPM, PDM, bandwidth-noise trade-off, quantization process, PCM, DPCM, DM, Adaptive DPCM, sub-band coding, linear predictive coding,.

Base band pulse transmission: Introduction, matched filter, error rate due to noise, inter symbol interference, Nyquist's criterion for distortion less base band binary transmission, correlative level coding.

Digital pass-band transmission: Introduction, pass band transmission model, Gram Schmidt orthogonalization procedure, geometric representation of signals, response of bank of correlators, to noisy input, coherent detection of signals in noise, probability of error, correlation receiver, detection of signals with unknown phase, hierarchy of digital modulation techniques, coherent binary PSK, coherent binary FSK, coherent QPSK, coherent minimum shift keying, differential phase shift keying, comparison of binary & quaternary modulation schemes, M-ary modulation techniques, power spectra, bandwidth efficiency,synchronization.

Source coding: Mathematical models of information sources, a logarithmic measure of information, source coding theorem, source coding algorithms- the Huffman source coding algorithm & the LEMEPel-Ziv source coding.

Channel capacity & coding: Modeling of communication channels, channel capacity, bounds on communication, coding for reliable communication, linear block codes, cyclic codes, convolutional codes.

Recommended Books::

- Digital communication, Simon Hykins,ohn Willey & Sons
- Digital communication, John G Proakis, McGraw Hill
- Fundamental of Telecommunications, R G Freeman , John Wiley
- Telecommunications Systems Engineering , R G Freeman, John Wiley
- Telecommunication Transmissions Systems, R G Winch, McGraw-Hill
- Electronic Communication Systems, W Tomasi, PHI

Signal &Systems

ECL 2130 **3 – 1 – 0 = 4**

<u>Course Outcomes</u>

CO1	To learn the basics of signal and systems.
CO2	Able to learn convolution property of the LTI systems.

CO3	To learn the Laplace and Z transforms
CO4	To study the direct form I and II.
CO5	To learn the DTFT and DFT theories.

Probability, Random Variables and Random Signals
Experiment, sample space, event, probability, conditional probability and statistical independence. Random variables: Continuous and Discrete random variables, cumulative distributive function,Probability density function, properties of CDF and PDF,Central Limit Theorem. Statistical averages, mean, moments andexpectations, standard deviation and variance. Probability models: Uniform, Gaussian, Poisson.
Introduction to Signals and Systems (CT & DT)
Fundamentals of signals, Elementary signals, Continuous-time and discrete-time (CT and DT) signals and systems. Classification of signals. Energy and power signals. Operating on signals to produce new signals. Sinusoids, complex exponentials, step and impulse functions. Classification of systems (linearity, time-invariance, causality, memory, invertibility).
Properties of Linear, Time-Invariant Systems
Convolution, Impulse response and superposition integral or sum for linear, time-invariant (LTI) systems. LTIsystems characterized by differential or difference equations using time & transform methods, frequency response of LTI Systems.
Structures For Discrete-time Systems: Block diagram representation of linear constant coefficient difference equations - their interconnection schemes; direct form-I, direct form-II, cascade form and parallel form structures. Finite word-length effect-number representation, analysis of effect of coefficient quantization and rounding of noise; zero input limit cycles in fixed-point realizations of IIR digital filters.
Fourier Transform (Discrete): DTFT & DFT and properties of DFT; circular convolution; linear convolution using DFT.

Recommended Books:
- Signals and Systems, S. Haykin and B. Van Veen, New York: John Wiley and Sons,
- Signals and Systems, M. J. Roberts, McGraw-Hill,
- Signals and Systems, A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, Prentice-Hall
- Signals, Systems and Transformations, C. L. Phillips and J. M. Parr, Prentice-Hall
- Fundamentals of Signals and Systems using MATLAB, E. W. Kamen and B. S. Heck, Prentice-Hall
- Signal Processing and Linear Systems, B. P. Lathi, BerkeleyCambridge Press, ISBN 0-941413-35-7, 1998.

Embedded Systems & Microcontrollers

ECL 3080 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To study the Issues and Challenges in Embedded System Design.
CO2	To study the architectures of RISC and CISC processors.
CO3	Able to understand the concept of Inter-Integrated Circuit (I2C) Interface, Interrupts, Analog-to-Digital Converter and Controller Area Network (CAN).
CO4	Able to do programming using Kiel µVision IDE & Simulator.
CO5	To apply the knowledge for embedded system applications using Keyboards, display, Relays etc.

Introduction: Introduction to Embedded Computing, Issues and Challenges in Embedded System Design, Trends: SoC, custom designed chips, configurable processors and multi-core processors.

Embedded Processor Architecture (Intel 8051 Platform-8 bit): Harvard Architecture, RISC v/s CISC, µProcessor v/s µController, CPU Architecture and instruction sets **:** Hardware architecture-program memory consideration – register file structure and addressing modes – CPU Register – instruction set – Port architecture, Timer/Counter Block Configuration & Interrupts, Serial Port Configuration & Interrupts, External interrupts

Embedded Processor Architecture (Freescale S12X Platform-16 bit): Introduction to the S12 and S12X Microcontroller, Core Architecture, Clock Generation&Resets, Port Architecture, Timer functions, Serial Communication Interface (SCI), Serial Peripheral Interface (SPI), Inter-Integrated Circuit (I^2C) Interface, Interrupts, Analog-to-Digital Converter, Controller Area Network (CAN), Internal Memory Configuration and External Memory Expansion

Development tools and Programming: Hardware and Software Development Tools, C Language Programming, Kiel µVision IDE & Simulator, CodeWarrior tools – Project IDE, Compiler, Assembler and debugger, JTAG and hardware debuggers, Code optimization.

Embedded Applications & Interfacing: Embedded System Applications using Keyboards, display, Relays, Motors, Sensor Interface, ADC, DAC, SCI, SPI, RTC, I^2C, Interrupts with 8051 & S12X

Recommended Books:
- Mazidi, "8051 Microcontrollers & Embedded systems", Pearson

- John B Peatman, " Design with PIC Microcontrollers", Pearson Education Asia, Low price edition
- The HCS12/9S12, An Introduction to Hardware and Software Interfacing By Han-Way Huang
- A.K. Ray, K.M. Bhurchandi, " Advanced Microprocessors and Peripherals – Architecture, Programming and Interface", Tata McGrawHill
- MykePredko, "Programming and Customizing the 8051 Microcontroller", Tata McGrawHill
- Assembly and C Programming for the Freescale HCS12 Microcontroller Second Edition by Fredrick M. Cady
- Embedded Microcomputer Systems: Real Time Interfacing by Jonathan W. Valvano

Electronic Measurement & Instrumentation

ECL 3091 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To understand Basic concept of measurement and error analysis
CO2	To Learn about some basic analog and digital instruments
CO3	To understand the basic concept of bridge measurement and CRO
CO4	To acquire knowledge about Transduces and signal conditioners
CO5	To Learn the design concept of data acquisition systems

Unit I: Measurement and error
Accuracy and precision, sensitivity, resolution, Types of errors, Limiting errors, calibrationand standards.
Unit II: Analog Instruments
PMMC, DC Ammeter, DC Voltmeter, Ohm Meter, Electronic Voltmeter, Unit I AC Voltmeter with rectifier and amplifier combination, Electronic Multimeter, AC current indicating instruments, Q Meters, Wave Analysers, Harmonic Distortion Analyser, Spectrum Analyser, Vector Impedance Meter,
Unit Bridge Measurement
Wheatstone bridge, Kelvin bridge, Maxwell's Bridge, Schering Bridge, Wiens bridge, LCR Measurement.
Unit III: Digital Instruments
Advantages of digital instruments over analog instruments, Digital voltmeters, Ramp type DVM, Integrating DVM, successive approximation DVM, Dual Slope DVM, Microprocessor Based DVM,
Unit IV: CRO
Basic block diagram, Horizontal deflection system, Vertical Deflection system, Special Purpose CRO: Dual beam, dual trace, sampling type, Digital storage, Storage target.,
Unit V: Transducers
Classifications of Transducers, Strain Gauge, Displacement Transducers, Linear variable differential transducers(LVDT), Photoelectric transducers, Temperature measurements, Thermocouples, Photosensitive device, Peizo electric transducer, Measurement of Non-electrical Quantities like Temperature, Pressure, Flow, pH, Thermal Conductivity, Humidity.
Unit VI: Signal Conditioning
Introduction, Basic Instrumentation Amplifier, Application of Instrumentation amplifiers, Modulators.
V/I Controllers, I/V Controllers, F/V Controllers, V/F Controllers, Linearization Technique,Noise Reduction technique in Instrumentation, Isolation Amplifier, Isolation Transformer.
Unit VII: Data Acquisition Systems
Introduction, objective, single channel data acquisition, multi channel data acquisition, computer based DAS, Data loggers. Analog and Digital Recorders, Introduction to various process control systems like SCADA,DCS, CCU etc.

Recommended Books::
- Modem Electric Instrumentation, Albert D. Cooper, PHI.
- Electronic Instrumentation , H S Kalsi , Tata Mc Graw Hill
- A Course in Electrical and Electronic Measurement and Instrumentation , A.K Sahwney
- Electronics and Electrical Measurement, G B Gupta, Kataria& Sons Publication

Signal Processing

EECL 312B **3 – 1 – 0 = 4**

Course Outcomes

CO1	Identify the signals and systems (SO A)
CO2	Apply the principles of discrete-time signal analysis to perform various signal operations (SO A, E)
CO3	Apply the principles of z-transforms to finite difference equations. (SO A, E)
CO4	Apply the principles of Fourier transform analysis to describe the frequency characteristics of discrete-time signals and systems (SO A, E)
CO5	Apply the principles of signal analysis to filtering (SO A, C, E)

Probability, Random Variables and Random Signals

Review of probability theory, Random variables CDF, PDF, properties of CDF and PDF, Central Limit Theorem. Statistical averages, mean, moments and expectations, standard deviation and variance. Probability models: Uniform, Gaussian, Poisson.

Introduction to Signals and Systems

Fundamentals of signals, Elementary signals, Classification of Signals and Systems (Continuous-time and discrete-time (CT and DT). Basic operations on Signals.

Properties of Linear, Time-Invariant Systems

Convolution, Impulse response and superposition integral or sum for linear, time-invariant (LTI) systems. LTI systems characterized by differential or difference equations, Correlation.

Structures For Discrete-time Systems: Block diagram representation of linear constant coefficient difference equations - their interconnection schemes; direct form-I, direct form-II, cascade form and parallel form structures. Finite word-length effect-number representation, analysis of effect of coefficient quantization and rounding of noise; zero input limit cycles in fixed-point realizations of IIR digital filters.

Fourier Transform (Discrete): DTFT & DFT and properties of DFT; circular convolution; linear convolution using DFT.

Z- Transform: Bilateral and Unilateral Z-transform, ROC, Inversion of Z-transform, Solution of Discrete Time LTI systems using Z-transform.

Recommended Books:

- Linear Systems And Signals, B. P. Lathi, Oxford University Press
- Signals and Systems, A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, Prentice-Hall
- Probability, Statistics And Random Processes, T Veerarajan, Mcgraw-Hill
- Signals And Systems, M. J. Roberts, McGraw-Hill,
- Fundamentals of Signals and Systems using MATLAB, E. W. Kamen and B. S. Heck, Prentice-Hall

Digital Signal Processing

ECL 3181 3-0-0

OBJECTIVES:

1. To learn discrete Fourier transform and its properties
2. To know the characteristics of IIR and FIR filters learn the design of infinite and finite impulse response filters for filtering undesired signals.
3. To understand Finite word length effects.
4. To study the concept of Multirate and adaptive filters

UNIT I DISCRETE FOURIER TRANSFORM 9

Discrete Signals and Systems- A Review – Introduction to DFT – Properties of DFT – Circular Convolution - Filtering methods based on DFT – FFT Algorithms – Decimation in time Algorithms, Decimation in frequency Algorithms – Use of FFT in Linear Filtering.

UNIT II IIR FILTER DESIGN 9

Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives – (LPF, HPF, BPF, BRF) filter design using frequency translation.

UNIT III FIR FILTER DESIGN 9

Structures of FIR – Linear phase FIR filter – Fourier series - Filter design using windowing techniques (Rectangular Window, Hamming Window, and Hanning Window), Frequency sampling techniques – Finite word length effects in digital Filters: Errors, Limit Cycle, and Noise Power Spectrum.

UNIT IV FINITE WORDLENGTH EFFECTS 9

Fixed point and floating point number representations – ADC –Quantization- Truncation and Rounding errors - Quantization noise – coefficient quantization error – Product quantization error - Overflow error – Roundoff noise power – limit cycle oscillations due to product round off and overflow errors – Principle of scaling

UNIT V DSP APPLICATIONS 9

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Adaptive Filters: Introduction, Applications of adaptive filtering to equalization.

OUTCOMES:

Upon completion of the course, students will be able to

1. apply DFT for the analysis of digital signals & systems
2. design IIR and FIR filters
3. characterize finite Word length effect on filters
4. design the Multirate Filters
5. apply Adaptive Filters to equalization

TEXT BOOK:

1. John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education / Prentice Hall, 2007.

REFERENCES:

1. Emmanuel C..Ifeachor, & Barrie.W.Jervis, “Digital Signal Processing”, Second Edition, Pearson Education / Prentice Hall, 2002.
2. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Tata Mc Graw Hill, 2007.

IC Fabrication & VLSI

ECL 3130 **4 – 0 – 0 = 4**

Course Outcomes

CO1	· Understand the fabrication process of IC technology
CO2	· Analysis of the operation of MOS transistor
CO3	· Analysis of the physical design process of VLSI design flow
CO4	· Analysis of the design rules and layout diagram
CO5	· Design of Adders, Multipliers and memories etc

Introduction: Overview of the VLSI technologies and ASIC Design Flow, VLSI Circuits and Analog IC Design Fundamentals.Detailed Design flow .

Fundamentals of Semiconductor Fabrication: Cleanroom technology - Clean room concept – Growth of single crystal Si, surface contamination, cleaning & etching. Oxidation – Growth mechanism and kinetic oxidation, oxidation techniques and systems, oxide properties, oxide induced defects, charactrisation of oxide films, Use of thermal oxide and CVD oxide; growth and properties of dry and wet oxide, dopant distribution, oxide quality. Solid State Diffusion – Fick's equation, atomic diffusion mechanisms, measurement techniques, diffusion in polysilicon and silicon di-oxide diffusion systems. Ion implantation – Range theory, Equipments, annealing, shallow junction, high energy implementation. Lithography – Optical lithography, Some Advanced lithographic techniques. Physical Vapour Deposition – APCVD, Plasma CVD, MOCVD. Metallisation - Different types of metallisation, uses & desired properties.

CMOS: Introduction to CMOS, CMOS Capabilities and Limitations and CMOS Transistors and Logic . VLSI Circuits Design Theory. Process overview. Transistor device model, Circuit characterization. Technology libraries Overview. Pre-layout parasitics estimation. Post layout simulation techniques. VLSI Circuit Schematics and Simulation EDA Tool Flow.

Recommended Books:

- May G S and Sze S M, *“Fundamentals of Semiconductor Fabrication”*, John Wiley & Sons, India.
- Sze S M, “*VLSI Technology*”, McGraw Hill International Edition
- Ghandhi S K, *“VLSI fabrication Principles”*, John Wiley Inc., New York
- Streetman BG, *“Solid State Electronics Devices”*, Prentice Hall of India, New Delhi,
- Chang C Y and Sze S (Ed),*“ULSI Technology”*, McGraw-Hill Companies Inc.
- Allen, Phillip E. &Holberg, Douglas R. “CMOS Analog Circuit Design” Oxford University Press
- J. Baker “CMOS: Circuit Design, Layout, and Simulation” Wiley IEEE Press
- Neil H. E. Weste, Kamran Eshraghian “ Principles of CMOS VLSI Design ”, Pearson
  - Education India
- Kang S.M, Leblebici Y,"CMOS Digital Integrated Circuits : Analysis and Design" Tata McGraw Hill

Probability Theory & Stochastic Process

ECE 3182 **3 – 0 – 0 = 3**

ECL 3182				Probability Theory & Stochastic Process			Pre Requisites		MTL 1026 / ECL 2180	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Assignment & Quiz	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	3 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to model and analyse;

1. To provide mathematical background and sufficient experience so that student can read, write and understand the language of probability theory.

2. To introduce students to the basic methodology of probabilistic thinking and apply it to problems.
3. To understand basic concepts of Probability and Random Variables, how to deal with multiple Random Variables.
4. To understand the difference between time averages statistical averages.
5. To teach students the stochastic processes, temporal and spectral characteristics.

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Unit IProbability, Random Variables And Operations On Random Variables: Random Experiments, Sample Spaces, Events, Probability, Axioms, Joint, Conditional and Total Probabilities, Bay's Theorem, Independent Events. Random Variables: Definition, Conditions for mapping function of a Random Variable, Types of Random Variable, Distribution and Density functions: Definition and Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, random variables, Methods of defining Conditioning Event, Conditional Distribution, Conditional Density and their Properties, Expected Value of a Random Variable, Function of a Random Variable, Standard and Central Moments, Variance and Skew, Chebychev's Inequality

Unit IISingle Random Variable Transformations, Multiple Random Variables

Characteristic Function, Moment Generating Function, Monotonic and Non-monotonic Transformations of Single Random Variables (Continuous and Discrete), Vector Random Variables, Joint Distribution Function and its Properties, Marginal Distribution Functions, Joint Density Function and its Properties, Sum of Two and more Random Variables, Central Limit Theorem: Equal and Unequal Distribution..

Unit IIIOperations On Multiple Random Variables – Expectations

Expected value of a function of multiple random variables, Correlation and Covariance, Correlation Coefficient, Joint Moments about the origin, Joint Central moments, Joint characteristic function, Joint moment generating function. Transformations of Multiple Random Variables.

Unit IVRandom Processes – Temporal Characteristics

Random Process: Definition and Classification, Distribution and Density Functions, Stationarity and Statistical Independence., First- Order, Second- Order , Wide-Sense Stationarities (N-Order) and Strict Sense Stationarity, Time Averages and Ergodicity, Mean-Ergodic and Correlation-Ergodic Processes, Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties, Covariance Functions, Gaussian and Poisson Random Processes. Response of Linear Systems to Random Process input, Mean and MS value of System Response, Autocorrelation Function of Response, Cross- Correlation between Input and Output.

Unit VRandom Processes – Spectral Characteristics

Power Density Spectrum: Definition and Properties, Relationship between Power Density Spectrum and Autocorrelation Function, Cross Power Spectral Density: Definition and Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function, System Evaluation using Random Noise, Spectral Characteristics of System Response: Power Density Spectrum of Response.

Text/References:

1. Probability, Random Variables & Random Signal Principles - Peyton Z. Peebles, TMH, 4^{th} Edition, 2001.

2. Probability Theory and Stochastic Processes - Y. Mallikarjuna Reddy, University Press, 4^{th} Edition, 2013
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. Random Processes for Engineers-Bruce Hajck, Cambridge unipress, 2015
5. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S.Unnikrishna Pillai, PHI, 4^{th} Edition, 2002.

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Microwave Engineering

ECL 3050 **3 – 1 – 0 = 4**

Course Outcomes

CO1	Gain knowledge of basic concepts of Microwave Engineering and its applications.
CO2	Gain knowledge about the transmission lines and discuss about rectangular and circular waveguides
CO3	Understand the basic operation, characteristics, parameters, and apply basic concepts for design and analysis of microwave devices and various components such as amplifier and oscillators, microwave filter and mixer, E&H plane Tee, Magic tee, couplers &phase shifters.
CO4	Analyze and design basic microwave devices including solid-state devices, particularly klystrons, magnetron, diode models.
CO5	Become proficient with microwave measurement of power, frequency and VSWR, impedance for the analysis and design of circuits

Unit I: Introduction
Microwave Frequency Range, Characteristics features of microwaves, Microwave Systems.
Unit II: Transmission line and Waveguides
General solution for TEM, TE and TM waves, Rectangular waveguides, Circular Wave guides, Evanescent modes, Dominant modes, Power flow and energy storage in a waveguide, Planar transmission lines, Microstrip, Strip line, slot line, Smith Chart and its applications.
Unit III: Microwave Network and Passive Components
S- Parameters, Scattering Matrices for Some Typical Networks, Microwave cavities, Microwave Hybrid circuits, Waveguide Junctions, Magic Tee, Rat Race Circuits, Directional Couplers, Waveguide bends, Matched Loads, Coupling, Attenuators, Phase shifters.
Unit-IV: Microwave Solid State Devices and Application
Tunnel Diodes, Gunn Effect Diodes, Read Diodes, IMPATT Diodes, TRAPATT Diodes, PIN Diodes.
Unit-IV: Microwave Vacuum Tube Devices
Klystron, Reflex Klystron, Magnetron, TWT
Unit-V: Microwave Measurements
Slotted line arrangement and VSWR meter, Measurement of wave-guide impedance at load port by slotted line, Microwave power measurement, Microwave frequency measurement techniques.
Recommended Books::

- Liao Y.S. —MicrowaveDevices‖, PHI
- Collins R.E. Microwave Engine, McGraw Hill.
- Reich J.H. -Microwave Principles, East West Press
- Pozar, D M -Microwave Engineering' John Wiley & Sons
- Gupta, K.C- Microwave Engg: New Age Pub.
- M.L Sisodia and VijayaLaxmi Gupta- Microwave : Introduction to circuits, devices and antennas , New Age publication
- P. A. Rizzy- Microwave Engineering: Passive Circuits: Prentice Hall Int.

