National Institute of Technology, Mizoram

Department of Electronics & Communication Engineering
Course Structure for B. Tech, Electronics and Communication Engineering

Semester III				
Course Code	**Course Name**	**Category**	**L-T-P**	**Credit**
ECL 1301	Semiconductor Devices	DC	3-0-0	6
ECL 1302	Digital Logic Design	DC	3-0-0	6
HUL1301	Managerial Economics	DC	3-0-0	6
MAL 201	Mathematical Methods	DC	3-0-0	6
EEL 1301	Signals, Systems and Networks	DC	3-1-0	8
CSL1301	Data Structures	DC	3-0-0	6
ECP 1302	Digital Circuits Laboratory	DC	0-0-3	3
CSP1301	Data Structure Laboratory	DC	0-0-3	3
			TOTAL	44

Semester IV				
Course Code	**Course Name**	**Category**	**L-T-P**	**Credit**
ECL 1401	Analog Circuits	DC	3-1-0	8
CSL 14XX	Computer Organisation and Operating Systems	DE	3-0-0	6
EEL 1402	Electrical and Electronic Measurement	DE	3-0-0	6
MAL 202	Numerical Methods and Probability Theory	DC	3-0-0	6
ECL 1404	Analog Communication	DC	3-1-0	8
ECP 1401	Analog Circuits Lab	DC	0-0-3	3
EEP 1402	Measurement Lab	DE	0-0-3	3
			TOTAL	40

Semester V				
Course Code	**Course Name**	**Category**	**L-T-P**	**Credit**
ECL 1501	Digital Communication	DC	3-1-0	8
EEL 1502	Control Systems	DE	3-0-0	6
ECL 1502	Microprocessors and Microcontrollers	DC	3-0-0	6
ECL 1503	Introduction to VLSI Design	DC	3-0-0	6
ECL 1505	Electromagnetic Theory and Antennas	DC	3-1-0	8
ECP 1501	Communication Lab.	DC	0-0-3	3
ECP 1502	Microprocessors and Microcontrollers Lab	DC	0-0-3	3
ECP 1503	VLSI Lab-I	DC	0-0-4	4
			TOTAL	44

Prof. R. Bhattacharjee IIT Guwahati
Prof. R. P. Palathinkal IIT Guwahati
Prof. S. Baishya NIT Silchar
Ms. Chaitali Koley AP, NIT Mizoram
Mr. Sushanta Bordoloi Trainee Teacher, NIT Mizoram

Semester VI				
Course Code	**Course Name**	**Category**	**L-T-P**	**Credit**
ECL 1601	Digital Signal Processing	DC	3-0-0	6
ECL 1602	Information Theory and Coding	DC	3-0-0	6
ECL 1603	RF & Microwave Engineering	DC	3-0-0	6
ECL/EEL/CSL 16XX	Open Elective	DE	3-0-0	6
ECL/EEL/CSL 16XX	Elective I	DE	3-0-0	6
ECL 1606	Advance Electronic Circuits	DC	3-0-0	6
ECP 1601	Digital Signal Processing Lab	DC	0-0-3	3
ECP 1603	RF & Microwave Engineering Lab	DC	0-0-3	3
ECP 1604	Industrial Training	DC		2
ECP 1606	Advance Electronic Circuit Lab	DC	0-0-3	3
			TOTAL	47

Semester VII				
Course Code	**Course Name**	**Category**	**L-T-P**	**Credit**
ECL 1701	Communication Networks	DC	3-0-0	6
ECL 1702	Wireless Communications	DC	3-0-0	6
ECL 1703	Embedded Systems	DC	3-0-0	6
ECL/EEL/CSL 17XX	Elective II	DE	3-0-0	6
ECL/EEL/CSL 17XX	Elective III	DE	3-0-0	6
ECP 1701	Communication Networks Lab	DC	0-0-3	3
ECD 1701	Project Phase – I	DC		4
			TOTAL	37

Semester VIII				
Course Code	**Course Name**	**Category**	**L-T-P**	**Credit**
CHL 1802	Environmental Science	DC	3-0-0	6
ECL/EEL/CSL 18XX	Elective IV	DE	3-0-0	6
ECL/EEL/CSL 18XX	Elective V	DE	3-0-0	6
ECP 1801	VLSI Lab-II	DC	0-0-4	4
ECD 1802	Project Phase – II	DC	0-0-4	8
ECD 1803	Grand viva	DC		4
			TOTAL	34

Semester/year	**1st year**	**III sem**	**IV Sem**	**V Sem**	**VI Sem**	**VII Sem**	**VIII Sem**
Credit	**78**	**44**	**40**	**44**	**47**	**37**	**34**
Total							**324**

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Sl. No.	Code	Open Elective Subject
1	ECL 1604	Solar Photovoltaics: Fundamentals, Technologies and Applications
2	ECL 1608	Introduction to MEMS
3	ECL 1609	Optoelectronic Devices and Circuits
4	ECL 1610	Bio-medical Instrumentation

Sl. No.	Code	Electives Subject
1	ECL 1607	Optical Communication
2	CSL 1602	Software Engineering
3	CSL 1604	Artificial Intelligence
4	EEL 1603	Power Electronics
5	ECL 1705	Low power VLSI Design
6	EEL 1703	Instrumentation
7	ECL 1801	Nano Electronics
8	ECL 1802	Radar Communication
9	EEL 1801	Non-Conventional Energy Source
10	ECL 1X11	Switching Circuits and Fault Diagnosis
11	ECL 1X12	Remote Sensing
12	ECL 1X13	CAD for VLSI
13	ECL 1X14	Queuing Theory
14	ECL 1X15	Radio Frequency Circuit Design
15	ECL 1X16	Sensors and Instrumentation
16	ECL 1X17	Digital Image Processing
17	ECL 1X18	ATM Networks and B-ISDN
18	ECL 1X19	Wireless LAN
19	ECL 1X20	Advanced Digital Signal Processing
20	ECL 1X21	Adaptive Signal Processing
21	ECL 1X22	Satellite Communication
22	ECL 1X23	Digital System Design

23	ECL 1X24	Wireless Sensor Networks
24	ECL 1X25	Detection and Estimation Theory
25	ECL 1X26	Numerical Techniques in Electromagnetics
26	ECL 1X27	Physics of Semiconductor Devices
27	CSL 1XXX	Robotics
28	CSL 1XXX	Soft computing
29	EEL 1XXX	Smart Grid
30	EEL 1XXX	Digital Control Systems

Syllabus
Third Semester

ECL 1301 Semiconductor Devices

L-T-P: 3-0-0 **Credits: 6**

1. Physics of semiconductor: Bonding Forces in Solids, Energy Bands theory in crystals (Qualitative Analysis), Metals, Semiconductors, & Insulators, Fermi-Level, Intrinsic, Extrinsic Semiconductors, Concept of Holes, Carrier Conc. and Mobility, diffusion and drift or carriers, Poisson's equation, continuity equation, Injected minority carrier charge. Recombination & generation of charge carriers.
4 Lectures

2. Junction Devices: Physical Description of p-n junction, current flow at a junction, I–V characteristics, Quantitative analysis of p-n diode characteristics, equivalent circuit, temperature dependence, Capacitance of p-n junction diode (transition & storage), junction Breakdown (Avalanche & Zener), Step and linearly graded junction, diode switching characteristics, M – S junction (Schottky barrier, Ohmic contact and rectifying contact), zener and varacter diodes, Hetero-junction. **10 Lectures**

3. Bipolar transistor: Junction transistor, Operational Considerations, modes and configurations, Performance parameters (Emitter efficiency, Base Transport Factor, Common Base Current Gain, Common Emitter Current Gain) and their derivation for an Ideal Transistor, Charge transport in BJT, base narrowing (Early effect), Avalanche breakdown & Punch through, transistor switching, Coupled-Diode model, Ebers-Moll equations, LF and HF model. **9 Lectures**

4. Field Effect Transistors: Junction FET (theory of operation, I-V relationship), MOS structure, Basic operation of Enhancement & Depletion mode MOSFET, MOS capacitance (Operation with band diagram, threshold voltage & Characteristics), Non Ideal MOS (M-S Work Function Difference, Oxide Charges, Threshold Adjustment and considerations), LF and HF model. **8 Lectures**

5. Physics & Technology of UJT and SCR: Silicon Controlled rectifier (theory of operation, switching considerations), Uni Junction Transistor (theory of operation). **2 lectures**

6. Optoelectronic devices: Optical absorption in semiconductors, photovoltaic effects, solar cells (p-n junction), Photoconductors, Photodiode, PIN photodiode, Avalanche photodiode, Phototransistor, LED, Semiconductor Laser (p-n junction) **4 Lectures**

7. Negative Resistance devices: Tunnel, Gunn & IMPATT diode **2 Lectures**

8. CCD and CCD Cameras **1 Lecture**

Text Books

1. Solid State Electronic Devices, Ben G. Streetman & Sanjay kumar Banerjee, 6th Edition, Pearson, 2005.
2. Semiconductor Devices- Physics and Technology, Nandita Dasgupta and Amitava DasGupta, PHI, 2010.

Reference Books

1. Principles of semiconductor devices by Dimitrijev, 2nd Edition, oxford, 2012.
2. Microelectronics by jacob millman& Arvin Grabel, 2nd Edition, TMH, 2004.
3. Electronic Devices and Circuits (schaum services) by Jimmie Cathey, 2nd Edition, (TMH), 2002.
4. Integrated Electronics by Jacob Millman, Christos C. Halkias, Chetan Parikh, 2nd Edition, TMH, 2011.
5. Semiconductor Optoelectronic Devices by Pallab Bhattacharaya, 2nd Edition, PHI, 2004.
6. Physics of Semiconductor Devices by J. P. Colinge & C. A. Colinge, Springer, 2005.
7. Semiconductor physics and Devices by Donald A.Neamen, 4th Edition, TMH,2012.
8. Introduction to Semiconductor Materials and Devices by M.S Tyagi, John Willy & Sons, 2008.

ECL 1302 Digital Logic Design

L-T-P: 3-0-0 **Credits: 6**

1. Introduction to Boolean Algebra and Logic Gates: Signed binary number, Binary arithmetic, Codes—BCD, Gray, Excess-3, Error detection & Correcting code-Hamming code, Logic Gates, Universal gates, Boolean Algebra, Basic theorems & properties of Boolean Algebra, De-Morgan's theorem, Min terms &Max terms, K-map representation, Q-M Method, simplification and realization with logic gates. **8 Lectures**

2. Combinational Circuits: Code Converters, Adders (Half and Full adders, parallel binary adders, look ahead carry adder generator, BCD Adder), Subtractor (Half and Full subtractor), decoders and Encoders, Priority Encoder, Multiplexer and De-multiplexer, Parity generator/checkers. **6 Lectures**

3. Sequential Logic: Latches, Flip-Flops (SR, D, JK, T and Master Slave JK, Edge Triggered), Conversion of Flip-Flops, Glitches, Shift Register (SISO, SIPO, PIPO, PISO, Bidirectional), Counter (ripple and synchronous, Ring and Johnson Counters). **8 Lectures**

4. Memory: Memory concepts, RAM, ROM, uv EPROM, EEROM, Flash memory, Optical memory. **4 Lectures**

5. Programmable Logic Devices: PAL, PLA, PROM, CPLD, FPGA and Programmable ASIC.

2 Lectures

6. Finite State Machine (FSM): Brief introduction to finite automata theory; Moore, Mealy and Turing machine; state diagram, state variable, state table and state minimization. Design of state machines using combinational logic circuits and memories. **4 Lectures**

7. Introduction to Logic Families: Standard logic families (TTL, ECL, CMOS) **4 Lectures**

8. D/A and A/D: Sample and Hold Circuits, Digital to Analog converter (Binary weighted resister network & R-2Rladder network), Analog to Digital converter (Flash type, Counter type, Dual Slope & Successive approximation type). **4 Lectures**

Text Books

1. Digital Logic and Computer Design, M. Morris Mano, PHI, 2008.
2. Digital design- Principles and Practices, J. F. Wakerly, 4th Edition, Pearson, 2006.

