B. Tech Electronics & Communication Engineering Syllabus Structure and Detail (July 2020 onwards)

Course No.	Course Name	L	T	P	C	Course No.	Course Name	L	T	P	C
Semester I						**Semester II**					
UPH101	Engineering Physics	3	1	0	8	UCH201	Engineering Chemistry	3	1	0	8
UMA101	Engineering Mathematics-I	3	1	0	8	UMA201	Engineering Mathematics-II	3	1	0	8
UEE101	Basic Electrical Engineering	3	1	0	8	UCSE201	Programming for Problem Solving	4	1	0	10
UHSS101	English Communication	2	0	0	4	UCE201	Engineering Drawing and Computer Graphics	1	0	0	2
UME101	Engineering Workshop	1	0	0	2	UHSS201	Professional Ethics and Human Value	2	0	0	4
UPH171	Engineering Physics Lab	0	0	3	3	UCH271	Engineering Chemistry Lab	0	0	2	2
UEE171	Basic Electrical Engineering Lab	0	0	2	2	UCSE271	Programming for Problem Solving Lab	0	0	3	3
UHSS171	English Communication Practice	0	0	2	2	UCE271	Engineering Drawing and Computer Graphics Lab	0	0	4	4
UME171	Workshop Practice	0	0	4	4						
Contact Hours: 26		**12**	**3**	**11**	**41**	**Contact Hours: 25**		**13**	**3**	**9**	**41**
Semester III						**Semester IV**					
UECE301	Electronic Devices	3	0	0	6	UECE401	Analog Communication	3	0	0	6
UECE371	Devices &Network Lab	0	0	2	2	UECE471	Communication Engineering Lab	0	0	2	2
UECE302	Digital System Design	3	0	0	6	UECE402	Analog Circuits	3	0	0	6
UECE372	Digital System Design Lab	0	0	2	2	UECE472	Analog Circuits Lab	0	0	2	2
UECE303	Signals and Systems	3	0	0	6	UECE403	Microcontrollers	3	0	0	6
UECE304	Network Theory	3	0	0	6	UECE473	Microcontrollers Lab	0	0	2	2
UCSE306	Data Structure using C	3	0	0	6	UMA401	Numerical Methods and Computer Programming	3	0	0	6
UCSE376	Data Structure using C lab	0	0	2	2	UMA471	Numerical Methods and Computer Programming Lab	0	0	2	2
UHSS371	Group Discussion	0	0	2	2	UCSE401	Data Base Management System	2	0	0	4
UECE305	Indian Constitution (MC)										
Total Contact Hours: 23		**15**	**0**	**8**	**38**	**Total Contact Hours: 23**		**15**	**0**	**8**	**38**
Semester V						**Semester VI**					
UECE501	Electromagnetic Waves	3	0	0	6	UECE601	VLSI Design	3	0	0	6
UECE571	Electromagnetic Waves Lab	0	0	2	2	UECE671	VLSI Design lab	0	0	3	3
UECE502	Control Systems	3	0	0	6	UECE602	Computer Network	3	0	0	6
UECE503	Digital Communication Systems and Stochastic Process	3	0	0	6	UECE672	Computer Network Lab	0	0	3	3
UECE504	Digital Signal Processing	3	0	0	6	UECE694	Mini Project/ Electronic Design Workshop	0	0	4	4
UECE574	Digital Signal Processing Lab	0	0	2	2	UECE615	A. Antennas and Wave Propagation B. Speech and Audio Processing	3	0	0	6
UECE515	A. Nano Electronics B. System Design using HDL C. Linear IC and Systems	3	0	0	6	UECE616 (**OE-2**)	A. Digital Image Processing B. Power Electronics C. Automotive Electronics	3	0	0	6
UECE516 (**OE-1**)	A. Bio-Medical Electronics B. Introduction to MEMS C. Optimization Theory	3	0	0	6	UHSS601	Engineering Economics	3	0	0	6
Total Contact Hours: 22		**18**	**0**	**4**	**40**	**Total Contact Hours: 25**		**15**	**0**	**10**	**40**
Semester VII						**Semester VIII**					
UECE711	A. Microwave Theory and Techniques B. Advanced Antenna Theory and Design C. High Speed Devices and Circuits	3	0	0	6	UECE811	A. Optical Communication B. Spread Spectrum Communication C. Optical Signal Processing and Optical Computing	3	0	0	6
UECE712	A. Wireless & Mobile Communication B. Wireless Sensor Networks C. Quantum Transport in Nanoscale Devices	3	0	0	6	UECE812	A. Information Theory and Coding B. Error correcting codes C. Signal Detection and Estimation Theory	3	0	0	6
UECE713 (**OE-3**)	A. Adaptive Signal Processing B. Satellite Communication	3	0	0	6	UECE813 (**OE-5**)	A. Computer Vision B. RADAR and Electronic	3	0	0	6

	C. Cryptography and Network Security						Navigation Systems C. Introduction to IoT and ARM Processors				
UECE714 (**OE-4**)	A. Embedded systems B. Machine Learning C. Quantum Computation and Quantum Information	3	0	0	6	UECE814 (**OE-6**)	A. Mixed Signal VLSI Design B. Analog IC Design C. Radio Frequency Integrated Circuits (RFIC)	3	0	0	6
ECE795	Project Stage-I	0	0	8	8	UECE895	Project Stage-II	0	0	8	8
ECE796	Industrial Training	0	0	2	2	UECE896	Seminar	0	0	4	4
UHSS701	Industrial Management and Entrepreneurship	3	0	0	6	UECE897	Grand Viva	0	0	4	4
Contact Hours: 25		**15**	**0**	**10**	**40**	**Contact Hours: 28**		**12**	**0**	**16**	**40**
Total Mandatory Credits: 318											

DETAILED CURRICULUM CONTENT

Undergraduate Degree in Engineering & Technology

Branch/Course: ELECTORNICS & COMMUNICATION ENGINEERING

B. Tech Electronics and Communication Engineering Syllabus Detail

Semester I

Paper code: UPH101
Paper name: Engineering Physics **Credit: 8**
Total contact hours: 40 **L-T-P: 3-1-0**

1. **Mathematical Physics:**
   Vector and Scalar field, grad, divergence, curl, Laplacian, line integral, surface integral, volume integral, physical examples in the context of electricity and magnetism, Stokes theorem, Gauss theorem (No proof). [5]

2. **Electrodynamics:**
   Gauss Law of electrostatics, Biot-Savart Law, Ampere's Law, Displacement current, Equation of Continuity, Maxwell's equations in differential and integral form, Maxwell's wave equation in free space, propagation of EM wave in free space, transverse nature of EM wave. [6]

3. **Heat and thermodynamics**:
   Thermodynamic system and state variables, Heat &Work, Zeroth Law, 1^{st} and 2^{nd} laws of thermodynamics, Isothermal and adiabatic changes, Carnot theorem, Carnot engine, entropy, pyrometer. [5]

4. **Wave and Oscillations:**
   - Transverse wave on a string, reflection and transmission of waves at boundary, impedance matching, standing waves and their eigen frequencies, acoustics waves and speed of sound.
   - Simple harmonic motion**,** Damped oscillation-its differential equation, energy decay in a damped oscillation, Forced vibration, Resonance, Sharpness of resonance and quality factor. [8]

5. **Introduction to Quantum Mechanics:**
   Wave-Particle duality, Black body radiation, Photoelectric effect, Compton effect, Uncertainty principle, wave function, the Schrodinger time dependent and time independent equations, application of Schrodinger equation for free particle in one dimensional infinite potential box. [6]

6. **Optics and Optoelectronics:**
   - Huygens' Principle, superposition of waves and interference of light, Young's double slit experiment, Newton's rings, Diffraction, Single slit diffraction, grating.
   - LASER: Einstein's theory of matter radiation interaction and A and B coefficients, amplification of light by population inversion, properties of laser: monochromaticity, coherence, directionality and brightness, different types of laser: gas lasers (He-Ne) and solid-state laser (Ruby), applications of laser in science, engineering and medicine.
   - Light emitting diodes (LED): device structure, materials, characteristics and figures of merit. [10]

Books / References:

1. *Engineering Physics, Malik and Singh, Tata Mc Graw Hill*
2. *Engineering Physics, Naidu, Pearson*
3. *Engineering Physics, Gupta & Gaur, Dhanpat Rai*
4. *Quantum Mechanics, Ajay Ghatak S. Lokanathan, Trinity*
5. *Quantum Mechanics: A Text Book for undergraduates, Mahesh C Jain, TMH*
6. *Thermodynamics and kinetic theory of gases*, W. Pauli, Dover Publications, 2010
7. *Electromagnetic Theory, Prabir K. Basu&HrishikeshDhasmana, AneBooks*
8. *Introduction to Electrodynamics, David Griffiths*
9. *Electricity, magnetism and light, W. Saslow*
10. *Oscillations and waves in physics, Ian G. Main,*
11. *The physics of vibrations and waves, H.J. Pain,*
12. *Arthur Beiser, Concepts of Modern Physics (Sixth Edition), Tata McGraw-Hill Publication, New Delhi (1988).*

Paper Name: Engineering Physics Lab **Credit: 3**
Paper code: UPH171 **L-T-P: 0-0-3**

List of experiments:

Experiment No 1: To determine the magnetic moment of a bar magnet and the horizontal component of the earth's magnetic field.

Experiment No 2: To study the Hall Effect in semiconductor (Germanium Crystal) and then to calculate the Hall coefficient.

Experiment No 3: To Verify Stefan-Boltzmann law of thermal radiation by electrical method.

Experiment No 4: To determine the coefficient of thermal conductivity of a bad conductor (glass) by using Lee's Disc apparatus.

Experiment No 5: To study the variation of time period of a bar pendulum about different axes and determine the value of acceleration due to gravity (g) at the place.

Experiment No 6: To determine the wavelength of sodium light by measuring the diameters of Newton's Rings.

Experiment No 7: To determine the wavelength of Laser light by using diffraction grating.

Experiment No 8: To determine the grating element by using sodium vapour lamp.

Experiment No 9: To determine the value of Planck's constant with the help of vacuum phototube.

Experiment No 10: To study the current flowing through an external circuit by a potentiometer and determine the internal resistance of a standard cell.

Paper code: UMA101
Paper name: Engineering Mathematics-I **Credit: 8**
Total contact hours: 40 **L-T-P: 3-1-0**

Module 1: Calculus-I **(15hours)**

Successive derivative, Libnitz's Theorem, Tangent and Normal, Derivation of arc length (Cartesian and Polar coordinates), curvature, partial derivatives, homogeneous functions. Expansions of functions using Taylor's theorem

Beta and Gamma functions and their properties, applications of definite integrals.

Module2: Sequences and Series **(10 hours)**

Convergence of sequence and series, tests for convergence (Comparison test, Ratio test, Cauchy's Root test), Fourier series, Change of intervals, Half range sine and cosine series.

Module 3: MultivariableCalculus **(15 hours)**

Differentiation of vector functions, scalar and vector filed, gradient of a scalar function, directional derivatives, divergence, curl and their properties, integration of vector functions, line, surface and volume integral, Green's, Gauss's and Stoke's Theorems.

Textbooks/References:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition,Pearson,Reprint, 2002.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.
3.Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11thReprint, 2010.
5. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
7. B.S. Grewal, Higher Engineering Mathematics

Paper code: UHSS101
Paper name: ENGLISH COMMUNICATION **Credit: 4**
Total contact hours:39 **L-T-P: 2-0-0**

Module 1: Vocabulary Building: 1.1 Word Formation 1.2 Root words from foreign languages and their use in English 1.3 Understanding prefixes and suffixes to form derivatives 1.4 Antonyms and Synonyms, Functional Vocabulary, Idioms and Phrasal Verbs	**Contact hours: 3**
Module 2: Basic Writing Skills 1.1 Sentence Structure 1.2 use of phrases and clauses in sentences 1.3 Importance of proper punctuation 1.4 Creating Coherence 1.5 Organizing Principles of paragraph in documents 1.6 Techniques of writing precisely	**Contact hours: 4**
Module 3: Identifying Common Errors in Writing 1.1 Subject-verb Agreement 1.2 Noun-pronoun agreement 1.3 Effective Principles of Sentence Structure 1.4 Misplaced Modifiers 1.5 Articles 1.6 Prepositions 1.7 Redundancies 1.8 Cliches	**Contact hours: 4**
Module 4: Nature and Style of Sensible Writing 1.1 Describing 1.2 Defining 1.3 Classifying 1.4 Providing examples or evidence 1.5 Writing Introduction and Conclusion	**Contact hours: 4**
Module 5: Business Writing 1.5 Letter Writing, Memo, Report 1.6 Email 1.7 CV, Resume	**Contact hours: 4**
Module 6: Oral Communication (The Unit involves interactive practice sessions in language Lab) 6.1 IPA Symbols, pronunciation, Intonation, Stress and Rhythm 6.2 Listening Comprehension 6.3 Common Everyday Situations: Conversation and dialogues 6.4 Communication at work place 6.5 Interviews **6.6** Formal Presentations	**Contact hours: 4**
Module 7: Learning Language through Literature 7.1 Novel: R.K. Narayan *The Guide* 7.2 Poem: John Keats *Ode to a Nightingale* and *Ode to a Grecian Urn*	**Contact hours: 4**

BOOKS RECOMMENDED:

(1) Practical English Usage, Michael Swan, OUP,1995
(2) Remedial English Grammar, F.T. Wood, Macmillan, 2007
(3) On Writing Well, William Zinsser, Harper Resource Book, 2001
(4) Study Writing, Liz Hamp-Lyons and Ben Heasely, CUP, 2006
(5) Communication Skills, Sanjay Kumar and PushpLata, OUP, 2011
(6) Exercises in Spoken English, Parts-I-III, CIEFL, Hyderabad, OUP

Paper code: UHSS171
Paper name: English Communication Practice **Credit: 2**
Total contact hours:40 **L-T-P-C: 0-0-2-2**

Module 1Listening Practices 1.1 Enhancing listening skills 1.2 Different types of listening 1.3 How to be a good listener 1.4 Barriers to Effective Listening	**Contact hours: 3**
Module 2: Speaking Skills 2.1 The sounds of English 2.2 Benefits of Speaking 2.3 Self Development through Speaking Skills	**Contact hours: 4**
Module 3: Reading Skills 3.1 Definition 3.2 Kinds of reading 3.3 Critical Reading Practices 3.4 Reading Method 3.5 Reading Speed Skimming Scanning Active Reading	**Contact hours: 4**
Module 4: Writing Skills 4.1 Purpose 4.2 Importance of Style 4.3 Essay 4.4 Business Writing	Contact hours: 4
Module 5: Remedial English Grammar 5.1 Tense 5.2 Subject Verb agreement 5.3 Relative Clauses 5.4 Prepositions 5.5 Understanding voice changes	

BOOKS and Software RECOMMENDED:

(1) Practical English Usage, Michael Swan, OUP,1995
(2) Remedial English Grammar, F.T. Wood, Macmillan, 2007
(3) On Writing Well, William Zinsser, Harper Resource Book, 2001
(4) Study Writing, Liz Hamp-Lyons and Ben Heasely, CUP, 2006
(5) Communication Skills, Sanjay Kumar and PushpLata, OUP, 2011
(6) Exercises in Spoken English, Parts-I-III, CIEFL, Hyderabad, OUP
(7) Study Skills in English, Michael J.Wallace, CUP]
(8) Sky Pronunciation
(9) Tense Buster
(10) Business Writing

Paper code: UME101
Paper name: Engineering Workshop Credits: 2
Total contact hours: 12 L-T-P: 1-0-0

Module 1: Carpentry shop (2 hrs)

i. Introduction with the shop
ii. Various structure of wood and types of wood
iii. Different types of tools, machine and accessories used in Carpentry shop
iv. Safety Precautions in workshop

Module 2: Fitting Shop (2 hrs)

i. Introduction with the fitting shop
ii. Various marking, measuring, cutting, holding and striking tools
iii. Different Operations like chipping, filing, marking drilling etc.
iv. Working principle of drilling machine, lapping dies etc.