Optical Fiber Communication

ECL 4170 **3-0-0 = 3**

Course Outcomes

CO1	To learn the basic concept of optical fiber
CO2	To acquire knowledge about various losses in optical fiber
CO3	To understand basic design concept of optical sources and detectors
CO4	To learn and analyze the dedign concept of optical fiber networks
CO5	Able to learn design parameters of Optical Fiber Communication System

Introduction
Introduction to Telecommunications and Fiber Optics, The Evolution of Fiber Optic Systems, Basic Optical Laws and Definitions, Propagation of light inside fiber, Critical-Angle, Numerical-Aperture, Acceptance-

Angle ,Cut-off wavelength , V-Number, Mode Field Diameter, Leaky Modes , Single and Multi-Mode Fibers, Fiber Types, Waveguide Equations, Step-Index Fiber Structure, Graded-Index Fiber Structure, Splicing Techniques and Connectors, Elements of an Optical Fiber Transmission Link. Merits and Demerits of Fiber Optics over conventional copper wire systems

Losses and Dispersion

Attenuation, Absorption Losses, Scattering Losses, Bending Losses, Core and Cladding Losses, Total combined Losses.

Dispersion, Group-Delay, Material Dispersion, Waveguide Dispersion, Intermodal Distortion.

Optical Sources and Detectors

Light-Emitting Diodes (LEDs), LED Structures, Characteristics of LEDs, Laser Diodes, Laser Diode Modes and Threshold Conditions, Laser Diode Structures, Characteristics of Laser Diodes, Comparison between LED and Laser Diode.Physical Principles of Photodiodes, PIN Photodetector, Avalanche Photodiodes (APD), Photodetector-Noise, Noise-Sources, Signal-to-Noise Ratio, Comparison of Photodetectors.Optical Receiver.

Optical Fiber Network and its Components

Point-to-Point Links, System Considerations, Link Power Budget, Rise-Time Budget. Single and Multi-Hop Networks, SOA, EDFA, WDM-MUX/DEMUX, Optical-Switches, Couplers, Splitters, Photonic Switching.

Economics and Potential Applications ofOptical Fiber CommunicationSystems

Economics with Optical Fiber Communication Systems, Prospects for Optical Fiber Communication, Fiber-Optic Applications, Applications of Integrated Optics.

Recommended Books:

- Keiser, "Optical fiber communication", Tata McGraw Hill
- John M Senior, "Optical Fiber Communication-Principles and Practice ", Prentice Hall International
- Joseph C Patios, "FiberOptical Communications", PHI
- John Gowar, "Optical Communication System", Prentice Hall International
- Sharma, "Fiber Optics in Telecommunication", Tata Mc Graw Hill
- M K Liu, "Principles and applications of optical communication ", Tata Mc Graw Hill

Lab Courses

Basic Electrical Engineering Lab

ECP 1020 **0 – 0 - 2 = 1**

1. Verification of KirchoffsVoltage and Current law.
2. Verification of Superposition theorem.
3. Verification of Thevenin's' theorem/
4. Verification of Reciprocity theorem.
5. Verification of Maximum power transfer theorem.
6. To study transient response of RC low pass and high-pass filters and find out time constants.
7. To verify voltage, current relationship in series and parallel RLC circuit.
8. Measurement of current in various branches of RLC series –parallel circuit and verification of the same by calculation.
9. Study of voltage –current relationship of a series RLC circuit and obtaining series resonance.
10. Study of three phase A.C circuits with
    a. Star connected load. b) De
11. Study of a single phase transformer-Determination of voltage ratio, turns ratio and polarity test.
12. Open –circuits and short –circuit test for a given single phase transformer. Determination of regulation and Efficiency
13. Phasor Diagram and Power factor of LCR circuit

Basic Electronics Lab

ECP 1010 **0 – 0 - 2 = 1**

1. To study CRO & function generator.
2. To find phase difference on CRO using RC filter.
3. To determine and plot operating characteristics of a PN junction diode.
4. To study the input / output waveform of Half wave rectifier and find its ripple factor and its efficiency.
5. To study the input / output waveform of bridge wave rectifierand find its ripple factor and its efficiency.
6. To study the clipper circuit using PN diode for positive and negative configurations.
7. To study clamper circuits using PN diode and clamper circuits.
8. To study the Zener characteristics and its application as voltage regulator
9. To plot characteristics of transistor in CE / CB configuration
10. To plot drain and transfer characteristics of a JFET.

Circuits& Simulation Lab

ECP 1030 **0 – 0 – 2 = 1**

1. Design a transistor bias circuit.
2. Study of h-parameters of Transistor
3. Design a two stage RC coupled amplifier-using BJT.
4. Design a bias circuit of FET

5. Design a single stage amplifier using FET.
6. Design a power supply with C filter.
7. Design a voltage regulator.
8. Design a push pull class B amplifier without input and output transformer.
9. Study of Feedback Amplifier
10. Input impedance output impedance of common emitter Amplifier and measurement of gain.
11. Exercises on circuit simulation using PSPICE

Digital Electronics Lab

ECP 2070 **0 – 0 – 2 = 1**

1. Study of PIN diagram of various ICs & to test the logic gates and verify their truth table.
2. Implementation of Half adder, Full adder & Half subtracter using NAND gates only.
3. Implementation of Boolean functions of three and four variables using 74153 (4:1) Mux.
4. Implementation of De-multiplexer, decoder and encoder.
5. To add two 4 bit binary numbers using 7483.
6. To compare two 4 bit binary number using 7485 (magnitude comparator).
7. To verify the operation of different modes of shift Register using 7495.
8. To design an asynchronous counter of any modulus using JK FF's (7473).
9. To design a synchronous counter of any arbitrary count using 7473.
10. Design of BCD to seven-segment display using logical gates ICs.
11. To study and verification by truth tables of SR, JK, MSJK, D & T flip flops.
12. To design and test non-sequential counter and study of shift registers.

Industrial Electronics Lab

ECP 2020 **0 – 0 – 2 = 1**

1. To study working and operating characteristics of D.C. machines.
2. To study working and operating characteristics of induction motors (Squirrel cage and Phase wound)
3. To study working, find the voltage regulation and efficiency of an alternator.
4. To find the static characteristics of an SCR and its operation as Half Wave Rectifier
5. Single Phase Full Wave Bridge Rectifier with DC motor as load
6. To Study SCR Firing Circuits.
7. To study working of Step Up and Step Down Chopper.
8. To study AC voltage regulation using anti parallel SCRs and Triac
9. To study operation of H-Bridge Inverter circuit with an AC motor as load.
10. To study Microprocessor based phase angle control of thyristors.

Electrical & Electronics Lab

ECP 1021 **0 – 0 – 2 = 1**

Introduction to various T&M equipment in Lab including Power Supplies, Function Generators & CRO's

14. To study &Verify KirchoffsVoltage Law, Superposition Theorem &Thevenin's Theorem.
15. To study transient response of RC low pass and high-pass filters and find out time constants.
16. To verify voltage, current relationship in series and parallel RLC circuit.
17. Study of voltage –current relationship of a series & parallel RLC circuit and obtaining series resonance.
18. To determine and plot operating characteristics of a PN junction diode.
19. To study the input / output waveform of Half wave rectifier & bridge rectifier and find its ripple factor and its efficiency.
20. To study the Clipper & Clamper circuit using PN diode
21. To study the Zener characteristics and its application as voltage regulator
22. To plot characteristics of transistor in CE / CB configuration
23. To plot drain and transfer characteristics of a JFET.

MATLAB Programming

ECP 1200 **0-0-2=1**

<u>Course Outcomes</u>

CO1	Able to use Matlab for interactive computations.
CO2	Familiar with memory and file management in Matlab.
CO3	Able to generate plots and export this for use in reports and presentations.
CO4	Able to program scripts and functions using the Matlab development environment.
CO5	Able to use basic flow controls (if-else, for, while).

Introduction: Introduction to Matlab,Workspace, Windows, and Help, Scalar Mathematics, Basic Mathematical Functions, Computational Limitations, Display Options, Accuracy and Precision.
File Management: Definitions and Commands Saving and Restoring Matlab Information, Script M-Files, Errors and Debugging, Matlab Search Path, Path Management, and Startup.
Trigonometry And Complex Numbers: Trigonometry, Complex Numbers, Two-Dimensional Plotting.
Arrays And Array Operations: Vector Array, Matrix Array, Array Plotting Capabilities.

Mathematical Functions And Applications: Signal Representation, Processing, and Plotting, Polynomials, Partial Fraction Expansion, Functions of Two Variables, User-Defined Functions, Plotting Functions.
Data Analysis: Maximum and Minimum, Sums and Products, Statistical Analysis, Random Number Generation.
Selection Programming: Relational and Logical Operators, Flow Control, Loops, Selection Statements in User-Defined Functions, Update Processes.
Vectors, Matrices And Linear Algebra: Vectors, Matrices, Solutions to Systems of Linear Equations.
Integration And Differentiation: Numerical Integration, Numerical Differentiation.
Symbolic Processing: Symbolic Expressions and Algebra, Manipulating Trigonometric Expressions, Evaluating and Plotting Symbolic Expressions, Solving Algebraic and Transcendental Equations, Calculus, Linear Algebra.
SIMULINK: Building basic models using SIMULINK.

1. Analysis of circuits and networks using MATLAB and SIMULINK.

Electronics Workshop

ECP 2201 **0 – 0 – 2 = 1**

1. Identification of Components
2. Using Multi-meter for tracing existing circuits
3. Soldering & De-soldering of Components
4. Design, Simulation, PCB Design & Fabrication, Component Soldering & Testing of DC Regulated Power Supply circuit or Similar

Linear Integrated Circuits Lab

ECP 2030 **0 – 0 – 2 = 1**

1. To study and verify the op-amp parameters including Offset voltage, CMRR & Slew-Rate
2. To study and verify the Op-amp as an Inverting & Non-Inverting amplifier.
3. To study and verify the application of an Op-amp as a Differentiator & Integrator.
4. To study and verify the application of an Op-amp as a Comparator, Schmitt Trigger, Peak Detector, Zero crossing detector.
5. To study and verify the application of an Op-amp as a Clipper & Clamper.
6. To study and verify the application of an Op-amp as a Precision Rectifier.
7. To study and verify the application of an Op-amp as a Voltage-to-Current / Current-to-Voltage Converter.
8. To study and verify the application of an Op-amp as an AstableMultivibrator / MonostableMultivibrator using IC 555 timer.
9. To study and verify Phased Lock Loop(PLL)
10. To study the performance of a 3 pin fixed voltage regulator and a 3 pin variable Voltage regulator.
11. To study the working of Op-amp based filters.
12. To study and verify the application of op-amp as Wave-form generator
13. To study and verify the application of op-amp as log / anti-log amplifier.
14. To study and verify the application of op-amp as A/D & D/A convertor

Analog Communication Laboratory

ECP 2151 **0 – 0 –2 = 1**

1. To study and calculate the modulation index of AM wave
2. To study the demodulation of AM wave and find out modulation frequency
3. To study and observe frequency modulation
4. Study of various FM receivers
5. Study of modulation and detection of single side band modulation.
6. To find the selectivity & sensitivity of the AM receiver
7. To find and plot the fidelity of the AM receiver.
8. Study of various AM receivers
9. To study the sample and hold process.
10. To study PAM and its demodulation
11. To study PWM and its demodulation
12. Study of 3 –band superhetrodyne receiver.
13. Noise power spectral density measurement

Digital Electronics Fundamentals Lab

ECP 2072 **0 – 0 – 2 = 1**

1. Study of PIN diagram of various ICs & to test the logic gates and verify their truth table.
2. Implementation of Half adder, Full adder & Half subtracter using NAND gates only.
3. Implementation of Boolean functions of three and four variables using 74153 (4:1) Mux.
4. Implementation of Demultiplexer, decoder and encoder.
5. To add two 4 bit binary numbers using 7483.
6. To compare two 4 bit binary number using 7485 (magnitude comparator).
7. To verify the operation of different modes of shift Register using 7495.
8. To design an asynchronous counter of any modulus using JK FF's (7473).
9. To design a synchronous counter of any arbitrary count using 7473.
10. To study and verification by truth tables of SR, JK, MSJK, D & T flip flops.
11. To design and test non-sequential counter and study of shift registers.

Microprocessor & Interfacing Lab

ECP 3061 **0 – 0 –3 = 1**

25-30 Programs in 8085 & 8086 Assembly Language including Interfacing problems(using 8255PPI) to interface to LEDs, Switches, ADC, Stepper Motor, LDR etc.

Digital Design & VHDL Lab

ECP 2071 **0 – 0– 2 = 1**

Design of Simple combinational logic circuits like Adders, Subtractors, Multiplexers, De-multiplexers, Encoders, Decoders, Latches, Comparators,
Design of Flip-Flops, Counters, Registers, Shift Registers,
Design of ALU
Design of State Diagrams for Digital System Design
Design of 7 segment Driver circuit, Motor Drive, Traffic Light Control, Vending Machine
Implementation of Circuits on Spartan 3E/ Virtex-II boards

Embedded Systems & Microcontrollers Lab

ECP 3080 **0 – 0 – 2 = 1**

At least 25 practical based on the 8051 Microcontroller & S12X (Assembly Language, Embedded C, Interface of Keys, LED Matrix, ADC, DAC, Stepper Motor, SPI Protocol based interface)

Digital Communication Engg.Lab

ECP 2152 **0 – 0 – 2 = 1**

1. Study of Sample and hold circuit
2. Generation & detection of PAM / PWM / PPM
3. Generation & detection of ASK / FSK / PSK / APSK
4. Generation & detection of PCM, ADPCM, DM
5. Power spectrum analysis of various modulation techniques
6. Study of framing & marker with voice coding kit
7. Data conditioning & Carrier modulation kit
8. Data Re-conditioning & carrier de-modulation

Instrumentation & Control Lab

ECP 3090 **0 – 0 – 2 = 1**

Note: Five practical from each section to be performed

<u>Measurement & Instrumentation Practicals</u>

1. To measure the harmonic distortion in output of function generator.
2. To measure strain using strain simulators.
3. Measurement of temperature with various types of sensors.
4. Measurement of Linear displacement using LVDT.
5. Measurement of frequency and phase of input signal in CRO usingLissagious pattern
6. Study of various transducers for measurement of common physical parameters like pH, conductivity, pressure, flow whichever possible

<u>Control Systems Practicals</u>

1. Transient response of second order system comprising of R,L,C to find maximum overshoot, rise time, settling time, damping factors/ratio, natural undamped frequency.
2. Frequency response of first and second order system comprising RL, RLC. Draw Nyquist and Bode plots.
3. Transient response of first order, second order and higher order pneumatic servo system
4. Transient response of first order, second order and higher order hydraulic system
5. To find torque speed, torque voltage characteristics of servomotor and determine its transfer function.
6. Study of synchronous transmitter, receiver and control transfer.
7. To simulate a second and higher order system on analog simulator and find its transient response to step, ramp and other input functions.
8. Study of open and closed loop servo system loop comprising of error detector, amplifier and a motor cum load with techno feedback.

Study of phase lag and phase lead networks.

Digital Signal Processing Lab

ECP 3181 **0 – 0 – 2 = 1**

Using MATLAB

1. Representation of time-series; computation of convolution
2. Response of a difference equation to initial conditions; stability
3. DFT computation
4. Computational experiments with digital filtering
5. Sampling & Waveform generation
6. FIR & IIR Filters Implementation
7. Fast Fourier transforms
8. Quantization Noise
9. Adaptive Filters
10. Multirate Signal Processing

VLSI Laboratory

ECP 3130 **0 – 0 –2 = 1**

1. Introduction to VLSI software.
2. Study of Digital Design Flow.
3. Study of Analog Design Flow.
4. To design and simulate CMOS inverter on EDA tool.
5. To study layout design of CMOS inverter.
6. To study post layout simulation of CMOS inverter.
7. To implement a complete circuit on EDA Tool right from simulation to generation of GDS-II file.

Project I: To design and simulate a project utilizing a complete EDA tool package.
Instructor are suggested to make student aware of Digital and Analog Design flows on the given EDA Tools.

Microwave Engineering Lab

ECP 3050 **0 – 0 – 2 = 1**

1. To plot the characteristics of Reflex Klystron.
2. To plot the characteristics of Gunn Diode
3. To measure the Low, Medium & High VSWR of rectangular wave guide terminated with unknown load.
4. To determine the attenuation due to component under test
5. To study the isolater and circulator
6. To measure the input impedence of unknown load with the help of slotted line section
7. To draw the radiation pattern of HORN Antenna.
8. To verify the E-plane and H-Plane Tee.
9. To verify the Magic Tee.
10. To find the directivity and coupling factor of two hole directional coupler.
11. To measure dielectric constant of material
12. To study the phase shifter
13. To find the directivity, isolation , main line insertion loss and coupling factor of directional coupler

Optical fiber CommunicationLab

ECP 4170 **0-0-2 = 1**

1. To Study and Verify Optical Communication Analog Link.
2. To Study and Verify Optical Communication Digital Link
3. Measurement of Numerical Aperture.
4. Measurement of Characteristics of Light-Emitting Diodes (LEDs).
5. Measurement of Characteristics of Laser Diodes.
6. To Study and Verify FDM & TDM.
7. To Study and Verify OTDM
8. Measurement of Bending Losses
9. Measurement with OTDR
10. To Study and Analyse Various Connectors and Splicing Mechanisms.
11. To Study ISDN Communication System (with sub-practicals)
12. To study EPABX System (with sub-practicals)
13. To Study Key Matrix (with sub-practicals)
14. To study DTMF (with sub-practicals)

Major Project

ECD4992 **12 Credits**

The same student team continues working as per work plan of Phase-I. Design of PCB, procurement of components is to be carried out. Acceptance tests for hardware and software are to be carried out vis-à-vis specifications from Phase-I. Functioning product is displayed at an Open House. Professional quality documentation of all designs, data, drawings, and results, change history, overall assessment, etc. is mandatory, along with a final presentation.

Digital Integrated Circuits

EECE 404B **3 – 0 – 0 = 3**

Course Outcomes

CO1	Analyze functionality of digital circuits including combinational, sequential, and memory.
CO2	Characterize speed, energy consumption, and robustness of combinational, sequential, and memory circuits.
CO3	Design combinational, sequential, and memory circuits to meet specified functionality, speed, energy, and robustness targets
CO4	Perform simulation of digital circuits, and write reports conforming to technical writing standards.

Unit-I

MOS Inverter: Introduction to resistive - load inverter, inverter with n-type MOSFET load, CMOS inverter

Switching Characteristics and Interconnects Effects: Introduction, Delay time definitions, Calculation of delay
times, Inverter design with delay constraints, MOS Inverters: Switching Characteristics & Interconnect Effects. Estimation of interconnect parasitic.

Unit-II

Sequential MOS Logic Circuits: Introduction, SR latch circuits, Clocked latch and Flip-flop circuits, CMOS D-latch and edge -triggered flip-flop. Dynamic MOS Logic Circuit

Unit-III

Semiconductor Memories: Introduction, Dynamic random access memory (DRAM), Static random acces memory(SRAM),Non-volatile memory.

Low Power CMOS Logic Circuits: Introduction, Overview of power consumption, Switching power dissipation o
CMOS inverter, Estimation and optimization of switching activity.