Reference Books

1. Digital Fundamentals, Thomas L.Floyd, 10th Edition, pearson, 2011.
2. Digital Principles and Applications, Donald P. Leach, Albert Paul Malvino, 5th Edition, TMH, 1995.
3. Digital Fundamentals, T. L. Floyd & Jain, Pearson Education.
4. Switching & Finite Automata Theory, Zovi Kohavi , 2rd Edition , TMH.,2008.
5. Fundamentals of Digital Logic, Anand Kumar, 2nd Edition, PHI, 2008.
6. Fundamentals of Logic Design , Charles H. Roth Jr, 4th Ed, Jaico publishers, 2002.

ECP 1302 Practical: Digital Circuit Laboratory

L-T-P: 0-0-3 **Credits: 3**

As per above syllabus

Syllabus
4th Semester

ECL 1401 ANALOG CIRCUITS

L-T-P: 3-1-0 **Credits: 8**

1. Introduction to Analogue Circuits: Active & Passive Devices, overview of analog circuits, application of analog circuits-implementation etc. **1 Lecture**

2. Diodes and their Applications: Characteristics of ideal & real diodes, diode circuits- rectifiers, clipping, clamping, special types of diodes & their applications. **3 Lectures**

3. Bipolar Junction Transistors and Amplifiers (Review): Characteristics of BJT; Ebers-Moll equations and large signal models; inverse mode of operation, early effect; BJT as an amplifier and as a switch; DC biasing of BJT amplifier circuits; small signal operations and models; Single state BJT amplifiers – CE, CB and CC amplifiers; high frequency models and frequency response of BJT amplifiers; Basic design in discrete BJT amplifiers; complete design examples; Basic BJT digital logic inverter. **10 Lectures**

4. MOSFETS and Circuits (Review): MOSFET operational Characteristics; PMOS, NMOS and CMOS current voltage characteristics; DC analysis; Constant Current Sources and Sinks; MOSFET as an Amplifier and as a Switch; Biasing on MOS Amplifiers; Small Signal Operation of MOS amplifiers; Common-source, common gate and source Follower Amplifiers; CMOS amplifiers; MOSFET Digital logic inverters; voltage transfer characteristics. **10 Lectures**

5. Voltage & Power: Classification amplifiers; Class A, Class B, Class AB Class C – Circuit operation, transfer characteristics, power dissipation, efficiency. Practical BJT and MOS power transistors; thermal resistance; heat sink design; IC power amplifiers. **4 Lectures**

6. Feedback in Amplifiers and Oscillators: Feedback concept and definition; Four basic feedback topologies; Analysis of Series-shunt, series-series, shunt-shunt and shunt-series feedback amplifiers; stability in feedback amplifiers, frequency compensation; principle of sinusoidal oscillators and Barkhausen criterion; Active-RC and Active-LC sinusoidal oscillators; Wien Bridge; Phase-Shift; Quadrature Oscillators; Crystal Oscillators, application in voltage regulation. **10 Lectures**

7. Introduction to Operational Amplifier. **2 Lectures**

Text Books

1. Microelectronic Circuits, Adel S. Sedra and Kenneth Carless Smith, 5th Edition, Oxford, 2004.
2. Analysis and Design of Analog Integrated Circuits, Gray and Meyer, 5th Edition, 2009.
3. Design of Analog CMOS integrated circuits, Behzad Razavi, TMH, 2008.

Reference Books

1. Electronic devices and Circuit Theory, Robert L. Boylestad, 9th Edition, Pearson Education, 2007.
2. Microelectronics: Analysis and Design, Sundaram Natarajan, TMH, 2006.
3. Electronic Circuits, D.L. Schilting and C. Belove, TMH.
4. Op Amp and Linear ICs, Ramakanth A. Gackward, 4th Edition, PHI, 2002.

ECP 1401 Practical: Analog Circuits Lab

L-T-P: 3-0-0 **Credits: 3**

As per above syllabus

ECL 1404 Analog Communication

L-T-P: 3-1-0 **Credits: 8**

1. Introduction: Introduction to communication systems, signals and spectra, electromagnetic spectrum and its usage, communication channels and propagation characteristics. Review of signal representation using Fourier series & Fourier transform, Hilbert transform, random variables, random processes, stationary processes, mean correlation & covariance, ergodic processes, power spectral density. **8 Lectures**

2. Introduction to Noise: Thermal noise, shot noise, White noise, Narrow band noise and its representation, signal to noise Ratio (SNR), noise temperature, noise equivalent bandwidth, noise figure. **4 Lectures**

3. Analog Modulation Techniques: Introduction, amplitude modulation (AM); different type of AM, AM power calculations, analog modulation: frequency modulation (FM) and phase modulation (PM); spectra of FM signals, narrow band and wide band FM, transmission bandwidth of FM, frequency translation and multiplexing. **6 Lectures**

4. AM Generation and Reception: Introduction, generation of AM signals, square law modulator, Vander Bijl modulator, suppressed carrier AM generation, ring modulator, balanced modulator. Tuned radio frequency (TRF) receiver, basic elements of AM super-heterodyne receiver; RF amplifiers characteristics- sensitivity, selectivity, image frequency rejection, mixers, tracking and alignment, local oscillator, IF amplifier, AM detectors; envelope detection, AGC. Generation of SSB. vestigial side-band modulation (VSB). Detection of SSB and VSB signals. Noise in AM receivers using envelop detection and coherent detection, figure of merits. **12 Lectures**

5. FM Generation and Reception: Generation of FM by direct methods. Indirect generation of FM: the Armstrong method. FM receiver direct methods of frequency demodulation; slope detector, Foster Seely or phase discriminator, ratio detector, indirect methods of FM Demodulation: FM detector using PLL. Noise in FM receivers, pre-emphasis and de-emphasis. **6 Lectures**

6. Pulse Modulation Transmission and Reception: Introduction, pulse amplitude modulation (PAM), PAM modulator circuit, demodulation of PAM signals, pulse time modulation (PTM): pulse width modulation (PWM), pulse position modulation (PPM); PPM demodulator. **4 Lectures**

Text Books

1. Modern Digital and Analog Communication Systems, B P Lathi, 4th Edition ,Oxford University Press, 2009.
2. Communication system engineering, J.G. Proakis and Salehi, 2nd Edition, PHI, 2001.
3. Communication Systems, Simon Haykin, John Wiley and Sons, 5th Edition, 2009.

Reference Books

1. Electronic Communication, Dennis Roddy, John Coolen, 4th Edition, Pearson, 1997 .
2. Communication Systems, A. B. Carlson,5th Edition, TMH/MGH.
3. Principles of communication Engineering, Umesh Sinha.
4. Communication Theory, T. G. Thomas & S Chandrasekhar, TMH, 2005.
5. Principle of Communication Systems, Herbert Taub & Donald L. Schilling, TMH..
6. Digital and Analog Communication Systems, Leon W. Couch, 7th Edition, Pearson, 2008.
7. Contemporary Communication Systems using MATLAB and Simulink, John G. Proakis & Masoud Salehi& Gerhard Bauch, 3rd Edition, Cengage Learning, 2013.

Syllabus
5th Semester

ECL 1501 Digital Communication

L-T-P: 3-1-0 **Credits: 8**

1. Sampling Theory: Sampling theorem, signal reconstruction in time domain, practical and flat top sampling and sampling of band pass signal. **3 Lectures**

2. Waveform Coding Techniques: Pulse code modulation: linear quantizer, quantization noise power calculation, signal to quantization noise ratio, non-uniform quantizer, A-law & μ-law,

companding, encoding and bandwidth of PCM; differential pulse code modulation (DPCM), delta modulation, slope overload, adaptive delta modulation. **5 Lectures**

3. Digital Multiplexing: Fundamentals of time division multiplexing, electronic commutator, bit, byte interleaving T1carrier system, synchronization and signaling of T1, TDM, PCM hierarchy, North-American CCITT standards, T1 to T4 PCM TDM system (DS1 to DS4 signals), signal format of M12 Mux for AT & T (Bell) system, bit rate calculation for DS1 to DS4 signals. **3 Lectures**

4. Digital Base Band Transmission: Line coding & its properties. NRZ & RZ types, signaling format for unipolar, polar, bipolar (AMI) & Manchester coding and their power spectra, HDB and B8ZS signaling, ISI, Nyquist criterion for zero ISI & raised cosine spectrum, matched filter receiver, derivation of its impulse response and peak pulse signal to noise ratio, correlation detector, decision threshold and error probability for binary unipolar (on-off) signaling. **6 Lectures**

5. Elements of Signal space Analysis: Geometric representation of signals, Gram-Schmidt orthoganization Technique. Coherent detection of signals in noise, correlation receiver. **4 Lectures**

6. Digital Modulation Techniques: Types of digital modulation, waveforms for amplitude, frequency and phase shift keying, method of generation and detection of coherent & non-coherent binary ASK, FSK & PSK, differential phase shift keying, quadrature modulation techniques, M-ary FSK, minimum shift keying (MSK), probability of error and comparison of various digital modulation techniques. Coherent reception of ASK, PSK and FSK, non-coherent reception of ASK, FSK, PSK and QPSK, calculation of error probability of BPSK and BFSK, error probability for QPSK. **10 Lectures**

7. Elements of Information Theory: Information: mutual information and channel capacity of a discrete memoryless channel, calculation of channel capacity of discrete memoryless and continuous AWGN channels, Hartely- Shannon law, bandwidth-S/N tradeoff. **4 Lectures**

8. Spread-spectrum modulation: Pseudo-Noise sequence, basics of spread spectrum, direct-sequence spread-spectrum communication systems, frequency-hop spread spectrum systems, other types of spread spectrum signals. **5 Lectures**

Text Books:

1. Communication Systems, Simon Haykin& Michael Moher, 5th Edition, Wiley publication, 2009.
2. Modern Digital and Analog Communication Systems, B. Bhagwandas Pannalal Lathi& Zhi Ding, Oxford University Press, 4th Edition, 2010.
3. Communication system engineering, J. G. Proakis and Sahhi, 2nd Edition, PHI, 2001.

Reference Books

1. Digital Communications, John G. Proakis, Masoud Salehi, 5th Edition, T Mc Graw –Hill, 2008.
2. Digital &Analog Communication systems, K.S.Shammugham, John Wiley & Sons, 2006.
3. Principles of Digital Communication, P. Chakravarti, Dhanpat Rai & Co, 2008.
4. Wireless Digital Communication, Kamilo Feher, PHI, 1995.
5. Digital Communication System Design, Martin S. Roden, PHI, 1988.

ECL 1502 Microprocessors and Microcontrollers

L-T-P: 3-0-0 **Credits: 6**

1. Introduction to Microprocessors:

General definitions of mini computers, microprocessors (8085 & 8086) and microcontrollers (8051, PIC). **2 Lectures**

2. Architecture of 8085 & 8086 microprocessors:
CPU Architecture, Pin configuration, Instructions, Flag structure, Addressing Modes/ Instruction Word size, Languages. **10 Lectures**

3. Assembly language (8085 & 8086):
Description of Instructions, Assembly directive, Assembly software programs with algorithm will be new addition to the existing chapter and it will be extended to 8086. **7 Lectures**

4. Timing Diagram:
Instruction cycle, fetch cycle, execute cycle: I/O read cycle, I/O Write cycle, Memory Read, Memory Write. **3 Lectures**

5. Interrupts:
Concept and structure. Interrupt service routines. **3 Lectures**

6. Methods of data transfer:
Serial, parallel, synchronous asynchronous. IN/OUT instructions with timing diagrams, simple hardware interface & programmable peripheral interfaces, various controller, display devices and DAC, ADC interfacing. **8 Lectures**

7. Microcontrollers & their application:
Conception about program counter, data pointer. register bank, Flags, program status word (PSW), internal memory, RAM memory, ROM memory map, stack and stack pointer, Input and output ports , External memory, counter and timers ,serial data input/output, interrupts, applications. **8 Lectures**

Text Books:
1. Microprocessor Architecture, Programming and Applications with 8085/ 8086 A, Ramesh S. Gaonkar, 5th Edition, PHI, 2002.
2. Microprocessors: Theory & Applications, M. Rafiquizzaman.
3. The 8051 Microcontroller and Embedded system, M.A. Mazidi, Rolin McKinlay, 2nd edition, Pearson, 2007.