Module 3: Welding Shop (2 hrs)

i. Introduction
ii. Types of Welding, Arc Welding, Gas Welding, Gas Cutting
iii. Welding of dissimilar materials, selection of welding rod material, size of rod and work piece
iv. 3 Different types of flames
v. Elementary symbolic Representation
vi. Safety and precautions

Module 4: Machine Shop (2 hrs)

i. Introduction
ii. Study of Different types of Lathe machine, shaping machine, Drilling machine
iii. Study of Different types of hand tools and machine tools and parts
iv. Safety & precautions

Module 5: Turning shop (2hrs)

i. Introduction
ii. Various marking, measuring, cutting, holding, and string tools
iii. Working principle of Drilling machine, tapping, dies, its uses
iv. Safety precautions

Module 6: Electrical Shop (2hrs)

i. Introduction
ii. Various terms and instruments used in electrical wiring
iii. Study of different tools used in simple house wiring
iv. Difference between ac and dc line

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
(ii) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
(iii) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Paper code: UME171
Paper name: Workshop Practice **Credits: 4**
Total contact hours: 36 **L-T-P: 0-0-4**

Module 1: Carpentry shop (6 hrs)

Demo of different wood working tools and machines
Demo of different wood working processes
Simple joints like T joints, Cross halving joint, dovetail joint etc.
One simple utility job.

Module 2: Fitting Shop (6 hrs)

Demo of different fitting tools and machines and power tools
Demo of different processes in fitting shop
Squaring of a rectangular metal piece
Making a V-block of metal piece
One simple utility job.

Module 3: Welding Shop (6 hrs)

Demo of different welding tools and machines
Demo of Arc Welding, Gas Welding, Gas Cutter and rebuilding of broken parts with welding
Any one Composite job involving lap joint welding process.

Module 4: Machine Shop (6hrs)

Demo of different machines and their operations
Preferably prepare a simple job (e.g Turning operation etc)

Module 5 Turning shop (6 hrs)

Demo of lathe machine, drilling machine
One job related to plane and taper turning , threading and knurling
One job related to drilling and tapping

Module 6 Electrical Shop (6 hrs)

Demo of simple house wiring and use of tools
One job related to simple house wiring
Fittings of cut outs, fuses and other simple fittings etc.
Difference between Single phase wiring and three phase wiring

Paper code: UEE101
Paper name: Basic Electrical Engineering **Credit: 8**
Total contact hours: 40 **L-T-P: 3-1-0**

Module 1: Contact hours: 2
Introduction: Sources of energy; General structure of electrical power systems, Power transmission and distribution via overhead lines and underground cables.

Module 2: Contact hours: 6
DC circuits: Definitions of active, passive, linear, non-linear circuits elements and networks, Kirchoff's laws, Nodal and mesh analysis, voltage and current sources, network theorems superposition. Thevenin's, Norton's, maximum power transfer, Millman's, and reciprocitytheorems, analysis of simple circuits with DC excitation.

Module 3: Contact hours: 8
Single phase AC circuits: generation of single phase sinusoidal EMF, instantaneous, average and effective value, form and peak factor, examples of other alternating waveforms and average and effective value calculations, concept of phasor and phasor diagrams, lagging and leading of phasors, pure resistive, inductive and capacitive circuits, power factor, complex power, R-L, R-C and R-L-C series circuits, parallel AC circuits, series and parallel resonance.

Module 4: Contact hours: 4
Three phase AC circuits: Generation of three phase EMF, delta and star connections, line and phase value of emf and current, solutions of simple 3-phase balance circuits with resistive and inductive loads, 3-phase power, comparison between 3-phase and 1-phase systems, applications of 3-phase systems.

Module 5: Contact hours: 5
Magnetic circuits: Ampere's circuital law, B-H curve, definition of mmf, flux, flux-density and reluctance, comparison between electric and magnetic circuits, series, parallel and series-parallel circuits and their solutions, energy stored in magnetic circuit, lifting magnets, electromagnetic induction, self and mutual inductance, hysteresis and eddy current losses.

Module 6: Contact hours: 5
Electrical machines: Introduction of electrical machines, classifications (DC and AC machines), transformers, technical specifications, reading of nameplate data, general applications (especially 1-phase and 3-phae induction motors).

Module 7: Contact hours: 5
Electrical measuring instruments: Classification of instruments, essentials of indicating type instruments – deflecting torque, controlling torque, damping, types of indicating instruments, MC and MI type ammeters and voltmeters, extension of range, use of shunts and multiplier, errors and compensation.

Module 8: Contact hours: 5
Electrical installations: Electrical wiring and type, fuse and its ratings, types of wires and cables, LT switch gears: MCB, ELCB, MCCB etc. Earthing and its importance. Electrochemical power sources: primary and secondary cells, classifications of secondary cells based on applications, Lead-acid cell, electrical characteristics of lead-acid cell, maintenance, charging methods of batteries.

Books / References:
(i) D.P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
(ii) D.C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
(iii) B.L. Thereja, A.K. Thereja, " A Textbook of Electrical Technology", S.Chand

Paper code: UEE171
Paper name: Basic Electrical Engineering Lab **Credit: 2**
Total contact hours: 18 **L-T-P: 0-0-2**

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter,ammeter, rheostat and wattmeter.
2. Make a measured resistance from a given rheostat
3. Verification of Kirchhoff's laws
4. Verification of Superposition theorem
5. Verification of Thevenin's theorem
6. Verification of Maximum Power Transfer theorem
7. Measurement of voltage, current, power and power factor in single phase AC circuits.
8. Measurement of lamp's filament resistance.
9. Wiring

Semester II

Paper code: UCH201
Paper name: Engineering Chemistry **Credit: 8**
Total contact hours: 40 **L-T-P: 3-1-0**

UNIT:1Molecular Structure and Quantum Mechanics: Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures. Molecular orbital and quantum mechanics: Schrodinger equation, Eigen function, orthogonal and orthonormal. (6L)

UNIT:2 Electrochemistry: Electrochemical Cells – EMF of a cell, Electrodes, reference electrodes, application of Nernst equation and related problems. Principle of fuel cell, lead acid battery. Corrosion and material oxidation (4L)

UNIT:3 Reaction dynamics and Thermodynamics: Reaction laws: rate and order; molecularity; first and second order kinetics; (Arrheniousequation)catalysis. Laws and applications of thermodynamics, 1^{st} law and 2^{nd} law, Carnot cycle and related problems. (8L)

UNIT:4 Instrumental Methods of Analysis: Introduction to sophisticated instrumental techniques for characterization of compounds, materials, metals such as Powder X-ray diffraction, surface area, IR, UV,-Vis, NMR, SEM, TEM and GCMS (3L)

UNIT:5Structure, Reactivity of Organic Molecules and Synthesis of Drug Molecule: Concept of electron displacement and their applications, types of intermediate organic species, brief study of some addition, elimination and substitution reaction, cyclization and ring openings. Benzyne reaction, Chichibabin reaction, Hoffman Exhaustive reactions, few important name reactions, to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule. (5L)

UNIT:6Polymerization: Concepts, classifications and industrial applications; polymerization processes, degree of polymerization (addition and condensation polymerization); preparation, structure and use of some common polymers: plastic (PE, PP, PVC, Bakelite), rubber (natural rubber, SBR, NBR), fibre (nylon 6,6; polyester); conducting and semiconducting polymers. (4L)

UNIT:7Industrial Chemistry: Solid liquid and gaseous fuels; constituents of coal, carbonization of coal, coal analysis, proximate and ultimate analysis, classification of coal, petroleum, gasoline. Octane number, cetane number, aviation fuel, natural gas, water gas. (4L)

UNIT:8 Materials Engineering: Concept of nano-chemistry, new forms of carbon, S.W.C.N.T., M.W.C.N.T., Liquid crystals. (4L)

UNIT:9 Biochemistry: Carbohydrates, lipids, amino acids, proteins, Nucleic acid– DNA and RNA, Vitamins and hormones – sources and application. (2L)

Paper name: Engineering Chemistry Lab **Credit: 2**
Papercode: UCH271 L-T-P: 0-0-2

Experiment-1: Aim of the experiment: *To determine the coefficient of viscosity of the glycerol by using Ostwald's viscometer*.

Experiment-2: Aim of the experiment: *To determine the surface tension of the given liquid with respect to water at room temperature by using Stalagnometer*.

Experiment-3: Aim of the experiment: *To identify acid radicals be dry and wet tests.*

Experiment-4 Aim of the experiment: *To identify basic radicals be dry and wet tests*

Experiment-5 Aim of the experiment: *Preparation of standard solution of* Na_2CO_3

Experiment-6 Aim of the experiment: *Preparation of standard solution of oxalic acid.*

Experiment-7 Aim of the experiment: *Determination of strength of* H_2SO_4 *by titrating with 0.1 N* Na_2CO_3

Experiment-8 Aim of the experiment: *Determination of strength of NaOH by titrating with 0.1 N HCL*

Experiment-9 Aim of the experiment: *Redox Titration* $KMnO_4$ *Vs* $H_2C_2O_4$

Experiment-10 Aim of the experiment: *Introduction to sophisticated instruments like FT-IR, UV-Visible and GC*

Text/Reference Books:

1. S. Chawla, *A Text Book of Engineering Chemistry*, Dhanpat Rai Publishing Co.
2. Jain and Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Co.
3. Atkins, *Physical Chemistry*, Oxford.
4. J. D. Lee, *Concise Inorganic Chemistry*, Blackwell Science.
5. V.R. Gowariker, N.V. Viswanathan, J. Sreedhar, *Polymer Science*, New Age International Publisher.
6. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, McGraw-Hill
7. S.K. Ghosh Advanced General Organic Chemistry (A Modern Approach) (Set I &Ii) NCBA Publisher, New Delhi, 2009
8. B. Viswanathan, P. S. Raghavan, Practical Physical Chemistry, Viva
9. Dr. S. Rattan, Experiments in Applied Chemistry, S. K. Kataria& Sons.

Paper code: UMA201
Paper name: Engineering Mathematics-II **Credit: 8**
Total contact hours: 40 **L-T-P: 3-1-0**

Module –1: Matrices **(10 hours)**

Inverse and rank of a matrix, rank-nullity theorem, System of linear equations, Symmetric, skew symmetric and orthogonal matrices, Determinants, Eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamilton Theorem.

Module-2: **First order ordinary differential equations** **(10 hours)**

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree, equations solvable for p, equations solvable for x and y, and Clairaut's form.

Module -3: Ordinary differential equations of higher orders **(8 hours)**

Second order linear differential equations with constant and variable coefficients, method of variation of parameters, Cauchy-Euler equation, System of linear differential equations.

Module-4: **Probability and Statistics** **(12 hours)**

Probability spaces, conditional probability, independence; Discrete and continuous random variables and their properties, Independent random variables; Expectation of Discrete and continuous random variables, Moments, mean and variance.

Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions.

Reference /Text Books

1. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
2. V. Krishnamurthy, V.P. Mainra and J.L. Arora, An introduction to Linear Algebra,Affiliated East–West press, Reprint 2005.
3. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications, Reprint, 2010.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.
8. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary ValueProblems, 9th Edition, Wiley India, 2009.
9. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
10. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice HallIndia, 1995.
11. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
12. G.F. Simmons and S.G. Krantz, Differential Equations, Tata McGraw Hill, 2007.

Paper code: UCSE201
Paper name: Programming for Problem Solving **Credit: 10**
Total contact hours: 75 **L-T-P: 4-1-0**

Module 1: Introduction to Programming **Contact hours: 10**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm. Flowchart/Pseudocode with examples.
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code

Module 2: Arithmetic expressions and precedence **Contact hours: 7**

Module 3: Conditional Branching and Loops **Contact hours: 8**

Writing and evaluation of conditionals and consequent branching
Iteration and loops

Module 4: Arrays **Contact hours: 7**

Arrays (1-D, 2-D), Integer arrays and Strings

Module 5: Basic Algorithms **Contact hours: 8**

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Module 6: Function **Contact hours: 8**

Functions (including using built in libraries), Parameter passing in functions, call by value,
Passing arrays to functions: idea of call by reference

Module 7: Recursion **Contact hours: 5**

Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module 8: Structure **Contact hours: 6**

Structures, Defining structures and Array of Structures

Module 9: Pointers **Contact hours: 8**

Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Module 10: File handling **Contact hours: 8**

Books / References:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Paper code: UCSE271
Paper name: Programming for Problem Solving Lab **Credit: 3**
Total contact hours: 45 **L-T-P: 0-0-3**

The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value:
Lab 7: Simple functions
Tutorial 8 and 9: Numerical methods (Root finding, numerical differentiation, numericalintegration):
Lab 8 and 9: Programming for solving Numerical methods problems
Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions
Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures
Tutorial 12: File handling:
Lab 12: File operations

Paper code: UCE201
Paper name: Engineering Drawing and Computer Graphics **Credit: 2**
Total contact hours: 12 **L-T-P: 1-0-0**

Module 1: Theory of Lettering and Plane Curves **Contact hours: 2**

Essentials of lettering, Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Module 2: Theory of Projection of Points, Lines and Plane Surfaces **Contact hours: 2**

Introduction to orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

Module 3: Theory of Projection of Solids **Contact hours: 2**

Introduction to the concepts and description of methods of drawing projections of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

Module 4: Theory of Projection of Sectioned Solids and Development of Surfaces
Contact hours: 2

Introduction to the concepts and description of sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinders and cones.

Module 5: Theory of Isometric and perspective projections **Contact hours: 2**

Principles of isometric projection – Introduction to the concepts and description of isometric scale – Isometric projections of simple solids and truncated solids – Prisms, pyramids, cylinders, cones-combination of two solid objects in simple vertical positions – Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Module 6: Basics of AutoCAD **Contact hours: 2**

Introduction to AutoCAD, Basics of AutoCAD: applicability and capability, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES.