Recommended Books:

1. Rabaey J.M, Chandrakasan A, Nikolic B , "Digital Integrated Circuits- A Design Perspective", Prentice Hall
2. S M Kang and Y Lebici,"CMOS Digital Integrated Circuits-analysis and design", McGraw Hill.
3. Pucknell D A and Eshraghian K, *"Basic VLSI Design"*, Prentice Hall India, New Delhi,
4. Glaser L and Dobberpuhl D, *"The Design and Analysis of VLSI Circuits"*, Addison Wesley,
5. Weste N and Eshranghian K, *"Principles of CMOS VLSI Design"*, Pearson Education Asia,

Introduction to Wireless Networks

ECE 3101 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To basic understanding of concept of data communication and computer networks that will further help to understand the different kind of wireless technologies.
CO2	To provide ability to understand the concept of various multiple access techniques, channel diversity, and fading.
CO3	To acquire knowledge about Wi-Fi, and WPANs technology.
CO4	To develop an interest among student to do research in emerging research area as MANETs & WSN

Unit 1: Review of Computer Networks & Data Communication, Wireless LANs: IEEE 802.11 WLANs - protocol architecture, Physical layer, MAC layer, analysis, deployment of 802.11 infrastructures.

Unit 2: WPANs: IEEE 802.15.4, Bluetooth, ZigBee. Protocol architecture, Physical layer, MAC layer, analysis, deployment of 802.15.4 infrastructure.

Unit 3: Introduction to MANETS; MAC Protocols, Routing Protocols, performance comparison; Quality of Service.

Unit 4: Wireless Sensor Networks (WSNs): Overview/Architectures; Data Dissemination/Data Gathering; Routing Protocol, Security, Power control; Cross layer design; Localization.

Recommended Books:

- Rappaport, "Wireless Communications – Principles& Practices", PHI, Latest Edition
- C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Pearson Education, Inc.,
- Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons,
- Charles E Perkins, "Ad Hoc Networking", Addison Wesley,
- Jochen Schiller, "Mobile Communications", Addison Wesley,
- Ramjee Prasad and Luis Munoz, "WLANs and WPANs towards 4G wireless", Artech House,
- Selected papers from IEEE & ACM to be provided by Faculty

Image and Video Processing

ECE 4192 **3 – 0 – 0 = 3**

Course Outcomes

CO1	**Describe the fundamentals of image and video processing and their applications**
CO2	**Develop familiarity and implement basic image and video processing algorithms.**
CO3	**Select and apply appropriate technique to real problems in image and video analysis.**

This is a basic undergraduate-level class that covers fundamentals image processing, computer vision, and
Multimedia computing. The students will be exposed to dealing with image and video data through programming assignments using Java and Matlab.

1. **Introduction to Multidimensional Signal Processing**
   Historical overview, multimedia representations, software tools, authoring tools. Multidimensional Fourier Transform, sampling and Filtering (including decimation and interpolation), Introduction to wavelet transformation
2. **Human Visual Perception**

Human Visual System, visual masking, noise visibility, color vision

3. **Image Scanning and Display**
   Acquisition and Display of images (camera, digitizers, Film, printers); sampling and quantization issues
4. **Video Scanning and Display**
   Monochrome and Color TV, videoconferencing, videophone
5. **Image Analysis and Enhancement**
   Contrast and color adjustment, Noise Reduction, Edge Enhancement, Edge Detection, Texture, Image Segmentation
6. **Image Compression**
   Basics for Lossy Compression: Fourier Transform, Discrete Cosine Transform. Application to image compression (JPEG compression), VLC coding and Dictionary Codes
7. **Video Compression**
   Fundamental concepts of video, Video compression techniques, MPEG video coding, MPEG 4,7, and beyond. Introduction to CA VLC

Recommended Books

- R. Gonzalez and R. Woods, Digital Image Processing, Prentice-Hall
- A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall,
- W. K. Pratt, Digital Image Processing, Wiley
- A. M. Tekalp, Digital Video Processing, Prentice{Hall,
- M. Ghanbari, Video Coding - an introduction to standard codecs, IEE Telecommunica-tions Series, Burger & M. Burge"Digital Image Processing: An algorithmic introduction using Java", Springer 978-1-84628-379-6
- Z. Li and M. S. Drew, "Fundamentals of Multimedia", Prentice Hall 0-13-061872-1

Multimedia Communication

ECE 4190 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Understand basics of different multimedia networks and applications.
CO2	Understand different compression techniques to compress audio and video.
CO3	Describe multimedia Communication across Networks.
CO4	Analyse different media types to represent them in digital form.
CO5	Compress different types of text and images using different compression techniques and analyse DMS.

Part I: Overview of Multimedia Processing & Coding

Multimedia Communication: Multimedia information representation. Multimedia Networks, Multimedia applications, Network QoS and application QoS.

Information Representation: text, image, audio and video. text and image compression, compression principles, text compression, image compression. Audio and Video compression Principles

Part II: Multimedia Coding Standards

Video compression standards: H.261. H.263.PI.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video.

Detailed study of MPEG 4: coding of audiovisual objects, MPEG 4 systems. MPEG 4 audio and video, profile and levels. MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework, Significant features of JPEG 2000, MPEG 4 transport across the internet

Part III: Multimedia Networking

Synchronization: notion of synchronization, presentation requirements, reference model for synchronization, Brief Introduction to SMIL: Multimedia operating System, Resource management and process management techniques.

Multimedia communication across networks: Multipoint data conferencing: T.120 Layered video coding, error relevant video coding techniques, multimedia transport across IP networks and relevant products such as RSVP, RTP, RTCP, DVMRP, multimedia in mobile networks, multimedia broadcast networks, and content based retrieval in digital libraries Multicast, Multimedia over ATM

Recommended Books:

1. Ze-Nian Li & Mark S. Drew, "Fundamentals of Multimedia", Pearson Education
2. J.R. Ohm. "Multimedia Communication Technology", Springer International Edition,.
3. K.Sayood. "Introduction to Data Compressiojn", Morgan Kauffman. Indian Edition,
4. V.Bhaskaran and K. Konstantinedes. "Image and Video Compression Standards. Algorithms and Architecture." Kluwer publication,
5. Fred Halsall, "Multimedia communication", Pearson Education,
6. K.R. Rao, Zoram S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication System", Pearson Education,

7. Raifsteinmetz, klaraNahrstedt. "Multimedia Computing, Communication and Application". Pearson Education,
8. Tay Vaughan. "Multimedia: Making it work". Tata McGraw Hill.
9. John Billamil, louis Molina." Multimedia: An Introduction". PHI,
10. PallapaVenkataram, Multimedia information System, Pearson Education

Introduction to MEMS Design

ECE 4140 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Students will explain MEMS Technology, Present, Future and Challenges.
CO2	Students will be able to explain micro sensors, micro-actuators, their types and applications.
CO3	Students will be able to explain about fabrication processes for producing micro-sensors and actuators. They will also be able to apply Reliability, and Failure Analysis Testing.

Module 01
Introduction toMEMS, MEMS and VLSI design , MEMS examples , overview of MEMS fabrication , Special MEMS materials and their properties . Potential of MEMS in Industry.
Module 02
Bulk Micromachining : Isotropic Etching and Anisotropic Etching, WaferBonding, High Aspect-Ratio Processes (LIGA)
Module 03
Surface Micromaching: Surface micromachining techniques, Polysilicon surface micromachining, Characterisation of MEMS devices.
Module 04
Introduction to Smart MEMS sensors, Sensor Principles and Examples , Microactuators and examples . Mechanicaldesign of microactuators,
Module 05
Design of MEMS Pressure sensors , Design of silicon accelerometers , Examples of MEMS actuators
Text Books: .
1. MEMS and Microsytems Design and Manufacture, Tai- Ran Hsu, *Tata McGraw Hill*
2. MEMS, NitaigourMahalik, *Tata McGraw Hill*

Recommended Books:
1. Stephen D. Senturia, Microsystem Design, *Kluwer Academic Publishers,*
2.M-H. Bao, Elsevier, Micromechanical Transducers: Pressure sensors, accelerometers, andgyroscopes, New York

Optoelectronic Devices

ECE 4171 **3 – 0 – 0 = 3**

Course Outcomes

CO1	explain key concepts in quantum and statistical mechanics relevant to physical, electrical and optoelectronic properties of materials and their applications to optoelectronic devices and photonic integrated circuits that emit, modulate, switch, and detect photons
CO2	describe fundamental and applied aspects of optoelectronic device physics and its pplications to the design and operation of laser diodes, light-emitting diodes, and photodetectors
CO3	analyze optoelectronic device characteristics in detail using concepts from quantum mechanics and solid state physics
CO4	describe techniques to improve the operation of optoelectronic devices and device characteristics that have to be optimized for new applications by employing their understanding of optoelectronic device physics

Unit-I
Introduction: Semiconductor materials; Crystal lattices; Bulk Crystal growth, epitaxial growth.
Energy bands and Charge carriers in Semiconductors: direct and indirect semiconductors; variation of
Energy bands with alloy composition. Charge carriers in semi-conductors-electrons, holes, effective mass; intrinsic and extrinsic materials. Drift of carriers in electric and magnetic fields.
Unit-II
Excess carries in Semiconductors: Optical absorption; luminescence - photoluminescence, electroluminescence ,electroluminescence. Carrier lifetime and photoconductivity, diffusion of carriers.
P-N Junction Diode: Current-Voltage Characteristics; hetrojunctions.
Unit-III
Optoelectronic Devices: Principle of operation and characteristics; Light emitting diodes, lasers, photo detectors, solar cells.
Relevance of III-V and IV-VI material-systems in optoelectronic devices.
Integrated Optics: Optical waveguides-passive, electro-optical; optical modulators and switches; optical storage devices.
Recommended Books:
1. Pallab Bhattacharya, “Semiconductor Optoelectronic Devices”,

2. Street B G and Banerjee S, “Solid State Electronic Devices”, PHI New Delhi,
3. Sze S M, “Physics of Semiconductors Devices”, Wiley Eastern Limited, New Delhi.
4. Wilson and Hawkes, “Optoelectronics; An Introduction”, PHI
5. Hummel R E, “Electronic Properties of Materials”, Narosa Publishing House, New Delhi.

Object Oriented Programming

ECE 425B **3 – 0 – 0 = 3**

Course Outcomes

CO1	Define the principles of OOP and the concept of CLASSES
CO2	Recognize the ideology of Procedure Oriented and Object Oriented Programming
CO3	Apply the concepts of OOP and Use CLASSES in basic level programs
CO4	Examine basic level programs for possible outcome and potential errors.

Principles of Object Oriented Programming
The Traditional Approach, Shortcoming of procedure oriented languages, Basic concepts of Object Oriented Programming, Benefits of OOP, Object Oriented Languages
Overview of Programming Basics
Input/Output using cin/cout, processor directives, basic and user defined data types, operators, loops, decision making, control statements, functions, pointers to functions
Classes
Definition, Class objects, Class member functions, Static Class Members, Class Scope, Nested Classes, Local Classes, Composite class, Constructor, Destructor, Friends, *this* Pointer
Operator Overloading
Overloading unary and binary operators, Special operators : Operator [ ], ( ), □, ++ and --, << and >>
Inheritance and Polymorphism
Class hierarchy : Definition, Identifying the members of the hierarchy, Base class member access, Base and derived class construction, Member wise initialization and assignment, virtual functions, multiple inheritance, class scope under inheritance, virtual classes.
Templates
Class Templates, Function Templates
Exception Handling
Throwing, The try…..catch block, Exception specifications

Recommended Books:
Object Oriented Programming with C++ ANSI/ISO Standards, R. Subburaj

Advanced Embedded System design

ECE 4082 **2-0-2 = 3**

Course Outcomes

CO1	**Understand the architecture, ISA, programming, and interface requirements of a commercially 32-bit microprocessor (ARM Cortex-M4F).**
CO2	**Analyze and design to interface a microprocessor to displays, memories, ports, serial ports (USART, SPI, I2C), etc.**
CO3	**Apply 32-microprocessor systems (ARM) to solve real-time problems like timers, counters, A2D, Motors, etc.**
CO4	**Learn to use assemblers, compilers, simulators and emulators to help with design and verification for ARM processors.**
CO5	**Develop closed and open embedded/Linux based systems for ARM processors**

Embedded Architecture: Embedded systems Overview, Design Challenge – Optimizing design metrics, Processor Technology, Embedded system design process- Requirements, Specification, Architectural Design, Designing Hardware and Software Components, System Integration.
Embedded Processor and Computing Platform: Power PC processor- Power architecture and Programming model, Memory management, Interrupts and Exceptions and debugging, Communication Processor module, Interrupt controller, SCC, SMC, FEC, TSEC, UCC, MCC, QMC and Code Warrior Tools.
Networks: Distributed Embedded Architecture- Hardware and Software Architectures, Networks for embedded systems- I2C, CAN Bus, TDM, ATM , Ethernet, HDLC, Wirelees Protocols – IrDA, Bluetooth, WI FI, WIMAX, Network-Based design- Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design .**Real-Time Characteristics:** Introduction to RTOS-Special considerations in an RTOS, Clock driven Approach, weighted round robin Approach, Priority driven Approach, Dynamic Versus Static systems, effective release times and deadlines, Optimality of the Earliest deadline first (EDF) algorithm, challenges in validating timing constraints in priority driven systems, Off-line Versus On-line scheduling.
System Design Techniques: Design Methodologies, Requirement Analysis, Specification, System Analysis and Architecture Design, Quality Assurance, Design Example: VOIP phone, Network based Appliance control- Hardware Design and Software Design.

Recommended Books:

1. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman Publishers, 2001.
2. Jane.W.S. Liu "Real-Time systems", Pearson Education Asia,
3. C. M. Krishna and K. G. Shin , "Real-Time Systems" ,McGraw-Hill,
4. Frank Vahid and Tony Givargi, "Embedded System Design: A Unified Hardware/Software Introduction",John Wiley
5. MPC885 PowerQUICC Family Reference by Freescale Semiconductor
6. MPC8323E PowerQUICC II Pro Integrated Communications Processor Reference Manual by Freescale Semiconductor

Satellite Communication

ECE 4160 **3-0-0 = 3**

Course Outcomes

CO1	Able to learn the dynamics of the satellite.
CO2	Able to understand the communication satellite design.
CO3	Able to understand how analog and digital technologies are used for satellite communication networks.
	Able to learn the design of satellite links.
	Able to study the design of Earth station and tracking of the satellites.

Unit-I: Basic Principles.
General features, frequency allocation for satellite services, properties of satellite communication systems.
Unit-II: Satellite Orbits
Introduction, Kepler's laws, orbital dynamics, orbital characteristics, satellite spacing and orbital capacity, angle of elevation, eclipses, launching and positioning, satellite drift and station keeping.
Unit-III: Satellite Construction (Space Segment)
Introduction; attitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, antenna subsystem, equipment reliability and space qualification.
Unit-IV: Satellite Links
Introduction, general link design equation, system noise temperature, uplink design, downlink design, complete link design, effects of rain.
Unit-V: Earth Station
Introduction, earth station subsystem, different types of earth stations.
Unit-VI: The Space Segment Access and Utilization
Introduction, space segment access methods, TDMA, FDMA, CDMA, SDMA, assignment methods.
Unit-VII: The Role and Application of Satellite Communication.

Recommended Books:

1. Timothy Pratt, Charles W. Bostian, Satellite Communications, John Wiley & Sons.
2. Dennis Roddy, Satellite Communications, Mc. Graw-Hill International Ed

3. W. L. Pritchard, J. A. Sciulli, Satellite Communication Systems Engineering, Prentice-Hall, Inc.,
4. M. O. Kolawole, Satellite Communication Engineering, Marcel Dekker, Inc. NY.

Pervasive Computing & Wireless Sensor Networks

ECE 3100 **3-0-0 = 3**

Course Outcomes

CO1	discover the characteristics of pervasive computing applications including the basic computing application problems, performance objectives and quality of services, major system components and architectures of the systems;
CO2	discover the basic problems, performance requirements of pervasive computing applications, and the trends of pervasive computing and its impacts on future computing applications and society;
CO3	analyse the strengths and limitations of the tools and devices for development of pervasive computing systems;
CO4	analyze and compare the performance of different data dissemination techniques and algorithms for mobile real-time applications;
CO5	develop an attitude to propose solutions with comparisons for problems related to pervasive computing system through investigation.

Introduction to concept of Pervasive Computing – characteristics & features of Pervasive Computing Systems, Components of such systems, Communication and network requirements, Personal Area Network as defined by IEEE 802.15.4, Potential applications of Pervasive computing systems. Introduction to context, Need for context, Relationship between sensors and context
Wireless Sensor Networks – Introduction to sensors, basic Concepts & characteristics, Need for wireless sensors, Advantages and disadvantages of wireless sensors, Self Organization of Networks, Self-healing capabilities, Network Formation

Routing Algorithms used in WSNs - Introduction to Routing algorithms, Criteria for "good" routing methods, Classification of routing algorithms based on their class, Destination based routing, All-pairs Shortest path Problem – the Floyd-Warshall Algorithm, Routing with Compact Routing Tables
Security Issues in WSNs – Security requirement, issues and goals. Security threats, types of attacks on sensor networks and countermeasures. Symmetric key, public-key, Hash function algorithms, Key Management issues
Localization & Target Tracking in WSNs - Concept of Distributed Digital Signal Processing in Wireless Sensor Networks, Localization techniques based on Signal strength, Angle of Arrival, Beacon based Triangulation. Issues involved in Tracking of moving targets, Collaborative signal processing, its need & challenges.Distributed estimation in sensor networks using Kalman Algorithm.
Recommended Books:

1. Fundamentals of Mobile & Pervasive Computing, Gupta, TMH

Radar Systems and Navigational-Aid

ECE 4161 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Knowledge in the topics such as Fundamentals of Radar
CO2	To become familiar with fundamentals of Different types of RADAR
CO3	To gain in-depth knowledge about the different types of RADAR and their operations
CO4	Understand signal detection in RADAR and various detection techniques
CO5	Understand Navigational Aids and Modern Navigation

Introduction:
Historical background, Radar terminology, Radar band designations, Basic Radar, Radar block diagram, Radar frequencies, Radar-clutter, Information from radar signals, propagation of Radar waves, Applications of Radar.
Radar Equation
Detection of signals in noise, receiver noise and signal to noise ratio, Radar cross-section of targets, transmitter power, PRF, Antenna parameters, other Radar equation considerations**.**
MTI and Pulse Doppler Radar
FM and CW-Radar**,** Doppler and MTI Radar, Delay-line cancelers, Digital MTI processing, moving target detector, Pulse Doppler Radar,
Tracking Radar
Tracking with Radar, Mono-pulse Radar, Conical and Sequential Lobing and ADT.
Detection of Signals in Noise
Detection, Matched filter receiver, Detectors, automatic detection, signal management.
Radar Antenna
Antenna parameters, Phased Array Radars ESPAA, MSPAA and Radiation pattern synthesis.
Radar Transmitters and Receiver
Linear beam power tubes, CFA, solid-state RF-power sources, Radar receiver.
Displays: A-scope, B-scope, PPI, modern displays.
Radio Navigation:
Radio direction finding, LORAN Radio ranges, Distance measuring equipments,Instrument and landing systems (ILS), MLS.

Textbooks:

1. Introduction to Radar Systems M.I. Skolnik- McGraw Hill
2. Radar Principles- N. Levanon- Wiley
3. Principles of Modern Radar- J.L. Eaves, and E.K. Reedy- Chapman & Hall
4. Elements of Electronic Navigation - N.S. Nagaraja (TMH publication)

Virtual Instrumentation using LabView

ECE 3091 **2 – 0 – 2 = 3**

Course Outcomes

CO1	1. Recollect and compare basic knowledge of programming languages.
CO2	2. Understand &use data handling for representation and analysis.
CO3	3. Understand basics of acquisition techniques and its interface.
CO4	4. Study and use interfacing techniques to connect with hardware.
CO5	5. Ability to use state machines to solve complex problems.

Review of virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming.
VI Programming Techniques: VIS and sub-VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

Data Acquisition Basics: ADC, DAC, DIO, counters & timers, PC Hardware structure, timing, interrupts, DMA, software and hardware installation.
Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB, System buses, interface buses: **USB, PCMCIA, VXI, SCXI, PXI, etc., networking basics for office & Industrial applications**, VISA and IVI, image acquisition and processing. Motion control.
Use of Analysis Tools: Fourier transforms, power spectrum, correlation methods, windowing & filtering. VI applications in various fields.
Lab work will include practical based on learning & Utilizing LabView Software

Recommended Books:

1. Gary Johnson - Labview Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
2. Lisa K. wells & Jeffrey Travis - Labview for everyone, Prentice Hall, New Jersey, 1997.
3. Sokoloff - Basic concepts of Labview 4, Prentice Hall, New Jersey, 1998.
4. S.Gupta, J.P. Gupta - PC interfacing for Data Acquisition & Process Control, Second edition, Instrument Society of America, 1994.
5. LabViewusers manual.
6. National instruments Product catalog.
7. Virtual Instrumentation Using LabView, Gupta S., Tata McGraw Hill Publishing Company Limited.