Reference Books:
1. Advanced Microprocessor and Interfacing, Badri Ram, TMH, 2001.
2. Microprocessors & Interfacing, Douglas V. Hall, TMH, 2006.
3. The Intel Microprocessors Architecture, Programming & Interfacing, B. B. Brey, 8th Edition , Pearson and PHI, 2009.
4. Advanced Microprocessor & Peripherals, K.M. Bhurchandi & A.K. Ray, 3rd Edition, TMH, 2012.
5. The 8085 Microprocessor: Architecture, programming, interfacing, K. Uday Kumar, Pearson, 2008.

ECL 1503 Introduction to VLSI Design

L-T-P: 3-0-0 **Credits: 6**

1. Fabrication & Layout of CMOS: Fabrication Process Flow- Basic steps, CMOS n-Well Process, Layout & Design Rules, CMOS inverter Layout Design **6 Lectures**

2. MOS Inverter Characteristics: Transistor as switch, ideal and practical inverter characteristic (Noise Margin, Propagation delay, Speed-Power product, Fan-in, Fan-out), Transfer Characteristics-MOS, CMOS inverter, Transient Analysis of CMOS Inverter and Delay analysis. **6 Lectures**

3. CMOS Logic Circuits: NAND & NOR Gates, Complex Logic Circuits, Pseudo n-MOS logic, CMOS Full adder circuit, CMOS Transmission Gate (Pass transistor Logic). Stick Diagram, Layout & Design rules. **4 Lectures**

4. Advanced CMOS Logic circuits: Dynamic CMOS Logic, Domino CMOS Logic, Differential Cascode voltage switch logic, NORA Logic. **4 Lectures**

5. Sequential CMOS logic circuits: Behavior of Bi-stable elements, SR Latch Circuit, Clocked JK Latch/Master-Slave JK, CMOS D-latch and edge triggered Flip-flop. **4 Lectures**

6. Subsystem Design: Adders- Carry ahead adder, carry save adder, Manchester carry chain. Multipliers-Serial-parallel Multiplier, array multiplier. ROM, Static RAM, Dynamic RAM, SD RAM, Flash Memory. **6 Lectures**

7. Physical Design: Basics of Partition, placement, floor planning and routing **3 Lectures**

8. Basic Analog Building Blocks: Basic Amplifiers-Low frequency and High frequency models, cascade amplifier, folded cascade, frequency response, stability, and noise issues of amplifiers, Current /source/sink/mirror. Wilson current source & regulated cascade current source, Band gap reference. **8 Lectures**

Text Books

1. Digital Integrated Circuits, Rabaey & Chandrakashan& Nicolic, 2nd Edition, PHI, 2003.
2. Algorithms for VLSI Physical Design Automation, N. A. Sherwani, Bsp Books Pvt. Ltd., 3rd edition, 2005.
3. CMOS Analog Circuit Design, Philips E. Allen & Douglas R. Holberg, 3rd Edition, Oxford University Press, 2012.

Reference Books

1. Analysis & Design of Digital Integrted Circuits by David Hodges, Horace G Jackson, & Resve A Saleh, Tata McGraw-Hill Edition (For Module 2, 3, 4, 5), 1983.
2. Digital Integrated Circuits by Kenneth William Martin , Oxford University Press (For Module 2, 4, 5, 6), 2000.
3. VLSI Design techniques for Analog and Digital Circuits, R. L. Geiger, P. E. Allen, Noel R. Strader, McGraw-Hill International Edition.(For Module 9, 10 & 11), 1990.
4. Modern VLSI Design – System-on-chip Design, Wayne Wolf, 3rd Edition, Prentice Hall India/Pearson Education, 2002.
5. CMOS Digital Integrated Circuits, Analysis & Design by Sung-Mo Kang & Yusuf Lablebici, 4th Edition, Tata McGraw-Hill Edition, 2013.
6. Digital integrated circuits a design perspective, Jan M Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2nd Edition, Prentice Hall, 2002.

ECL 1505 Electromagnetic Theory and Antennas

L-T-P: 3-1-0 **Credits: 8**

1. Review of co-ordinate systems and vector calculus: Different coordinate systems, **l**ine, surface and volume integrals. Gradient, divergence and curl. Divergence theorem and stokes theorem. **3 Lectures**

2. Review of Electrostatics: Coulomb's law, Gauss's law and its applications. the potential functions, equipotential surface, Poisson's and Laplace's equation. Capacitance, electrostatics energy, conductor properties and boundary conditions. Uniqueness theorem. **4 Lectures**

3. Review of Magneto Statics: Biot-Savart law, Ampere circuital law, magnetic flux and magnetic flux density. Energy stored in magnetic field. Ampere's force law, Magnetic vector potential. **4 Lectures**

4. Maxwell's Equation: Equation of continuity for time varying field, inconsistency of Ampere circuital law. Concept of displacement current, Maxwell's equation in integral and differential form. Maxwell equation for time harmonic fields. **3 Lectures**

5. Electromagnetic waves: Solution for free space condition, uniform plane waves, Wave propagation in lossless and lossy dielectric media, skin depth. Polarization of EM waves. **4 Lectures**

6. Reflections and Refractions of plane waves: Reflection by a perfect conductor with normal and oblique incidence, reflection & refractions by perfect dielectrics with normal and oblique incidence. Surface impedance. **6 Lectures**

7. Poynting vector: Poynting theorem, instantaneous average and complex poynting vector, power loss in a plane conductor. **2 Lectures**

8. Antennas: Retarded potentials, Radiation from a current element (Herzian dipole), basic antenna parameters: radiation pattern, radiation intensity, radiation resistance, beamwidth, gain-power gain and directive gain, input impedance. Radiation from an elementary loop antennas, linear wire antennas, antenna efficiency, effective aperture, effective length, FRIIS transmission equation, Radar Cross Section. Aperture antennas: Horn, reflector and microstrip antennas. Introduction to antenna array. **9 Lectures**

9. Radio Wave Propagation: Modes of propagation, structure of troposphere, tropospheric scattering, ionosphere, ionospheric layers-D, E, F_1, F_2, regions. Sky wave propagation-propagation of radio waves through ionosphere, effect of earth's magnetic field, virtual height, skip distance, MUF, critical frequency. Space wave propagation, ducting, fading. **5 Lectures**

Text Books:

1. Element of Electromagnetics, Mathew N. O. Sadiku, 5th Edition, Oxford University, 2010.
2. Electromagnetic waves and Radiating Systems, E. C. Jordan & K. G. Balmain, 2nd Edition, PHI.
3. Electromagnetics Theory, David K Chang, 2nd edition, Addison Wesley Longman, 1999.
4. Antennas and Radio Wave Propagation, R.E.Collin, McGraw – Hill, 1985.

Reference Books

1. Introductory course in electromagnetic fields, P.V. Gupta, 2nd Edition, Dhanpetrai Publications, 1975.
2. Fundamental of Electromagnetics, M.A. Wazed Miah, 5th Edition, TMH, 1985.
3. Electromagnetic fields and waves, V. V. Sarvate, bohem press, 1993.
4. Electromagnetics by B.B. Laud.
5. Antenna Theory and Practice, R. Chatterjee, New age Publisher, 2004.

6. Antenna & Wave Propagation, K. D. Prasad
7. Antenna by J. D. Kraus, Tata McGraw Hil, 2006.
8. Principles of Antenna Theory, K. F. Lee, Wiley, 1984.
9. Electronic and Radio Engineering, Frederick Emmons Terman,4th Edition, TMH, 1955.
10. Electromagnetic waves and radiating system, E.C Jordan & K.G Balmain, 2nd Edition, PHI, 1979.
11. Engineering Electromagnetics, William Hayt, John Buck, 8th Edition, TMH, 2008.

Antenna theory, analysis and design, Constantine A. Balanis, 2nd. Edition, John Wiley & Sons, 2012.

ECP 1501 Practical: Communication Lab

L-T-P: 0-0-3 **Credits: 3**

As per above syllabus

ECP 1502 Practical: Microprocessors and Microcontrollers Lab

L-T-P: 0-0-3 **Credits: 3**

As per above syllabus

ECP 1503 Practical: VLSI Lab-I

L-T-P: 0-0-4 **Credits: 4**

As per above syllabus

Syllabus
6th Semester

ECL 1601 Digital Signal Processing

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction:** Limitations of analog signal processing, Advantages of digital signal processing and its applications; Some elementary discrete time sequences and systems; Basic elements of digital signal processing such as convolution, correlation and autocorrelation, Concepts of stability, causality, linearity, and difference equations. **6 Lectures**

2. **Sampling of continuous time signals:** Sampling and aliasing problem, Reconstruction of a continuous time signal from its samples; Discrete Time Processing of Continuous time signals and vice-versa. Decimation & Interpolation; changing the sampling rate by integer and non-integer factors using discrete time processing. **3 Lectures**

3. **The Z Transform**: Review and analysis of LTI system in Z-domain, definition and mapping between S-plane and Z-plane, unit circle, convergence and ROC, Z- Transform on sequences, Inverse Z-Transform and numericals. **5 Lectures**

4. **Discrete Fourier Transform:** DFT and its properties; Linear Periodic and Circular convolution; Linear Filtering Methods based on DFT; Filtering of long data sequences; Fast Fourier Transform algorithm using decimation in time and decimation in frequency techniques; Linear filtering approaches to computation of DFT. **8 Lectures**

5. **Digital filter structures:** System describing equations, filter categories, direct form I and II structures, cascade and parallel communication of second order systems, linear phase FIR filter structures, frequency sampling structure for the FIR filter. **2 Lectures**

6. **IIR Filter design technologies**: Analog lowpass filter design techniques, methods to convert analog filters into digital filters, frequency transformations for converting lowpass filters into other types, all- pass filters for phase response compensation. **3 Lectures**

7. **FIR filter design techniques:** Windowing method for designing FIR filters, DFT method for approximating the desired unit sample response, combining DFT and window method for designing FIR filters, frequency sampling method for designing FIR filters. **3 Lectures**

8. **Finite precision effects:** Fixed point and Floating point representations, Effects of coefficient unitization, Effect of round off noise in digital filters, Limit cycles. **2 Lectures**

9. **Application of DSP:** DTMF signal detection, resical sound Processing, Digital FM stereo generation, oversampling A/D, D/A converter. **4 Lectures**

Text Books

1. Digital Signal Processing: Principles Algorithms and Applications, J. G. Proakis and D. G. Manolakis, Pearson Education, 4th Edition, 2007.
2. Digital Signal Processing, A. V. Oppenheim, R. W. Schafer, Pearson Education, 2004.
3. Digital signal processing, S. Salivahanan, A Vallavaraj, C Gnanapriya, TMH, 2nd Edition, 2010.
4. Digital Signal Processing: Fundamentals and Application, Li Tan, Academic Press, Elseviers.