Books / References:

1. *Bhatt N.D. and Panchal V.M., —Engineering Drawing‖, Charotar Publishing House, 50th Edition, 2010.*
2. *Basant Agarwal and Agarwal C.M., —Engineering Drawing, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.*
3. *Venugopal K. and Prabhu Raja V., —Engineering Graphics, New Age International (P) Limited, 2008.*
4. *Natrajan K.V., —A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2009.*
5. *Gopalakrishna K.R., —Engineering Drawing (Vol. I&II combined), Subhas Stores, Bangalore, 2007.*
6. *N S ParthasarathyAnd Vela Murali, —Engineering Graphics, Oxford University, Press, New Delhi, 2015.*
7. *Shah M.B., and Rana B.C., —Engineering Drawing, Pearson, 2nd Edition, 2009.*

Paper code: UCE271
Paper name: Engineering Drawing and Computer Graphics Lab **Credit: 4**
Total contact hours: 48 **L-T-P: 0-0-4**

Module 1: Lettering and drawingplane curves **Contact hours: 8**

Lettering, Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Module 2: Drawing projection of points, lines and plane surfaces **Contact hours: 8**

Drawing orthographic projection-Principal Planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

Module 3: Drawing projection of solids **Contact hours: 8**

Drawing projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

Module 4: Drawing projection of sectioned solids and development of surfaces
Contact hours: 8

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinders and cones.

Module 5: Drawing isometric and perspective projections **Contact hours: 8**

Drawing isometric projections – isometric scale –Isometric projections of simple solids and truncated solids – Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions – Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Module 6: AutoCAD practice **Contact hours: 8**

Familiarization of AutoCAD application software, Use of DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES.

Paper code: UHSS201
Paper name: Professional ethics and human values **Credit: 4**
Total contact hours: 40 **L-T-P-C: 2-0-0-4**

Module 1: Engineering Ethics Senses of 'engineering ethics' – variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – professions and professionalism – professional ideals and virtues – theories about right action – self-interest – customs and religion – uses of ethical theories	**Contact hours: 4**
Module 2: Engineering as Social Experimentation Engineering as experimentation – engineers as responsible experimenters – codes of ethics – a balanced outlook on law – the challenger case study	**Contact hours: 4**
Module 3: Responsibility for safety Safety and risk – assessment of safety and risk – risk benefit analysis – reducing risk	**Contact hours: 4**
Module 4: Responsibilities and Rights Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – intellectual property rights – discrimination	**Contact hours: 4**
Module 5: Global issues Multinational corporations – environmental ethics – computer ethics – weapons development – engineers as managers – consulting engineers – engineers as expert witnesses and advisors – moral leadership – sample code of conduct	**Contact hours: 4**

TEXTBOOKS/REFERENCES:

1. Mike Martin and Roland Schinzinger, "*Ethics in Engineering*", McGraw Hill, New York, 1996.
2. Charles D Fleddermann, "*Engineering Ethics*", prentice Hall, New Mexico, 1999.
3. LauraSchlesinger, "*How Could You Do That: The Abdication of Character, Courage, and Conscience*", Harper Collins, New York, 1996.
4. Stephen Carter, "*Integrity*", Basic Books, New York, 1996.

Semester III

UECE301	**Electronic Devices**	**3L: 0T: 0P Total contact hours: 3**	**6 credits**

Module 1
Introduction to Semiconductor Physics: Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance, design of resistors (10L)

Module 2
Generation and recombination of carriers; Poisson and continuity equation P-N junction characteristics, I-V characteristics, and small signal switching models; Avalanche breakdown, Zener diode, Schottky diode (8L)

Module 3
Bipolar Junction Transistor, I-V characteristics, Ebers-Moll Model, MOS capacitor, C-V characteristics, MOSFET, I-V characteristics, and small signal models of MOS transistor, LED, photodiode and solar cell (12L)

Module 4
Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process. (10L)

Total: 40L

Text /Reference Books:

1. G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson,2014.
2. D. Neamen , D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices,” 3rd edition, John Wiley & Sons, 2006.
4. C.T. Sah, “Fundamentals of solid-state electronics,” World Scientific Publishing Co. Inc, 1991.
5. Y. Tsividis and M. Colin, “Operation and Modelling of the MOS Transistor,” Oxford Univ. Press, 2011.

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Understand the principles of semiconductor physics

2. Understand and utilize the mathematical models of semiconductor junctions and MOS transistors for circuits and systems.

UECE371: Devices & Network Lab [0L: 0T: 2P] (2 credits)
Total contact hours: 02/Week

Hands-on experiments related to the course contents **UECE301 and UECE304**

UECE302	Digital System Design	3L: 0T: 0P Total contact hours: 3	6 credits

Module 1
Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion. (5L)

Module 2
MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU (8L)

Module 3
Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation (10L)

Module 4
Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices. (10L)

Module 5
VLSI Design flow: Design entry: Schematic, FSM & HDL, different modelling styles in VHDL, Data types and objects, Dataflow, Behavioural and Structural Modelling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits. (8L)

Total: 41L

Text/Reference Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd edition,2006.
4. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
5. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd edition, 2012.

Course outcomes:

At the end of this course students will demonstrate the ability to
1. Design and analyze combinational logic circuits
2. Design &analyze modular combinational circuits with MUX/DEMUX, Decoder, and Encoder
3. Design &analyze synchronous sequential logic circuits
4. Use HDL & appropriate EDA tools for digital logic design and simulation

UECE372: Digital System Design Laboratory [0L: 0T: 2P] (2 credits)
Total contact hours: 02/Week

Hands-on experiments related to the course contents **UECE302**

UECE303	Signals and System	3L: 0T: 0P Total contact hours: 3	6 credits

Module 1
Signals and systems as seen in everyday life, and in various branches of engineering and science. (4L)

Module 2
Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. (6L)

Module 3
Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input output behaviour with a-periodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations. (8L)

Module 4
Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and orthogonal bases, The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behaviour. (12L)

Module 5
The z-Transform for discrete time signals and systems- Eigen functions, region of convergence, z-domain analysis. (4L)

Module 6
State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. (4L)

Module 7
Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems. (4L)

Total: 42L

Text/Reference books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
3. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
4. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
5. Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.
6. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
7. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.
8. M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", TMH, 2003.
9. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems", TMH New Delhi, 2001.
10. Ashok Ambardar,"Analog and Digital Signal Processing", 2nd Edition, Brooks/ Cole Publishing Company (An international Thomson Publishing Company), 1999.

Course outcomes:

At the end of this course students will demonstrate the ability to
1. Analyze different types of signals
2. Represent continuous and discrete systems in time and frequency domain using different transforms
3. Investigate whether the system is stable
4. Sampling and reconstruction of a signal

UECE304	Network Theory	3L: 0T: 0P Total contact hours: 3	6 credits

Module 1
Node and Mesh Analysis, matrix approach of network containing voltage and current sources, and reactance, source transformation and duality. Network theorems: Superposition, reciprocity, Thevenin's, Norton's (10L)

Module 2
Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits. Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation. (10L)

Module 3
Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions. (10L)

Module 4
Transient behaviour, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and Two four port network and interconnections, Behaviours of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters. (15L)

Total: 45L

Text/Reference Books

1. Van, Valkenburg.; "Network analysis" ; Prentice hall of India, 2000
2. Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata McGraw-Hill New Delhi, 1994
3. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Understand basics electrical circuits with nodal and mesh analysis.
2. Appreciate electrical network theorems.
3. Apply Laplace Transform for steady state and transient analysis.
4. Determine different network functions.
5. Appreciate the frequency domain techniques.

UCSE306	Data Structure using C	3L: 0T: 0P Total contact hours: 3	6 credits

Module 1
Introduction: Arrays and strings; packing; space arrays; algorithm development; complexity; simple example of algorithm development; recursion. (5L)

Module 2
Search and Sort: Linear search**,** Divide and conquer binary search; selection and insertion sort; merge-sort; quick sort; complexity of sorting and searching. (7L)

Module 3
Linear lists: Stack, operations and applications of stack, queue, operations and applications of queue, circular queue. (5L)

Module 4
Linked list: Single, double linked list, creation and deletion of nodes; circular and deletion of nodes; circular and doubly linked lists; applications of list. (7L)

Module 5
Graphs: Graph algorithms; optimization and greedy method; minimum spanning tree, shortest path, Breadth first and depth first traversal. (6L)

Module 6
Trees: Trees, AVL trees; threaded trees; heap-sort; tries and B-trees, external search. (5L)

Module 7
Tables: hashing, String algorithms-pattern search and text editing. (5L)

Total: 40L

Suggested Text Books & References

1. Wirth Niclaus, "Algorithms +Data Structures = Programs", Prentice Hall International, 1978.
2. Horwitz, E., and Sahni, S. "Fundamentals of data structures", Computer Science Press. 1978.
3. Knuth, D. "The art of computer programming", Vols. 1-2, Addision-Wesley, 1970-80.
4. Aho A.V., Hopcroft, and Ullman; J.E, "Data Structures and Algorithms", Admission Weseley,1982.
5. Tanonbaum, A.M. and Augenstein, M.J., "Data Structures with Pascal", Prentice II all International, 1985.
6. Trembley and Sorenson, "Data Structures using Pascal McGraw Hill", 1985.
7. Stubbas, D., "Data Structures with Abstract Data Types and Modula 2", Brooks & Cole publications Compo 1987.

Course outcomes:

1. Understand basic data structures like single dimensional/multi-dimensional arrays, single/double/circular linked lists, stack and queue.
2. Understand advanced data structures such as tree, graphs and heaps.
3. Understand the algorithms, asymptotic notations to represent their complexity (efficiency).
4. Develop algorithms to use the above-mentioned data structures in suitable applications for problem solving.
5. Develop algorithms to perform basic operations such as searching, sorting, retrieving, inserting and deleting of data.

UCSE376: Data Structure using CLaboratory [0L: 0T: 2P] (2 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UCSE306**

Paper code: UHSS371
Paper name: Group Discussion **Credit: 2**
Total contact hours: 40 **L-T-P-C: 0-0-2-2**

Module 1: Introduction 1.1 Why GD 1.2 Group Discussion as a selection Process 1.3 Topics in GD	Contact hours: 3
Module 2: Outcome of GD 2.1 Communication Skills in GD 2.2 Knowledge and Ideas on a given subject 2.3 Leadership and Coordinating capabilities	Contact hours: 4
Module 3: Structure of GD 3.1 Initiation Techniques 3.2 Body of the GD 3.3 Summarization and Conclusion	Contact hours: 4
Module 4: Preparation for GD 4.1Practice 4.2Participate 4.3Clarity of speech 4.4 Reading Mocks	Contact hours: 4
Module 5: Successful GD Techniques 5.1Working out with group members 5.2 Avoiding problems 5.3 Time management 5.4 Emotional Outburst 5.5 Quantity and QUALITY 5.6 Egotism/Showing Off 5.7 GD Do's and Don'ts	Contact hours: 4

BOOKS RECOMMENDED:

(1) Soft Skills, S. Hariharan,N.Sundararajan, S.P.Shanmugapriya MJP Publishers, Chennai
(2) Communication Skills, Sanjay Kumar and PushpLata, OUP, 2011
(3) Exercises in Spoken English, Parts-I-III, CIEFL, Hyderabad, OUP

UECE305	MC:Model Curriculum for Mandatory Non-credit course as per AICTE guidelines **Constitution of India**	**0L: 0T: 0P**	**0 credit**

Module 1--Introduction and Basic Information about Indian Constitution:

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947,Enforcement of the Constitution, Indian Constitution and its Salient Features, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme inIndia.

Module 2-Union Executive and StateExecutive:

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, Lok Ayukta, The Lokpal and Lok ayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Module 3- Introduction and Basic Information about Legal System:

The Legal System: Sources of Law and the Court Structure: Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law, Principles taken from decisions of judges constitute binding legal rules. The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court). Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration. Contract law, Tort, Law atworkplace.

Module 4- Intellectual Property Laws and Regulation toInformation:

Intellectual Property Laws: Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright and its Ownership, Infringement of Copyright, Civil Remedies for Infringement, Regulation to Information-Introduction, Right to Information Act, 2005, Information Technology Act, 2000, Electronic Governance, Secure Electronic Records and Digital Signatures, Digital SignatureCertificates, Cyber Regulations Appellate Tribunal, Offences, LimitationsoftheInformation TechnologyAct.

Module 5 -Business Organizations and E-Governance:

Sole Traders, Partnerships: Companies: The Company's Act: Introduction, Formation of a Company, Memorandum of Association, Articles of Association, Prospectus, Shares, Directors, General Meetings and Proceedings, Auditor, Windingup.

E-Governance and role of engineers in E-Governance, need for reformed engineering serving at the Union and State level, Role of I.T. professionals in Judiciary, Problem of Alienation and Secessionism in few states creating hurdles in Industrial development.

COURSE OBJECTIVE:

- To acquaint the students with legacies of constitutional development in India and help those to understand the most diversified legal document of India and philosophy behindit.
- To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
- To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.
- To acquaint students with latest intellectual property rights and innovation environment with related regulatoryframework.
- To make students learn about role of engineering in business organizations and e-governance.

COURSE OUTCOME: At the end of the course, learners should be able to-

1. Identify and explore the basic features and modalities about Indian constitution.
2. Differentiate and relate the functioning of Indian parliamentary system at the centerand statelevel.
3. Differentiate different aspects of Indian Legal System and its relatedbodies.
4. Discover and apply different laws and regulations related to engineeringpractices.
5. Correlate role of engineers with different organizations and governancemodels

Suggested Readings:

- Brij Kishore Sharma: *Introduction to the Indian Constitution*, 8th Edition, PHI Learning Pvt.Ltd.
- Granville Austin: *The Indian Constitution: Cornerstone of a Nation (Classic Reissue)*, Oxford UniversityPress.
- Subhash C. Kashyap: *Our Constitution: An Introduction to India's Constitution and constitutional Law*, NBT,2018.
- Madhav Khosla: *The Indian Constitution*, Oxford University Press.
- PM Bakshi: *The Constitution of India*, Latest Edition, Universal LawPublishing.
- V.K. Ahuja: *Law Relating to Intellectual Property Rights*(2007)

Semester IV

UECE401	Analog Communication	3L: 0T: 0P	6 credits

Module 1 **4L**

Introduction to communication system:Need for modulation, Frequency Division Multiplexing, Amplitude Modulation, Definition, Time domain and frequency domain description, single tone modulation, power relations in AM waves, Generation of AM waves, square law Modulator, Switching modulator, Detection of AM Waves; Square law detector, Envelope detector.

Module 2 **8L**

DSB Modulation: Double side band suppressed carrier modulators, time domain and frequency domain description, Generation of DSBSC Waves, Balanced Modulators, Ring Modulator, Coherent detection of DSB-SC Modulated waves, COSTAS Loop.

SSB Modulation: Frequency domain description, Frequency discrimination method for generation of AM SSB Modulated Wave, Time domain description, Phase discrimination method for generating AM SSB Modulated waves. Demodulation of SSB Waves, Vestigial side band modulation: Frequency description, Generation of VSB Modulated wave, Time domain description, Envelope detection of a VSB Wave pulse Carrier, Comparison of AM Techniques, Applications of different AM Systems.

Module 3 **10L**

Angle Modulation: Basic concepts, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave - Generation of FM Waves, Direct FM, Detection of FM Waves: Balanced Frequency discriminator, Zero crossing detector, Phase locked loop, Comparison of FM & AM.