Modeling and analysis of nanoscale devices
ECE 4071 **3– 0 – 0 = 3**

Course Outcomes

CO1	Ability to perform simple analysis of nanoelectronic devices.
CO2	Ability to calculate the density of states in nonelectronic devices
CO3	Ability to perform in-depth analysis of nanoelectronic devices
CO4	Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
CO5	Study of various Nanodevices and their models

Introduction to nanoelectronics – device scaling, how device physics is fundamentally different in mesoscopic and nano devices – voltage drop, heat dissipation etc., Necessity to understand and invoke quantum mechanics in nanoelectronics.

Quantum mechanics, Schrödinger equation, Free electron wavefunction, Particle/electron in a box, electrons in a solid.

Models in nanodevices : Introduction to KP model, Brillouin Zones, KP model – origin of energy bands in solids. Density of states – 0D, 1D, 2D, 3D conductors, Fermi function, The notion of modes in a conductor. Conductance, Bottom-up approach, Landauer's formalism, Ballistic and Diffusive transport – transmission, transition from ballistic to diffusive transport.
Introduction to MOSFET – A barrier-controlled device, MOSFET electrostatics.MOSFET 2D electrostatics, MOSFET Capacitance. High-K dielectric, Strained Si technology, Quantum confinement in MOSFET.

MOSFET model analysis
ETSOI-MOSFET, Transport in MOSFET, Ballistic MOSFET. Ballistic injection velocity in MOSFET, Thermoelectric effects and thermoelectric devices.
Quantum dot devices – quantum capacitance, IV characteristics, self-consistent method.
Introduction to ab initio simulation, NEGF, Summary of the entire course.

Social Networks
ECE 4195 **3-0-0 = 3**

Course Outcomes

CO1	Understand a broad range of network concepts and theories.

CO2	Appreciate how network analysis can contribute to increasing knowledge about diverse aspects of society.
CO3	Use a relational approach to answer questions of interest to them (i.e. be able to apply 'network thinking').
CO4	Analyse social network data using various software packages.
CO5	Present results from social network analysis, both orally and in writing.

Introduction
Information Spread Puzzle, Introduction To Python-1, Introduction To Python-2, Introduction To Networkx-1, Introduction To Networkx-2, Social Networks: The Challenge, Google Page Rank, Searching In A Network, Link Prediction, The Contagions, Importance Of Acquaintances, Marketing On Social Networks
Handling Real-World Network
Datasets Introduction To Datasets, Ingredients Network, Synonymy Network, Web Graph, Social Network Datasets, Datasets: Different Formats, Datasets : How To Download, Datasets, Analyzing Using Networkxm, Datasets: Analyzing Using Gephi, Introduction : Emergence Of Connectedness,
Strength Of Weak Ties
Granovetter's Strength Of Weak Ties, Triads, Clustering Coefficient And Neighborhood Overlap, Structure Of Weak Ties, Bridges, And Local Bridges, Validation Of Granovetter's Experiment Using Cell Phone Data, Embededness, Structural Holes, Social Capital, Tie Strength, Social Media And Passive Engagement, Betweenness Measures And Graph Partitioning, Finding Communities In A Graph (Brute Force Method) And Others
Strong And Weak Relatonships & Homophily
Introduction to Homophily, Selection And Social Influence, Interplay Between Selection And Social Influence, Homophily - Definition And Measurement, Foci Closure And Membership Closure, Introduction To Fatman Evolutionary Model and Coding
Homophily And+Ve / -Ve Relationships
Spatial Segregation: An Introduction, Simulation Of The Schelling Model, Spatial Segregation: Conclusion, Schelling Model Implementation
Positive And Negative Relationships (Introduction),
Structural Balance, Enemy's Enemy Is A Friend, Characterizing The Structure Of Balanced Networks, Balance Theorem, Proof Of Balance Theorem, Introduction To Positive And Negative Edges, Outline Of Implementation, Creating Graph, Displaying It And Counting Unstable Triangles, Moving A Network From An Unstable To Stable State,
Link Analysis
The Web Graph, Collecting The Web Graph, Equal Coin Distribution, Random Coin Dropping, Google Page Ranking Using Web Graph, Implementing Pagerank Using Points Distribution Method- Degree Rank Versus Pagerank,
Cascading Behavior In Networks
We Follow,Why Do We Follow?, Diffusion In Networks, Modeling Diffusion, Modeling Diffusion (Continued),Impact Of Commmunities On Diffusion,Cascade And Clusters, Knowledge, Thresholds And The Collective Action, An Introduction To The Programming Screencast (Coding 4 Major Ideas),
Hubs and Authorities
Introduction To Hubs And Authorities, Principle Of Repeated Improvement Principle Of Repeated Improvement Hubs And Authorities, Pagerank
Power Laws And Rich-Get-Richer Phenomena
Introduction To Powerlaw, Power Law Emerges In www Graphs, Detecting The Presence Of Powerlaw, Rich Get Richer Phenomenon, Implementing Rich-Getting-Richer Phenomenon (Barabasi- Albert Model)-1 And Others
Power Law Epidemics
Sis and Sir Model Implementation
Small World Phenomenon
Milgram Experiment, Generatiye Model
Pseudo Core
How To Go Viral On Web

Recommended Books:

- 1. Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010 (available for free download).
- 2. Social and Economic Networks by Matthew O. Jackson, Princeton University Press, 2010. (free chapter available)

Books and references

1. Lessons from Nanoelectronics by Supriyo Datta
2. Fundamentals of Nanotransistors by Mark Lundstrom
3. Near-Equilibrium Transport: Fundamentals and Applications by Mark Lundstrom
4. Introduction to Quantum Mechanics by David J. Griffiths

Open elective for B.Tech , M.Tech , M.Sc Physics .

Industry 5.0 & Industrial Internet of Things

ECE 4083 **3-0-0 = 3**

Course Outcomes

CO1	Understand the concept of industrial revolution from industry 1.0 to 5.0
CO2	CO2: Be able to define the various layers of Industrial IoT and the allied technologies
CO3	Analyse possible use case and applications for IIoT

Introduction: Sensing & actuation, Fundamentals of Communication and Networks

Industry 40 to 5.0: Globalization, The Fourth Revolution, LEAN Production Systems, Cyber-Physical Systems and Next Generation Sensors, Collaborative Platform, and Product Lifecycle Management

Cybersecurity in Industry 4.0, Basics of Industrial IoT, Transition to Industry 5.0, Human-Robot Interaction, likely impact on human workforce, improvement in industrial manufacturing processes,

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture, Layers- Sensing, Processing & Communication, Networking

Big Data Analytics and Software Defined Networks, Introduction to Machine Learning and Data Science

Security and Fog Computing in IIoT

Industrial IoT- Application Domains - Healthcare, Power Plants, Inventory Management & Quality Control, Oil, chemical, and pharmaceutical industry

Recommended Books:

1.Raj Kamal *The internet of things*. John Wiley & Sons, 2017.

2. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. *Introduction to industrial internet of things and industry 4.0*. CRC Press, 2021.

3.Introduction to IoT. Authors, Sudip Misra, Anandarup Mukherjee, Arijit Roy. Edition, illustrated. Publisher, Cambridge University Press, 2021.

4.Gilchrist, A., 2016. *Industry 4.0: the industrial internet of things*. Apress.

Program Structure of the
M. Tech (Electronics & Communication Engineering)Programme

Semester I **First Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
ECL 6150	Advanced Digital Communications	3-1-0	4
ECL 6182	Signal Processing Techniques & Applications	3-1-2	5
ECL 6221	Integrated Circuit Design	3-0-2	4
ECL 6110	Wireless Networks & Protocols	3-1-2	5
BUL 8223	Research Methodology	4-0-0	4
Total Credits		**18-0-6**	**22**

Semester II **First Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
ECL 6051	Microwave Circuit Design	3-0-2	4
ECL 6170	Optical Switching & Networks	3-0-2	4
ECL 6071	CMOS Digital Design	3-0-0	3
ECE XXXX	School Elective-I	3-0-0	3
ECE XXXX	School Elective-II	3-0-0	3
PCL 1067	Discourse on Human Virtues (Non-Credit/Audit)	3-0-0	0
Total Credits		**16-1-4**	**17**

Semester III **Second Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
	Open Elective-I		3
ECE XXXX	School Elective-III	3-0-0	3
ECL 7084	Embedded System Design	3-0-2	4
ECC 7981	Seminar	-	3

ECD 7990	Project-Synopsis (Phase-I)	-	8
Total Credits		**3-0-0**	**21**

Semester IV **Second Year**

Course Code	Course Title	L-T-P	Credits
ECD 7991	Project-Dissertation (Phase-II)		20
Total Credits			**20**

Total = 80 Credits

List of Electives

Elective –I	Elective –II & III
ECE 6193 Audio & Video Processing	EECE 201P Artificial Materials
ECE 6110 Wireless Sensor Networks & Applications.	ECE 6082Real Time Embedded Systems
ECE 6150 Advanced Wireless Communications	ECE 6121 Wireless Networks & Security Issues
ECE 6195 Pattern Recognition	ECE 6065 Advanced Digital Signal Processors & its Applications
ECE 6194 Audio Engineering	ECE 6052 Microwave Antenna Design
ECE 6112 Advanced Computer Networks	EECE 6142 NEMS Design
ECE 6211 ASIC Design & FPGA	ECE 6160 Terahertz Electronics
ECE 6010 Semiconductor Device Modeling	ECE 6222 Digital integrated Circuits
ECE 6141MEMS Design	ECE 6161 RFIC Design
ECE 6063 Advanced Computer Architecture	ECE 7170 Photonics Networks & switching
EECE 105P Detection & Estimation	ECE 7111 Advanced Wireless Sensor Networks
ECE 6106 Information Theory & Coding	ECE 6210P Mixed Signal Testing
ECE 6070 Synthesis & Optimization of Digital Circuits	ECE 6230 Advanced CMOS VLSI Design
ECE XXXX Social Networks	ECE 6111 Internet of Things
ECE 6231 Modelling of Nanodevices	

Advance Digital Communication

ECL 6150 **4 - 0 - 0 = 4**

Course Outcomes

CO1	use mathematical models for describing advanced communication channels and systems such as communication systems with dispersion, interference, multiple users, multipath propagation, multiple carriers and multiple antennas
CO2	use mathematical models for characterising properties for advanced communication channels and systems and identify properties that limit the communication
CO3	summarise advantages and disadvantages with different advanced communication technologies and be able to discuss their optimality and complexity
CO4	choose and optimise design parameters (e.g., power distribution, modulation, redundancy, speed) in advanced communication technologies to adapt them to a given channel model and given requirements
CO5	for a given combination of channel model and communication technique use mathematical models for analysing the expected performance (e.g., error probabilities, speed) and compare the performance for different solutions.

Unit I:Introduction
Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms.
Unit II: Modulation
Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-array ASK, PSK, FSK, DPSK), Continuous phase modulation (QPSK and variants, MSK, GMSK).
Unit III: Receiver in additive white Gaussian noise channels
Coherent and non-coherent demodulation: Matched filter, Correlator demodulator, square-law, and envelope detection; Detector: Optimum rule for ML and MAP detection Performance: Bit-error-rate, symbol error rate for coherent and non-coherent schemes.
Unit IV: Band-limited channels
Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel with distortion: Design of transmitting and receiving filters for a known channel and for time varying channel (equalization); Performance: Symbol by symbol detection and BER, symbol and sequence detection, Viterbi algorithm.
Unit V: Synchronization
Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods)
Unit VI:Communication over fading channels
Characteristics of fading channels, Rayleigh and Rician channels, receiver performance-average SNR, outage probability, amount of fading and average bit/symbol error rate.

Signal Processing Techniques & Applications

ECL 6182 **4 - 0 - 0 = 4**

Course Outcomes

CO1	To apply DFT for the analysis of digital signals & systems
CO2	To design FIR filters
CO3	To design IIR filters
CO4	To characterize finite Word length effect on filters
CO5	To design the Multirate Filters

Continuous-Time and Discrete-Time Signals and Systems:
Continuous and discrete time signals: Some Elementary Continuous-time and Discrete-Time signals. Classification of Signals ,Periodic and a periodic even , odd ,energy and power signals ,Deterministic and random signals ,Causal and non-causal signals complex exponential and sinusoidal signals ,Simple Manipulations of Continuous and discrete time signals.
Continuous-Time Systems: Mathematical equation governing LTI Continuous-Time systems, Block diagram and signal flow graph representation, response of LTI Continuous-Time system in time domain, classification of Continuous-Time systems, convolution of Continuous-Time signals.
Discrete-Time Systems: Input-Output Description, Block Diagram Representation, Classification, Interconnection;
Analysis of Discrete-Time LTI Systems: Techniques, Response of LTI Systems, Properties of Convolution, Causal LTI Systems, Stability of LTI Systems; Discrete-Time Systems Described by Difference Equations; Implementation of Discrete-Time Systems;
Correlation of Discrete-Time Signals: Cross correlation and Autocorrelation Sequences, Properties. Understanding of SISO, SIMO, MISO and MIMO
Deterministic Discrete signal analysis:

Discrete Fourier transforms (DFT), Periodic and aperiodic signal analysis, limitations of DFT, Fast Fourier Transforms, Transform equivalence: Z, DTFT, CTFT, FS, DFT. DFT for long sequences, STFT. Practical aspects of DFT. Application of DFT: Filter banks. Stability analysis, Response of a stable system, marginal and asymptotic stability.

Random Discrete signal and systems:

Mathematical description of random signals, pseudorandom signals, stochastic processes. Brief review of probability. Spectral representation and analysis of nonstationary signals, random signals. Linear systems to random input. Parametric representation of Stochastic processes. Basic concept of processing random signals

Image Representation and compression:

Gray scale and colour Images, image sampling and quantization. Two dimensional orthogonal transforms: DFT, WHT, Haar transform, KLT, DCT. Fundamental Concepts of Image Compression: Compression models - Information theoretic perspective -Fundamental coding theorem - Lossless Compression: Huffman Coding- Arithmetic coding - Bit plane coding – Run length coding - Lossy compression: Transform coding - Image compression standards.

Video Processing:

Representation of Digital Video, Spatio-temporal sampling; Motion Estimation; Video Filtering; Video Compression, Video coding standards.

Recommended Books:

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, Pearson.
2. Alan V. oppenheim and Alan S. Willsky ,Signals and Systems---, PHI
3. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India,
4. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education.

Integrated Circuit Design

ECL6221 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Able to carry out research and development in the area of analog and mixed signal IC design.
CO2	To be well versed with the MOS fundamentals, small signal models and analysis of MOSFET based circuits.
CO3	Able to analyze and design analog circuits such as Differential Amplifier, OP-AMP, Current mirrors, Biasing circuits.
CO4	Able to analyze and design mixed mode circuits such as Comparator, ADCs, DACs, PLL.
CO5	Solve practical and state of the art analog IC design problems to serve VLSI industries.

Unit I:

IC components - their characterization and design. Analysis and design of basic logic circuits. Linear ICs. Large Scale Integration.

Unit II:

Basics of MOSFET ,Introduction to digital IC design, MOS inverter-Resistive load ,Depletion load,CMOS inverter,Switching Characteristics of MOS inverter, design of combinational logic gates in CMOS- static and dynamic CMOS -design, CMOS Transmission gates, Power consumption in CMOS gates,Low power CMOS logic ckts ,MOS memory circuits, Bi-CMOS Logic ckts, Design of sequential logic circuits, Set up time,Hold time requirements.

Unit III:

Low power design:

Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Physics of power dissipation in CMOS devices.

Device & Technology Impact on Low Power Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.

Power estimation, Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems.

Recommended Books:

1. R.S. Muller and T.I. Kamins, "*Device Electronics for Integrated Circuits*", Wiley,
2. DA. And Eshrachian K, "*Basic VLSI design systems & circuits*", PHI,
3. Geigar BR, Allen PE &Strader ME, " *VLSI design techniques for analog & digital circuit*",McGraw Hill,
4. Carver Mead and Lynn Conway, "*Introduction to VLSI Systems*", BS Publications, Indian Reprint
5. Neil H. E. Weste& Kamran Eshraghian, "*Principles of CMOS VLSI Design*", Pearson education asia,
6. Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP,
7. Rabaey, Pedram, "Low power design methodologies" Kluwer Academic,
8. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley,
9. Rabaey J.M, Chandrakasan A, Nikolic B , "Digital Integrated Circuits- A Design Perspective", Prentice Hall.
10. S M Kang and Y Lebici,"CMOS Digital Integrated Circuits-analysis and design", McGraw Hill.

Wireless Networks & Protocols

ECL 6110 **4 - 0 - 0 = 4**

Course Outcomes

CO1	Understand fundamentals of wireless communications.
CO2	Analyze security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.
CO3	Demonstrate basic skills for cellular networks design.
CO4	Apply knowledge of TCP/IP extensions for mobile and wireless networking.

Unit 1
Introduction to Fundamentals of Wireless Communication, Channel Diversity & Fading, Multiple Access Techniques, Wireless LANs: IEEE 802.11 WLANs - protocol architecture, physical layer, MAC layer, analysis, deployment of 802.11 infrastructure
Unit 2
WPANs: IEEE 802.15.4, Bluetooth, ZigBee, UWB. protocol architecture, physical layer, MAC layer, analysis, deployment of 802.15.4 infrastructure
Unit 3
Mobile Ad-Hoc Networks (MANETS): Introduction; MAC Protocols - classification, comparative analysis; Routing - reactive and proactive routing, power-aware routing, performance comparison; Quality of Service
Unit 4
Wireless Sensor Networks (WSNs): Overview/Architectures; Data Dissemination/Data Gathering; MAC Protocols; Routing Protocol, Security, Power control; Cross layer design; Localization

Lab Work: Simulation of Various Wireless Networks using Qualnet Simulation Software

Recommended Books:

1. Rappaport, "Wireless Communications – Principles& Practices", PHI, Latest Edition
2. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Pearson Education, Inc.,
3. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons,
4. Charles E Perkins, "Ad Hoc Networking", Addison Wesley,
5. Jochen Schiller, "Mobile Communications", Addison Wesley,
6. Ramjee Prasad and Luis Munoz, "WLANs and WPANs towards 4G wireless", Artech House,
7. Selected papers from IEEE & ACM to be provided by Faculty

Microwave Circuit Design

ECL6051 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Understanding the design concept of various RF/Microwave devices.
CO2	Knowledge of Microwave Circuit Analysis and Impedance matching.
CO3	Understanding the behavior of non-linear RF/Microwave Devises.
CO4	Ability to design discrete RF/ Microwave Devices

Unit -1
Introduction
Importance of RF Design, RF Behavior of Passive Components: High Frequency Resistors, High-Frequency Capacitors, High-Frequency Inductors. Chip Components and Circuit Board Considerations: Chip Resistors, Chip Capacitors, Surface-Mounted Inductors.
Unit -2
An Overview of RF Filter Design I
Basic Resonator and Filter Configurations: Filter Type and Parameters, Low-Pass Filter, High Pass Filter, Bandpass and Bandstop Filters, Insertion Loss, Special Filter Realizations: Butterworth –Type, Chebyshev and De-normalization of Standard Low-Pass Design.
Unit -3
An Overview of RF Filter Design II
Filter Implementations: Unit Elements, Kuroda's Identities and Examples of Microstrip Filter Design. Coupled Filter: Odd and Even Mode Excitation, Bandpass Filter Section,Cascading Bandpass Filter Elements, Design Examples.
Unit -4

Matching and Biasing Network
Impedance Matching using Discrete Components: Two Component Matching Networks, Forbidden regions, Frequency Response and Quality Factor, Microstrip Line Matching Networks: From Discrete Components to Microstrip Lines, Single-Stub Matching Networks, Double-Stub Matching Networks, Amplifier Classes of Operation and Biasing Network: Classes of Operation and Efficiency of Amplifiers, Bipolar Transistor Biasing Networks, Field Effect Transistor Biasing Networks.

Unit -5

RF Transistor Amplifier Design I
Characteristics of Amplifiers, Amplifier Power Relations: RF source, Transducer Power Gain, Additional Power Relations, Stability Considerations: Satbility Circles, Unconditional Stability, Stabilization Methods.

Unit -6

RF Transistor Amplifier Design II
Constant Gain: Unilateral Design, Unilateral Figure of Merit, Bilateral Design, Operating and Available Power Gain Circles. Noise Figure Circles, Constant VSWR Circles. Broadband, High Power and Multistage Amplifiers.

Unit -7

RF Oscillators and Mixers:
Basic Oscillator Model: Negative Resistance Oscillator, Feedback Oscillator Design, Design Steps, Quartz Oscillators. High Frequency Oscillator Configuration: Fixed Frequency Oscillators, Dielectric Resonator Oscillators, YIG-Tuned Oscillators, Voltage Controlled Oscillators, Gunn Element Oscillator. Basic Characteristics of Mixers: Basic Concepts, Frequency Domain Considerations, Single-Balanced Mixer Double-Balanced Mixer.