Reference Books

1. Digital Signal Processing: A computer based approach, S. K. Mitra,4th Edition, TMH, 2011.
2. Theory and Application of Digital Signal Processing, L. R. Rabiner and B. Gold, Pearson Education, 2004.
3. Signal & Systems by Oppenheim A V, Willsky A S & Young I T, Prentice Hall.
4. Digital Signal Processing, Emmanuel C. Ifeachor, Barrie W. Jervis, Pearson Education India, 2002.
5. Digital Filters, Analysis, Design and Applications, Andrias Antonion, 2nd Edition, TMH, 2006.
6. Digital Signal Processing, D.J. DeFatta, J.G.Lucas and W. S. Hodgkiss, J Wiley and Sons.
7. Digital Signal processing, Ramesh Babu C. Durai, Laxmi Publications, 2005.

ECP 1601 **Practical: Digital Signal Processing Lab**

L-T-P: 0-0-3 **Credits: 3**

As per above syllabus

ECL 1602 Information Theory and Coding

L-T-P: 3-0-0 **Credits: 6**

1. Introduction: Entropy and mutual information for discrete ensembles, source coding, variable length coding, discrete memoryless channels, mutual information, channel capacity, channel coding theorem, differential entropy and mutual information for continuous ensembles, channel capacity for Gaussian channels, channel coding, linear block codes, and cyclic codes, convolution codes, sequential and probabilistic decoding, majority logic decoding, burst error-correcting codes, turbo codes and low-density-parity check codes. **25 Lectures**

2. Cryptography: Basic concepts on cryptography and crypto analysis, security issues; private-key encryption algorithms-stream ciphers, block ciphers, Shannon's theory; introduction to number theory – modular arithmetic, exponentiation and discrete logarithms in Galois field; public key encryption algorithms-Diffie-Hellman public-key distribution scheme, RSA public-key cryptosystem; Message authentication, hashing functions, digital signatures. **15 Lectures**

Text Books:

1. Communication Systems, S. Haykin, 4th Edition, John Wiley & Sons, New York, 2001.
2. Elements of Information Theory, T M Cover and J A Thomas, John Wiley, 1991.
3. Information Theory, Coding and Cryptography, R. Bose, Tata McGraw-Hill, 2002.

Reference Books

1. Introduction to Cryptography with Coding Theory, Wade Trappe, Lawrence C. Washington, 2nd Edition, Pearson Education India, 2007.
2. Modern digital and Analog communications, B. P. Lathi, 3rd Edition, Oxford University Press, 2000.
3. Cryptography: Theory and Practice, Douglas R. Stinson, 3rd Edition, Champmen & Hall/CRC, 2006.

ECL 1603 RF and Microwave Engineering

L-T-P: 3-0-0 **Credits: 6**

1. Introduction: Microwave frequencies, standard frequency bands, behaviour of circuits at conventional and microwave frequencies, microwave application, review of Maxwell's equations. **3 Lectures**

2. Transmission lines: Transmission line theory, low loss radio frequency and UHF transmission line. UHF line as circuit element, quality factor of resonant transmission line section, the quarter wave line as a transformer, impedance matching, Smith chart. **5 Lectures**

3. Waveguide: Overview of guided waves; TE and TM modes in rectangular and circular wave guide, cut off wavelength, dominant mode, attenuation in waveguides. **5 Lectures**

4. Microwave Components & Devices: N-port microwave networks. Scattering matrix representation. Reciprocal and lossless networks. Passive microwave devices: E-plane tee, H-plane tee, magic tee, attenuators, directional coupler and power dividers, resonator, ferrite devices: circulator, isolator, phase-shifter. **10 Lectures**

5. Microwave Generators: Transit-time effect, limitations of conventional tubes, two-cavity and multi-cavity klystrons, reflex klystron, TWT and magnetrons. Solid state devices-transferred electron devices, avalanche diode oscillator, microwave transistor. **9 Lectures**

6. Microwave Measurements Technique: Power measurement; calorimeter method, bolometer bridge method, thermocouples, impedance measurement, measurement of frequency and wavelength, measurement of unknown loads, measurement of reflection coefficient and VSWR. **8 Lectures**

Text Books:

1. Microwave Engineering, D M Pozar, 4th Edition,John Wiley & Sons, 2011.
2. Microwave Devices & circuits, Liao Samuel Y., Liao, 3rd Edition, Pearson Education India, 1990.

Reference Books

1. Microwaves: Introduction to Circuits, Devices and Antennas by M L Sisodia, V. L. Gupta, New Age international, 2007.
2. Foundations of Microwave Engg., R E Collin, 2nd Edition, McGraw-Hill, 2007.
3. Microwave principles, Herbert J. Reich, Van Nostrand, 1966.
4. Microwave, K. C. Gupta, John Wiley & Sons Canada, Limited, 1980.
5. Microwave techniques, D. C. Agrawal.
6. Elements of Microwave Engineering, R. Chatterjee, Prentice Hall, 1988.
7. Microwaves Active devices vacuum and solid state, M. L. Sisodia, New age international, 2006.
8. Microwave circuits and passive devices, M. L. Sisodia, G. S. Raghuvanshi, Wiley Publisher, 1987.

ECP 1603 Practical: RF & Microwave Engineering Lab

L-T-P: 0-0-3 **Credits: 3**

As per above syllabus

ECL/EEL/CSL 16XX Open Elective

L-T-P: 3-0-0 **Credits: 6**

ECL/EEL/CSL 16XX Elective I

L-T-P: 3-0-0 **Credits: 6**

ECL 1606 Advance Electronic Circuits

L-T-P: 3-0-0 **Credits: 6**

1. Differential Amplifiers: Advantages of differential amplifiers; MOS and BJT differential pair; Small signal and large signal operation of differential pairs; Parameters and non-ideal characteristics of differential amplifiers; differential amplifier with active load frequency response, constant current bias, current mirror, cascaded differential amplifier stages, level translator. **10 Lectures**

2. Operational Amplifiers and its Applications: Concept of operational amplifiers; Ideal operational amplifier parameters; Inverting and non-inverting configurations; Common OPAMP Ics: Input offset voltage, input bias and offset current, Thermal drift, CMRR, PSRR, Frequency response. Gain-frequency and Slew rate; DC, ac amplifiers, summing differential amplifier, V to I and I to V

converters, Instrumentation amplifiers; Integrators, Differentiators; Logarithmic Amp; Multipliers; Comparators; Schmitt triggers. Limiters, log/antilog amplifiers, multipliers, function generators, waveform generators. **10 Lectures**

3. Filters and Tuned Amplifiers: Filter characteristics and specifications; First and Second Order Filter functions; First-order and second order filter network using OPAMPS (low/high/band pass/band reject/ All pass filter); Tuned Amplifiers; Basic principle; amplifiers with multiple tuned circuits; Synchronous and Stagger tuning; RF amplifiers considerations. **10 Lectures**

4. Waveform Generation and Shaping Circuits: Multivibrators–Astable, monostable and bistable circuits; bistable circuit as memory element comparator generation of square, triangular waveforms and standardized pulse using AMV and MMV; Application of 555 timer. **10 Lectures**

Text Books

1. Analysis and Design of Analog Integrated Circuits, Gray and Meyer, 5th Edition, John Wiley & Sons, Incorporated, 2010.
2. RF Microelectronics, Behzad Razavi, 2nd Edition, Pearson Education International, 2012.
3. CMOS Analog Circuit Design, Philips E. Allen & Douglas, R. Holberg, Elsevier Publisher, 2011.

Reference Books

1. Electronic devices and Circuit Theory, Robert L. Boylestad, Louis Nashelsky, Pearson/Prentice Hall, 2009.
2. Microelectronic Circuits, Adel S. Sedra, Kenneth Carless Smith, 5th Edition, Oxford University Press, 1998.
3. Microelectronics: Analysis and Design, Sundaram Natarajan , TMH, 2005.
4. Electronic Circuits, D.L. Schilting and C. Belove, TMH.
5. Op Amp and Linear ICs, R. A. Gackward, 4th Edition,PHI/Pearson Education, 2002.

ECP 1606 Practical: Advance Electronics Circuits Lab

L-T-P: 0-0-3 **Credits: 3**

As per above syllabus

ECP 1604 Industrial Training

Credits: 2

Syllabus
7th Semester

ECL 1701 Communication Networks

L-T-P: 3-0-0 **Credits: 6**

1. Networks and services: Network topologies, switching methods, network evolution, concept of layered architecture, the OSI model, the TCP/IP model, standardization. Study of telephone network, PCM-TDM based IDN, circuit switching, circuit and packet switching, space and time division switching, signalling methods, store-and-forward operation: error detection and correction, ARQ

strategies. Overview of ISDN, ATM networks, SONET and SDH. **8 Lectures**

2. MAC protocols and LANs: ALOHA, slotted ALOHA, CSMA and CSMA-CD protocols; IEEE 802.3 protocol and MAC frame format. Details of 802.3 hardware options; 100 Mbps and 1000 Mbps Ethernet LANs, switches, bridges and VPN; Wireless LANs; LAN applications; client-server architecture. **9 Lectures**

3. Network Layer: Services offered to the transport layer, internal organization as datagram or virtual circuit subnets, routing algorithms, link state and distance vector routing, congestion control, internetworking, Study of IPv4 and IP v6, DNS and Internet routing protocols such as RIP, OSPF, BGP. **6 Lectures**

4. Transport Layer: Design issues, study of TCP, connection setup and removal, flow control, reliable and efficient delivery, timer management. The TCP/IP protocol stack: ICMP, IGMP, UDP, BOOTP, DHCP etc. **6 Lectures**

5. Network applications: World Wide Web and HTTP, Web servers and browsers, Content Engines, FTP and TFTP, SMTP and MIME, DNS, multimedia networking, streaming stored audio and video, Internet audio and video communications. **7 Lectures**

6. Network Security: Principles of cryptography, symmetric and public key cryptography authentication, integrity, key distribution and certification, secure e-mail, Fire-walls. **4 Lectures**

Text Books:

1. Communication Networks, Leon-Garcia and Widjaja, TMH, 3e, 2003.
2. Computer Networks-a systems approach, Peterson and Davie- Morgan Kauffman, 2e, 2000.
3. Computer Networking, a top-down approach featuring the Internet, Kurose and Ross, Addison Wesley, 6e, 2012.

Reference Books

1. Data and Computer Communication, Stallings William, PHI, 6e, 2007.
2. Data communications and networking, Behrouz A. Forouzan, TMH, 4e, 2006.
3. Computer Communications and Networking Technologies, Gallo and Hancock, Thomson Learning, 1e, 2001.
4. Telecommunication networks: protocols, modeling and analysis, M. Schwartz, 1e, 1987.
5. Data network, Bertsekas and Gallager, PHI, 2e, 1992.
6. Data Communication, Computer network & open systems, PHI, F. Halsall, 4e, 1996.
7. An Engineering approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network, S. Keshav, PHI, 1e, 1997.