Module 4 **10L**

Transmitters: Radio Transmitter - Classification of Transmitter, AM Transmitter, Effect of feedback on performance of AM Transmitter, FM Transmitter – Variable reactance type and phase modulated FM Transmitter, frequency stability in FM Transmitter.

Receivers: Radio Receiver - Receiver Types - Tuned radio frequency receiver, Super-heterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, AGC, FM Receiver, Comparison with AM Receiver, Amplitude limiting.

Module 5 **8L**

Pulse Modulation: Time Division Multiplexing, Types of Pulse modulation, PAM (Single polarity, double polarity) PWM: Generation & demodulation of PWM, PPM, Generation and demodulation of PPM.

Total: 40L

Text/Reference Books:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., "Principles of Communication Engineering", John Wiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., "Digital Communication", Kluwer Academic Publishers, 2004.
6. Proakis J.G., "Digital Communications", 4th Edition, McGraw Hill, 2000.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Analyse and compare different analog modulation schemes for their efficiency and bandwidth
2. Analyse the behaviour of a communication system in presence of noise

3. Investigate pulsed modulation system and analyse their system performance
4. Analyse different analog modulation schemes in presence of noise and their system performance

UECE471: Communication Engineering Laboratory [0L: 0T: 2P] (02 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UECE401**

UECE402	Analog circuits	3L: 0T: 0P	6 credits

Module: 1 **10L**

Diode Circuits, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.

Module: 2 **10L**

High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.); their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.

Module: 3 **5L**

Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators.

Module: 4 **8L**

Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP-AMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation.

Module: 5 **5L**

OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines.

Module: 6 **7L**

Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc.
Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.
Total: 45L

Text/Reference Books:

1. J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
2. J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.
3. P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, Edition IV
6. Paul R. Gray and Robert G. Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition

Course Outcomes:

At the end of this course students will demonstrate the ability to:
1. Understand the characteristics of diodes and transistors
2. Design and analyze various rectifier and amplifier circuits
3. Design sinusoidal and non-sinusoidal oscillators
4. Understand the functioning of OP-AMP and design OP-AMP based circuits
5. Design ADC and DAC

UECE472: Analog Circuit Laboratory [0L: 0T: 2P] (02 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UECE402**

UECE403	Microcontrollers	3L: 0T: 0P	6 credits

Module: 1 **4L**

Overview of microcomputer systems and their building blocks, memory interfacing, concepts of interrupts and Direct Memory Access, instruction sets of microprocessors (with examples of 8085 and 8086);

Module: 2 **6L**

Introduction to single chip microcontrollers: Intel MCS-51 family features - 8051/8031 architecture - pin configuration - basic assembly language programming & application examples.

Module: 3 **7L**

8051 Instruction Set: Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simpleexamples of assembly language program (without loops) to use these instructions.

Module: 4 **8L**

8051 Stack, I/O Port Interfacing and Programming: 8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops - Delay subroutine, Factorial of an 8 bit number (result maximum 8 bit), Block move without overlap, Addition of N 8 bit numbers, Picking smallest/largest of N 8 bit numbers. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.

Module: 5 **8L**

8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode-2 on a port pin. 8051 Serial Communication-Basics of Serial Data Communication, RS-232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.

Module: 6 **7L**

8051 Interrupts and Interfacing Applications: 8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a 73 switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804; LCD and stepper motor and their 8051-assemblylanguageinterfacingprogramming.

Total: 40L

Text/Reference Books:

1. R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing, 1996
2. D A Patterson and J H Hennessy, Computer Organization and Design The hardware and software interface, Morgan Kaufman Publishers.
3. Douglas Hall, Microprocessors Interfacing, Tata McGraw Hill, 1991.
4. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Do assembly language programming
2. Do interfacing design of peripherals like I/O, A/D, D/A, Timer etc.
3. Develop systems using different microcontrollers
4. Understand RSIC processors and design ARM microcontroller-based systems

UECE473: Analog Circuit Laboratory [0L: 0T: 2P] (02 credits)

Total contact hours: 02/Week

Hands-on experiments related to the course contents **UECE403**

UMA401	Numerical Methods and Computer Programming	3L: 0T: 0P	6 credits

Module 1: Transcendental and Polynomial Equations (10 hours)
Methods of iteration for finding solution of algebraic and transcendental equations: Newton Raphson Method, Regula-Falsi Method, Bisection Method, Secant Method. Solution of linear simultaneous equations by Gauss Elimination Method & Gauss Siedal Method.

Module 2: Interpolation and Extrapolation (10hours)
Difference table, Newton's Forward and Backward interpolation formulae, Lagrange's Interpolation Formula.

Module 3: Numerical Differentiation & Integration (10 hours)
Numerical differentiation; Numerical Integration, Trapezoidal, Simpson's Rules and Gaussian Quadrature Formula.

Module 4: Numerical Solution of Ordinary Differential Equations (10 hours)
Euler method, Modified Euler Method, Runge - Kutta Method and Milne's Predictor – Corrector Method.

Textbooks/References:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI learning Pvt Ltd.
2. M.K Jain, S.R.K Iyengar and R.K Jain, Numerical Methods for Scientific and Engineering computation, New Age International Publishers.
3. E. Balagurusamy, Numerical Method, Tata McGraw Hill Publication.
4. Xavier: C Language and Numerical Methods.
5. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
8. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.

UMA471: Numerical Methods and Computer Programming Lab [0L: 0T: 2P] (02 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UMA401**

List of Experiments

1. Program to find a root of a nonlinear equation using the Method of Bisection.
2. Program to find a root of a nonlinear equation using the Method of Regula-Falsi method.
3. Program to find the root of a nonlinear equation using the Newton-Raphson method.
4. Program to find the root of a nonlinear equation using the Secant Method.
5. Program to construct Lagrange's interpolation polynomial method.
6. Program to evaluate a definite integral by Trapezoidal rule
7. Program to evaluate a definite integral by Simpson's 1/3 rule.
8. Program to evaluate a definite integral by Simpson's 3/8 rule.
9. Program to find the solution of initial value problem using Euler's method.
10. Program to find the solution of initial value problem using improved Euler's method.
11. Program to find the solution of initial value problem using Modified Euler's method.
12. Program to find solution of initial value problem using fourth order Runge Kuttamethod.
13. Program to find solution of initial value problem using third order Runge Kutta method.
14. Program for solving ordinary differential equation by Milne method.

Text/Reference Books

9. Introductory Methods of Numerical Analysis: S.S. Sastry, PHI learning Pvt Ltd.
10. Numerical Methods for Scientific and Engineering computation: M.K Jain, S.R.K Iyengar and R.K Jain, New age Inter-national Publishers.
11. Numerical Method: E. Balagurusamy, Tata McGraw Hill Publication.
12. Xavier: C Language and Numerical Methods.

UCSE404	Data Base Management System	3L: 0T: 0P	6 credits

Module 1: Foundations **[3L]**

Introduction: Database System Concepts and architecture, Data models, scheme and instances, Data independence Database language and Interface.

Module 2: Entity Relationship Model and Relational Data Model and Language **[9L]**

Data Modelling Using the Entity-Relationship Model: ER model concepts, Notations for ER diagram, Extended E.R. model, Relation-ships of higher degree. Relational Data Model and Languages: Relational data Model concepts, constraints, relational algebra. Relational Calculus, Tuple and Domain calculus. SQL, data definitions queries and up-dates in SQL, QBE, Data definitions, queries and up-dates in QBE

Module 3: DBMS Software **[5L]**

Example DBMS System (MySQL/ORACLE/INGRESS/SYBASE), Basic architecture. Data definitions Data Manipulation.

Module 4: Database Design **[7L]**

Functional dependencies, Normal forms, First, second, and third functional personal normal forms. BCNF. Multivalued dependencies Fourth Normal form. Join Dependencies and fifth Normal form, Inclusion Dependencies.

Module 5: Query Processing and Optimisation **[5L]**

Algorithms for executing query operations, Heuristics for query optimisations.

Module 6: Transaction and Concurrency **[6L]**

Transaction and system concepts, schedules and Recoverability serializability of schedules.
Concurrency Control Techniques: Locking Techniques for concurrency control Time stamping and concurrency control.

Suggested Text Books & References

1. Raghu Ramakrishnan and Johannes Gehkre, “Database Management System”, Mc. Graw Hill, Third Edition
2. Elmasri, RamexShamkant B. Navathe, "Fundamentals of Data base Systems".
3. Jeffry D. Ulman, "Principles of Data Base Systems", Second Edition Galgotia Pub.
4. Date, C.J. "An Introduction to Database System", Vol. I, II &IIIrd, Addison-Welsey.
5. Prakash, Naveen., "Introduction to Database Management", Tata McGraw Hill

Semester V

ECE501	Electromagnetic Waves	3L: 0T: 0P	6 credits

Introduction (**1L**)

Module:1 -Basics of Vector Analysis – orthogonal Coordinate Systems, Transformations of coordinate systems; Del operator; Gradient, Divergence, Curl – their physical interpretations; Laplacian operator. (**5L**)

Module: 2 -Coulomb's law, electric field intensity, charge distribution. Gauss' law, flux density and electric field intensity. Divergence theorem. Current Densities, Conductors, Poisson's & Laplace's equations, Uniqueness theorem, Biot-Savart law, Ampere's law, Relation between J & H, Vector magnetic potential, Stokes' theorem. (**8L**)

Module: 3 -Faraday's law & Lenz's law, Displacement Current, $J_C - J_D$ relation, Maxwell's equations, Time-harmonic fields, Wave Equation, Boundary Conditions between media interface; Uniform Plane wave; Wave Propagation in Lossy Dielectric, Loss-less Dielectric, Free space. Poynting Theorem, Power flow, Poynting vector, Skin Depth, Surface Resistance, Reflection and Transmission of wave for normal incidence (**12L**)

Module: 4 -Transmission Lines: Concept of Lump parameters and Distributed parameters, Line Parameters, Transmission line equations and solutions, Physical significance of the solutions. Propagation constant, Characteristic Impedance; Wavelength; Velocity of Propagation; Distortion-less Line Reflection and Transmission coefficients; Standing Waves, VSWR, Input Impedance, Smith Chart Applications; Load Matching Techniques. (**12L**)

Module: 5 -Types of transmission lines (open 2-wire, coaxial, microstrip), applications and limitations. (**2L**)

Total: 40L

Text/Reference Books:

1. Electromagnetic Waves & Radiating Systems, 2nd Edition –E. C. Jordan and K.G. Balmain, Pearson Education
2. Elements of Electromagnetics, 4th Edition – Matthew N O Sadiku Oxford University Press
3. Engineering Electromagnetics, 2ed Edition - Nathan Ida Springer India
4. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill India, 2005
5. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, Prentice Hall, India
6. Narayana Rao, N: Engineering Electromagnetics, 3rd ed., Prentice Hall, 1997.
7. David Cheng: Electromagnetics, Prentice Hall

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand characteristics and wave propagation on high frequency transmission lines
2. Carryout impedance transformation on TL
3. Use sections of transmission line sections for realizing circuit elements
4. Characterize uniform plane wave
5. Calculate reflection and transmission of waves at media interface

UECE571: Electromagnetic Waves Lab [0L: 0T: 2P] (02 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UECE501**

UECE502	Control Systems	3L: 0T: 0P	6 credits

Module:1 -Introduction to control problem- Industrial Control examples. Transfer function. System with dead-time. System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis. (**8L**)

Module: 2 -Time response of first, second and higher order systems to impulse, step and ramp inputs, Time response specifications, types of systems, steady state error and error constants. Basic control action and automatic controllers, Effect of P, I, D, PI, PD and PID controllers on system performance, Sensitivity of system**.** (**6L**)

Module: 3 -Concept of stability, necessary condition for stability, absolute and relative stability,Routh Hurwitz criterion, Construction of Root loci and its application, Stability analysis of electrical systems. (**8L**)

Module: 4 -Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. (**10L**)

Module: 5 -Concepts of state, state variable, state model, state modelsfor linearcontinuous time functions, diagonalization of transfer function, solution of state equations,concept of controllability & observability. (**8L**)

Total: 40L

Text/Reference Books:

1. Modern control system – Ogata
2. Automatic control system – B.C.Kuo
3. Modern control system – Nagrath& Gopal
4. Control system design – Graham C.Goodwin
5. Linear control system - B.S.Manke

Course Outcomes

At the end of this course students will demonstrate the ability to

1. learn about closed loop control sytems
2. know time domain response analysis of control systems
3. analyze the stability of control systems
4. understand state variable analysis, controllability and observability.

UECE503	Digital Communication Systems and Stochastic Process	3L: 0T: 0P	6 credits

Module: 1 - Review of probability and random process. Pulse modulation: Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Line coding: PSD of various line codes. Pulse shaping, Nyquist criterion for zero ISI. (**10L**)

Module: 2– Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation. The optimum filter, matched filter, probability of error using matched filter, coherent reception, non-coherent detection of FSK, calculation of error probability of ASK, BPSK, BFSK,QPSK. (**10L**)

Module: 3– Specification of a random process, Autocorrelation function of a random process, Power Spectral Density of a random process, Transmission of random process through linear systems. Bandpass random process: Bandpass White Gaussian Random Process, Sinusoidal in Noise. Optimum filtering: Wiener-Hopf filter.
(**8L**)

Module: 4–Stochastic Processes: Stationary Processes, Cumulative Distribution Function and Probability Distribution function, First order stationary processes, Second order stationary processes. Correlation functions: The auto-correlation function, Wide-sense stationary processes and Ergodic processes, Linear filtering of stochastic processes: Basics of LTI filtering, Time domain description of filtering of stochastic processes: Mean value of the filter output, Autocorrelation functions of the output, Cross-correlation of the input and the output. Spectra of filter output. Spectrum of a random data signal. Probability density function of the envelope and phase of bandpass noise. (**12L**)

Total: 40L

Text/Reference Books:

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education
2. A. Papoulis and S. Unnikrishnan Pillai, “Probability, Random Variables and Stochastic Processes,”" Fourth Edition, McGraw Hill.
3. Proakis J.G., “Digital Communications”, 4th Edition, McGraw Hill, 2000
4. Wozencraft J. M. and Jacobs I. M., “Principles of Communication Engineering", John Wiley, 1965.
5. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Investigate pulsed modulation system and analyse their system performance
2. Analyse different digital modulation schemes and can compute the bit error performance
3. Make use of theorems related to random signals and processes
4. To understand propagation of random signals in LTI systems.