Text Book :

1. RF Circuit Design Theory and Application, Reinhold Ludwig and Pavel Bretchko, Ed. 2004, Pearson Education

Reference Book:

1. Radio Frequency & Microwave Electronics Illustrated, Radmanesh, Pearson,

Optical Switching & Networks

ECL 6170 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Recognize and classify the structures of Optical fiber and types.
CO2	Discuss the channel impairments like losses and dispersion (Absorption, Scattering, Material loss, Wave guide loss, Chromatic loss, Coupling Loss, PMD loss, MFD loss, Bending loss etc.)
CO3	Students learn about the various optical sources (LED, LASERS), detectors (PIN, APD) and fiber types and their suitability for any application
CO4	Familiar with Design considerations of fiber optic systems like WDM, PON, SONET/SDH etc.
CO5	To perform characteristics of optical fiber, sources and detectors, design as well as conduct experiments in software (OptiSystem) and hardware, analyze the results to provide valid conclusions.
CO6	Display a wide breadth of knowledge regarding current developments at the forefront of optical technologies (160Gbps backhaul support network, SDON, Next Generation Backhaul network)
CO7	Use practically, configure optimally and deploy several complex optical measurement and systems, be able to interpret systematically measurement results and evaluate errors.

Unit I: Optical Networking Introduction and Challenges
Advantages of optical network, telecom network overview and architecture, WDM optical networks, WDM network evolution, WDM network construction, broadcast and select optical WDM network, wavelength routed optical WDM network, Challenges of optical WDM network.

Unit II: Optical Networking Components/Building Blocks
Optical transmitters, semiconductor laser diode, tunable and fixed laser, laser characteristics, photo-detectors, tunable and fixed optical filters, channel equalizers, optical amplifiers and its characteristics, semiconductor laser amplifier, Raman amplifier, doped fiber amplifier, various switching elements, OADM, OXC, CLOS architecture, MEMS, wavelength convertors.

Unit III: Single and Multi-hop Networks
Introduction to single and multi-hop networks, Characteristics of single and multi-hop networks, experimental single hop networks: LAMBDANET, STARNET, SONATA, Rainbow, experimental multi-hop networks: Shufflenet, De Bruijn Graph, And Hypercube.

Unit IV: Optical switching
Optical packet switching basics, slotted and un-slotted networks, header and packet format, contention resolution in OPS networks, self routing, examples on OPS node architecture, optical burst switching, signaling and routing protocols for OBS networks, contention resolution in OPS networks, multicasting, implementation and application. MEMs based switching, switching with SOAs.

Unit V: Optical Access Network
Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation, STARGATE: overview, need, architecture, operation and application, gigabit Ethernet, radio over fiber network.

Unit VI: Optical Multicasting and traffic grooming
Introduction to multicasting, Multicastcapable switch architecture, unicast,broadcast and multicast traffic, multicast tree protection, traffic grooming overview, static and dynamic traffic grooming.

Synthesis & Optimization Of Digital Circuits

ECL6070 **3 - 0 - 0 = 3**

Course Outcomes

CO1	To give theoretical background and practical skills in the area of synthesis and design of modern digital systems from high-level architectural synthesis to physical (chip) design stage.
CO2	Analyze the functional and nonfunctional performance of the system early in the design process to support design decisions.
CO3	Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.
CO4	Describe architectures for control-dominated and data-dominated systems and real-time systems.
CO5	Understand synthesis process of EDA tools, Case studies include the architectural synthesis in DSP applications from specification to logic implementation.

Unit-I
Introductions: Models for systems, characteristics of a signal processing system.
Unit-II
Design Space Exploration: Introduction to the fundamental architectural synthesis problems: scheduling, allocation, binding, estimation, and control-unit synthesis
Unit-III
Optimization: Introduction to graph theory and combinatorial optimization, optimization of digital signal processing systems, graph representation and annotation, mapping techniques, Optimizing timing/area.
Unit-IV
Scheduling: Various scheduling techniques, scheduling algorithms, as-soon-as-possible and as-late-as-possible, list scheduling, integer linear programming.
Unit-V
Binding and resource allocation: Resource sharing algorithms, interval graphs, graph colouring, integer linear program models, register sharing, Retiming, function approximation.
Unit-VI
Technology Mapping and logic optimization: Technology mapping, technology libraries, cost models, graph covers, Two-level, multilevel factorization, CAD tools.

Recommended Books:

1. Synthesis and Optimization of Digital Circuits – Giovanni De Micheli, McGraw Hill International edition,
2. Logic synthesis and verification, S. Hassoun and T. Sasao, Kluwer Academic Publishers,
3. Logic Synthsis, Srinivas Devadas et al, McGraw Hill,

Embedded System Design

ECL7084 **2 - 0 - 0 = 2**

Course Outcomes

CO1	Acquire a basic knowledge about fundamentals of microcontrollers
CO2	Acquire knowledge about devices and buses used in embedded networking
CO3	Develop skills in embedded systems for various applications
CO4	Acquire knowledge about Life cycle of embedded design and its testing.

Unit I: Introduction of Embedded Systems: Hardware/software systems and codesign, Hardware Software synthesis, Hardware Software Interface
Unit II: Modeling: Models of computation for embedded systems, Behavioral design, Requirement Specifications, System Architecture
Unit II: Architectural Aspects: Architecture selection, Hardware software partitioning, scheduling, and communication, resource allocation and binding. Optimization techniques.
Unit IV: Design: Implementation, Simulation, synthesis, and verification, Hardware/software implementation. System level low power and high performance techniques.
Unit V: Methodologies: Design methodologies and tools, Performance analysis and optimization.
Unit VI: Examples: Design examples and case studies

ecommended Books:

1. Embedded System Design by Peter Marwedel, Springer,
2. *Computers as Components* by Wayne Wolf, Morgan Kaufman
3. Readings in Hardware/Software Co-Design by G. De Micheli, Rolf Ernst, and Wayne Wolf, eds. Morgan Kaufmann, **Systems-on-Silicon Series**
4. Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid and Tony D. Givargis, Addison Wesley
5. Programming Embedded Systems in C and C++ by Michael Barr, O'Reilly,
6. An Embedded Software Primer by David E. Simon, Addison Wesley

7. The Art of Designing Embedded Systems by Jack Ganssle, Newnes

Lab Courses

Wireless Networks Lab

ECP 6110 **0 - 0 - 2 = 1**

Introduction to Simulation Tool & its features
Simulation & Analysis of IEEE 802.11 based network scenarios
Simulation & Analysis of IEEE 802.15.4 based Network scenarios
Design & Simulation of Simple Routing Algorithm (Modified AODV etc.)
Introduction to Programming of Motes to form simple WSN

Signal Processing Lab

ECP 6182 **0 - 0 -2 = 1**

- Basic Sampling Rate Alteration Devices
- Decimator and Interpolator Design and Implementation
- *Design of Digital Filter and Implementation*
- *IIR Filter Design*
- *FIR Filter Design*
- Simulation of IIR Digital Filters
- Simulation of FIR Digital Filters
- Design of Tunable Digital Filters
- Function Approximation

VLSI Lab

ECP 6130 **0 - 0 - 2 = 1**

Description of Analog & Digital Design flow. Circuit level simulation, pre-layout simulation, Layout , Design Rule Check, parasitic extraction, post layout simulation , generation of GDS-II format.
Digital Design implementation on EDA Tools.
Project covering detailed flows both and analog and digital need to submitted by students for evaluation

Embedded Systems Lab

ECP 7084 **0 - 0 - 2 = 1**

Introduction to Kiel IDE & its features
Introduction to Open Source Tools for Embedded system Design
Embedded Programs for utilizing on-board resources of ARM Processors
Interface of UART based Devices, SPI

Optical Networks Lab

ECP 6170 **0 - 0 - 2 = 1**

Practical Work pertaining to:

- Digital/optical link communication
- Propagation loss
- Intensity modulation
- NA/LED/LASER Performance analysis
- Computer to computer serial Port Communication
- Design an Optical Network in Optiwave
- Analyze the network on the basis of BER, SNR etc.
- Receiver response analysis
- Performance analysis of Different Amplifier

Microwave Circuits Lab

ECP 6051 **0 - 0 - 2 = 1**

Introduction to CAD Tool & its features
Simulation of Microwave Passive Components – Filters, Antennas, Couplers, Power dividers
Introduction to Measurement Techniques: Measurement of Passive Components using VNA & Spectrum Analyzer

List of Electives

Audio & Video Processing

ECE 6193 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Interpret and analyze 2D signals in frequency domain through image transforms.
CO2	Understand theory and models in Image and Video Processing.
CO3	Apply quantitative models of image and video processing for various engineering applications.

CO4	Develop innovative design for practical applications in various fields.
CO5	Understand different methods, models for video processing and motion estimation.

UNIT-I

Speech processing: Physiology of speech generation: characteristic of speech sounds; glottal excitation; speech production models: discrete time speech production model; discrete time filter model for speech production; source excitation model.

Linear prediction analysis: All-pole models; least-squares estimation; spectral matching; spectral envelopes; applications of LP analysis.

Speech coding: Coder's attributes; waveform coding; vocoders; analysis-by-synthesis coding; code-excited linear predictive vocoder; regular pulse-excited LPC.

UNIT-II

Image processing: Fundamentals of digital image: Digital image representation and visual perception, image sampling and quantization.

Image enhancement: Histogram processing; Median filtering; Low-pass filtering; High-pass filtering; Spatial filtering; Linear interpolation, Zooming.

Image coding and compression techniques: Scalar and vector quantizations; Codeword assignment; Entropy coding; Transform image coding; Wavelet coding; Codec examples

Image analysis and segmentation: Feature extraction; Histogram; Edge detection; Thresholding.

Image representation and description: Boundary descriptor; Chaincode; Fourier descriptor; Skeletonizing; Texture descriptor; Moments.

UNIT-III

Audio processing: Fundamentals of digital audio: Sampling; Dithering; Quantization; psychoacoustic model. Basic digital audio processing techniques: Anti-aliasing filtering; Oversampling; Analog-to-digital conversion; Dithering; Noise shaping; Digital-to-analog Conversion; Equalisation.

Digital Audio compression: Critical bands; threshold of hearing; Amplitude masking; Temporal masking; Waveform coding; Perceptual coding; Coding techniques: Subband coding and Transform coding; Codec examples.

UNIT-IV

Video processing: Fundamentals of digital video: Basics of digital video; Digital video formats. Basic digital video processing techniques: Motion estimation; Interframe filtering; Motion-compensated filtering; Error concealment.

UNIT-V

Video coding techniques: Temporal redundancy; Spatial redundancy; Block-based motion estimation and compensation; Coding techniques: Model-based coding, Motion-compensated waveform coding; Codec examples.

Recommended Books:

1. Alistair Mo_at and Andrew Turpin, Compression and Coding Algorithms, Kluwer Academic Publishers, Boston,
2. K.R. Rao & J.J. Hwang, Techniques & Standards for Image, Video & Audio Coding, Prentice Hall,

Wireless Sensor Networks & Applications

ECE 6110 **3-0-0 = 3**

Course Outcomes

CO1	explain the basic concepts of wireless sensor networks, sensing, computing and communication tasks
CO2	describe and explain radio standards and communication protocols adopted in wireless sensor networks
CO3	describe and explain the hardware, software and communication for wireless sensor network nodes
CO4	explain the architectures, features, and performance for wireless sensor network systems and platforms
CO5	describe and analyze the specific requirements of applications in wireless sensor networks for energy efficiency, computing, storage and transmission

Unit 1: Introduction to Pervasive Computing, Characteristics & features of Pervasive Computing Systems, Potential applications of Pervasive computing systems, Context, Context aware applications, Relationship between sensors and context, Personal Area Network as defined by IEEE 802.15.4, Introduction to Sensors, Need for Wireless Sensor Networks, Scope & Limitations of Wireless sensor Networks, Adhoc Networks v/s Sensor Networks,

Unit 2: Routing Algorithms: Need for routing mechanism, requirements & characteristics of routing algorithms, Traditional routing algorithms AODV, DSR, LMR. Concept of Network Lifetime, Categorisation of Routing algorithms – Flat, Hierarchical, Cluster based, Single-hop, Multi-hop & Energy Aware.

Unit 3: MAC Layer in Sensor Networks: Importance of Media Access Control (MAC) Protocols in Sensor Networks, Issues in designing MAC protocols , Classifications of MAC protocols, Popular MAC protocols

Unit 4: Localization: Need for localization, requirements,- hardware & software, Localization techniques based on Distance, Angle Measurements. Different localization algorithms – Triangulation, MDS, Probabilistic localization. Tracking of moving objects

Unit 5: Applications of Wireless Sensor Networks: Potential Application Areas of Wireless Sensor Networks, Data Acquisition Systems using WSN, Target Tracking, HVAC Applications using WSN, Intrusion Detection using WSN

Lab Work: Programming of Crossbow Motes, Creation of Wireless Sensor Network Testbed, Data Acquisition using WSN, Localization techniques using test bed

Recommended Books:

1. Adelstein, Sandeep Gupta "Fundamentals of Mobile & Pervasive Computing", Tata McGraw Hill
2. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Pearson Education, Inc.,
3. Selected papers from IEEE & ACM to be provided by Faculty

Advanced Wireless Communication

ECE 6150 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Derive expressions for error performance and capacity for various transmission schemes covered in the lectures, such as space-time coding, MRC, OFDM, CDMA.
CO2	Explain the operation of example algorithms covered in lectures, and discuss the effects of varying parameter values within these (water-filling, channel inversion, MMSE, ZF);
CO3	Apply the principles and technique to communication systems design or undertake further research (case study based on allocated power, spectrum and users, QoS)

Unit I: Wireless Communications and Diversity
Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space.

Unit II: Broadband Wireless Channel Modeling
WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading

Unit III: Cellular Communications
Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes - Call Setup, Handover etc, Teletraffic Theory.

Unit IV: CDMA, OFDMA, MIMO
Introduction to CDMA, Walsh codes, Variable tree OVSF, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization, Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues, Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, MRT, MIMO - OFDM

Unit V: Ultrawide Band
UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit-Error Rate Performance of UWB

Unit VI: 3G and 4G Wireless Standards
GSM, GPRS, WCDMA, LTE, WiMAX

Pattern Recognition

ECE 6195 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
CO2	Summarize, analyze, and relate research in the pattern recognition area verbally and in writing.
CO3	Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.
CO4	Apply pattern recognition techniques to real-world problems such as document analysis and recognition.
CO5	Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

Basics of pattern recognition;
Bayesian decision theory: Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, Discrete features;
Parameter estimation methods: Maximum-Likelihood estimation, Gaussianmixture models, Expectation-maximization method, Bayesian estimation; Hidden Markov models for sequential pattern classification;
Dimension reduction methods: Fisher discriminant analysis, Principal component analysis; Non-parametric techniques for density estimation;
Linear discriminant function based classifiers: Perceptron Support vector machines; Non-metric methods for pattern classification;
Unsupervised learning and clustering: Algorithms for clustering: K-means, Hierarchical and other methods

Recommended Books:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley,
2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press,
3. C.M.Bishop, Pattern Recognition and Machine Learning, Springer,

Detection & Estimation

EECE 105P **3 - 0 - 0 = 3**

Course Outcomes

CO1	Implement the estimation techniques in Communication and Signal Processing problems and acquire expertise in Classical and Bayesian estimation techniques for parameters and signals, and Detection of signals in the presence of white Gaussian noise
CO2	Conduct in-depth analysis of estimation problems and apply suitable estimation and detection techniques that meet the constraints of the problem such as performance, bandwidth and power overheads and computational complexity
CO3	Judge the scenarios under which signal or parameter estimation techniques are preferred and develop estimation techniques that are suitable for the context from a wider perspective
CO4	Design and implement the solutions to problems that are critical to humanity

Review of random process, problem formulation and objective of signal detection and signal parameter estimation; Hypothesis testing: Neyman-Pearson, minimax, and Bayesian detection criteria; Randomized decision; Compound hypothesis testing; Locally and universally most powerful tests, generalized likelihood-ratio test; Chernoff bound, asymptotic relative efficiency; Sequential detection; Nonparametric detection, sign test, rank test. Parameter estimation: sufficient statistics, minimum statistics, complete statistics; Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, Bhattacharya bound; Linear models; Best linear unbiased estimation; Maximum likelihood estimation, invariance principle; Estimation efficiency; Least squares, weighted least squares; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.

Recommended Books:

H. V. Poor, An Introduction to Signal Detection and Estimation, Springer,
S. M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall PTR,
S. M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall PTR,
H. L. Van Trees, Detection, Estimation and Modulation Theory, Part I, John Wiley
D. L. Melsa and J. L. Cohn, Detection and Estimation Theory, McGraw Hill,
L. L. Scharf, Statistical Signal Processing: Detection, Estimation, and Time Series Analysis, Addison-Wesley,
V. K. Rohatgi and A. K. M. E. Saleh, An Introduction to Probability and Statistics, Wiley,

Audio Engineering

ECE 6194 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Demonstrate the initial steps to set up a control room mixing board for a multitrack to two-track mixdown.
CO2	Effectively utilize VGA signal processing equipment during a recording session and during mixdown.
CO3	Plan a complete recording session by preparing pre-session tracking sheets and organizational documents.
CO4	Recognize by ear, the 10 audio spectrum octaves and discern specific frequency ranges.
CO5	Demonstrate effective use of equalization, imaging, subgrouping, balancing, and fader moves as used during a mixdown.

Sound and Hearing

The Basics of Sound, Waveform Characteristics, Loudness Levels, the Ear, Auditory Perception, Perception of Direction, Perception of Space, Doubling

Studio Acoustics and Design

Studio Types, Primary Factors Governing Studio and Control Room Acoustics, Frequency Balance, Reverberation, Acoustic Echo Chambers, Power- and Ground-Related Issues

Microphones: Design and Application

The Microphone: An Introduction, Microphone Design, Microphone Characteristics, Microphone Preamps, Microphone Techniques, Pickup Characteristics as a Function of Working Distance, Stereo Miking Techniques, Surround Miking Techniques, Recording Direct, Microphone Placement Techniques for different instruments like Brass, Strings, Keyboard, Percussion, Wood instruments, Voice etc. Microphone Selection

Multimedia Audio:

Data acquisition, Sampling and Quantization, Human Speech production mechanism, Digital model of speech production, Analysis and synthesis, Psycho-acoustics, Data structures used in audio files, Characteristics of sound waves, psycho, digital audio, MIDI and MIDI File format, CD and DVD formats.

Audio file formats: WAV, VOC, AVI, MPEG Audio,mp3,mp4 etc

Audio compression: Compression in audio, PCM, DM, DPCM study of different audio file formats and compression techniques Programming considerations for audio compression.