ECL 1702 Wireless Communication

L-T-P: 3-0-0 **Credits: 6**

1. Wireless Communication Systems & Standards: Evolution of Mobile Radio Communications, Cellular telephone systems, Different generations (1G to 4G) of wireless communication and

Networks; GSM, GPRS, EDGE, CDMA, UMTS, WLAN, WLL, Bluetooth, PAN, Recent advances in mobile computing. **7 Lectures**

2. **Propagation & Fading:** Review of Path losses in indoor and outdoor propagation channels, Multipath fading, Doppler shift, time and frequency dispersive channels, delay spread and coherence bandwidth, flat and frequency selective fading, slow and fast fading, coherence time, LCR and ADF. **8 Lectures**

3. **The Cellular Concept:** Frequency Assignment and Channel Assignment, Frequency Reuse, Handoff, Sectoring, Repeaters for range extension, Microcell zone, Spectral efficiency & capacity of cellular systems. **6 Lectures**

4. **Mobile Radio Interferences & System Capacity:** Co-channel Interference and System Capacity, Channel planning for Wireless Systems, Adjacent channel interferences, Power control for reducing interference, Near-end-to-far-end interference, Inter-symbol and Simulcast interference, False alarm rate and word error rate. **5 Lectures**

5. **Multiple access schemes:** FDMA, TDMA, CDMA and SDMA. **3 Lectures**

6. **Diversity & Combining Techniques:** Diversity Schemes (Space, frequency, field and polarization diversities) and combining techniques, diversity receivers- selection, MRC & EGC. RAKE receiver, equalization linear- ZFE and adaptive, DFE. **7 Lectures**

7. **Antennas for wireless communication:** Antennas used for Mobile Communications, Radiation patterns, antennas for mobile terminal, base station antennas, Smart antenna (basic concept). **4 Lectures**

Text Books:

1. Wireless Communication: Principles & Practice, T. S. Rappaport, Prenctice Hall, 2e, 2002.

Reference Books

1. Mobile Cellular Telecommunications Systems, W. C. Y. Lee, TMH, 2e, 2002.
2. Wireless communication, Andrea Goldsmith, Cambridge University press, 2005.

ECL 1703 Embedded Systems

L-T-P: 3-0-0 **Credits: 6**

1. **Study of Microcontrollers:** Introduction of 16 bit microcontroller 8096- architecture, memory organization, details of microcontroller ATMEL/ARM. **8 Lectures**

2. **Introduction to embedded systems:** Categories and requirements of embedded systems, Challenges, and issues related to embedded software development, Hardware/Software co-design, Introduction to IC technology, Introduction to design technology. Concepts of concurrency: processes, threads, mutual exclusion and inter-process communication, Models and languages for embedded software, Introduction to RTOS, Basic design using RTOS. Distributed embedded system, architecture, network for embedded system: 12C bus, CAN Bus. **10 Lectures**

4. **Programming Embedded systems:** Digital Patterns for embedded systems, data flow graphs, control/data flow graphs, assembly and linking, basic compilation techniques, analysis and optimization of execution time. **8 Lectures**

5. ARM & PIC Processor: Architecture of ARM & PIC Processor, Memory, Interrupt functions, Parallel I/O ports, Timers/Counters, Serial communication, Analog interfaces. Few current applications. **6 Lectures**

6. Case Studies: Data compressor, alarm clock, software modem, elevator controller, digital camera, etc. **8 Lectures**

Text Books

1. Computer as components: Principles of Embedded Computing Design, Morgan Kaufmann Publishers, 2001.
2. Embedded Systems Architecture, Programming and Design, R. Kamal, Tata McGraw-Hill, 2e, 2003.
3. The 8051 Microcontroller and Embedded System, M. A. Mazdi & J. G. Mazdi, Pearson Education India, 2e, 2005.
4. Embedded system design: A unified hardware/software introduction, Vahid, F. and Givargis, T., John Wiley & sons, 2e, 2001.
5. Embedded Microcomputer systems, J. W Valvano Brooks, Thomson Learning, 2e, 2002.

Reference Books

1. The 8051 Microcontroller Architecture, Programming and Application, K J Ayala, Penram International Publishing (India), 3e, 2004.
2. Embedded Microcontrollers, T. D Morton, Pearson Education, 1e, 2003.
3. Embedded Microcomputer Systems, Jonathan Valvano, Cengage lerning, 3e, 2012.

ECL/EEL/CSL 17XX Electives II

L-T-P: 3-0-0 **Credits: 6**

ECL/EEL/CSL Electives III

L-T-P: 3-0-0 **Credits: 6**

ECD 1701 Project Phase-I

Credits: 4

ECP 1701 Communication Networks Lab

L-T-P: 0-0-3 **Credits: 3**

As per subject syllabus.

Syllabus
8th Semester

ECL/EEL/CSL 18XX Elective IV

L-T-P: 3-0-0 **Credits: 6**

ECL/EEL/CSL 18XX **Elective V**
L-T-P: 3-0-0 **Credits: 6**

ECD 1802 **Project Phase-II**

Credits: 8

ECD 1803 **Grand viva**

Credits: 4

ECP 1801 **VLSI Lab-II**
L-T-P: 0-0-4 **Credits: 4**
As per subject syllabus.

Open Elective

ECL 1604 **Solar Photovoltaics: Fundamentals Technologies and Applications**
L-T-P: 3-0-0 **Credits: 6**

1. Solar Photovoltaic (PV) as energy source: energy scenario of the world, current energy resources and reserves, total worlds consumption, potential of solar PV. **2 Lectures**

2. Solar radiation and sun earth movement: measurement and estimation of solar radiation, earth-sun geometry and various angles that affect the amount of solar radiation falling on a collector surface, the Sun-Earth movement. **4 Lectures**

3. Optimum solar energy collection: Angle of Sun rays on solar collector, Local apparent time, day length calculations, sun tracking systems. **4 Lectures**

4. Introduction to solar PV cells: difference between solar thermal and solar PV energy conversion, semiconductor and potential generation, elemental and compound semiconductors used in solar cell application. **2 Lectures**

5. Review of semiconductor properties: Charge Carriers and charge carrier concentration, Carrier drift and carrier diffusion, Carrier generation and carrier recombination- thermal generation and optical generation, absorption coefficient and absorption length for different materials, radiation intensity, and generation rate of electron hole pairs, excess charge carrier density, lifetime of carriers, rate of recombination, mechanisms of recombination, recombination at surface and in bulk. Continuity equation for charge balance. **5 Lectures**

6. Theory of P-N junction diode & P-N junction as a solar cell: Biasing of P-N junction and I-V relationship, Illumination of P-N junction diode, generation of photovoltage (photovoltaic effect), Solar cell as power source, carrier concentration profile in solar cells, current-voltage relationship of solar cells, I_{sc}, V_{oc}, FF and η of solar cells, power rating of solar cells, input power, peak output/rated power. **4 Lectures**

7. Solar Cell Parameters and power ratings: Solar cell as power source, Carrier concentration profile in solar cells, Current-voltage relationship of solar cells, Isc, Voc, FF and η of solar cells, power rating of solar cells, input power, peak output/rated power. **4 Lectures**

8. Design of solar cells: (1) Design for high open circuit voltage, surface recombination velocity (SRV), effect of base and emitter recombination on voltage, Back Surface Field (BSF), (2) Design for high FF, metal-semiconductor ohmic contacts, resistive losses, metal contact design, series resistance and FF, shunt resistance and FF. **5 Lectures**

9. Production of Si: (Current status of Si production in world, Types of Si, Purification routes of Si, MGS to EGS conversion, Poly-Si to Crystalline SI conversion, Si ingot to wafers, SoG-Si and Si sheets. **4 Lectures**

10. Fabrication of Si cells: Fabrication steps used in industrial cell process, saw-damage removal, surface texturing, diffusion and its parameters, edge isolation, ARC deposition, metal printing, contact firing. **4 Lectures**

11. Solar-PV systems: Battery Charging. DC micro grid – A reality! Solar-PV system for DC micro grid. **2 Lectures**

Text Books:

1. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan S. Solanki, Prentice Hall of India, 2009.

Reference Book:

1. Solar Cells: Operating Principles, Technology and System Applications, M. Green, University of New South Wales, 1998.
2. Silicon Solar Cells: Advanced Principles and Practice, M.A. Green, University of New South Wales.
3. Physics of Solar Cells, J. Nelson, Imperial College Press, UK, 2003.
4. Solid State Electronic Devices, Ben Streetman, Pearson Education, 2000.

ECL1608 Introduction to MEMS

L-T-P: 3-0-0 **Credits: 6**

1 Introduction: Benefits of Miniaturization, Smart Materials, Structures and Systems, Applications of Smart Materials and Microsystems. **4 Lectures**

2 Micro Sensors, Actuators, Systems and Smart Materials: An Overview, Silicon Capacitive Accelerometer, Piezoresistive Pressure Sensor, Conductometric Gas Sensor, Electrostatic Comb-Drive, Magnetic Microrelay, Portable Blood Analyzer, Piezoelectric Inkjet Print Head, Micromirror Array for Video Projection. **10 Lectures**

3 Micromachining Technologies: Silicon as a Material for Micromachining, Thin-Film Deposition, Lithography, Etching, Silicon Micromachining, Specialized Materials for Microsystems, Advanced Processes for Microfabrication. **10 Lectures**

4. Modeling of Solids in Microsystems: Deformation, Bimorph Effect, Beam theory, resonance, Stresses, Torsion, Numerical Methods for Solution of Equations, Finite Element Method, Modeling of Coupled Electromechanical Systems e,g. Electrostatics, Electromechanics. **6 Lectures**

5. Electronics Circuits and Control for Micro and Smart Systems: Semiconductor Devices, Electronics Amplifiers, Practical Signal Conditioning Circuits for Microsystems, Circuits for Conditioning Sensed Signals, Introduction to Control Theory, Implementation of Controllers. **8 Lectures**

6. Integration of Micro and Smart Systems: Microsystems Packaging, Case Studies of Integrated Microsystems, Scaling Effects in Microsystems**.** **2 Lectures**

Text Books:

1. Micro and Smart Systems: Technology and Modeling, G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Aatre, Wiley Publisher, 2012.

References:

1. Microsystem Design, Stephen D. Senturia, Springer (India) Pvt. Limited, 2006.
2. Fundamentals of Microfabrication, Marc Madou, 3rd Edition, Taylor & Francis Limited, 2011.
3. Micromachined Transducers Sourcebook, Gregory T. A. Kovacs, WCB/MacGraw-Hill, 1998.
4. Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes, M-H. Bao, Elsevier publisher, NewYork, 2000.
5. MEMS, Vijay Vardan, Wiley Publication.
6. MEMS and Microsytems Design and Manufacture, Tai- Ran Hsu, TMH, 2002.
7. MEMS, Nitaigour Mahalik, Tata McGraw-Hill Education, 2008.
8. MEMS and MOEMS Technology and Applications, Rai Chaoudhary, PHI Learning, 2000.

ECL 1609 Optoelectronics Devices and Circuits

L-T-P: 3-0-0 **Credits: 6**

1. **Elements Of Light And Solid State Physics:** Wave nature of light, Polarization, Interference, Diffraction, Light Source, review of Quantum Mechanical concept, Review of Solid State Physics, Review of Semiconductor Junction Device. **6 Lectures**

2. **Display Devices And Lasers:** Introduction, Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, LED, Plasma Display, Liquid Crystal Displays, Numeric Displays, Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers, Mode Locking, laser applications. **10 Lectures**

3. **Optical Detection Devices:** Photo detector, Thermal detector, Photo Devices, Photo Conductors, Photo diodes, Detector Performance. **8 Lectures**

4. **Optoelectronic Modulator:** Introduction, Analog and Digital Modulation, Electro-optic modulators, Magneto Optic Devices, Acousto-optic devices, Optical, Switching and Logic Devices. **8 Lectures**

5. **Optoelectronic Integrated Circuits:** Introduction, hybrid and Monolithic Integration, Application of Opto Electronic Integrated Circuits, Integrated transmitters and Receivers, Guided wave devices. **8 Lectures**

Text book:

1. Opto Electronics – An Introduction, J. Wilson and J.Haukes, 3rd Edition, Prentice Hall of India Pvt. Ltd., 1998.

References book:

1. Semiconductor Opto Electronic Devices, Pallab Bhattacharya, 2nd Edition, Prentice Hall of India Pvt., Ltd, 2004.
2. Opto Electronics – As Introduction to materials and devices, Jasprit Singh, McGraw-Hill International Edition, 1996.