UECE504	Digital Signal Processing	3L: 0T: 0P	6 credits

Module: 1 - Discrete time signals: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals; Discrete systems attributes, Z-Transform, Analysis of LTI systems, frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT). (**10L**)

Module: 2 - Fast Fourier Transform Algorithm, Implementation of Discrete Time Systems. (**5L**)

Module: 3 - Design of FIR Digital filters: Window method, Park-McClellan's method / Frequency-sampling method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low pass, Band pass, Band stop and High pass filters. (**10L**)

Module: 4 - Parametric and non-parametric spectral estimation. (**5L**)

Module: 5 - Effect of finite register length in filter design (IIR or FIR - any one of the two). (**5L**)

Module: 6 - Introduction to multi-rate signal processing. (**5L**)

Total: 40L

Text/Reference Books:

1. S.K.Mitra, Digital Signal Processing: A computer-based approach.TMH
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 1997.
4. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
5. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6. D.J. De Fatta, J. G. Lucas and W.S. Hodgkiss, Digital Signal Processing, John Wiley & Sons, 1988.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Represent signals mathematically in continuous and discrete time and frequency domain
2. Get the response of an LSI system to different signals
3. Design of different types of digital filters for various applications

UECE574: Digital Signal Processing Laboratory [0L: 0T: 2P] (02 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UECE504**

UECE515	A. Nano Electronics	3L: 0T: 0P	6 credits

Module: 1 -Introduction to nanotechnology, meso-structures,Basics of quantum mechanics: Schrodinger equation, Density of states. (**7L**)
Module: 2 -Particle in a box Concepts, Degeneracy. Band theory of solids. Kronig-Penny model. Brillouin zones. (**8L**)

Module: 3 -Shrink-down approaches: Introduction, CMOS Scaling, the nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.), Resonant Tunnelling Diode, Coulomb dots, Quantum blockade. (**12L**)

Module: 4 -Single electron transistors, Carbon nano-tube electronics, Band-structure and transport, devices, applications, 2D semiconductors and electronic devices. (**10L**)

Module: 5 -Graphene, atomistic simulation. (**3L**)

Total: 40L

Text/ Reference Books:

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand various aspects of nano-technology and the processes involved in making nano components and material.
2. Leverage advantages of the nano-materials and appropriate use in solving practical problems.
3. Understand various aspects of nano-technology and the processes involved in making nano components and material.
4. Leverage advantages of the nano-materials and appropriate use in solving practical problems.

UECE515	B. System Design using HDL	3L: 0T: 0P	6 credits

Module: 1 –Introduction: Introduction to Reconfigurable Computing Systems: Objectives, Expectations, Logistics, characterization of Reconfigurable Computing & Reconfigurable Hardware, Reconfigurable Software (**8L**)

Module: 2–Verilog: Lexical conventions - comments, identifiers, numbers, strings. Data types: nets, registers, vectors, arrays. Parameter types. Operators. Operator types, precedence.
Behavioral modeling blocks: always block, event-based timing control, branch statements, case, casex, casez. Procedural assignments: blocking and non-blocking. Data flow modeling. Assign statements. Delays. Implicit net declaration. Regular, implicit continuous assignment and net declaration delay. Logic statement implementation. The conditional operator.
Gate level modeling. Gate types: and/or, buf/not gates, bufif/notif gates. Gate truth tables. Gate delays. Specify block. UDP. Ports. Port connection rules: by order and name.
Switch level modeling. Primitives. Use of trireg. Testbench creation. Initial block. Delay-based timing control. (**15L**)

Module: 3–System Verilog: Overview and history of Verilog and SystemVerilog, SystemVerilog Syntax and Semantics, Programming Statements and Operators, Modeling RAMs and ROMs (**7L**)

Module: 4 -Verilog-A: Language Tokens, Verilog-A Keywords, Analog Operator Keywords, System Tasks and Functions**,** Built-In Mathematical Functions, Analog Operators, Signals, Analog Behavior. (**6L**)

Module: 5 -System design methodology:Finite-State Machine, RTL Design, RTL Implementation Options, A Case Study: Liquid-Crystal Displays. (**4L**)

Total: 40L

Text/ Reference Books:

1. Jha, N.K.; Gupta, S. Testing of Digital Systems; Cambridge University Press: Cambridge, UK, 2003
2. Ghosh, S.K. Hardware Description Languages: Concepts and Principles; Wiley-IEEE Press: Hoboken, NJ, USA, 1999
3. M. Ciletti, Advanced Digital Design with the Verilog(TM) HDL. (Prentice Hall, Upper Saddle River, NJ, 2002).
4. M. Morris R. Mano, Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog, 6th Edition, 2018
5. Ronald W. Mehler, Digital Integrated Circuit Design Using Verilog and Systemverilog, Newnes, 2014
6. Dan FitzPatrick, "Analog Behavioral Modelling with the Verilog-A Language", Kluwer Academic Publishers
7. V. Pedroni. Finite State Machines in Hardware: Theory and Design (with VHDL and SystemVerilog). The MIT Press; 2013
8. Ming-Bo Lin, Digital System Designs and Practices: Using Verilog HDL and FPGAs, ISBN: 978-0-470-82323-1, 2008

Course Outcomes:

At the end of the course, students will demonstrate the ability to:
1. understand a reconfigurable computing system.
2. understand Verilog and SystemVerilog.
3. understand system design methodologyusingFinite-State Machine and RTL design.

UECE515	C. Linear IC and Systems	3L: 0T: 0P	6 credits

Module: 1 -Introduction to Electronic system Design:
Design flow of Electronic systems, methodologies, Specifications, Electronic Products Classification: Consumer, Industrial and Military, Linear/Nonlinear, Analog signal conditioning, Choice of Op-Amps in signal conditioning applications.
Op-amp, In-Amps: Specifications, types of op-amps, Comparison different topologies, µA741 IC Internal schematics & discussions. (**12L**)
Module: 2 -Applications of Op-Amps:
Linear Applications: VCVS, VCCS, CCVS, CCCS implementation using Op-Amp, Differentiator, Integrator, Non-Linear Applications: Clippers and Clampers, Precision rectifier, Log and Antilog amplifiers, Comparators, PWM signal generation using comparator, Series/Shunt Regulator using OP-AMP. Discussions on: LM 317, 78XX, 79XX. (**10L**)
Module: 3 -Data Acquisition& Conversion Systems:
Data Acquisition system and basics, Data Converters, Specifications, Types of D/A converters Current driven DAC, Types of A/D converters Flash, Single slope, Dual slope, Successive Approximation Register- Delta Sigma Modulation. (**8L**)

Module: 4 -Signal Generation using Op-Amps:
Types of Signal generators, Specifications of Oscillators, Relaxation Oscillators, sine wave oscillators. Circuits and explanations, PLL: case study (**10L**)

Total: 40L

TEXTBOOKS:

1. Lienig, Jens, Bruemmer, Hans. *Fundamentals of Electronic Systems Design,* Springer, 2007
2. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th edition, Mc-graw Hill
3. Bruce Carter Ron Mancini, Op Amps for Everyone, 5th Edition, Newnes, 2017
4. William D. Stanley, Operational Amplifiers With Linear Integrated Circuits, pearson , 2004
5. Behzad Razavi, Principles of Data Conversion System Design, Wiley-IEEE Press, 1995
6. Carusone, Johns, and Martin, Analog Integrated Circuit Design, 2nd edition, John Wiley, 2012

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. understand linear/nonlinearanalog signal conditioning.
2. express the different applications of Op-Amp.
3. understand data acquisition & conversion systems.
4. understand signal generation using Op-Amps.

UECE516	A. Bio-Medical Electronics(OE-1)	3L: 0T: 0P	6 credits

Module: 1 - Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. (**12L**)

Module: 2 - Bio-electrodes and bio-potential amplifiers for ECG, EMG, EEG, etc. (**8L**)

Module: 3 - Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, X-ray and nuclear imaging. (**10L**)

Module: 4 - Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects. (**10L**)

Total: 40L

Text/Reference Books:

1. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
2. J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
3. A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the application of the electronic systems in biological and medical applications.
2. Understand the practical limitations on the electronic components while handling bio-substances.
3. Understand and analyse the biological processes like other electronic processes.

UECE516	B. Introduction to MEMS (OE-1)	3L: 0T: 0P	6 credits

Module: 1 - Introduction and historical background, scaling effects. Micro/Nano Sensors, Actuators and Systems overview: Case studies. (**10L**)

Module: 2 - Review of Basic MEMS fabrication modules: Oxidation, Deposition Techniques, Lithography (LIGA) and Etching. Micromachining: Surface Micromachining, sacrificial layer processes, Stiction; Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding. (**10L**)

Module: 3 - Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear Thermal Expansion, Bending; Energy methods. (**10L**)

Module: 4 - Overview of Finite Element Method, Modelling of Coupled Electromechanical Systems. (**10L**)

Total: 40L

Text/Reference Book:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.
2. S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Microengineering (Vol. 8). CRC press, (2005).
3. S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
4. M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.
5. G. Kovacs, Micromachined Transducers Sourcebook, McGraw-Hill, Boston, 1998.
6. M.H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and Gyroscopes, Elsevier, New York, 2000.

Course Outcomes:

At the end of the course the students will be able to

1. Appreciate the underlying working principles of MEMS and NEMS devices.
2. Design and model MEM devices.

UECE516	C. Optimization Theory(OE-1)	3L: 0T: 0P	6 credits

Module-I: Introduction to optimization, Constraints, Objective function, Variable bounds, Exhaustive search, Region Elimination method, Gradient based methods: Steepest descent, Newton-Raphson, Linear programming. (**10L**)

Module-II: Optimality criteria, Powel's conjugate direction method, Gradient based methods: gradient descent, Newton's method, Quasi-Newton's method, Conjugate gradient, Levenbarg-Marquardt algorithm. (**10L**)

Module-III: Constrained Optimization, Kuhn-Tucker Condition, Penalty function method, Direct search for constrained minimization, Linearized search techniques, Linear programming. (**10L**)

Module-IV: Non-traditional optimization algorithms, Golden section search, Simulated annealing, Genetic algorithm, Particle swarm optimization. (**10L**)

Total: 40L

Text/Reference Book:

1. Singiresu S Rao **,** Engineering Optimization Theory and Practice, Fifth Edition, 2019
2. Kalyanmoy Deb, Optimization for Engineering Design, Second edition, 2012
3. Edwin K.P. Chong and Stainslaw H. Jak, "An introduction to Optimization", 3rd edition.

Learning Objectives:

- Introduction to optimization techniques using both linear and non-linear programming. The focus of the course is to know about the classical optimization techniques and their implementation in practical problems. After completion of the classical optimization algorithm, students will learn about some non-traditional optimization methods like Simulated Annealing, Genetic algorithm, Particle swarm optimization etc.
- By the end of the course, students should be able to:
  - Cast engineering minima/maxima problems into optimization framework.
  - Learn efficient computational procedures to solve optimization problems.
  - MATLAB/Python implementation to optimization methods.

Knowledge Prerequisite:

- Introductory knowledgein linear algebra and probability theory
- Elementary knowledge in Vector Calculus

Semester VI

UECE601	VLSI Design	3L: 0T: 0P	6 credits

MOS TRANSISTOR [10L]

Introduction to MOS Transistor Theory: nMOS, pMOS Enhancement Transistor, MOSFET as a Switch, Threshold voltage, Body effect. MOS Device Design Equations, Basic DC equations, Short Channel Effects and Device Models – Scaling Theory, Threshold Voltage Variation, Mobility Degradation with Vertical Field, Velocity Saturation, Hot Carrier Effects, Output Impedance Variation with Drain- Source Voltage, MOS Device Models, Small Signal AC Characteristics and Modeling of MOS Transistors using SPICE.

MOS INVERTERS: Static Characteristics [16L]

Introduction, Voltage Transfer Characteristic (VTC), Noise Immunity and Noise margins, Resistive-Load Inverter, Inverters with n-Type MOSFET Load and CMOS Inverter, DC Characteristics of CMOS Inverter, Calculation of VIL, VIH, VOL, VOH and Vth, Design of CMOS Inverters, Supply Voltage Scaling in CMOS Inverters, Power and Area considerations.

Switching Characteristics and Interconnect Effects

Switching Characteristics of CMOS Inverter- Delay-Time Definitions, CMOS Propagation Delay, Calculation of Delay times, Estimation of Interconnect parasitic- Interconnect Capacitance Estimation, Interconnect Resistance Estimation, Layout of an Inverter, Calculation of Interconnect Delay- RC Delay Models, The Elmore Delay, Buffer Chains, Low Swing Drivers, Power Dissipation-Switching, Short-Circuit and Leakage Components of Energy and Power, Power-Delay Product, Power Distribution and Performance Optimization of Digital Circuits by Logical Effort Sizing; CMOS Ring Oscillator Circuit.

CMOS Logic Structures and Subsystem Design [10L]

COMBINATIONAL MOS LOGIC CIRCUITS- CMOS Logic Circuits (NAND, NOR and Complex Logic Gates, Multiplexers etc.), CMOS Transmission Gates (Pass Gates), Pseudo nMOS logic, Dynamic CMOS logic, Clocked CMOS logic and CMOS Domino logic. SEQUENTIAL MOS LOGIC CIRCUITS-Behavior of Bistable Elements, The SR Latch Circuit, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop.

Subsystem design process- design of 4-bit shifter, arithmetic building blocks like adders, multipliers and ALU.

SEMICONDUCTOR MEMORIES AND LOW-POWER CMOS LOGIC CIRCUITS [8L]

Semiconductor memories: non-volatile and volatile memory devices, flash memories, SRAM Cell Design, Differential Sense Amplifiers, DRAM Design, Single Ended Sense Amplifier.

Overview of Power Consumption, Low-Power Design Through Voltage Scaling, Estimation and Optimization of Switching Activity, Reduction of Switched Capacitance and Adiabatic Logic Circuits

Total: 44L

REFERENCES BOOKS:

1. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits” TMH 2003
2. Jan M. Rabaey, “Digital Integrated Circuits” Pearson Education, 2003 3. Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.
3. Kamran Ehraghian, Dauglas A. Pucknell and SholehEshraghiam, “Essentials of VLSI Circuits and Systems” – PHI, EEE, 2005 Edition.
4. Neil H. E. Weste and David. Harris Ayan Banerjee, “CMOS VLSI Design” - Pearson Education, 1999.
5. John P.Uyemura, “CMOS Logic Circuit Design”, Springer International Edition.2005.Logic Circuit Design”, Springer International Edition.2005.
6. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, 2005.
7. M. Ercegovac, T. Lang and L.J. Moreno, “Introduction to Digital Systems”, Wiley,2000.

Course Outcomes:

After taking this course, the student will be able to:

1. Understand the working of MOSFET and its level-1 model in SPICE
2. Analyze the static and dynamic characteristics of CMOS inverter
3. Design and analyze CMOS circuits for combinational and sequential logic
4. Design and analyze memory cells and low power logic circuits.