Advanced Computer Networks

ECE 6112 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Define what is a computer network and what are computer protocols

CO2	Discuss and explain the need of abstract layer protocol model, OSI model and TCP/IP model
CO3	Discuss and Explain the issues prevalent in LANs, WANs, and packet switched networks
CO4	Describe, analyse and compare a number of data-link, network, and transport layer protocol
CO5	Design and analyse subnets for IP based LANs

Chapter 1: Networks and need of Internetworking, PAN, LAN, WAN, MAN
Chapter 2: Physical Layer: Baseband Communication, Ethernet, Frame Relay: Electrical features, frame structure and principle of operation
Chapter 3: Network Layer: Routing and Routed Protocols, Best Effort Service, Distance Vector and Bellman Ford Algorithms, Routing Loops, OSPF, RIP and IP: Packet Structure, Fragmentation and Routing Tables
Chapter 4: Transport Layer: Connectionless and Connection oriented transports, Reliable and Unreliable Transports, Error Control, Flow Control, Congestion Control, Sliding Window and Handshaking, UDP & TCP and their implementations
Chapter 5: Other Protocols: ICMP, SNMP, IGMP, Multicasting and Broadcasting, DoS

ASIC Design and FPGA

ECE 6211 **3-0-0 = 3**

Course Outcomes

CO1	To study the design flow of different types of ASIC.
CO2	To familiarize the different types of programming technologies and logic devices.
CO3	To analyse the synthesis, Simulation and testing of systems and Apply the techniques to improve the timing analysis of digital circuits
CO4	Model the digital designs including FSMs to Processor architectures using the knowledge of HDL Language
CO5	Apply the knowledge of Reconfigurable architectures like FPGAs in designing and implementing digital ICs

Introduction To ASICS, CMOS Logic And ASIC Library Design
Types of ASICs - Design flow - CMOS transistors CMOS Design rules - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort -Library cell design - Library architecture.
Review of VHDL/Verilog: Entities and architectures
Programmable Asics, Programmable ASIC Logic Cells And Programmable ASIC I/O Cells, Anti fuse -static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA - Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.
Programmable ASIC Interconnect, Programmable ASIC Design Software And Low Level Design Entry Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 – Altera FLEX - Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language - PLA tools - EDIF- CFI design representation.
ASIC Construction, Floor Planning, Placement And Routing, System partition - FPGA partitioning - partitioning methods - floor planning - placement - physical design flow - global routing – detailed routing - special routing - circuit extraction - DRC. Design using Xilinx family FPGA
Recommended Books:

- M.J.S .Smith, - " Application - Specific Integrated Circuits " - Addison –Wesley Longman Inc.,
- Skahill, Kevin,” VHDL for Programmable Logic”, Addison-Wesley,
- John F. Wakherly, “ Digital Design: Principles and Practices”, Prentice Hall International
- Charles W. Mckay, “Digital Circuits a proportion for microprocessors”, Prentice Hall

Semiconductors Devices & Modelling

ECE 6010 **3-0-0 = 3**

Course Outcomes

CO1	knowledge of semiconductor bonding and energy band models
CO2	ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the pn-junction diode
CO3	ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Metal-Oxide- Semiconductor Field Effect Transistor
CO4	ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Bipolar Junction Transistor

1. BASIC SEMICONDUCTOR PHYSICS
Introduction, Solis-state Structure, Band Structure, Electrons and Hole: SemiconductorStatistics, Intrinsic; Extrinsic and Compensated Semiconductors, Electron and HoleMobilities and Drift Velocities, Hall Effect and Magnetoresistance.
2. P-N JUNCTIONS, SCHOTTKY BARRIER JUNCTIONS, HETEROJUNCTIONSAND OHMIC CONTACTS

Introduction, p-n Junction Under Zero Bias Condition, Current Voltage Characteristics ofan Ideal p-n Junction (The Diode Equation), Tunneling and Tunnel Diodes, JunctionBreakdown – Breakdown Mechanisms; Impact Ionization and Avalanche Breakdown,Schottky Barriers, Current Voltage Characteristics of Schottky Diodes – Thermionic
Emission Model; Current Voltage Characteristics : Thermionic Field Emission & FieldEmission; Small-Signal Circuit of a Schottky Diode

3. BIPOLAR JUNCTION TRANSISTORS

Principle of Operation, Minority Carrier Profiles in a Bipolar Junction Transistor, CurrentComponents and Current Gain, Base Spreading Resistance and Emitter Current Crowdingin Bipolar Junction Transistor, Effects of Non-Uniform Doping in the Base Region:Graded Base Transistors, Output Characteristics of Bipolar Junction Transistors and Earlyeffect, Ebers-Moll Model, Bipolar Junction Transistor as a Small Signal Amplifier: CutoffFrequencies, Bipolar Junction Transistor as a Switch, Bipolar Junction Transistors inIntegrated Circuits.

4. FIELD EFFECT TRANSISTORS

Introduction, Surface Charge in Metal Oxide Semiconductor Capacitor, Capacitance-Voltage Characteristics of an MIS Structure, Metal Oxide Semiconductor Field-EffectTransistors (MOSFETs), Velocity Saturation Effects in MOSFETs, Short Channel andNonideal Effects in MOSFETs, Subthreshold Current in MOSFETs, MOSFETCapacitances and Equivalent Circuit, Enhancemment-and Depletion-Mode MOSFETsComplementary MOSFETs (CMOS) and Silicon on Sapphire, Metal Semi-conductorField-Effect Transistors.

Recommended Books:

1. R.S. Muller and T.I. Kamins, “*Device Electronics for Integrated Circuits*”, Wiley,
2. R. F. Pierret, Addison, “*Semiconductor Device Fundamentals*”, Wesley,
3. S M Sze, “*Physics of Semiconductor Devices*”, Wiley,
4. S M sze,G S May, “*Fundamentals of semiconductor fabrication*”, Wiley
5. S. Wolf, “*The Submicron MOSFET, volume 3 of Silicon Processing for the VLSI Era*”,Lattice Press,

MEMS Design

ECE 6141 **3-0-0 = 3**

Course Outcomes

CO1	To learn important concepts and terminology pertaining to MEMS.
CO2	To learn the basic MEMS fabrication process and comparison with microelectronics fabrication.
CO3	To learn operating principle of variousMEMS sensors and actuators, and their applications.
CO4	To learn the design principle of MEMS sensors and actuators.
CO5	To learn advanced concepts like Microstereolithography (MSL) and its application.

Module 01: Historical Background: Silicon Pressure sensors, Micromachining, MicroElectro Mechanical Systems. Micro fabrication and Micromachining: Integrated Circuit Processes. Potential of MEMS in industry.

Module 02: Bulk Micromachining: Isotropic Etching and Anisotropic Etching, WaferBonding, High Aspect-Ratio Processes (LIGA)

Module 03: Physical Micro sensors: Classification of physical sensors, Integrated,Intelligent, or Smart sensors, Sensor Principles and Examples: Thermalsensors, Electrical Sensors, Mechanical Sensors, Chemical and Biosensors.

Microactuators: Electromagnetic and Thermal microactuation, Mechanicaldesign of microactuators, Microactuator examples, microvalves,micropumps, micromotorsMicroactuator systems: Success Stories, Ink-Jetprinter heads, Micro-mirror TV Projector.

Module 04: Microstereolithography (MSL) for 3D fabrication, Two photon MSL,Dynamic mask MSL, scanning systems, Optomechatronics system forMSL. Ceramic and Metal Microstereolithography.

Module 05: Ceramic and Metal Microstereolithography. Scattering of light by smallparticles. Effect of particle properties on accuracy and resolution ofcomponent in Ceramic and Metal MSL. Monte carlo ray tracing method.Nanolithography.

Module06: Surface Micromaching: One or two sacrificial layer processes, Surfacemicromachining requirements, Polysilicon surface micromachining, Othercompatible materials, Silicon Dioxide, Silicon, Micromotors, Gear trains,Mechanisms. Characterisation of MEMS devices.

Recommended Books:

1. MEMS, Vijay Vardan, *Wiley Publication*
2. MEMS and Microsytems Design and Manufacture, Tai- Ran Hsu, *Tata McGraw Hill*
3. MEMS, NitaigourMahalik, *Tata McGraw Hill*
4. MEMS and MOEMS Technology and Applications, Rai Chaoudhary, PHI Learning
5. Stephen D. Senturia, Microsystem Design, *Kluwer Academic Publishers,*
6. Marc Madou, Fundamentals of Microfabrication, *CRC Press*
7. Kovacs, Micromachined Transducers Sourcebook, WCB *McGraw-Hill, Boston*
8.M-H. Bao, Elsevier, Micromechanical Transducers: Pressure sensors, accelerometers, andgyroscopes, New York,

Advanced Computer System Architecture

ECE 6063 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Demonstrate concepts of parallelism in hardware/software.

CO2	Discuss memory organization and mapping techniques.
CO3	Describe architectural features of advanced processors.
CO4	Interpret performance of different pipelined processors.
CO5	Development of software to solve computationally intensive problems.

Chapter 1
History of Calculation and Computer Architecture, Influence of Technology and Software on Instruction Sets: Up to the dawn of IBM 360, Complex Instruction Set Evolution in the Sixties: Stack and GPR Architectures, Microprogramming, Simple Instruction Pipelining, Pipeline Hazards
Chapter 2
Multilevel Memories – Technology, Cache (Memory) Performance Optimization, Virtual Memory Basics, Virtual Memory
Chapter 3
Complex Pipelining, Out of Order Execution and Register Renaming, Branch Prediction and Speculative Execution, Advanced Superscalar Architectures, Microprocessor Evolution
Chapter 4
Synchronization and Sequential Consistency, Cache Coherence, Cache Coherence (Implementation), Snoopy Protocols, Relaxed Memory Models
Chapter 5
VLIW/EPIC: Statically Scheduled, Vector Computers, Multithreaded Processors, Reliable Architectures, Virtual Machines

Artificial Material

EECE 201P **3 – 0 – 0 = 3**

Course Outcomes

CO1	Describe a metasurface; explain the types of metasurfaces; and identify their limitations and properties.
CO2	Develop analytic models to characterize canonical metasurfaces and periodic structures.
CO3	Choose the appropriate type of metasurface for a particular application.
CO4	Design basic metasurface structures with commercial software.
CO5	Develop an advanced microwave circuit or antenna that makes use of metasurfaces.

Unit I Introduction
Definition of Metamaterials (MTMs) and Left-Handed (LH) MTMs, Theoretical Speculation by Viktor Veselago, Experimental Demonstration of Left-Handedness, Further Numerical and Experimental Confirmations, Backward Waves and Novelty of LH MTMs, Terminology, Transmission Line (TL) Approach, Composite Right/Left-Handed (CRLH) MTMs, MTMs and Photonic Band-Gap (PBG) Structures
Unit II Fundamentals of LH MTMs
Left-Handedness from Maxwell's Equations, Entropy Conditions in Dispersive Media, Boundary Conditions, Reversal of Doppler Effect, Reversal of Vavilov- Cerenkov Radiation, Reversal of Snell's Law: Negative Refraction, Focusing by a Flat LH Lens, Fresnel Coefficients, Reversal of Goos-Hanchen Effect, Reversal of Convergence and Divergence in Convex and Concave Lenses, Sub-wavelength diffraction.
Unit IIITL Theory of MTMs
Ideal Homogeneous CRLH TLs, LC Network Implementation, Real Distributed 1D CRLH Structures, Experimental Transmission Characteristics, Conversion from Transmission Line to Constitutive Parameters.
Unit IVTwo-Dimensional MTMs
Eigenvalue Problem, Transmission Line Matrix (TLM) Modeling Method, Negative Refractive Index (NRI) Effects, Distributed 2D Structures.
Unit V Application
Guided wave application: Power divider, couplers, Resonators, Filters, Radiated wave Application: Fundamental Aspects of Leaky-Wave Structures, Leaky wave antenna, meta interfaces.

Recommended Books:

- Christophe Caloz and Tatsuo Itoh, "Electromagnetic metamaterials: Transmission line theory and microwave applications," Wiley Interscience.
- Nader Engheta and R. W. Ziolkowski, "Metamaterials Physics and Engineering Explorations" John Wiley and Sons.
- T. J. Kui, D. R. Smith, and R. Liu, "Metamaterials theory, design, and applications" Springer.
- M. A. Noginov and V. A. Podolskiy, "Tutorials in Metamaterials," CRC Press.

Real Time Embedded Systems

ECE 6082 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To present the mathematical model of the system.
CO2	To develop real-time algorithm for task scheduling.
CO3	To understand the working of real-time operating systems and real-time database.
CO5	To work on design and development of protocols related to real-time communication.

Chapter 1
Real-Time Scenarios, Computer as Real-Time Component, Embedded Processors in Real-Time Systems, Role of RISC technology, ARM and MIPS: Architecture, Versions, Instruction Sets
Chapter 2
Simultaneous Multitasking, Real-Time Constraints, Task Scheduling Policies (Rate Monotonic, Earliest Deadline First etc.), Preemption, Context Switching
Chapter 3
Real Time Operating Systems, flavors and the design approach, Linux as Real-Time OS, OS for Sensor Networks
Chapter 4
Simulation of Real Time Systems using TIME tool, Build Tools for Real-Time Embedded Systems, IDEs, Compilers, Debugger

Wireless Networks & Security Issues

ECE 6121 **3 – 0 – 0 = 3**

Course Outcomes

CO1	The aim of this course is to introduce the student to the areas of cryptography and cryptanalysis.
CO2	This course develops a basic understanding of the algorithms used to protect users online and to understand some of the design choices behind these algorithms.
CO3	To develop a workable knowledge of the mathematics used in cryptology in this course.
CO4	The course emphasizes to give a basic understanding of previous attacks on cryptosystems with the aim of preventing future attacks.

Introduction: Basic objectives of cryptography, secret-key and public-key cryptography, one-way and trapdoor one-way functions, cryptanalysis, attack models, classical cryptography.
Block ciphers: Modes of operation, DES and its variants, RCS, IDEA, SAFER, FEAL, BlowFish, AES, linear and differential cryptanalysis.
Stream ciphers: Stream ciphers based on linear feedback shift registers, SEAL, unconditional security.
Message digest: Properties of hash functions, MD2, MD5 and SHA-1, keyed hash functions, attacks on hash functions.
Public-key parameters: Modular arithmetic, gcd,primality testing, Chinese remainder theorem, modular square roots, finite fields.
Intractable problems: Integer factorization problem, RSA problem, modular square root problem, discrete logarithm problem, Diffie-Hellman problem, known algorithms for solving the intractable problems.
Public-key encryption: RSA, Rabin and EIGamal schemes, side channel attacks.
Key exchange: Diffie-Hellman and MQV.
Digital signatures: RSA, DSA and NR signature schemes, blind and undeniable signatures.
Entity authentication: Passwords, challenge-response algorithms, zero-knowledge protocols.
Standards: IEEE, RSA and ISO standards.
Network security: Certification, public-key infra-structure (PKI), secure socket layer (SSL), Kerberos.
Advanced topics: Elliptic and hyper-elliptic curve cryptography, number field sieve, lattices and their applications in cryptography, hidden monomial cryptosystems, cryptographically secure random number generators.
Recommended Books:

1. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press.
2. William Stallings, Cryptography and Network Security: Principles and Practice, Prentice Hall of India.
3. Neal Koblitz, A course in number theory and cryptography, Springer.
4. Johannes A. Buchmann, Introduction to Cryptography, Undergraduate Text in Mathematics, Springer.
5. Doug Stinson, Cryptography Theory and Practice, CRC Press.
6. A. Das and C. E. VeniMadhavan, Public-Key Cryptography: Theory and Practice, Pearson Education Asia.

Advanced Digital Signal Processors & Applications

ECE 6065 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Know the analysis of discrete time signals.
CO2	To study the modern digital signal processing algorithms and applications.
CO3	Have an in-depth knowledge of use of digital systems in real time applications
CO4	Apply the algorithms for wide area of recent applications.

TMS320C6x Architecture: CPU Operation – Pipelined CPU- VelociTI – C6x DSP- Software tools: EVM – DSK Target C6x board – Assembly file – Memory management- Compiler utility- Code initialization – Code composer studio – Interrupt data processing.
Freescale DSP56XXX Architecture and Programming: Introduction, Core Architecture Overview, Data Arithmetic Logic Unit, Address Generation Unit, Program Control Unit, PLL and Clock Generator, Debugging Support, Instruction Cache, External Memory Interface, DMA Controller, Operating Modes and Memory Spaces, Instruction Set, Benchmark Programs.
FFT and Filter Implementation using DSP Processors: Implementation of FFT: Radix- 2 fast Fourier transforms – Block floating point scaling – Optimized radix- 2 DIT FFT, Filtering, Modulation, Audio and Image Processing.
Code optimization: Word – wide optimization – Mixing C and assembly- software pipelining – C64x improvements - Real time filtering – Circular buffering- Adaptive filtering.

Recommended Books:

1. Sen M Kuo, Bob H Lee, Wenshun Tian "Real-Time Digital Signal Processing Implementations and Applications" John Wiley.
2. User manuals of TI TMS320C55X from www.ti.com
3. User manuals of DSP 56371 from www.freescale.com
4. TMS320C55x DSP CPU Reference Guide
5. TMS320C55x DSP Mnemonic Instruction Set Reference Guide
6. Digital Signal Processing Applications With Motorola's DSP56002 Processor by Mohammed El-Sharkawy
7. Motorola Dsp Assembler Reference Manual

CMOS Digital Design

ECE 6071 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To analyse and implement various CMOS static logic circuits.
CO2	To learn the design of various CMOS dynamic logic circuits.
CO3	To learn the design techniques for CMOS Sequential Circuits.
CO4	To learn the different types of memory circuits design and testability.

Unit-I

Designing Combinational Logic Gates in CMOS

Static CMOS Design. Dynamic CMOS Design. How to Choose a Logic Style? Perspective: Gate Design in the Ultra Deep-Submicron Era.

Unit-II

Dynamic Logic circuits. Bootstrap Logic , Domino Logic. Basic Principles of Pass Transistor Circuits, Synchronous Dynamic Circuit Techniques ,High-Performance Dynamic CMOS Circuits

Unit-III

Sequential MOS Logic Circuits: Introduction, SR latch circuits, Clocked latch and Flip-flop circuits, CMOS D-latch and edge -triggered flip-flop. Dynamic MOS Logic Circuit. Timing Metrics for Sequential Circuits. Classification of Memory Elements. Static Latches and Registers. Dynamic Latches and Registers. Pulse Registers. Sense-Amplifier Based Registers. Pipelining: An Approach to Optimize Sequential Circuits. Non-Bistable Sequential Circuits. Perspective: Choosing a Clocking Strategy.

Unit-IV

Semiconductor Memories: Introduction, Dynamic random access memory (DRAM), Static Read-Write Memory (SRAM) Circuits ,Non-volatile memory. Read-Only Memory (ROM) Circuits and Dynamic Read-Write Memory (DRAM) Circuits

Unit -V
Design for testability : Introduction to fault types and Models, Built in Self Test (BIST).

Recommended Books:
1. Rabaey J.M, Chandrakasan A, Nikolic B , "Digital Integrated Circuits- A Design Perspective", Prentice Hall
2. S M Kang and Y Lebici,"CMOS Digital Integrated Circuits-analysis and design", McGraw Hill.
3. Pucknell D A and Eshraghian K, *"Basic VLSI Design"*, Prentice Hall India, New Delhi
4. Glaser L and Dobberpuhl D, *"The Design and Analysis of VLSI Circuits"*, Addison Wesley
5. Weste N and Eshranghian K, *"Principles of CMOS VLSI Design"*, Pearson Education Asia

Microwave Antenna Design

ECE 6052 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Gain proficiency regarding microwave circuit concepts and relation between different parameters.
CO2	Design impedance matching networks and familiarity with passive microwave components
CO3	Design of basic microwave laboratory set up along with measurement of parameters
CO4	Knowledge of VNA will help in the measurement of S parameters of different microwave antennas
CO5	Familiarity with VNA concept can be used for finding gain, phase, reflection and transmission coefficient etc.

Unit I
Antenna Fundamentals and Definitions: Radiation mechanism - over view, Electromagnetic Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation Patterns, Directivity and Gain, Antenna Impedance, Radiation Efficiency. Antenna Polarization
Unit II
Resonant Antennas: Wires and Patches, Dipole Antennas, wide band antennas, Helix antenna, Lens Antenna, Microstrip Antenna.
Unit III
Arrays: Array factor for linear arrays, uniformly excited, equally spaced Linear arrays, pattern multiplication, directivity of linear arrays, non- uniformly excited -equally spaced linear arrays, Mutual coupling, multidimensional arrays, phased arrays, feeding techniques.
Unit IV
Aperture Antennas: Techniques for evaluating Gain, reflector antennas - Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, offset parabolic reflectors, dual reflector antennas, Gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice.
Unit V
Antenna Synthesis: Formulation of the synthesis problem, synthesis principles, line sources shaped beam synthesis, linear array shaped beam synthesis — Fourier Series, Woodward — Lawson sampling method, comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods Dolph Chebyshev linear array, Taylor line source method.
Recommended Books:
1. Stutzman and Thiele, "Antenna Theory and Design", John Wiley and Sons Inc.
2. C. A. Balanis: "Antenna Theory Analysis and Design", John Wiley and Sons Inc.
3. Kraus, "Antennas", McGraw Hill, TMH, .
4. Kraus and R.J. Marhefka:, "Antennas", McGraw Hil.
5. V. F. Fusco, "Foundations of Antenna Theory and Techniques," Pearson Education Limited

NEMS Design

ECE 6142 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Gain a knowledge of basic approaches for various sensor design

CO2	Gain a knowledge of basic approaches for various actuator design
CO3	Develop experience on micro/nano systems for photonics .
CO4	Gain the technical knowledge required for computer-aided design, fabrication, analysis and characterization of nano-structured materials, micro- and nano-scale devices.