ECL 1610 Bio-medical Instrumentation

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction to Biomedical Instrumentation:** Biometrics, introduction to the man-instrument system, components of the man-instrument system, problems encountered in measuring a living system; **3 Lectures**

2. **Bio-Electric signals and electronics:** Origin of bio-electric signals, bioelectric potentials, biopotential electrodes; **3 Lectures**

3. **Physiological Transducers:** Pressure transducers, transducers for body temperature measurement, pulse sensors, respiration sensors; **4 Lectures**

4. **Biomedical Recorders:** Electrocardiograph, phonocardiograph, electroencephalograph, electromyograph; **5 Lectures**

5. **Patient Monitoring System:** System concepts, measurement of heart rate, blood pressure measurement, measurement of temperature, measurement of respiration rate, apnoea detectors. **4 Lectures**

6. **Blood Flow Meters:** Electromagnetic blood flow meter, ultrasonic blood flow meter, NMR blood flow meter, laser doppler flow meter; **4 Lectures**

7. **Blood Gas Analyzers:** Blood pH measurement, blood PCO2 measurement; **2 Lectures**

8. **Blood Cell Counters:** Method of cell counting, coulter counters, automatic recognition and differential counting of cells; **4 Lectures**

9. **Recent Developments.** **1 Lecture**

Text Books:

1. Biomedical Instrumentation and Measurements, L. Cromwell, F. J. Weibell, E. A. Pfeiffer, Pearson Education, Delhi, 2e, 2005.
2. Handbook of Biomedical Instrumentation R. S. Khandpur, Tata Mc Graw Hill, New Delhi, 2e, 2003.

Reference Books

1. Bioinstrumentation, J. G. Webster, Wiley, 4e, 2004.
2. Biomedical Digital Signal Processing, W. J. Tompkins, PHI , 3e, 2008.

Electives

ECL 1607 Optical Communication

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction**: Fundamental of fiber optics, different generations of optical fiber communication system, optical fiber structure, fiber types. modes in optical fiber signal degradation in optical fibers, fiber losses. **10 Lectures**

2. **Optical sources:** principles of operation, modulation characteristics and driver circuits, LED, laser diodes, light source linearity, light source materials. **8 Lectures**

3. **Power launching and coupling:** Source to fibre power launching, lensing schemes for coupling improvement, fibre to fibre joints, couplers, multiplexers and splices. **8 Lectures**

4. **Photo detectors**: principles of operation: PIN photodiodes and avalanche photodiodes, circuits and performance, preamplifiers and post-detection amplifiers. **8 Lectures**

5. **Optical fiber systems**: Intensity modulation/direct detection system, link budget using direct detection, coherent system, wavelength converters, coherent and WDM systems, EDFA, Photonic switching. **6 Lectures**

Text Books:

1. Optical Fibre Communications, G. Keiser, McGraw Hill, 4e, 2010.
2. Optical Fiber Communications: Principles and Practice, John M. Senior, PHI, 3e, 2008.
3. Fiber Optics communication system, G. P. Agrawal, John Willy & Sons, 1992

Reference Books

1. Introduction to Optical Fiber Communications Systems, Jones, William B. Jones, Oxford University Press, 1995.
2. Understanding Optical Fiber Communications, A. J. Rogers, Artech House, 2001
3. Fiber optic communication, J. C. Palais, Prentice Hall, 5e, 2004.
4. Optical fiber & Fiber Optical Communication Systems, Subir Kumar Sarkar, S. Chand, 2007.

ECL 1705 Low Power VLSI Design

L-T-P: 3-0-0 **Credits: 6**

1. **Low power Basics:** Need for low power VLSI chips, Sources of power dissipation on Digital. **2 Lectures**

2. **Integrated circuits**: Emerging Low power approaches. Physics of power dissipation in CMOS devices, Subthreshold Circuit Design. **3 Lectures**

3. **Device & Technology Impact on Low Power:** Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation. **6 Lectures**

4. **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. **8 Lectures**

5. **Low Power Design Circuit level:** Power consumption in circuits. Flip Flops & Latches design, high capacitance nodes, low power digital cells library. **5 Lectures**

6. **Logic level:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. **3 Lectures**

7. **Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design. **6 Lectures**

8. **Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co-design of clock network. **4 Lectures**

9. **Algorithm & architectural level methodologies:** Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis. **3 Lectures**

Textbook:

1. Low-Power CMOS VLSI Circuit Design, Kaushik Roy, Sharat and C. Prasad, John Wiley & Sons, 2009.
2. Digital integrated circuits: a design perspective, Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolic, 2nd Edition, Pearson Education, 2003.

References Book:

1. Practical Low Power Digital VLSI Design, Gary K. Yeap, Springer London, Limited, 1998.
2. Low power design methodologies, Jan M. Rabaey, Massoud Pedram, 2nd Edition, Kluwer Academic Publishers, 1996.

ECL 1801 Nano Electronics

L-T-P: 3-0-0 **Credits: 6**

1. **Principles of Quantum Mechanics:** Wave nature of particles and wave-particle duality, Pauli-exclusion principle, wave functions and Schrodinger's equations. Transport mechanisms: drift, diffusion, and Ballistic. Quantum dots, wires, and wells. Principles of optical devices.
10 lectures

2. **Shrink-down approaches:** CMOS scaling: advantages and limitations. Nanoscale MOSFETs, FINFETs, Vertical MOSFETs, system integration limits (interconnect issues etc.), Tunneling Transistors, Single electron transistors, spintronics, and Junctionless Transistor. **15 Lectures**

3. **Atoms-up approaches:** Single molecules as electronic devices, transport in molecular structures, molecular systems as alternatives to conventional electronics, molecular interconnects; Carbon nanotube electronics, band structure, applications. **15 Lectures**

Text Books:

1. Solid State Physics, Ashcroft amd Mermin, Thomson Press (India) Ltd, 2003
2. Introduction to Solid State Physics, C. Kittel, Wiley, 2012
3. Introduction to Nanotechnology, C.P. Poole Jr., F. J. Owens, Wiley, 2003.

Reference Books

1. Nanosystems: molecular, machinery, manufacturing and computation, K.E. Drexler, Wiley, 1992.
2. The Physics of Low-Dimensional Semiconductors, John H. Davies, Cambridge University Press, 1998.
3. Nanoelectronics and Information Technology (Advanced Electronic Materials and Novel Devices), Waser Ranier, Wiley-VCH, 3e, 2012.
4. Fundamentals of Nanoelectronics, G. W. Hanson, Pearson, 2007.

ECL 1802 RADAR Communication

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction:** Principle of detection and ranging, Radar frequencies and bands, applications, radar block diagram and operation. **6 Lectures**

2. **Radar range equation:** Range prediction, minimum detectable signal, receiver noise and SNR, noise temperature, pattern propagation factor, antenna gain, loss factors, jamming & clutter, accuracy of prediction, integration of radar pulses, radar cross section of targets, transmitter power, PRF and range ambiguities, system losses & propagation effects. **14 Lectures**

3. **CW FM radar:** Doppler effect, CW radar, frequency-modulated CW radar, multiple-frequency CW radar. **12 Lectures**

4. **MTI and pulse doppler radar:** MTI delay lines, delay line cancellers, coherent and non-coherent mti, pulse doppler radar. **8 Lectures**

Text Books:

1. Introduction to Radar Systems, M. I. Skolnik, McGrawhill, 2004.

Reference Books

1. Radar Engineering, D. G. Rink.
2. Principles of Radar and Sonar Signal Processing, Francois Le Chevalier, Artech House, 2002.

ECL 1X11 Switching Circuits and Fault diagnosis

L-T-P: 3-0-0 **Credits: 6**

1. **Switching Circuits:** Functional decomposition and symmetric functions, symmetric networks, reduced and minimal network for symmetric functions, identification of symmetric functions. Threshold logic, elementary properties of threshold functions, synthesis of threshold networks, identification and realization of threshold functions. **10 Lectures**

2. **Hazards:** Static and Dynamic Hazards in Digital circuits. **2 Lectures**

3. **Fault diagnosis test for combinational circuits:** Fault detection in combinational circuits; Fault location experiments, Boolean differences and Path sensitization. Detection of multiple faults, Failure Tolerant design, Quadded logic. **10 Lectures**

4. **Sequential circuits:** Finite state model, Synchronous sequential machines, synthesis of synchronous sequential circuits and iterative networks; Capabilities, minimization and transformation of sequential machines, Asynchronous Sequential circuits. **8 Lectures**

5. **Fault diagnosis test for sequential circuits:** Distinguishing sequences, Homing sequences, Synchronizing sequences, checking experiment for machine identification, Diagnosable machine. Design of testable and fault tolerant systems, Application of Linear sequential circuits to error correction. Case studies on combinational and sequential circuits. **10 Lectures**

Text Books:

1. Switching and Finite Automata Theory, Zvi Kohavi, TMH, 3e, 2009.
2. Digital Circuits and Microprocessor, Herbert Taub, TMH
3. Digital Logic Design, B. Holdsworth, Clive Woods, 4e.

Reference Books

1. Digital Logic and Computer Design, M. Morris Mano, PHI, 2e, 1996.
2. Modern Switching Theory and Digital Design, Lee S.C, PHI.

ECL 1X12 Remote Sensing

L-T-P: 3-0-0 **Credits: 6**

1. **Concept of remote sensing:** Introduction, distance remote sensing, remote sensing process, sources of energy, interaction with atmosphere, advantage of remote sensing , limitation of remote sensing , ideal remote sensing . **3 Lectures**

2. **Global information system:** Concepts, functions and advantages of GIS, process of GIS, planning, implementation management of GIS, data models of GIS. **4 Lectures**

3. **Photogrammetry:** Introduction, developement and classification, sterio model complitation, stereoscopic 3d viewing, measurement and extraction. **4 Lectures**

4. **Orthorectification:** Low and high resolution DEM, multiimage fusion, spatial domain fusion, spectral domain fusion, Scale -space fusion. **4 Lectures**

5. **Image Processing:** Visual image interperetation, digital image processing, data integration, analysis and presentation, thermatic maps, thermal image interpretation. **4 Lectures**

6. **Noise and Correction:** Noise reduction, global noise, sigma filter, local noise, periodic noise, radiometric calibration, distortion correction. **3 Lectures**

7. **Electromagnetic Radiation:** Introduction, electromagnetic spectrum, radiation laws, interaction with atmosphere and surfaces. **2 Lectures**

8. **Sensors:** Introduction, Photograpic sensors, multispectral remote sensing system, thermal remote sensing system, microwave remote sensing system, atmospheric sensors-radar, LIDAR, SONAR. **8 Lectures**
9. **Modern trends in GIS:** Local and global concepts, increase in dimension of GIS, linear and nonlinear techniques in GIS, 3D GIS , Mobile GIS , CGIS. **8 Lectures**

Text Books:
1. Remote Sensing and GIS, B Bhatta, Oxford.
2. Introduction to Remote, J. B. Campbell,Taylor and Francis,3e.
3. Remote Sensing of the environment, J. R. Jenson, Pearson Education,2e.

Reference Books
1. Remote Sensing, R. A. Schowengerdt, Elsevier, 2e.
2. Satellite Remote Sensing of Natural Resources, D. L. Verbyla ,CRC Press.
3. Furure Trends in Remote Sensing, P. Gudmandsen, A. A. Balkema / Rotterdam.

ECL 1X13 CAD for VLSI

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction**: VLSI design flow, Full-custom, standard-cell, gate-array and FPGA, VLSI Design automation tools. **4 Lectures**

2. **Basic concepts of high-level synthesis:** Partitioning, scheduling, allocation and binding. **4 Lectures**

3. **Verilog/VHDL:** Introduction and use in synthesis, modeling combinational and sequential logic, Procedures, assignments and control statements in Verilog, writing test benches. **10 Lectures**

4. **Technology mapping, Testability issues:** Fault modeling and simulation, test generation, design for testability, built-in self-test, Testing SoC's, Basic concepts of verification, Silicon Compiler.