UECE671: VLSI Design Laboratory [0L: 0T: 3P] (3 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UECE601**

UECE602	Computer Network	3L: 0T: 0P	6 credits

UNIT-I

Communication Networks–An Introduction and Overview: Communication Switching, Circuit Switching, Message and Packet Switching, Connectionless and Connection Oriented networks- X.25, frame relay, ATM networks.Communication Process and Layered Architecture: Communication between Two Computers and the Layering Concept, OSI Layers and Protocols, Internet architecture. [8L]

UNIT-II

The Physical Layer: Theoretical basis for communication, guided transmission media.
Local Area Networks: LAN Topologies, Access Mechanisms and Media, Ethernet, Contention Based LANs, Token Passing LANs.
Metropolitan Area Networks: Distributed Queue Dual Bus (DQDB), Fibre Distributed Data Interface (FDDI). [8L]

UNIT-III

The Data link Layer- Design issues, framing, error detection and correction, flow control, HDLC, The medium access sub-layer- Channel allocation problem, multiple access protocols, Data link layer switching, Wireless LAN. [7L]

UNIT-IV

The Network Layer- Design issues, Internetworking, network layer in the internet (IPv4 and IPv6), IP addressing, ICMP, Routing algorithms. [6L]

UNIT-V

The Transport layer- Services, elements of transport protocol, Simple Transport protocol, internet transport layer protocols- UDP and TCP. [6L]

UNIT-VI

The Application layer- Domain name system, electronic mail, World Wide Web: architectural overview, dynamic web document, HTTP, Application layer protocols- Simple network management protocol, File Transfer Protocols, Simple Mail Transfer Protocols, Telnet. [7L]

Text Books:

1. Computer Networks — Andrew S Tanenbaum,David J. Witherall, 5th Edition. Pearson Education
2. Data Communications and Networking – Behrouz A. Forouzan.Third Edition TMH.

REFERENCES:

1. An Engineering Approach to Computer Networks- S. Keshav, 2nd Edition, Pearson Education
2. Understanding communications and Networks, 3rd Edition, W.A. Shay, Thomson

UECE672: Computer Network Laboratory [0L: 0T: 3P] (3 credits)
Total contact hours: 02/Week
Hands-on experiments related to the course contents **UECE602**

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UECE694	Mini Project/ Electronic Design Workshop	0L: 0T: 4P	4 credits

Guidelines:

1. The mini-project is a group activity having 3-4 students in a group. The final outcome after the mini-project should be an electronic product with emphasis of electronic circuit design.

This is electronic product design work with a focus on electronic circuit design.

2. The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.

3. Mini Project should cater to a small system required in laboratory or real life.

4. It should encompass components, devices, analog or digital ICs, micro controller with which functional familiarity is introduced.

5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini project.

6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.

7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.

8. Art work and Layout should be made using CAD based PCB simulation software. Due considerations should be given for power requirement of the system, mechanical aspects for enclosure and control panel design.

9. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

10. The lab sessions should be used for discussion on standard practices used for electronic circuits/product design, converting the circuit design into a complete electronic product, PCB design using suitable simulation software, estimation of power budget analysis of the product, front panel design and mechanical aspects of the product, and guidelines for documentation /report writing.

Course Outcomes:

At the end of the course, students will have the ability to:

1. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.

2. Design, implement and test the prototype/algorithm in order to solve the conceived problem.

3. Write comprehensive report on mini project work.

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UECE615	A. Antennas and Propagation	3L: 0T: 0P	6 credits

Fundamental Concepts-
Types of Antennas, Physical concept of radiation (Single wire, Two Wires), Fields from oscillating dipole, Radiation pattern, Field regions(near andfar-field), Types of radiation pattern, Beam area, Radiation power density, Radiation Intensity, Beam efficiency, Directivity and Gain, Antenna Apertures, Radiation resistance, Antenna polarization, Axial Ratio, Input Impedance, Effective height, Impedance Bandwidth, Friss-transmission equation
Radiation integrals and auxiliary potential functions. [12L]

Radiation from Wires and Loops-
Infinitesimal dipole (Hertizian), Short dipole, Finite length infinitesimally thin dipole, Half wave dipole, Loop antenna, Quarter wave Monopole antenna. [8L]

Antenna Arrays-
Analysis of two element arrays and N-element uniform arrays, Broad side and end fire array, Phased array. [7L]

Aperture and Reflector Antennas-
Radiation from sectoral and pyramidalhorns, prime-focuses parabolic reflector and Cassegrain antennas. [2L]

Broadband Antennas-
Log-periodic and Yagi-Uda antennas [2L]

Micro strip Antennas-
Basic characteristics of micro strip antennas, radiation mechanisms, feedingmethods,methods ofanalysis, design of rectangular patch antenna. [5L]

Wave Propagation:
Introduction, Ground wave propagation, Sky wave propagation: The ionosphere and its effects, Electrical properties of the ionosphere, virtual height, critical frequency, maximum useable frequency, skip distance, Fading, super refraction or ducting, Modified refractive Index. [4L]

Total: 40L

Text/Reference Books:
1. J.D. Kraus, Antennas, McGraw Hill, 1988.
2. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
3. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
4. R.C. Johnson and H. Jasik, Antenna Engineering Handbook, McGraw ill, 1984.
5. I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House, 1980.
6. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill, 2005
7. R.E. Crompton, Adaptive Antennas, John Wiley

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
1. Understand the properties and various types of antennas.
2. Understand the effects of arrays in the antenna parameters
3. Understand the radiation mechanism of wire antenna, reflector antenna and patch antenna
4. Understand the basics of wave propagation

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UECE615	B. Speech and Audio Processing	3L: 0T: 0P	6 credits

Module-1:
Applications, pattern recognition, feature extraction, modelling, testing. [6L]

Module-II
Speech recognition: Objective, issues, block diagram description, classification, development of speech recognition system using vector quantization (VQ), dynamic time warping (DTW), Hidden Markov Model (HMM) and Neural networks (NN). [12L]

Module III
Speech synthesis: Objective, issues, block diagram description, classification, development of speech synthesis system using articulatory, parametric, concatenative and HMM based approaches;
[8L]

Module-IV
Speaker recognition: Objective, issues, block diagram description, classification, development of speaker recognition system using VQ, DTW, GMM, NN and HMM;
[8L]

Module-V
Speech enhancement: Objective, issues, block diagram description, classification, enhancement of noisy speech, reverberant speech enhancement and multi-speaker speech processing.
[6L]

Total: 40L

References:

1.Lawrence Rabiner, Ronald Schafer, "Theory and Applications of Digital Speech Processing", Pearson; 1st edition

2. Soumya Sen, "Applied Speech and Audio Processing" Springer Technology and Engineering

Outcome of the course:

- Students should understand the fundamentals in human speech and music generation and analysis,
- Modelling and processing of digital filters and Pattern Recognition techniques for speech
- Students should know about different speech encoding techniques like vector quantization, Hidden Markov Models and other coding techniques.
- Students should learn how the dominant features of speech are extracted and analysed to form significant abstractions for speaker identification and speaker-independent linguistic comprehension.

Prerequisites: Audio Systems, Analog Filters, Digital Signal Processing

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UECE616	A. Digital Image Processing (OE-2)	3L: 0T: 0P	6 credits

Introduction and Digital Image Fundamentals

Digital Image Fundamentals, Human visual system, Image as a 2D data Image representation – Gray scale and Color images, image sampling andquantization [3L]

Image enhancement in Spatial domain:

Basic gray level Transformations, Histogram Processing Techniques, Spatial Filtering, Low pass filtering, High pass filtering [8L]

Filtering in the Frequency Domain:

Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering [5L]

Image Restoration and Reconstruction:

Noise Models, Noise Reduction, Inverse Filtering, MMSE (Wiener) Filtering [6L]

Color Image Processing:

Color Fundamentals, Color Models, Pseudo color image processing [4L]

Image Compression:

Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding, JPEG Compression standard [6L]

Morphological Image Processing:

Erosion, dilation, opening, closing, Basic Morphological Algorithms: [4L]

Image Segmentation:

point, line and edge detection, Thresholding, Regions Based segmentation, Edge linking and boundary detection, Hough transform [6L]

Total: 42L

Text/Reference Book:

1) Gonzalez & Woods, ―Digital Image Processing, 3rd ed., Pearson education,2008
2) Jain Anil K., ―Fundamentals Digital Image Processing, Prentice Hall India,2010
3) Pratt W.K, ―Digital Image Processing, 3rd ed., John Wiley & Sons,2007
4) Chanda and Majumder -- Digital Image Processing and Analysis, PHI publication

Course Outcomes:

a) Applications of image processing in various fields
b) Various noise removal and image enhancement techniques.
c) About image degradation and restoration models popularly used in image processing
d) Various state-of-the -art image compression algorithms
e) Various morphological operation of binary images
f) Segmentation of various images and their applications

UECE616	B. Power Electronics(OE-2)	3L: 0T: 0P	6 credits

Module-I: *Power Semiconductor Devices:*Switching characteristics of power diodes andFast recovery diodes and their specifications.Power BJT: Structure of vertical powertransistor, Principle of operation, its VI andswitching characteristics. Construction, operating principle and switchingcharacteristics of power MOSFET.Construction, operating principle and featuresof IGBT.Thyristors–Construction, working and characteristics of SCR, DIAC and TRIAC. [**8L**]

Module-II: *Protection of Power Semiconductor Devices:*Mounting techniques and heat sinks of power semiconductor devices. Selectionof devices, overload protection, Fuseprotection Circuit breakers, Transient protection. RC Networks, Zener, Metal Oxide resistors, TurnON and OFF snubbers, transient voltagesuppressors. [**4L**]

Module-III: *Controlled Rectifiers:*Single phase half wave and full wave control rectifier circuit–Principle of operation withresistive and inductive load. Use of freewheeldiode.Three phase half wave and full wave controlrectifier– Operation with inductive and resistiveload, Use of free-wheel diode.Concept of full control and half control rectifier. [**5L**]

Module-IV: *Inverters:*Principle of operation of self-oscillating anddriving inverter. Principle of operation of voltage driver, currentdriver, half bridge and full bridge inverter; Inverterloads.Three-phase inverter. [**5L**]

Module-V: *DC Regulated Power Supplies:*Linear Regulators-Series and shunt regulator using transistors and Op-Amps. IC Voltage Regulators**:** Positive & Negative and theirspecifications, Dual tracking regulators.Switching Regulator (SMPS):Principle ofoperation, Block diagram, circuit diagram andPWM control circuit of switching regulator.Principle of operation of buck converter, boostconverterand buck-boost converter.Comparison of linear and switching regulator. [**8L**]

Module-VI: *Power Conditioners and UPS:*Basic principle, types of UPS: Off-line, On-Line and Line Interactive, their comparison.Typical disturbances in commercial powersupplies, Isolation Transformer, EMI and RFIsuppression.AC Voltage regulators- Manually controlledregulators, Tap changing; Auto-TransformerSolid state tap-changes. Servo-Regulators.Constant Voltage Transformer (CVT). [**6L**]

Module-VII: *Stepper Motor*: Types and principle of operation of steppermotor. Stepper Motor Control: Stepper Drive –Dual Voltage Drive–Chopper Drive. [**4L**]

Total: 40L

Text/Reference Book:

1) Power Electronics- Bimbhra
2) Modern power Electronics-P.C. Sen
3) Power Electronics: Converters, Application & Design–Mohan, Undealand, Robbins
4) Industrial Electronics-S.N. Biswas
5) Power Electronics: Devices, Drivers, applications & passive Components - B. W. Williams

Course Outcomes:

At the end of the course the students will be able to

1) Understand the use Power devices, understand the requirement of cooling and protection of Power devices.
2) Learn Controlled Rectifier Circuits, Understand the principles of DC to AC inverters.
3) Acquire a thorough knowledge of DC RPS,Understand Power Line Disturbances and Conditioners & UPS.
4) Learn about Stepper motor and its control.

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UECE616	C. Automotive Electronics (OE-2)	3L: 0T: 0P	6 credits

Automotive Communication Protocols: [4L]

Automotive Electronics: Current trends in modern automobiles Open and close loop Systems-Components for electronic engine management. Electronic management of chassis system, Vehicle motion control.

Sensors and Actuators: Basic sensor arrangement, Types of sensors such as-Oxygen sensors, Crank angle position sensors-Fuel metering/vehicle speed sensor and detonation sensor; Altitude sensor, flow sensor. Throttle position sensors. Solenoids, stepper motors, and relays. [6L]

Electronic Fuel Injection and Ignition Systems: Introduction, feedback carburettor systems. Throttle body injection and multiport or point fuel injection, fuel injection systems, Contact less electronic ignition system, and electronic spark timing control. [6L]

Digital Engine Control System: Open loop and closed loop control systems-Engine cranking and warm up control-Acceleration enrichment-deacceleration leaning and idle speed control. Distributor less ignition-Integrated engine control systems, Exhaust mission control engineering. Electronic dashboard instruments-Onboard diagnosis system, security and warning system. [4L]

Networks in Automotive Systems: [20L]

3.1 History and foundation of CAN, CAN Applications, Main characteristics of CAN, CAN in OSI Reference Model, CAN Data Link Layer, Principles of data exchange in CAN, Arbitration, Data Frame, Remote Frame, Error detection and management in CAN, CAN physical Layer, Bit encoding, Bit timing and synchronization, Relationship between data rate and bus length, Single wire and twin wire media, CAN repeaters, Medium-to-medium gateway, Protocol handlers, Micro-controllers and line drivers

3.2 Interconnect Network (LIN) Protocol: Introduction to LIN, LIN consortium, LIN specification, LIN features, Technical overview, Work flow concept, LIN operation, LIN frame format, Scheduling table, Network management of LIN cluster, LIN Transport Layer, LIN node configuration and identification.

3.3 FlexRay Protocol, FlexRay frame format, Timing of configuration protocol, Error control, and FlexRay core mechanisms, Coding and Decoding, Medium Access Control, Frame and Symbol Processing, Clock Synchronization, FlexRay Components, Comparison with other IVN protocols and Case Study.

3.4 Media Oriented System Transport (MOST) Protocol: MOST Layer Model, Application Framework, New isochronous transmission mechanisms for MOST150, Network Services, MOST Data Link Layer, MOST Timing Master, Timing Slave, Physical Layer, Optical Physical Layer, Electrical Physical Layer, MOST Device, Network Management.

Total: 40L

Texts/References

1. Ronald k. Jurgen. Automotive Electronics Handbook, McGraw-Hill. 1999
2. William B. Ribbens, Understanding Automotive Electronics, 5th Edition, Butterworth, Heinemann Woburn, 1998.
3. Automotive Hand Book, Robert Bosch, Bently Publishers, 1997, Reprint 2012
4. Gilbert Held. Inter- and Intra-Vehicle Communications, CRC Press, (2007]
5. NajamuzZaman, "Automotive Electronics Design Fundamental'' first edition, Springer 2015.

UHSS601	Engineering Economics	3L: 0T: 0P	6 credits

Unit:1 [8L]

Definition of Economics, Consumer behaviour, Utility analysis and demand analysis, Kinds of Demand, Law of Demand and Law of Supply, Elasticity of Demand: Types and Measurement, Scope of Economics including economics of environment and e-commerce.

Unit:2 [8L]

Market forms-Perfect and Imperfect markets, Features of Perfect competition, Monopoly and Monopolistic competition. Price and output determination under Perfect Competition, Monopoly, Monopolistic and Oligopoly etc. Concept of Production function, Cost Analysis, Estimation of cost function-Profit and Break-Even Analysis.

Unit:3 [8L]

National Income, GNP and NNP, Per-Capita Income, Source of Public Revenue-Tax Revenue and Non-Tax Revenue, Direct and Indirect Tax. Inflation and Deflation. Banking-Definition-Types and function of Bank. Concept of Investment Analysis.