UNIT I :
Nanoscale I/V: Quantum wells, Q wires and dots, density of states, electrical transport properties in semiconductor nanostructures, quantization of conductance, coulomb blockade, Kondo effect, ballistic transport, non relativisticdirac fermions (massless electrons) & their conductance, Quantum Hall effect, fractional Q Hall effect
UNIT II :
Nanofluid mechanics; flow of nanofluid, electrophoresis dielectrophoresis: Size selective sepration of dielectric nano particles, nano and micro fluid channels, low reynold number fluid dynamics, optical tweezer.
Unit-III
Nanosensors: Gas sensors, Pollution sensor, Photo sensor, Temperature sensor, IR detector, Biosensor, nanomaterial gas discharge devices, CNT based fluid velocity sensor. Turbo and ultra high vacuum, Clean room technology, class 1000,100,10 clean rooms.
Unit-IV
Nature of carbon bonds, Different allotropes of carbon, structure and properties of C60, Graphene, Carbon nanotubes and its types, Laser vaporization techniques, arc discharge method and chemical vapor deposition techniques for CNT preparation, purification techniques. Properties of Carbon Nanotubes and Graphene: Optical, Electrical and electronic properties, Mechanical, Thermal and vibrational properties. C NT nanoelectronics, FETs, SETs
Unit V:
Fundamentals of carrier transport in quantum structures, temperature effects, Resonant tunneling diodes, single electron transistor, modulation-doped field effect transistor MODFETs, and Heterojunction Bipolar Transistors (HBTs),
Recommended Books:
M. Madou, *Fundamentals of Microfabrication*, CRC Press
Stephen D. Senturia, *Microsystem Design*, Kluwer Academic Publishers
G. Kovacs, *Micromachined Transducers*, McGraw-Hill,
L. Ristic, *Sensor Technology and Devices*, Artech House,
S. M. Sze, *Semiconductor Sensors*, John Wiley and Sons,

Terahertz Electronics

ECE 6160 **3 – 0 – 0 = 3**

Course Outcomes

CO1	overview on the unique specifications of terahertz waves and potential applications as well as the state of the current terahertz systems
CO2	Understand THz Detectors (single-photon detectors, microbolometers, Golay cells, Pyroelectric detectors, diode detectors, and focal-plane arrays), THz Sources (vacuum-electronics-based, semiconductor-based, photoconduction-based and nonlinearity-based),
CO3	Knowledge of THz electronic components (waveguides, Metamaterials, filters and modulators), sensing with THz radiation (THz spectroscopy, imaging and tomography)
CO4	Study THz applications (biology, medicine, space sciences, pharmaceutical industry, security and communications)

Unit I Introduction
Terahertz Terminology, Terahertz Applications and Opportunities, Terahertz components,

Unit II Terahertz Sources
Vacuum electronics, Semiconductor, Direct THz lasers, Photonic sources of THz radiation
Unit III Terahertz and Infrared Quantum Photodetectors
Detector Principles, Terahertz and Infrared Quantum Cascade Detectors, Terahertz Quantum Well Photodetector, Quantum Dots THZ-IR Photodetector, Terahertz and Infrared Photodetector based on Electromagnetically Induced Transparency
Unit IV Terahertz and Infrared Quantum Cascade Lasers
Quantum Cascade Laser Principles, Analysis of Transport Properties of THz QCLs, Dual-Wavelength Generation Based on Monolithic THz-IR QCL
Unit V Terahertz in communication
Broadband communication, Defense systems, High speed digital communication systems.

Recommended Books

- A. Rostami, H. Rasooli, and H. Baghban, “Terahertz Technology fundamentals and applications,” Springer.
- D. Mittleman, “Sensing with terahertz radiation,” Springer.
- Terry Edwards, “Gigahertz and Terahertz Technologies for Broadband Communications,” Artech House.
- Yun-Shik Lee, “Principles of Terahertz Science and Technology,” Springer.

Digital Integrated Circuits

ECE 6222 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To learn the basic concepts of integrated circuits and CMOS logic and be able to understand their applications.
CO2	To study to apply different logics to implement Boolean functions.
CO3	To learn the different power dissipation components and possible solutions for reduction.
CO4	To learn the basics of flip-flops and dynamic logics with their applications.

Unit-I

MOS Inverter: Introduction to resistive - load inverter, inverter with n-type MOSFET load, CMOS inverter **Switching Characteristics and Interconnects Effects:** Introduction, Delay time definitions, Calculation of delay
times, Inverter design with delay constraints, MOS Inverters: Switching Characteristics & Interconnect Effects. Estimation of interconnect parasitic.

Unit-II

Sequential MOS Logic Circuits: Introduction, SR latch circuits, Clocked latch and Flip-flop circuits, CMOS D-latch and edge -triggered flip-flop. Dynamic MOS Logic Circuit

Unit-III

Semiconductor Memories: Introduction, Dynamic random access memory (DRAM), Static random acces memory(SRAM),Non-volatile memory.

Low Power CMOS Logic Circuits: Introduction, Overview of power consumption, Switching power dissipation o
CMOS inverter, Estimation and optimization of switching activity.

Recommended Books:

1. Rabaey J.M, Chandrakasan A, Nikolic B , "Digital Integrated Circuits- A Design Perspective", Prentice Hall
2. S M Kang and Y Lebici,"CMOS Digital Integrated Circuits-analysis and design", McGraw Hill.
3. Pucknell D A and Eshraghian K, *"Basic VLSI Design"*, Prentice Hall India, New Delhi
4. Glaser L and Dobberpuhl D, *"The Design and Analysis of VLSI Circuits"*, Addison Wesley
5. Weste N and Eshranghian K, *"Principles of CMOS VLSI Design"*, Pearson Education Asia

RFIC Design.

ECE 6161 **3-0-0 = 3**

Course Outcomes

CO1	Ability to apply knowledge of mathematics, science and engineering to the solution of complex engineering problems
CO2	Ability to design and conduct experiments, analyse, interpret data and synthesise valid conclusions.
CO3	Ability to design a system, component, or process, and synthesise solutions to achieve desired needs.
CO4	Ability to identify, formulate, research through relevant literature review, and solve engineering problems reaching substantiated conclusions.
CO5	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal,and environmental constraints.

Unit I:Introduction

Need of RFIC, Introduction to MOS, Models and History of BJT systems. RF systems – basic architectures.

Unit II: Transmission media and reflections Maximum power transfer. Parallel RLC tank, Qfactor, Series RLC networks, matching: Pi match, T match. Interconnects and skin effect Resistors, capacitors.

Unit III:MOS device review, Introduction to MOS, Transmission lines, reflection coefficient, The wave equation, examples, Lossy transmission lines, Smith charts – plotting gamma. Bandwidth estimation using open-circuit time constants. Risetime, delay and bandwidth, Zeros to enhance bandwidth, Shunt-series amplifiers, tuned amplifiers, Cascaded amplifiers.

Unit IV:

Thermal noise, flicker noise review, Noise figure, Noise figure, Intrinsic MOS noise parameters,
Power match versus noise match.

Unit V:

Large signal performance, design examples & Multiplier based mixers. Sub-sampling mixers Class A, AB, B, C amplifiers, Class D, E, F amplifiers, RF Power amplifier design examples, Resonators, Negative resistance oscillators, Linearized PLL models, Phase detectors, charge pumps, Loop filters, PLL design examples, GSM radio architectures CDMA, UMTS radio architectures.

Recommended Books:

1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press,
2. RF Microelectronics by BehzadRazavi. Prentice Hall,

Photonic Networks & Switching

ECE 7170 **3-0-0 = 3**

Course Outcomes

CO1	Fundamental principles & techniques of optical fibre systems
CO2	Photonic components in optical communication systems
CO3	Optical analogue and digital modulation and demodulation techniques
CO4	Noise and signal analysis of optical communication systems
CO5	Design & application of various optical communication systems

Unit 1

Introduction: Overview of the architectures and principles of optical systems and networks; Access Network; LAN, WANS & MANS; SONET, SDH, ATM

Unit II

Components of Optical Networks: Fused fiber device such as couplers, WDMs, and WFC; Fabryperot etalons and Bragg grating; Optical Isolators, Integrated optic modulators and switches; Wavelength converters, Dispersion Compensating Techniques.

Unit III

Optical Amplifiers (EDFA and SOAs): Principles of operation; Gain characteristics; Wavelength characteristics; Cross talk and wavelength conversation; Noise characteristics and Noise figure; characteristics of amplifiers cascades; System performance analysis and power budget analysis for BER 10^{-9} for optically amplified links.

Unit IVPhotonics and Switching Networks: Switching Network, Switch, Non-Blocking Switch,Connection States, Switching Cell, Two-State Switches, Interconnection Network, Unique-Routing Network, Nonblocking Network, Alternate-Routing Network, Nonblocking Properties of Alternate-Routing Networks, Strictly Nonblocking, Wide-Sense Nonblocking, Multi-Stage Networks, Banyan Networks, Baseline Networks, Omega Networks , Divide-and-conquer Networks, Recursive Application, Central Control

Advanced Topics in Wireless Sensor Networks

ECE 7111 **3-0-0 = 3**

Course Outcomes

CO1	explain the constraints of the wireless physical layer that affect the design and performance of ad hoc and sensor networks, protocols, and applications;
CO2	explain the performance of various unicast and multicast routing protocols that have been proposed for ad hoc networks;
CO3	explain the operation of several media access protocols that have been proposed for ad hoc and sensor networks;
CO4	describe the platform architectures that are suitable for mobile computing and communications, e.g. personal digital assistants (PDAs), handsets, etc.;
CO5	Explain the energy issues in sensor networks and how they can be addressed using scheduling, media access control, and special hardware;

Unit 1: Security Issues in Senor Networks: Security requirement, issues and goals. Security threats, types of attacks on sensor networks and countermeasures. Routing attacks and challenges. Security support for In-network processing. Symmetric key, public-key, Hash function algorithms, Key distribution and certification, Key distribution center (KDC), Network wide shared key, Pair-wise key using PKI, Preconfigured pair-wise shared key.

Unit 2: Unit 3: Data Fusion & Aggregation: Need for Data aggregation, Address Centric Model (AC), Data Centric Model (DC), Different types of data aggregation, Comparative analysis between AC & DC, Compression v/s aggregation, Aggregation algorithms. Need for Sensor Data fusion, impact on bandwidth and inter-node communication, impact on network lifetime & power control Assumptions ,

Unit 3: Wireless Sensor & Actuator Networks: Requirement of Actuation Action in Sensor Networks, Characteristics of Actuator Nodes, preferred topologies for WSAN, Model for Inter-Communication between Actuators & Nodes and for Communication between Actuators, Fault Tolerance in WSAN

Unit-IV: Signal Processing in WSN's: Concept of Distributed Digital Signal Processing in Wireless Sensor Networks, Coherent & non- coherent processing. Collaborative signal processing, its need & challenges. Estimation Technqiues in sensor networks – Wiener filter, Kalman filter in WSN Environment

Recommended Books:

1. Holger Karl and Andreas Willig Protocols and Architectures for Wireless Sensor Networks WILEY (ISBN: 0-470-09510-5)
2. Ad Hoc Wireless Networks: Architectures and Protocols by C. Siva Ram Murthy and B. S. Manoj (Prentice Hall, 2004)
3. Wireless Sensor Networks: An Information Processing Approach by Feng Zhao and Leonidas J. Guibas (Morgan Kaufmann,
4. Selected papers from IEEE & ACM to be provided by Faculty

Information Theory & Coding

ECE 6106 **3-0-0 = 3**

Course Outcomes

CO1	Understand the basics of information and coding theories.
CO2	Discuss the various capacity reduction based coding techniques for text, audio and speech type of data.
CO3	Compare various capacity reduction based coding techniques for image and video type of data.
CO4	Illustrate various security oriented coding techniques for Block codes.
CO5	Implement various error control techniques for Convolutional codes

Module-1: Information Theory: Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Markoff Sources

Module-2: Source Coding: Source coding theorem, Prefix Codes, Kraft McMillan Inequality property – KMI Encoding of the Source Output, Shannon's Encoding Algorithm

Shannon Fano Encoding Algorithm, Huffman codes, Extended Huffman coding, Arithmetic Coding, Lempel – Ziv Algorithm

Module-3: Information Channels: Communication Channels. Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity, Channel Capacity of: Binary Symmetric Channel.

Module-4: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Single Error Correcting hamming Codes.

Recommended Books:

1.FUNDAMENTALS of INFORMATION THEORY and CODING DESIGN Roberto Togneri Christopher J.S. DaSilva CRC Press Company
2.Information theory, coding and cryptography - Ranjan Bose; TMH.
3.Information and Coding - N Abramson; McGraw Hill.
4.Introduction to Information Theory - M Mansurpur; McGraw Hill.
5.Information Theory - R B Ash; Prentice Hall.
6.Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall.

Mixed Signal Testing

ECE 6210 **3-0-0 = 3**

Course Outcomes

CO1	Understand the concepts of Switched capacitors Circuits
CO2	Able to know the concepts of PLLS
CO3	To study concepts of Data Converter Fundamentals.
CO4	Understand the concepts of Nyquist Rate A/D Converters ,and applications
CO5	Understand concepts of concepts of Continuous-Time Filters, CMOS Trans conductors

Overview of Mixed Signal Testing

Static Performance, Dynamic Performance, Digital Signals ,Digital Test Systems ,Analog Signals , Analog Test Systems ,Mixed Signal Devices ,Converters ,Datacom Devices

Telecom Devices.

Delay fault testing: path delay test, transition faults, delay test methodologies. IDDQ testing: basic concept, faults detected, test generation, limitations, IDDQ design for testability. Functional testing of arithmetic and regular arrays.

Functional testing of microprocessors and microcontrollers. Sequential circuit testing: time frame expansion and simulation-based approaches to ATPG, design of testable FSMs, use of coding theory. Advanced BIST techniques: theory of linear machines, practical BIST architectures.

System-on-chip design and test: SOC testing problem, core-based design and system wrapper, proposed test architectures for SOC, platform-based design and testability issues.

DSP-based analog and mixed-signal test: functional DSP-based testing, static ADC and DAC testing methods, realizing emulated instruments, CODEC testing, future challenges.

Model-based analog and mixed-signal test: analog fault models, levels of abstraction, analog fault simulation, analog ATPG. Analog test bus standard: analog circuit DFT, analog test bus, IEEE 1149.4 standard.

Recommended Books:

1.M. L. Bushnell and V. D. Agrawal, Essentials of Electronic Testing, Kluwer Academic Publishers.
2.A. Osseiran, Analog and mixed-signal boundary scan: a guide to the IEEE 1149.4 test standard, Kluwer Academic Publishers.
3.A. Krstic and K-T. Cheng, Delay fault testing for VLSI circuits, Kluwer Academic Publishers
4.S. Chakravarty and P. J. Thadikaran, Introduction to IDDQ testing, Kluwer Academic Publishers

Advanced CMOS VLSI Design

ECE 6230 **3-0-0 = 3**

Course Outcomes

CO1	Use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnects.
CO2	Learn the various fabrication steps of IC and come across basic electrical properties of MOSFET.
CO3	Apply CMOS technology-specific layout rules in the placement and routing of transistorsand interconnect and to verify the functionality, timing, power and parasitic effects.
CO4	The concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).
CO5	Design static CMOS combinational and sequential logic at the transistor level, including mask layout.

Design methodologies: VLSI Design flow, Design Hierarchy, Regularity, Modularity and Locality, VLSI design styles, Design quality, Packaging technology.MOS device design equations , Second order effects, the complementary CMOS Inverter DC characteristics.

Circuit Characterization and Performance Estimation: Parasitic effect in Integrated Circuits ,Resistance estimation, capacitance estimation, Inductance. Switching characteristics, CMOS - Gate transistor sizing, Power dissipation, CMOS Logic Structures, Clocking Strategies.

CMOS Process Enhancement & Layout Considerations: Interconnect, circuit elements, Stick diagram, Layout design rules, Latchup, latchup triggering, latchup prevention, Technology related CAD issues.

Subsystem Design: Structured design of combinational logic-parity generator, Multiplexer, code converters. Clocked sequential circuits-two phase clocking, charge storage, dynamic register element, dynamic shift register. Subsystem design process, Design of ALU subsystem, Adders, Multipliers. Commonly used storage/ memory elements.

Recommended books:

1. D.A. Pucknell, K. Eshraghian, Basic VLSI Design, PHI,.
2. John P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons.
3. Niel H.E. Weste, K. Eshraghian,, Principles of CMOS VLSI Design, Person,
4. Mead and L. Conway, Introduction to VLSI Systems, Addison-Wesley.

Modelling of Nanodevices

ECE 6231 **3-0-0 = 3**

Course Outcomes

CO1	To study and understand various transport mechanism in Nanodevices.
CO2	To study and understand about band diagrams at nanodevices level.
CO3	To understand modelling of potential in Nanodevices
CO4	To study and understand modelling of devices of contemporary research.

1.Introduction;
Key Concepts, Why Electrons Flow, Conductance Formula,Ballistic (B) Conductance, Diffusive (D) Conductance , Connecting Ballistic (B) to Diffusive (D), Angular Averaging, Drude Formula.
2. Energy Band Model
Introduction, E(p) or E(k) Relation, Counting States, Density of States , Number of Modes Electron Density (n),Conductivity vs. Electron Density (n), Quantum Capacitance, The Nanotransistor.
3. Modelling of Potential in devices
Introduction , A New Boundary Condition, Quasi-Fermi Levels (QFL's), Current from QFL's, Landauer Formulas , What a Probe Measures, Electrostatic Potential, Boltzmann Equation , Spin Voltages.
4. Nanodevices
CNTFETs Modelling, Molecular Quantum-Dot Cellular Automata.

1.S. Datta, Electronic Transport in Mesocopic Systems. Cambridge University Press 1995 . 2.S. Datta, Quantum Transport: Atom to Transistor. Cambridge University Press 2005.
3.P.L. Hagelstein, S.D. Senturia, and T.P. Orlando, Introductory Applied Quantum and Statistical Mechanics. Wiley 2004.
4.P.W. Atkins and R.S. Friedman, Molecular Quantum Mechanics. Oxford University Press, 3rd edition 1997.
5.M. Lundstrom and J. Guo, Nanoscale Transistors: Physics, Modeling, and Simulation, Springer 2006.
6.Y. Tsividis, The MOS Transistor. Oxford University Press, 2nd edition 1999
7.R. Feynman, Lectures on Computation. Editors A.J.G. Hey and R.W. Allen, Addison-Wesley 1996.

Modeling and analysis of nanoscale devices

ECE 6232 **3– 0 – 0 = 3**

Course Outcomes

CO1	Ability to perform simple analysis of nanoelectronic devices.
CO2	Ability to calculate the density of states in nonelectronic devices
CO3	Ability to perform in-depth analysis of nanoelectronic devices
CO4	Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
CO5	Study of various Nanodevices and their models

Introduction to nanoelectronics – device scaling, how device physics is fundamentally different in mesoscopic and nano devices – voltage drop, heat dissipation etc., Necessity to understand and invoke quantum mechanics in nanoelectronics.

Quantum mechanics, Schrödinger equation, Free electron wavefunction, Particle/electron in a box, electrons in a solid.

Models in nanodevices : Introduction to KP model, Brillouin Zones, KP model – origin of energy bands in solids. Density of states – 0D, 1D, 2D, 3D conductors, Fermi function, The notion of modes in a conductor. Conductance, Bottom-up approach, Landauer's formalism, Ballistic and Diffusive transport – transmission, transition from ballistic to diffusive transport.
Introduction to MOSFET – A barrier-controlled device, MOSFET electrostatics.MOSFET 2D electrostatics, MOSFET Capacitance. High-K dielectric, Strained Si technology, Quantum confinement in MOSFET.

MOSFET model analysis
ETSOI-MOSFET, Transport in MOSFET, Ballistic MOSFET. Ballistic injection velocity in MOSFET, Thermoelectric effects and thermoelectric devices.
Quantum dot devices – quantum capacitance, IV characteristics, self-consistent method.
Introduction to ab initio simulation, NEGF, Summary of the entire course.

Project – Synopsis

ECD 7990 **8 Credits**

The project seminar is required to evaluate the problem statement of the project. Students must have completed their problem definition and are required to submit a synopsis of their work. The students will be called up for an oral examination or viva voce, the stress is placed on an academically sound, stylistically acceptable and error-free piece of work.

Project – Mid Semester Review

The project seminar is required to evaluate the problem statement of the project. Students must have come up with progress report and will be required to discuss the status of the project. The students are required to present and demonstrate their work. The design or model must have been completed for review. The students will be called up for an oral examination or viva voce, the stress is placed on an academically sound, stylistically acceptable and error-free piece of work.

Project-Dissertation

ECD7991 **20 Credits**

A Master's dissertation is an advanced research project of defined scope and length (±120 pp., one and a half spacing, A4 paper). The criteria are: Technical competence, evidence of scholarly research, critical ability, understanding of relevant theoretical issues, lucidity and coherence. A dissertation should have a theme or 'thesis', usually stated in the title, and the success with which MTech candidates sustain that theme, thereby presenting a unified, cumulative argument, is an important consideration.