8 lectures

5. **Algorithmic Graph Theory:** Data structure for graph representation, graph algorithms – depth first search, breadth first search, Dijkstra's shortest path, Prim's algorithm. **4 Lectures**

6. **Physical design automation algorithms:** Floor-planning, placement, routing, layout synthesis, design rule check, compaction, power and delay estimation, clock and power routing, etc. Special considerations for analog and mixed-signal designs. **10 Lectures**

Textbook:

1. VHDL: Programming by Example, Douglas Perry, McGraw-Hill Professional; 4 ed., 2002.
2. Verilog HDL, Samir Palnitkar, 2 ed, Pearson, 2004
3. Algorithms for VLSI physical design automation, N. A. Sherwani, Kluwer Academic Publishers, 1999.

Reference Books:

1. Algorithms for VLSI Design Automation, S. H. Gerez, Wiley-India, 1999.
2. Synthesis and Optimization of Digital Circuits, Giovanni De Micheli, Tata McGraw Hill, 1994.
3. VLSI physical design automation: theory and practice, S. M. Sait and H. Youssef, World Scientific Pub. Co., 1999.
4. RTL Hardware Design using VHDL: Coding for efficiency, Portability, and Scalability, Pong P. Chu, John Wiley- & Sons Inc., Hoboken, New Jersey, 2006.
5. An introduction to physical design, M. Sarrafzadeh and C.K. Wong, McGraw Hill, 1996.

ECL 1X14 Queuing Theory

L-T-P: 3-0-0 **Credits: 6**

1. **Probability Review:** Probability, random variable and processes, probability distribution, Markov chain. **6 Lectures**

2. **Markov Chain Queuing Models:** Kendall's notation for Queues, Little's theorem, M/M/1, birth-death process, time-dependent state probability, balance equation, network of exponential servers, generating function, phase-dependent arrival and service. **13 Lectures**

3. **M/G/1 and G/M/1:** M/G/1, occupancy distribution, renewal theory, waiting time and busy period, pre-emptive-resume LCFS, head-of-the-line priority, embedded Markov chain. **13 Lectures**

4. **Case Studies:** 2-3 problems selected from real research issues. **8 Lectures**

Text Books:

1. Introduction to Queuing Theory, Robert B. Cooper, Elesvier, 2e.

Reference Books

1. Introduction to Queuing system, Sanjoy K Bose, Kluwer/Plenum publishers, Springer-verlag, 2001.

ECL 1X15 Radio Frequency Circuit Design

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction:** Characteristics of passive components for RF circuits. Passive RLC networks. Transmission lines. Two-port network modeling. S-parameter model. The Smith Chart and its applications. **6 Lectures**

2. **Active devices for RF circuits:** CMOS, SiGe MOSFET, GaAs pHEMT, HBT and MESFET. PIN diode. Device parameters and their impact on circuit performance. **6 Lectures**

3. **RF Amplifier design:** single and multi-stage amplifiers. Review of analog filter design. Low-pass, high-pass, band-pass and band-reject filters. Bandwidth estimation methods. Voltage references and biasing. **6 Lectures**

4. **Low Noise Amplifier design:** noise types and their characterization, LNA topologies, power match vs noise match. Linearity and large-signal performance. **4 Lectures**

5. **RF Power amplifiers:** General properties. Class A, AB and C PAs. Class D, E and F amplifiers. Modulation of power amplifiers. **6 Lectures**

6. **Analog communication circuits:** Mixers, phase-locked loops, oscillators and synthesizers. **6 Lectures**

7. **Design and performance:** Design and performance characterization. Different transreceiver designs. **6 Lectures**

Text Books:

1. The Design of CMOS Radio Frequency Integrated Circuits, Lee Thomas H Lee, Cambridge University Press, 2004.
2. RF Microelectronics, Behzad Razavi, 2nd Edition, Pearson Education International, 2012.

Reference Books:

1. Design of Analog CMOS integrated circuits, Razavi Behzad, McGraw Hill, 2001.
2. VLSI for wireless communication, Bosco Leung, Springer Publications, 2011.

ECL 1X16 Sensors and Instrumentation

L-T-P: 3-0-0 **Credits: 6**

1. **General Concepts of Measurement:** Generalized Measurement System – Performance Characteristics – Static and Dynamic Characteristics – Errors in Measurements. Transducers and their Classifications-Sensor characteristics-emerging fields of sensor technology-basic principle of resistive, capacitive, inductive, piezoelectric transducers, Hall effect sensors and their applications. **10 Lectures**

2. **Sensor Applications:** Introduction --Acceleration Sensors-Force Measurement-Torque and Power Measurement-Flow Measurement-Temperature Measurements-Distance Measuring and Proximity Sensors-Light sensor. **6 Lectures**
3. **Signal Conditioning**: Signal conditioning requirements: drift, noise, bandwidth, signal-to-noise ratio. Instrumentation amplifier, charge amplifier, Wheatstone bridge integration, differentiation and sampling, A/D and D/A conversion, choppers, voltage to time ADC, voltage to frequency conversion. **10 Lectures**
4. **Data Acquisition:** Introduction to real-time interfacing: Elements of data acquisition and control overview of I/O process, Data Acquisition conversion, General configuration: single channel and multichannel, Data Logging, Data conversion, Digital Transmission. **7 Lectures**
5. **Virtual Instrumentation:** Introduction to LabVIEW, Block diagram and architecture of the virtual instrumentation, data flow techniques, graphical programming, VIS and sub-VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input. **7 Lectures**

Text Books

1. Sensors and Transducers, Patranabis, D, Wheeler Publishing Co, Ltd., New Delhi, 1997.
2. Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics, Brian Morriss, McGraw Hill International Edition, 1995.
3. Measurement Systems - Application and Design, Deoblin E.O., McGraw Hill, 4e, 2005.
4. LABVIEW for Everyone, Lisa K. Wells and Jeffrey Travis, PHI, 1997.

Reference Books

1. Industrial Instrumentation and Control, Buchanan, W, Butterworth-Heinemann Publishers, 1999.
2. Measurement, Instrumentation, and Sensors Handbook, John G. Webster, CRC Press, 1999.
3. Experimental Methods for Engineers, Holeman. J, Mc Graw Hill, 6th Edition, 2000.
4. PC Interfacing for Data Acquisition and Process Control, ISA, S. Gupta and J.P. Gupta, 2e, 1994.

ECL 1X17 Digital Image Processing

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction:** Fundamental steps in digital image processing, components of an image processing system. **2 Lectures**
2. **Digital image fundamentals:** Image sampling and quantization, some basic relationships between pixels, linear and nonlinear operations. **3 Lectures**
3. **Image enhancement in spatial domain:** Some basic gray level transformations, Histogram processing, Smoothing and Sharpening spatial filters. **4 Lectures**

4. Image enhancement in frequency domain: Smoothing and sharpening frequency domain filters, homomorphic filtering. **4 Lectures**

5. Image segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region based segmentation, recent developments**.** **5 Lectures**

6. Image restoration: Noise models, restoration in the presence of noise only-spatial filtering, estimating the degradation functions, inverse filtering. **5 Lectures**

7. Color image processing: Color models, pseudo-color processing. **2 Lectures**

8. Image compression: Image compression models, loss-less and lossy compression. **3 Lectures**

9. Morphological image processing: Dilation and erosion, opening and closing, some basic morphological algorithms. **4 Lectures**

Text Books:

1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Pearson Education, 2006.
2. Digital picture Processing, A. Rosenfield & A. C. Kak.

Reference Books

1. Fundamentals of Digital Image Processing, K. Jain, Pearson Education, 2007.
2. Theory and Application of Digital Signal Processing, L. R. Rabiner and B. Gold, Pearson Education, 2004.

ECL 1X18 ATM Networks and B-ISDN

L-T-P: 3-0-0 **Credits: 6**

1. Introduction: Overview of ISDN and basic concepts of B-ISDN, overview of ATM, comparison to X.25, frame relay and ethernet: ATM basis, Pathes, channels and connections, cell switching ATM switch architecture, banyan networks. **10 Lectures**

2. ATM : ATM reference model, ATM physical layer, ATM Adaption layer details. **6 Lectures**

3. Signalling schemes for ATM networks. **4 Lectures**

4. Traffic Management: Traffic Management in ATM networks, CBR, VBR, ABR and UBR service classes connection admission control. **6 Lectures**

5. ATM internetworking wireless ATM networks. **4 Lectures**

6. Mobility management: Mobility management and handoff in wireless ATM networks. **5 Lectures**

7. ATM in WANs and ATM IN LANs. **5 Lectures**

Text Books:

1. ATM Communication network control, Neural Network by A. Hiramalsu.
2. ATM Communication network, Onvirall.

Reference Books

1. ATM network: concept, protocals, Applications, Rainer Handel and Manfred N. Huber.
2. Asynchronous Transfer Mode-solution for Broadband ISDN, Martin D. Prycker.

ECL 1X19 Wireless LAN

L-T-P: 3-0-0 **Credits: 6**

1. Radio technologies: Overview, spread spectrum, channel sets, 802.11 IEEE standards, association process, diversity antennas. **3 Lectures**

2. Wireless LAN topologies: What is a WLAN, single cell of coverage, multiple cells of coverage, wireless repeater, system redundancy (hot standard), peer to peer (Ad Hoc), multi-rate and gear shifting, overlapping coverage, 340/350 comparison, in line power, home base Station. **6 Lectures**

3. Wireless LAN Products: Access points, client devices, accessories. **3 Lectures**

4. Basis antenna theory: Directionality, gain, cisco antennas. **2 Lectures**

5. Client device configuration: Windows drivers, aironet client utility. **2 Lectures**

6. Basic access point configuration: Access point LEDs, setup of networks ports, statistics, setup of association parameters, firmware upgrade and distribution, SNMP set up, set up of event logs. **6 Lectures**

7. Home base station configuration: Base station client utility, BSM configuration, BSE configuration, client configuration. **4 Lectures**

8. Security: 802.11 and WEP, WEP configuration, 802.11 security issues, next generation security, 802.1x, EAP/LEAP, radius serve. **6 Lectures**

Text Book:

1. Microwave Engineering by David M. Pozar, John Wiley & sons, 2nd edition.

ECL 1X20 Advanced Digital Signal Processing

L-T-P: 3-0-0 **Credits: 6**

1. Introduction: Introduction to speech processing, speech production model, linear predictive coding for speech, yule-walker equations, short time fourier transform (STFT), analysis of speech signals using STFT. **6 Lectures**

2. Signal processing: Multi rate signal processing, decimator, interpolator, poly-phase decomposition, noble identities, application to discrete multi-carrier transmission, sigma-delta ADC. **7 Lectures**

3. Compression: Data compression, lossy and lossless compression, LZW compression, Arithmetic coding, discrete cosine transform (DCT) and its application to still image compression, audio compression. **8 Lectures**

4. Introduction to wavelet transform: Properties of wavelet transform, DWT, filter implementation of DWT, applications of DWT for image denoising and Scaling functions as signaling pulses in communication. **6 Lectures**

5. Introduction to commercial DSP processors & DSP architecture. 3 Lectures

Text Book:

1. Digital signal processing – a practical approach, Ifeachor E.C. & Jervis B.W., Pearson, 2nd edition.

Reference Books:

1. Introduction to data compression, Khalid Sayood, Elsevier, 2e.
2. Digital signal processing a computer based approach, S.K.Mitra, TMH, 3e.
3. Digital signal processing & applications, Dag stranne and William walker, Elsevier, 2e.
4. Wavelet Transforms: Introduction to Theory and Applications, A.M.Rao & A.S.Bopardikar, Pearson, 2e.