Unit:4 [8L]

Features of Indian Economy, Economic Reforms in India-Concept of Economic Liberalization, Privatization and Globalization, Unemployment Problem in India-Types, Causes, remedial measures and recent employment generation scheme of Government of India.

Unit:5 [8L]

International Trade, Gains from International Trade, The World Trading Environment and Multinational Corporations, BPO etc. Function and Role of IMF, World Bank and WTO. Concept of Stock Exchange Market and Market for Securities.

Total: 40L

Reference Book:

I)Samuelson, P. A. and W. D. Nordhaus, Economics, McGraw Hill, New York
II) Mishra, Sasmita (2009), Engineering Economics and Costing, Prentice Hall of India Pvt. Limited
III) Thuesen, G. J. and W. J. Fabrycky, Engineering Economics, Prentice Hall of India, New Delhi
IV) Dwivedy, D. N. (6^{th} ed), Managerial Economics, Vikas Publishing House
V) Mishra, R, Engineering Economics, University Science Press, New Delhi
VI) Datt&Sundharam (latest edition), Indian Economy, S. Chand Publication, New Delhi
VII) Misra&Puri (latest edition), Indian Economy, Himalaya Publishing House
VIII) Ahmed, A and Begum, G, Engineering Economics,Chandra Prakesh, Guwahati

Course Outcomes:

At the end of the course the students will be able to

1. Know how to use our limited resources to fulfil our unlimited wants.
2. Know what is the cost of production and how it effects on price and ultimately the demand of product.
3. Understand the behaviour of Producer and Consumer in different types of markets.
4. Understand the cost benefit analysis of any kind of projects.

Semester VII

UECE711	A. Microwave Theory and Techniques	3L: 0T: 0P	6 credits

1.**Introduction:**
RF & Microwave Spectrum, Historical Background, Typical applications of RF & Microwaves [1L]

2. **Microwave Waveguides:**Rectangular and Circular Waveguides– Mode structures, Cut-offfrequency, PropagationCharacteristics, wall currents, Attenuation constant, waveguide excitations. [5L]

3.**Waveguide Passive Components:**Waveguide Resonators – Rectangular & Cylindrical; Resonant frequencies, Mode structures, Q factor,Co-axial Resonators; Excitation & coupling of cavities. [5L]

N-port networks: circuit representations, Z-matrix, Y-matrix, S-matrix, transmission matrix, their relationships; attenuators, phase shifter, directional couplers, Bethe-hole coupler, Magictee, hybridring, circulators, isolators. [5L]

4.**Planar structure:**Strip lines, Micro-strip lines, coplanar structure, Slot lines, Suspended strip lines, Field patterns, propagation characteristics, Design considerations. Comparison of characteristics of lines. [5L]

5**. Microwave Tubes:**Limitations of conventional tubes in microwaves; Multi-cavity Klystron, Reflex klystron;Magnetron, Travelling wave tube. [5L]

6. **Semiconductor Microwave Devices**: Gunn diode, IMPATT [3L]

7.**Applications of Microwave:** Industrial applications: Process control, Measurement Techniques of parameters, A few examplesof industrial measurements: Thickness of dielectric sheets, diameters of wires, Moisture content insolid & liquids. Doppler sensors, Microwave heating, its applications, Bio-medical applications. [5L]

8.**Microwave Measurements**: Microwave Bench, Slotted line, Tuneable Probe, VSWR Meter, Slide screw tuner, Variableshorted line – operating principles with diagrams.
Measurements of VSWR – Low, Medium and High, Measurement of Power – Calorimetricmethod, Thermocouple, Bolometers, Frequency measurement, Impedance measurement by shift inminima. Network Analysers, TDR, and Spectrum analyser. [6L]

Total: 40L

Text Books

1. SY Liao - Microwave Devices & Circuits, Pearson Education /PHI
2. S Das & A Das - Microwave Engineering, Tata-McGraw Hill
3. David M Pozar - Microwave Engineering, John Willy & Sons Inc.
4. Robert E Collin - Foundation of Microwave Engineering, 2nd edition, McGraw Hill, Inc.

References Books

1. K C Gupta – Microwaves, New Age Publishers
2. ML Sisodia & GS Raghuvansi - Microwave Circuits and Passive Devices,New Age Publishers
3. PA Rizzi - Microwave Engineering-Passive Circuits, Pearson Education

Course Objectives: The subject aims to provide the student with:

1. An understanding of microwave waveguides, passive & active devices, tubes and network analysis.
2. An understanding of microwave source.
3. An ability to perform microwave measurements.
4. An ability to understand the application of Microwaves.

Course Outcomes: The student after undergoing this course will be able to:

1. Explain different types of waveguides and their respective modes of propagation.
2. Analyse typical microwave networks using impedance, admittance, transmission and scattering matrix representations.
3. Explain working of microwave passive circuits such as isolator, circulator, Directional couplers, attenuators etc.
4. Describe and explain working of microwave tubes and solid-state devices.
5. Perform measurements on microwave devices and networks

UECE711	**B. Advanced Antenna Theory and Design**	**3L: 0T: 0P**	**6 credits**

Module 1: Radiation from Wires and Loops [6L]

Physical concept of radiation, Radiation from -Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop. Polarization – Linear, Circular and Elliptical, Radiated Fields, Radiation resistance, Field regions & Directivity, Current distribution, Radiated Fields. Design of Half wave Dipole Antenna, Design of Monopole Antenna

Module 2: Aperture Antennas: [5L]

Huygens' Principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts.Design of Horn Antenna, Design of Parabolic Antenna

Module 4: Broadband Antennas: [4L]

Broadband concept, Log-periodic antennas, frequency independent antennas, Antennas for Satellite communication.Design of Circular antenna Simulation for UWB, Design of Log Periodic Dipole Antenna

Module 5: Microstrip Antennas: [5L]

Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.
Design of Microstrip Antenna Simulation, Design of Microstrip Antenna Array Simulation

Module 6: Antenna Arrays: [6L]

Analysis of uniformly spaced arrays with non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelenkuoff polynomial method, Woodward-Lawson method.

Module 7: Basic Concepts of Smart Antennas: [4L]

Concept and benefits of smart antennas, fixed weight beam forming basics, Adaptive beam forming
Design of 5G phased array antenna design and beam forming

Total: 30L

Text Books:

1. C. A. Balanis, "Antenna Theory and Design", 3rd Ed., John Wiley & Sons., 2005.
2. W. L. Stutzman, and G. A. Thiele, "Antenna Theory and Design", 2nd Ed., John Wiley & Sons., 1998.
3. R. S. Elliot, "Antenna Theory and Design", Revised edition, Wiley-IEEE Press., 2003.

Reference Books:

1. G.S.N. Raju, "Antennas and Wave Propagation", Person Education.

Course Objective

- To understand the theory and fundamentals of antenna design.
- This course helps the students to learn key aspects of practical antenna design.
- A broad range of antennas such as dipole, loop, microstrip patch, horn, smart etc are studied during the course.

Course Outcome

- Design and analyze antenna arrays
- Design and analyze wire and aperture antennas
- Design of Microstrip Patch antenna

UECE711	C. High Speed Devices and Circuits (OE-6)	3L: 0T: 0P	6 credits

1.Important parameters governing the high-speed performance of devices and circuits: - Transit time of charge carriers, junction capacitances, ON-resistances and their dependence on the device geometry and size, carrier mobility, doping concentration and temperature. Contact resistance and interconnection/interlayer capacitances in the Integrated Electronic Circuits. **[4L]**

2. Silicon based MOSFET and BJT circuits for high speed operation and their limitations: - Emitter coupled Logic (ECL) and CMOS Logic circuits with scaled down devices. Silicon on Insulator (SOI) wafer preparation methods and SOI based devices and SOICMOS circuits for high speed low power applications.

[**8L**]

3. Materials for high speed devices and circuits: - Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs ETC.), silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon-based devices. Brief outline of the crystal structure, dopants and electrical properties such as carrier mobility, velocity versus electric field characteristics of these materials. Material and device process technique with these III-V and IV – IV semiconductors. [**8L**]

4. Metal semiconductor contacts and Metal Insulator Semiconductor and MOS devices: Native oxides of Compound semiconductors for MOS devices and the interface state density related issues. Metal semiconductor contacts, Schottky barrier diode. Thermionic Emission model for current transport and current-voltage (I-V) characteristics. Effect of interface states and interfacial thin electric layer on the Schottky barrier height and the I-V characteristics. [**6L**]

5. Metal semiconductor Field Effect Transistors (MESFETs): Pinch off voltage and threshold voltage of MESFETs. D.C. characteristics and analysis of drain current. Velocity overshoot effects and the related advantages of GaAs, InP and GaN based devices for high speed operation. Sub threshold characteristics, short channel effects and the performance of scaled down devices. [**6L**]

6. High Electron Mobility Transistors (HEMT): Hetero-junction devices. The generic Modulation Doped FET(MODFET) structure for high electron mobility realization. Principle of operation and the unique features of HEMT. InGaAs/InP HEMT structures. [**6L**]

7. Hetero junction Bipolar transistors (HBTs): Principle of operation and the benefits of hetero junction BJT for high speed applications. GaAs and InP based HBT device structure and the surface passivation for stable high gain high frequency performance. SiGe HBTs and the concept of strained layer devices.

[**6L**]

8. High speed Circuits: GaAs Digital Integrated Circuits for high speed operation- Direct Coupled Field Effect Transistor Logic (DCFL), Schottky Diode FET Logic (SDFL), Buffered FET Logic (BFL). GaAs FET Amplifiers. Monolithic Microwave Integrated Circuits (MMICs) (4 hours) 9. High Frequency resonant – tunnelling devices. Resonant-tunnelling hot electron transistors and circuits. [**5L**]

Total: 35L

REFERENCES BOOKS:

1. C.Y. Chang, F. Kai, GaAs High-Speed Devices: Physics, Technology and Circuit Applications Wiley
2. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons
3. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams& Co., 1985

4. Avishay Katz, Indium Phosphide and Related materials: Processing, Technology and Devices, Artech House, 1992.
5. S.M. Sze, High Speed Semiconductor Devices, Wiley (1990) ISBN 0-471-62307-5
6. Ralph E. Williams, Modern GaAs Processing Methods, Artech (1990), ISBN 0-89006-343-5
7. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press (1991), ISBN 0-12-691740-X
8. G.A. Armstrong, C.K. Maiti, TCAD for Si, SiGe and GaAs Integrated Circuits, The Institution of Engineering and Technology, London, United Kingdom, 2007,ISBN 978-0-86341-743-6.
9. Ruediger Quay, Gallium Nitride Electronics, Springer 2008, ISBN 978-3-540-71890-1.

Course Outcomes:

After taking this course, the student will be able to understand:

1. Various factors that influence the speed of devices and circuits
2. The strategies to improve the speed of electronic devices such as fabrication using new materials, Schottky & hetero junctions and strain engineering etc.
3. The working of various high-speed logic families

UECE712	A. Wireless & Mobile Communication	3L: 0T: 0P	6 credits

Module-I:Cellular Mobile Radio Systems: Introduction to Cellular Mobile System, Performance criteria, uniqueness of mobile radio environment, operation of cellular systems, Hexagonal shaped cells, Analog and Digital Cellular systems.

Elements of Cellular Radio System Design: General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in Omni directional Antenna system, Cell splitting, consideration of the components of Cellular system [**10L**]

Module-II:.Interference: Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, design of Antenna system, Antenna parameters and their effects, diversity receiver, non-co-channel interference-different types.

Cell Coverage for Signal and Traffic: Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long-distance propagation antenna height gain, form of a point to point model. Handoff, dropped calls and cell splitting, types of handoff, handoff invitation,delayinghandoff, forced handoff, mobile assigned handoff. Intersystem handoff, cell splitting,microcells, vehicle locating methods, dropped call rates and their evaluation.

[**10L**]

Module-III:.Multiple Access Techniques: Introduction, Comparisons of multiple Access StrategiesTDMA, CDMA, FDMA, OFDM, CSMA Protocols.

GSM system for mobile: Services and features, System Architecture, RadioSub system Channel types, Frame Structure.CDMA Digital Cellular Standard (IS 95): Frequency and Channelspecifications, Forward CDMA channel and reverse CDMA channel [**10L**]

Module-IV:Introduction to Mobile Adhoc Networks, Introduction to Wi-Fi, WiMAX, ZigBee Networks, SoftwareDefined Radio, UWB Radio, Wireless Adhoc Network and Mobile
Portability, Security issues and challenges in a Wireless network.Mobile data networks, wireless standards IMT2000, Introduction to 4G and concept of 5G. [**10L**]

Total: 40L

TEXTBOOKS

1. Mobile Cellular Telecommunications – W.C.Y. Lee, MC Graw Hill, 2nd Edn., 1989.
2. Wireless Communications - Theodore. S. Rapport, Pearson education, 2nd Edn., 2002.

REFERENCES

1. Wireless Communication Technology – R. Blake, Thompson Asia Pvt. Ltd., 2004.
2. Wireless Communication and Networking – Jon W. Mark and WeihuaZhqung, PHI, 2005.
3. Cellular & Mobile Communications – Lee, MC Graw Hill.
4. Adhoc Mobile Wireless network, C.K.Toh Pearson

Learning Objectives: The course will provide fundamental of theoretical concepts thatform the basis for wireless communication. The course emphasises for creating the foundation of cellular network which is useful for understanding the fundamentals of mobile communication system design. The students will learn Mobile RadioPropagation models and various wireless channel effects. Student will understand Multiple Accesstechniques.The course also covers overview of recent trends likewireless communication like Wi-Fi, Wi-MAX, bee and Wireless Adhoc Networks.

Course Outcome:

After learning the course, the students should be able to:

1 Understand the basics of propagation of radio signals
2 Understand the basic concepts of basic Cellular System and the design requirements
3 Have an understanding of the basic principles behind radio resource management techniques such as power control, channel allocation and handoffs.
4 Gain insights into various mobile radio propagation models and how the diversity can be exploited to improve performance
5 Gain knowledge and awareness of the technologies for how to effectively share spectrum through multiple access techniques i.e. TDMA, CDMA, FDMA etc.
6 Have in-depth understanding of the design consideration and architecture for different Wireless Systems like GSM, CDMA, GPRS etc
7 Understanding of the emerging trends in Wireless communication like WiFi, WiMAXrelated issues and challenges.

UECE712	B. Wireless Sensor Networks	3L: 0T: 0P	6 credits

Introduction to Wireless Sensor Networks: Motivations, Applications, Performance metrics, History and Design factors [3L]

Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture [4L]

Medium Access Control Protocol design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled [4L]

Introduction to Markov Chain: Discrete time Markov Chain definition, properties, classification and analysis [4L]

MAC Protocol Analysis: Asynchronous duty-cycled X-MAC Analysis (Markov Chain) [3L]

Routing protocols: Introduction, MANET protocols [3L]

Routing protocols for WSN: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast [3L]

Opportunistic Routing Analysis: Analysis of opportunistic routing (Markov Chain) [3L]

Clustering: Clustering goals, types, high-level overview, clustering in WSNs [3L]

QoS management: Basic functions, centralized solution, Topology control, Sensor mode selection [3L]

Time Synchronization:Overview of different time synchronization protocols [2L]

Security: Possible attacks, countermeasures, SPINS, Static and dynamic key distribution [3L]

Energy Harvesting WSNs: Energy harvesting for self-sustainable WSNs [2L]

Open Research Issues: Course conclusion, research issues, simulation aspects, hardware platforms and general discussion [2L]

Total: 42L

Course objectives (CO)

The objective of the course is to learn the basic principles behind a Wireless Sensor Network. Following the ISO Open Systems Interconnection (OSI) model, the course includes the particular challenges of designing network protocols, services and applications for WSNs composed of large numbers of constrained devices.