A dissertation can be an original contribution to knowledge. It is given a mark and the degree can be awarded based on the quality of the thesis/dissertation

Courses offered to other schools

Semester I **First Year**

Course Code	Course Title	L-T-P	Credits
EEL 1006 EE	Fundamental Of Electrical Engineering	3-0-2	4
ECL 1010 EE	Basic Electronics	3-1-2	5
Total Credits			**9**

Semester II **First Year**

Course Code	Course Title	L-T-P	Credits
ECL 1010 CSE	Basic Electronics	3-1-2	5
Total Credits			**5**

Semester III **Second Year**

Course Code	Course Title	L-T-P	Credits
ECL 2070 EE	Digital Electronics	3-0-2	4
ECL 2070 CSE	Digital Electronics	3-0-2	4
Total Credits			**8**

Semester IV **Second Year**

Course Code	Course Title	L-T-P	Credits

EEL 2412 EE	Analog Electronics (EE)	3-0-2	4
ECL 2040 EE	Electromagnetic Field Theory	3-1-0	4
ECL 2060 EE	Microprocessor Systems	3-1-2	5
Total Credits			**13**

Semester V **Third Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
EEL 3511 EE	Control Systems	3-0-0	3
EEL 3541 EE	Power Electronics	3-1-0	4
CSL 2031 EE	Data Structure Using C	3-0-2	4
ECE 4195 EE	Social Networks	3-0-0	3
Total Credits			**14**

Basic Electronics

ECL 1010 **3-1–2=5**

Course Outcomes

CO1	To learn basic concepts of Semiconductor Devices
CO2	Able to understand and use BJT and MOS Devices.
CO3	Learn and able to apply small signal BJT and FET analysis.
CO4	To analyze and design rectifiers and amplifiers.
CO5	Able to understand advanced semiconductor devices and oscillators.

Introduction:- Semiconductor Classification ,Semiconductor bonds, Energy band description ,Semiconductor types, Hall effect.
Diodes:- P-N junction-I/V characteristics, diode equivalent circuits, semiconductor diodes, rectifiers-(efficiency, ripple factor),filters,clipers,clampers.
Transistors:-BJT construction, characteristics (cb,ce,cc), load line. BJT biasing. FET, JFET, MOSFET (Depletion and enhancement), FET biasing.
Transistor Modeling:-BJT small signal model, hybrid equivalent model,FET small signal model.
Amplifiers:- Single stage amplifiers, voltage gain, effect of frequency on Gain, multistage amplifier.
Other Semi-conductor devices- SCR'S , Diacs, triacs, and other thyristors, basic theory of operation, characteristics,Theory and operation of UJT,
Oscillators:-Feedback BH criteria, oscillator types, sinusoidal oscillator, Hartley oscillator,Collpitts Oscillator, Phase shift,Wein bridge oscillator, crystal oscillator.

Recommended Books:

- Basic Electronics: Devices, Circuits & IT Fundamentals, Kal,PHI
- Basic Electronics for Scientists
- Electronic Devices & Circuits: An Introduction, Mottershead,
- Electronic Devices & Circuits, Boylestad, Nashelky, PHI
- Semiconductor Devices , NanditaDass, PHI
- Electronic Devices & Circuits, Milman&Halkias
- Electronic Devices & Circuits, Theodore Bogart, Jr

Digital Electronics

ECL 2070 **4 – 0 – 0 = 4**

Course Outcomes

CO1	To provide the skills to efficiently acquire knowledge on digital electronic circuit analysis and design.
CO2	To acquire Knowledge of various number systems and codes from historic point of view.
CO3	To understand the logic families in digital circuits.
CO4	To obtain the ability to analyze various aspects of sequential circuit design.
CO5	To learn the design procedure for Sequential Circuits and data converters.

Basic concepts of Boolean Algebra: Review of number systems - Binary, Hexadecimal, conversion from one to another, complement arithmatic, Signed and unsigned numbers and their arithmetic operations. BCD, Excess-3, Gray and Alphanumeric codes. Review of Boolean algebra, De-Morgan's Theorems, Standard Forms of Boolean Expressions, Minimization-Techniques: K-MAPS, VEM Technique, Q-M (Tabulation) method.
CMOS Logic family : Logic family features, noise margin, setup time, hold time, delay, fan in, fan out, CMOS based logic gates**.**
Combinational Logic Circuits: Problem formulation and design of Basic Combinational Logic Circuits, Combinational Logic Using Universal Gates. Basic Adders, ALU, Parity-Checkers and Generators, Comparators, Decoders, Encoders, Code Converters, Multiplexer (Data Selector), De-multiplexers
Sequential Circuits: Latches, Flip-flops (SR, JK, T, D, Master/Slave FF,) Edge-Triggered Flip-Flops, Flip-Flop Operating Characteristics, Basic Flip-Flop Applications, Asynchronous Counter Operation, Synchronous Counter Operation, Up/Down Synchronous Counters.
Shift registers & Memories
Shift Register Functions, Serial In - Serial Out Shift Registers, Serial In - Parallel Out Shift Registers, Parallel In - Serial Out Shift Registers, Parallel In - Parallel Out Shift Registers, Bidirectional Shift Registers,Basics of Semiconductor Memories, Random-Access Memories (ROM), Read Only Memories (ROMs), Programmable ROM's (PROMs and EPROM's), PAL, PLA.FPGA introduction, CPLD.

A/D and D/A convertor
Characteristics of ADC, Types of ADC- SAR, Dual Slope, Flash ADC. Characteristics of DAC, R-2R Ladder, Weighted Resistance Type

Recommended Books:

- "Digital Fundamentals" by Thomas L. Floyd, Prentice Hall, Inc
- "Digital Systems - Principles and Applications" by Tocci, R. J. and Widner, Prentice Hall,
- Switching and finite automata theory: Z V Kohavi.–TMH
- Digital Logic Circuit Analysis & Design, by Victor P. Nelson, H. Troy Nagle, Bill D. Carroll and J. David Irwin, Prentice Hall,
- Digital logic and computer design: M Morris Mano –PHI
- Modern digital electronics: R.P. Jain. TMH
- *Digital Design: Principles and Practices, by* Wakerly J F, Prentice-Hall,
- "Digital Experiments Emphasizing Systems and Design," by David Buchla, Prentice Hall, Inc,

Analog Electronics

EEL 2412 **3 – 0 – 2 = 4**

Course Outcomes

CO1	To learn the basic concept and the characteristics of transistors.
CO2	Understand the design of OP-AMP and OP-AMP based circuits.
CO3	A thorough understanding, functioning of OP-AMP.
CO4	Design sinusoidal and non-sinusoidal oscillators.
CO5	Know the principle of converter and PLL

Overview of BJT: Structure and I-V characteristics of a BJT; BJT as a switch, Small signal equivalent circuits, high-frequency equivalent circuits.

MOSFET:MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Operational Amplifiers: Direct coupled and RC Coupled multi-stage amplifier; Differential amplifier; Internal structure of an operational amplifier, Ideal op-amp, non-idealities in an op-amp (offset voltage and current, input bias current, slew rate, gain bandwidth product), Frequency response of an operational amplifier, Power amplifier: Class A, B and C.

Linear and Nonlinear applications of op-amp: Inverting and non-inverting amplifier, Instrumentation amplifier, Integrator, Differentiator, Active filter, Voltage regulator. Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators,
Precision rectifier, peak detector, Monoshot.

Feedback Amplifiers: Different feedback amplifiers, Effect of Feedback on Amplifier characteristics, Feedback configuration: Voltage series and shunt, Current series and shunt feedback configurations.

Oscillators: Condition for Oscillations, RC type Oscillators, LC type Oscillators, Generalized analysis of LC Oscillators, Hartley, Colpitts, Wein Bridge and Crystal oscillator.

Converter: Voltage to frequency and frequency to voltage converter, D-A and A-D Converter, Clipper and clamper, ADC/DAC specification. Phase locked loop: Principle, Phase detector/comparator, Voltage controlled oscillator, Application of PLL.

Recommended Books:

- 1. A. S. Sedra and K. C. Smith, "Microelectronic Circuits," New York, Oxford University Press, 1998.
- 2. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and
- applications," McGraw Hill U. S., 1992.
- 3. Ramakant A. Gayakwad, "OP-AMP and Linear IC's," Prentice Hall
- 4. D. Roy Choudhury, "Linear Integrated Circuits," New Age International Pvt Ltd.
- 5. P.R. Gray, R.G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits," John
- Wiley & Sons.

Electromagnetic Field Theory

ECL 2040 **4 – 0 – 0 = 4**

Course Outcomes

CO1	Able to understand vector analysis and coordinate systems.
CO2	Able to learn time varying electromagnetic field.
CO3	To understand solution of wave equations.
CO4	Able to understand radiation & reflection in time varying EM field.
CO5	To understand the basics of transmission line.

Unit I: Introduction

Vector Analysis, Coordinate System, Gradient, Divergence, Curl, Laplaceian in rectilinear, Cyllindrical, Spherical Coordinate System, Line, surface and volume integrals, Divergence Theorem, Stoke's theorem

Unit II: Time varying fields and Maxwell's equations

Introduction, The Equation of Continuity For Time-Varying Fields, Inconsistency Of Ampere's Law, Maxwell's Equation in Integral and differential form, Physical Significance of Maxwell Equation, Boundary conditions.

ELECTROMAGNETIC WAVES

Solution For Free-Space Conditions, Uniform Plane Waves & Propagation, The Wave Equations For A Conducting Medium, Sinusoidal Time Variations, Conductors And Dielectrics, Polarization, Reflection By A Perfect Conductor Normal Incidence & Oblique Incidence, Reflection By A Perfect Dielectric — Normal Incidence & Oblique Incidence, Reflection At The Surface Of A Conductive Medium.

RADIATION

Potential Functions And Electromagnetic Field, Potential Functions For Sinusoidal Oscillations, Alternating Current Element, Power Radiated By Current Element, Application To Short Antennas, Radiation From A Monopole Or Dipole.

Transmission Line

Circuit theory analysis of Transmission Line, Loss less and Lossy transmission lines, Reflection coefficient, Transmission Coefficient, VSWR, Input Impedance, Matching of Transmission Line, pulse excitation. Group Velocity and Phase velocity.

Recommended Books:

- Fields & Wave Electromagnetics , DK Cheng
- Electromagnetic Waves and Radiating Systems, Jordan &Balmin
- Elements of Electromagnetics, Sadiku
- Engineering Electromagnetics: W H Hayt& J A Buck
- Advanced Engineering Electromagnetics: C A Balanis

Microprocessor Systems

ECL 2060 **3 – 0 – 0 = 3**

Course Outcomes

CO1	The student will be able to analyze, specify, design, write and test assembly language programs of moderate complexity.
CO2	The student will be able to select an appropriate 'architecture' or program design to apply to a particular situation; e.g. an interrupt-driven I/O handler for a responsive real-time machine.
CO3	The student will be able to calculate the worst-case execution time of programs or parts of programs, and to design and build, or to modify, software to maximize its run time memory or execution-time behavior.
CO4	Write programs to run on 8086 microprocessor based systems.
CO5	Design system using memory chips and peripheral chips for 16 bit 8086 microprocessor.

Introduction to 8085 Microprocessor: Functional block diagram – Registers, ALU, Bus systems, Memory & Instruction cycles Timing diagrams, Address Decoding techniques, Addressing modes, Instruction Set, Assembly Language Programming, Interrupts-Types & handling, ISR, Stack architecture

Memory and Peripheral interfacing: Basic interfacing concepts - Memory space partitioning - Buffering of buses – Timing constraints - Memory control signals - Read and write cycles, Interfacing RAM, ROM, 8255PPI, Interfacing applications using 8255. Need for direct memory access - DMA transfer types

Intel 16 bit Microprocessor: Register organization of 8086 – Architecture - Physical Memory organization - I/O addressing capability, Addressing modes of 8086 - Instruction set of 8086 - Assembler directives and operators, Assembly language programming, Interrupt Architecture

Freescale 32 bit ColdFire Processor:-Introduction to ColdFire Core, Comparison with 8085 & 8086 Architecture, Introduction to MCF5223X Microprocessor Architecture & Functional Blocks

Recommended Books:

- Gaonkar R. S, "Microprocessor Architecture: Programming and Applications with the 8085/8086A", New Age International (P) Ltd.,
- K. Ray, K. M. Bhurchandi – Advanced Microprocessors and Peripherals – Architecture, Programming and Interface – Tata McGraw Hill
- "ColdFire Microprocessors & Microcontrollers" – MunirBannoura, Rudan Bettelheim and Richard Soja, AMT Publishing.
- Douglas V. Hall, "Microprocessors and Interfacing Programming and Hardware", Tata McGraw Hill,
- Daniel Tabak, "Advanced Microprocessors", McGraw Hill,
- David A. Patterson, John.L.Hennessey – Computer organization and design-the hardware/software Interface- Elsevier-Morgan Kaufmann Publishers-

Control Systems

ECL 3090 **4-0-0 = 4**

Course Outcomes

CO1	To learn the basics of Control systems.
CO2	Able to perform time domain analysis of control system.
CO3	Able to know about the stabilty of a system.
CO4	Able to perform frequency domain analysis of a control system.
CO5	To learn about basic concepts of digital control systems.

1. Introduction to Feedback Control System
Mathematical models of physical system , Open loop and closed loop systems, regenerative feedback, Transfer function, Block diagrams and reduction techniques including signal flow graphics, deriving transfer function of physical system one mechanical system and field controlled and armature controlled DC servo motors.
2. Time Response Analysis
Standard test signals, time response of second order system, steady state errors and errorconstants, design specifications of second order system.
3. Stability Analysis
Concept of stability, condition of stability, characteristic equation, relative stability, Routh-Hurwitz criterion, special cases for determining relative stability, Nyquist stabilitycriterion, Nyquist plots
4. Root Locus Techniques.
Basic concept, rules of root locus, application of root locus technique for control systems.
5. Frequency Response Analysis
Bode plots, gain margin, phase margin, effect of addition of poles and zeros on bode-plots.
6. Compensators.
Preliminary design considerations, need of compensation, lead compensations, lag-compensation, lag-lead compensation.
7. Analysis of Control Systems in State – Space
Basic concepts of state, state variable and state models, transfer matrix, Controllability, absorbability, obtaining state space equations in canonical form.
8. Discrete control system: Z Transform and its properties, Basic structure of Digital Control systems, Description and analysis of Sampled-Data system, Stability analysis of Discrete-time systems

Recommended Books:

- Control System Engineering -- I.J. Nagrath, M.Gopal (Willey Eastern)
- Feedback Control Systems -- (Schaum's Series book)
- Modern Control System -- Dorf,Bishop (addison – Wesley Publication)
- Modern Control Engg.(II edition) – Katsuhiko Ogata
- Automatic Control Engg.(II edition)-Kuo

Data Structure Using C

CSL 2031 **3-0-2 = 4**

Course Outcomes

CO1	To impart the basic concepts of data structures and algorithms.
CO2	To understand concepts about searching and sorting techniques.
CO3	To Understand basic concepts about stacks, queues, lists, trees and graphs.
CO4	To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures

Unit 1
Introduction to programming methodologies and design of algorithms. Structured programming concepts Study and implementation of basic data structures like: Arrays, multidimensional arrays and their organization, introduction to sparse arrays
Unit 2
Linked list (singly, doubly and circular)
Unit 3
Stacks, Queues
Unit 4
Searching: Sequential and binary searching.
Unit 5
Sorting: Insertion, selection, shell, merge and quick sort
Unit 6
Introduction to trees and graphs and traversal methods.
Unit 7
Introduction to Files
List of Experiments
1. Implementation of Strings (with and without using functions)
2. Implementation of stack and its operations
3. Implementation of Q and its operations
4. Array and dynamic implementation of linked list and its operations

Recommended Books:

- Mark Allen Weiss, —Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 1996
- Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, —Data Structures and Algorithms, Pearson Education, 1983.
- Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla , — Data Structures and Program Design in C, Second Edition, Pearson Education, 2007
- Jean-Paul Tremblay and Paul G. Sorenson, —An Introduction to Data Structures with Applications, Second Edition, Tata McGraw-Hill, 1991.

Power Electronics

EEL 3541 **3-0-2 = 4**

Course Outcomes

CO1	Understand the differences between signal level and power level devices.
CO2	Analyse controlled rectifier circuits.
CO3	Analyse the operation of DC-DC choppers.
CO4	Analyse the operation of voltage source inverters.
CO5	Analyse the working and operation of cycloconverter

1. Introduction to Feedback Control System
Mathematical models of physical system , Open loop and closed loop systems, regenerative feedback, Transfer function, Block diagrams and reduction techniques including signal flow graphics, deriving transfer

Power switching devices:
Diode, Thyristor, MOSFET, IGBT: I-V Characteristics, Firing circuit for thyristor, Gate drive circuits for MOSFET and IGBT, Working and Characteristics of GTO, Working and Characteristics of DIAC, Working and Characteristics of TRIAC.

AC-DC Converters (Thyristor rectifiers):
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load, Operation and analysis of Single phase uncontrolled and controlled rectifiers with RLE load, Three-phase full-bridge uncontrolled and controlled rectifiers with R-load and highly inductive load; Estimation of RMS load voltage, RMS load current and input power factor, power factor improvement methods for phase controlled rectifiers, effect of source inductance Input current wave shape.

DC-DC converters:

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, Principle of step up and step down operation, Time ratio control for Chopper, Single quadrant DC chopper, Two quadrant and four quadrant DC choppers, analysis and waveforms at steady state.

DC-AC Converters (Inverter):
Power circuit of single-phase voltage source inverter, Single phase half-bridge inverter, Single phase full-bridge inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage, Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages.

AC-AC Converters :
AC Voltage regulator, Single phase half wave AC voltage controller with R load, Single phase full wave AC voltage controller with R load, Single phase full wave AC voltage controller with R-L load, Single phase to single phase (circuit step-up and step-down) cycloconverter, Three-phase to single-phase (halfwave) Cycloconverter, Three-phase to three-phase (half-wave) Cycloconverter.

Recommended Books:

- M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
- N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
- R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.
- L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
- PS Bhimbra, "Power Electronics", Khanna Publishers, 2019.

Fundamental of Electrical Engineering

EEL 1006 **3-0-2 = 4**

Course Outcomes

CO1	To solve the electrical circuits (DC & AC).
CO2	Solve and analyze the electrical circuits using network theorems and understand the behavior of AC electrical circuits and resonance.
CO3	To understand the three phase electrical systems and apply the concepts of measurements in measuring electrical quantities.
CO4	Solve and analyze the behavior of magnetic circuits and understand the concept of transformers and their applications.
CO5	To study the working principles of basic electrical machines including DC as well as AC machines.

Unit I
Introduction and Electrical Circuit Analysis: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation,
AC fundamentals: Sinusoidal, square and triangular waveforms – Average and effective values, Form and peak factors, Concept of phasors, Phasor representation of sinusoidally varying voltage and current

Unit II
Steady- State Analysis of Single Phase AC Circuits: Analysis of series and parallel RLC Circuits, Concept of Resonance in series & parallel circuits, bandwidth and quality factor; Apparent, active & reactive powers, Power factor, Concept of power factor improvement and its improvement (Simple numerical problems)
Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem (Simple numerical problems).

Unit III
Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, Three-phase power and its measurement (simple numerical problems).
Measuring Instruments: Types of instruments, Construction and working principles of PMMC and moving iron type voltmeters & ammeters, Single phase dynamometer wattmeter, Use of shunts and multipliers (Simple numerical problems on shunts and multipliers).

Unit IV
Magnetic Circuit: Magnetic circuit concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis and eddy current losses, Magnetic circuit calculations (Series & Parallel).
Single Phase Transformer: Principle of operation, Construction, EMF equation, Equivalent circuit, Power losses, Efficiency (Simple numerical problems), Introduction to auto transformer.

Unit V

DC Machines: Principle & Construction, Types, EMF equation of generator and torque equation of motor, applications of DC motors (simple numerical problems)
Three Phase Induction Motor: Principle & Construction, Types, Slip-torque characteristics, Applications (Numerical problems related to slip only)
Single Phase Induction motor: Principle of operation and introduction to methods of starting, applications.
Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor and their applications.

Recommended Books:

- D.P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
- L.S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
- E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
- V.D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
- B Dwivedi and A Tripathi, "Fundamentals of Electrical Engineering", Wiley India.
- Kuldeep Sahay, "Basic Electrical Engineering", New Age International Publishers.
- J. B. Gupta, "Electrical Engineering", Kataria and Sons.
- C L Wadhwa, "Basic Electrical Engineering", New Age International.
- W.H. Hayt and J.E. Kimerly, "Engineering Circuit Analysis", Mc Graw Hill.

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