ECL 1X21 Adaptive Signal Processing

L-T-P: 3-0-0 **Credits: 6**

1. Adaptive systems: Examples and applications. **2 Lectures**

2. Adaptive linear combiner: The performance function, gradient and minimum mean square error, alternative expression of gradient, LMS, NLMS, sign-error, sign-data and FXLMS algorithms, transform domain LMS, recursive least square algorithm, windowed RLS, computational complexity, Block adaptive filter (time and DFT domains), adaptive lattice filters. **6 Lectures**

3. IIR adaptive filter: Equation error form, adaptive filtering, adaptive channel equalization, adaptive line enhancement and adaptive system identification, hardware implementation of digital adaptive filter. **6 Lectures**

4. Applications of adaptive filter : 50Hz interference in electrocardiography, cancellation of donor-heart interference, cancellation of maternal ECG in electrocardiography, cancellation noise in speech signals, adaptive echo cancellation in long distance telephone line, self tunning filter. **7 Lectures**

5. Adaptive control systems: Model inverse and model reference controls, introduction of adaptive array and adaptive beam forming. Recent advances in adaptive filtering. **5 Lectures**

Text Books

1. Adaptive Filter Theory, S. Haykin and T. Kailath, Pearson Education, 4e, 2005.

Reference Books:

1. Adaptive Signal Processing, B. Widrow and S. D. Sterns, Pearson Education, 2nd Indian reprint, 2002.

ECL 1X22 Satellite Communication

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction:** Satellite communication system, communications satellites, different orbits, frequency bands, satellite multiple access formats. **4 Lectures**

2. **Satellite communication channel:** Power flow, polarization, atmospheric losses, receiver noise, CNR, satellite link analysis for uplinks and downlinks. **5 Lectures**

3. **Satellite transponder:** Transponder model, satellite signal processing RF-RF translation, IF demodulation. **8 Lectures**

4. **Multiple access techniques:** Frequency division multiple access, amplification with multiple FDMA carriers, AM/FM conversion with FDMA, switched FDMA, synchronization, SS-time division multiple access, code division multiple access, DS CDMA, frequency-hopped, CDMA. **10 Lectures**

5. **Satellite link design:** Performance requirements and standards. Design of satellite links – DOMSAT, INSAT, INTELSAT and INMARSAT, satellite- based personal communication. **6 Lectures**

6. **Earth station design:** Configuration, antenna and tracking systems, satellite broadcasting. **6 Lectures**

Text Books:

1. Satellite Communication, D. Roddy, Mc Graw- Hill, 3e, 2001.
2. Satellite Communications, T. Pratt and W. Boston, John Wiley & Sons, 2004.
3. Digital Satellite Communications, T. T. Ha, McGraw Hill, U. S. A., 2004.

Reference Books

1. Satellite Communications, Gagliardi.
2. Satellite Communications system using design principles, M. Richharia.
3. Principles of Communication Satellite, G. D. Gordon, W. L. Morgan, John Wiley & Sons, U. S. A., 2005.

ECL 1X23 DIGITAL System Design

L-T-P: 3-0-0 **Credits: 6**

1. **Introduction**: Introduction to VHDL, design units, data objects, signal drivers, inertial and transport delays, delta delay, VHDL data types, concurrent and sequential statements. **5 Lectures**

2. **Subprograms** – Functions, Procedures, attributes, generio, generate, package, IEEE standard logic library, file I/O, test bench, component declaration, instantiation, configuration. **5 Lectures**

3. **Combinational logic circuit design and VHDL implementation of following circuits:** fast adder, Subtractor, decoder, encoder, multiplexer, ALU, barrel shifter, 4X4 key board encoder, multiplier, divider, Hamming code encoder and correction circuits. **8 Lectures**

4. **Synchronous sequential circuits design** – finite state machines, Mealy and Moore, state assignments, design and VHDL implementation of FSMs, Linear feedback shift register (Pseudorandom and CRC). **8 Lectures**

5. **Asynchronous sequential circuit design** – primitive flow table, concept of race, critical race and hazards, design issues like metastability, synchronizers, clock skew and timing considerations. **8 Lectures**

6. Introduction to place & route process, Introduction to ROM, PLA, PAL, Architecture of CPLD and FPGA. Digital system design using FPGA. **6 Lectures**

Text Books:

1. Fundamentals of Digital Logic with VHDL design, Stephen Brown, Zvonko Vranesic, 3e, TMH, 2008.
2. VHDL, Douglas Perry, TMH, 3e,1998.
3. Digital Design Principles, Fletcher.
4. VHDL Synthesis, J Bhasker.
5. VHDL Primer, J Bhasker, Pearson Education.

Reference Books:

1. Digital System Design Using VHDL, Chales H. Roth.
2. Digital System Design, John Wakerley.
3. VHDL, Zainalabedin Navabbi.
4. VHDL, D. Smith.

ECL 1X24 Wireless Sensor Networks

L-T-P: 3-0-0 **Credits: 6**

1. **Overview of wireless sensor networks**: Challenges for wireless sensor networks, enabling technologies for wireless sensor networks. **2 Lectures**

2. **Architectures**: Single node architecture, hardware components, energy consumption of sensor nodes, operating systems and execution environments, network architecture, sensor network scenarios, optimization goals and figures of merit, gateway concepts. **8 Lectures**

3. **Networking sensors**: Physical layer and transceiver design considerations, MAC protocols for wireless sensor networks, low duty cycle protocols and wakeup concepts, S-MAC, the mediation device protocol, wakeup radio concepts, address and name management, assignment of MAC addresses, routing protocols, energy, efficient routing, geographic routing. **10 Lectures**

4. **Infrastructure establishment**: Topology control, clustering- LEACH, PEGASIS, ELBERA etc. Time synchronization, localization and positioning, sensor tasking and control. **10 Lectures**

5. **Sensor network platforms and tools**: Sensor node hardware, berkeley motes, programming challenges, node-level software platforms, node-level simulators, state-centric programming. **7 Lectures**

6. **Application and Case studies.** **6 Lectures**

Text Books:

1. Protocols And Architectures for Wireless Sensor Networks, Holger Karl & Andreas Willig, John Wiley, 2005.
2. Wireless Sensor Networks- An Information Processing Approach, Feng Zhao & Leonidas J. Guibas, Elsevier, 2007.

Reference Books:

1. Wireless Sensor Networks-Technology, Protocols, And Applications, Kazem Sohraby, Daniel Minoli, & Taieb Znati, John Wiley, 2007.
2. Wireless Sensor Network Designs, Anna Hac, John Wiley, 2003.

ECL 1X25 Detection and Estimation Theory

L-T-P: 3-0-0 **Credits: 6**

1. **Background material:** Recap of probability, calculus, linear algebra. **2 Lectures**

2. **Estimation theory:** Minimum variance unbiased estimation, best linear unbiased estimation, cramer-rao lower bound (CRLB). **4 Lectures**

3. **Maximum likelihood estimation (MLE):** Exact and approximate methods: EM, alternating max, etc. **4 Lectures**

4. **Bayesian inference & least squares estimation:** Basic ideas, adaptive techniques, Recursive LS, etc. kalman filtering (sequential Bayes). **6 Lectures**

5. **Finite state hidden markov models**: Forward-backward algorithm, viterbi (ML state estimation), parameter estimation (f-b + EM), graphical models. **6 Lectures**

6. **Applications**: Image processing, speech, communications. **4 Lectures**

7. Sparse recovery and compressive sensing introduction. **2 Lectures**

8. **Monte Carlo methods**: Importance sampling, MCMC, particle filtering, applications in numerical integration (MMSE estimation or error probability computation) and in numerical optimization (e.g. annealing). **6 Lectures**

9. **Detection theory:** Likelihood ratio testing, bayes detectors, minimax detectors, multiple hypothesis tests, neyman pearson detectors (matched filter, estimator correlator etc), wald sequential test, generalized likelihood ratio tests (GLRTs), wald and RAO scoring tests, applications. **6 Lectures**

Text books:

1. Detection, Estimation, and Modulation Theory, H.Van Trees.
2. Fundamentals of Statistical Signal Processing Vol I: Estimation Theory, S.M. Kay.
3. Fundamentals of Statistical Signal Processing Vol II: Detection Theory, S.M. Kay.

Reference Books:

1. Linear Estimation, Kailath, Sayed and Hassibi.
2. An Introduction to Signal Detection and Estimation, V. Poor.
3. Monte Carlo Strategies in Scientific Computing, J.S. Liu, Springer-Verlag, 2001.
4. Stochastic Simulation, B.D. Ripley, Wiley, 1987.

ECL 1X26 Numerical Techniques in Electromagnetics

L-T-P: 3-0-0 **Credits: 6**

1. **Review EM theory & EM problem**: Review of EM Theory, Classification of EM Problems, boundary condition. **3 Lectures**

2. **Review of analytical method**: Separation of variable, Laplace's equation and wave equation in different coordinate system, orthogonal functions. **4 Lectures**

3. **Finite difference method:** Finite difference scheme, differencing of parabolic, hyperbolic and elliptic PDEs, application to practical boundary value problems. **6 Lectures**

4. **Variational method:** Elements of calculus of variation, construction of functionals from PDEs, Reyleigh methods, weighted residual methods, Galarin method, practical application. **6 Lectures**

5. **Moment methods:** Elements of Integral equation, Greens function, application to quasi-static problem, scattering problems, radiation problems, etc. **7 Lectures**

6. **Finite element method:** Solution of Laplace's equation, Poission equation & wave equation, mesh generation in 2D & 3D, FEM for exterior problems. **7 Lectures**

7. **FDTD:** FDTD analysis in one and two dimension, the FDTD grid and the Yee algorithm, numerical stability, absorbing boundary conditions and perfectly matched layers. **7 Lectures**

Text Books:

1. Numerical Techniques in Electromagnetics, M. Sadiku, CRC Press, 3e, 2009.
2. Analytical and Computational methods in Electromagnetics, Ramesh Garg, Artech house, 1e, 2008.

ECL 1X27 Physics of Semiconductor Devices

L-T-P: 3-0-0 **Credits: 6**

1. Physics and Properties of Semiconductors: Crystal Structure, atomic bonding, Energy Bands, k-space diagram, carrier concentration at thermal equilibrium, carrier transport phenomenon, Generation and Recombination of carriers, continuity equation, tunnelling and high field effects. **12 Lectures**

2. Physics of Junction Devices: Thermal Equilibrium Condition, Depletion Region, Depletion and Diffusion Capacitances, Current-Voltage Characteristics, Tunnel diode, Metal Semiconductor Contacts, non-ideal effects, Heterojuntion, 2D electron gas. **10 Lectures**

3. Physics of MOSFET, MESFET: MOSFET nonuniform doping and buried-channels, ballistic transport, short-narrow channel effects, radiation and hot-electron effects, SOI MOSFET, Si-SiGe MOSFET, non-ideal MESFET. **9 Lectures**

4. Physics of BJT: Non-ideal BJT, Heterojunction BJT **4 Lectures**

5. Physics of Optical Devices: Wave nature of particles and wave-particle duality, optical absorption, emission, LED, LASER. **5 Lectures**

TEXT BOOK:

1. Introduction to Semiconductor materials and devices by M. S. Tyagi, John Wiley & Sons, 2008.
2. D.A. Neamen, Semiconductor Physics & Devices, TMH, 2003.
3. RF Pierrett, Semiconductor Device Fundamentals, Pearson, 2006.

REFERENCES BOOK:

1. C. Kittel, Introduction to solid state physics, Wiley, New York, 1976.
2. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
3. Semiconductor Opto Electronic Devices, Pallab Bhattacharya, 2nd Edition, Prentice Hall of India Pvt., Ltd, 2004.
4. Opto Electronics – As Introduction to materials and devices, Jasprit Singh, McGraw-Hill International Edition, 1996.
5. B. G. Streetman and Sanjay Banerjee, Solid State Electronic Devices, Pearson, 2008.
6. S. M. Sze, Physics of Semiconductor Devices, Wiley, New York, 1981.