Text Books:

1. Fundamentals of Wireless Sensor Networks: Theory and Practice, W. Dargie, Wiley, 2011.

2. Wireless Sensor Networks, I F Akyildiz and M C Vuran, Wiley, 2010.

3. Wireless Sensor Networks: From Theory to Applications, S Ramakrishnan and El Emary, CRC Press, 2013.

UECE712	C. Quantum Transport in Nanoscale Devices	3L: 0T: 0P	6 credits

Introduction: Theory of quantum transport Bottom up view point, Landauer approach, connection with diffusive transport. Examples of equilibrium calculations: concept of band structure, quantum wells, nanowires, carbon nanotubes, graphene, electrostatics, quantum capacitance. [10L]

Non-equilibrium transport: elastic resistor model re-visited from quantum transport perspective, introducing "contacts" to the Schrodinger equation, Green's function theory, self-energy, Non-equilibrium Green's function (NEGF) formalism Application of the NEGF formalism to concrete examples: a) molecular electronics, b) nanowire transport, c) resonant tunnelling diodes Non-coherent transport: Electron phonon interaction. [10L]

Examples of Quantum transport: Nano transistors, Thermoelectric transport, energy conversion efficiency, low dimensional thermoelectric, Energy, entropy and heat currents, connection with second law, quantum thermodynamics. [10L]

Advanced Topics: Strongly correlated transport, Second Quantization, Formal derivation of NEGF equations, qubit and quantum computation concepts, examples using quantum dots, Information theoretic description of transport, Maxwell's demon, fundamental limits of computation, smart contacts, spin caloritronics, and exploratory paradigms, future overlook. [10L]

Total: 40L

REFERENCES BOOKS:

1. Supriyo Datta, "Quantum Transport: Atom to Transistor", Cambridge, (2005)
2. Massimiliano Di Ventra, "Electrical Transport in Nanoscale Systems", Cambridge University Press (2008)
3. David K. Ferry, Stephen Goodnick, Jonathan Bird, "Transport in Nanostructures", Cambridge University Press (2009)
4. Y. Imri, "Introduction to Mesoscopic Physics", Oxford University Press (2008)
5. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Quantum Heterostructures: Microelectronics and Optoelectronics", Cambridge University Press 1999
6. Supriyo Dutta, "Electronic Transport in Mesoscopic Systems", Cambridge University Press 1995
7. Y. V. Nazarov, Y. M. Blanter, "Quantum Transport - Introduction to Nanoscience", Cambridge University Press (2009)
8. John M. Davies, "The Physics of Low-dimensional Semiconductors: An Introduction", Cambridge University Press (1997)
9. E. N. Economou, Green's functions in Quantum Physics, Springer, (2006)

Course Outcomes:

After taking this course, the student will be able to understand:

1. The impact of length scales on the type of electron transport
2. NEGF formalism which can model quantum transport in molecular structures
3. Strategies to incorporate scattering within the NEGF model
4. Transport from an information theoretic view point.

UECE713	A. Adaptive Signal Processing (OE-3)	3L: 0T: 0P	6 credits

Module 1:*Discrete random processes:* Random variables, random processes, filtered random processes. Ensemble averages, correlation, covariance, power spectrum, cross power spectrum. Ergodicity, time averages, biased & unbiased estimators, consistent estimators. [8L]

Module 2:*Linear prediction:* Direct form linear prediction filtering. Normal equations for linear prediction filtering. Levinson algorithm. Linear prediction lattice filtering. [12L]

Module 3:*Digital Wiener filtering:* Wiener smoothing and prediction filters. Application of Wiener smoothing to noise cancelling. Application of Wiener prediction filters. Constrained, linear MMSE filtering. [10L]

Module 4:*Least mean squares adaptive filter:* LMS adaptive algorithm. Properties of LMS adaptive filter. Normalized forms. Finite precision effects. [7L]

Module 5:*Least squares adaptive filters:* Godard algorithm. Lattice. [3L]

Total: 40L

Text Books:

1.T. Adali and S. Haykin, ADAPTIVE SIGNAL PROCESSING: Next Generation Solutions, John Wiley & Sons Inc., 2010.

2. D. G. Manolakis, V.K. Ingle, S.M. Kogon, Adaptive Signal Processing, McGraw-Hill, 2000 or latest.

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

Course objectives (CO)

1. The student will be aware and able to visualize the domain of adaptive signal processing
2. The student will be able to identify a random process and formulate to extract desired information
3. The student will be able to develop algorithms meeting application specific performance criteria.

UECE713	B. Satellite Communication (OE-3)	3L: 0T: 0P	6 credits

Introduction: Origin of Satellite Communications, Historical Back-ground, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communications. [4L]

Orbital Mechanics and Launchers: Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance. [6L]

Satellite Subsystems: Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment liability and Space qualification. [6L]

Satellite Link Design: Basic transmission theory, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example. [5L]

Multiple Access: Frequency division multiple access (FDMA) Inter-modulation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA), Spread spectrum transmission and reception. [6L]

Earth Station Technology: Introduction, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods. [5L]

Low Earth Orbit and Geo-Stationary Satellite Systems: Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation designs. [6L]

Satellite Navigation & the Global Positioning System: Radio and Satellite Navigation, GPS Position Location principles, GPS Receivers and codes, Satellite signal acquisition, GPS Navigation Message, GPS signal levels, GPS receiver operation, GPS C/A code accuracy. [7L]

Total: 45L

TEXT BOOKS:

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2nd Edition, 2003.
2. Satellite Communications Engineering – Wilbur L. Pritchard, Robert A Nelson and Henri G.Suyderhoud, 2nd Edition, Pearson Publications, 2003.

COURSE OUTCOME:

At the end of this course students will demonstrate the ability to

1.) Understand the basic knowledge about satellite communication, its history and future trends.
2.) Find the orbital mechanics about look angle determination, perturbation, launch vehicles and orbital effects in satellite communication.
3.) Understand about different types of satellite subsystems like TTC& M subsystem, power subsystem and communication subsystem.

4.) Study about the basic transmission theory and noise affect with variation in temperature in such design and understand about the different satellite link design.
5.) Understand about different multiple access and to calculate C/N ratio during transmission and reception process.
6.) Understand the different earth station technology with various power test methods.
7.) Study about different orbits and its frequency consideration by applying constellation design.
8.) Understand about the satellite navigation and GPS which can be used in satellite communication link process.

UECE713	C. Cryptography and Network Security (OE-3)	3L: 0T: 0P	6 credits

Introduction: Introduction to Security attacks, services and mechanisms (X.800), Introduction to cryptology, Conventional Encryption model, classical encryption techniques-substitution ciphers & transposition ciphers, cryptanalysis, stereography, stream & block ciphers. [6L]

Modern Block ciphers: Block Ciphers principles, DES, Strength of DES, Differential & Linear Cryptanalysis of DES, Block cipher modes of operation, triple DES, Confidentiality using conventional encryption, key distribution, random number generation, RC4. [9L]

Principles of Public Key Cryptography: Principle of public key cryptography, prime and relatively prime numbers, modular arithmetic, Euler's algorithm, Primality test, Congruence, RSA algorithm, Diffie-Hellman Key Exchange. [7L]

Authentication mechanisms: Data integrity, Message authentication, Message authentication code, Cryptographic hash key, Digital Signatures, Digital Signature Standard (DSS). [5L]

Electronics mail security: Pretty good privacy (PGP), S/MIME, IP security- IP security overview, architecture, authentication header, encapsulating security payloads, combining security association, key management. [9L]

Web security: Security socket layer & transport layer security, secure electronic transaction (SET) [5L]

System security: intruders, viruses and related threads, firewall design principles. [4L]

Total: 45L

Books and References:

1. *William Stalling "Cryptography and networks security: Principles and Practice," Prentice Hall, New jersey,*
2. *Johannes A Buchmann, "Introduction to cryptography," Spiringer–verlag*
3. *Bruce Schiener, "Applied Cryptography"*.

Course Outcome:

At the end of the course, the student should be able to:

- Understand the fundamentals of networks security, security architecture, threats and vulnerabilities
- Apply the different cryptographic operations of symmetric cryptographic algorithms
- Apply the different cryptographic operations of public key cryptography
- Apply the various Authentication mechanisms.
- Understand various Security practices and System security standards

UECE714	A. Embedded Systems (OE-4)	3L: 0T: 0P	6 credits

Introduction to Embedded System [**10L**]

1.1 Core of the embedded system, Memory, Sensors and Actuators Communication Interface, Embedded firmware; Examples: Smart card, ECU, ADAS, Smart Watch

1.2 Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency.

1.3 Embedded Product development life cycle, Program modelling concepts: DFG, CDFG, FSM, Petri-net, UML

Embedded Hardware and Design **[10L]**

2.1 Embedded RISC Processors: The ARM Design Philosophy, ARM processor Families, Core extensions, Architecture Revisions Arm Cortex-M4 Processor,

2.2 Hardware accelerators- CPUs and accelerators, accelerator system design.

2.2 Memory Systems: RAM, ROM, types of RAM and ROM, memory testing, CRC, Flash memory

2.3 Sensors/Actuators/RF Modules

Buses and I/O, Networking: **[10L]**

3.1 Onboard communication interfaces-I2C, SPI, CAN, parallel interface;

3.2 External communication interfaces-RS232 and RS485, USB, infrared, Bluetooth, Wi-Fi, ZigBee, GPRS, GSM

3.1 Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, CAN, LIN Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee; BLE

Embedded Software & Firmware Concepts **[10L]**

4.1 Basic embedded C programs/applications, C Programs involving 8-bit AVR microcontrollers; Serial data transmission/ reception; programming with interrupts; SPI/I2C programming for EEPROM, ADC, DAC, RF Module; Programming involving ARM microcontrollers.

4.2 Real time operating system: Need of RTOS in Embedded system software, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling: non-pre-emptive and pre-emptive scheduling; task communication-shared memory, message passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques.

Total: 40L

Text/References

1. Embedded Systems: Frank Vahid, Wiley India, 2002
2. Frank Vahid & Tony Givargis, "Embedded System Design-A Unified Hardware/Software Introduction", Third Edition, John Wiley & Sons Inc., Reprint 2010
3. Introduction to Embedded Systems: Shibu K. V. (TMH)
4. Embedded Microcomputer Systems – Real Time Interfacing – Jonathan W. Valvano; Cengage Learning; Third or later edition
5. Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education, India ISBN: 9788131708408, 8131708403, 2015
6. Embedded Systems: Real-Time Interfacing to ARM Cortex M Microcontrollers, Fifth edition 2016, ISBN: 978-1463590154
7. Z. Yifeng, "Embedded Systems with ARM Cortex-M microcontrollers in Assembly Language and C", E-Man Press.
8. G.H. Raghunathan, "Microcontrollers (ARM) & Embedded Systems" Cengage Learning

COURSE OBJECTIVE/OUTCOME:

• To get acquainted with modern electronic systems many embedded systems in it.

• To understand the design flow of an embedded product.

• To learn the ARM RISC processors used in many embedded products.

• Learn and write the embedded C programming for AVR / ARM microcontrollers.

• Understanding the RTOS concepts

• Understand the specifications for a targeted Embedded design

• Formulate the hardware and firmware aspects of the design for the first pass.

• On completion of the course, student will be able to design embedded System for real life problem.

• Being adapted to recent technologies and devices for a specific design challenge.

UECE714	B. Machine Learning (OE-4)	3L: 0T: 0P	6 credits

Module-I

Introduction to Machine learning and its application. Supervised and unsupervised learning, Concept learning, Hypothesis testing, Find-S algorithm, candidate elimination algorithm, Decision Trees for Classification, Regression and logistic regression.

[8L]

Module-II

Linear Models and Learning via Optimization, Learning via Probabilistic Modelling, Probabilistic Models for Supervised Learning: Discriminative approaches, Probabilistic Models for Supervised Learning: Generative approaches.

[8L]

Module-III

Optimization, Hyperplane based Classifiers, Perceptron and Support vector machine.

[8L]

Module -IV

Nonlinear Learning via Kernel Methods, Making Linear Models Nonlinear via Kernel Methods, Unsupervised learning: K-means clustering, Expectation Maximization, Latent variable models and its parameter estimation, Dimensionality reduction

[8L]

Module-V

Introduction to Artificial Neural Network, Feature extraction, Loss function, Backpropagation, Deep architectures, Convolutional Neural Network.

[8L]

Total: 40L

References:

- Hal Daumé III, A course in Machine Leaning (CIML), 2017 (freely available online)
- Kevin Murphy, Machine Learning: A probabilistic Perspective (MLAPP), MIT Press, 2012
- Christopher Bishop, Pattern Recognition and Machine Learning (PRML), Springer, 2007.
- David G. Stork, Peter E. Hart, and Richard O. Duda. Pattern Classification (PC), Wiley-Blackwell, 2000
- Ian Goodfellow and YoshuaBengio and Aaron Courville. Deep Learning (DL), MIT Pess, 2016 (individual chapters freely available online)
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning (ESL), Springer, 2009 (freely available online)
- Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From theory to Algorithms (UML), Cambridge University Press, 2014
- MehryarMohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Leaning (FOML), MIT Press

Outcome of the Course:

After completing this course, the student will be able to

- Understand the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
- Understand of the strengths and weaknesses of many popular machine learning approaches.
- Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and unsupervised learning.

Be able to implement various machine learning algorithms in a range of real-world applications

UECE714	C. Quantum Computation and Quantum Information(OE-4)	3L: 0T: 0P	6 credits

Module-1 **[12L]**

Introduction: Postulates of Quantum Mechanics, Dirac bra and ket notation, the idea of a qubit, Bloch sphere, Composite states, tensor products. Entanglement, EPR and GHZ states.
Quantum gates: Single qubit gates, Controlled-NOT gate, Toffoli gate. Quantum no-cloning.
Quantum Circuits: quantum teleportation, super dense coding.

Module-2 **[12L]**

Quantum Algorithms: Quantum parallelism, Deutsch Algorithm, Deutsch-Jozsa algorithm, Simon's algorithm. Quantum Fourier transform. Phase estimation algorithm. Shor's algorithm for factorization. Grover's search algorithm.

Module-3 **[12L]**

Density operators, pure and mixed states, decoherence. Entropy and information: Shannon Entropy and Von Neumann entropy. Quantum error correction: Shor's and Steane's codes, Fault tolerant quantum computation.

Module-4 **[8L]**

Quantum cryptography: quantum key distribution, BB84, B92, and EPR protocols, quantum privacy and security.
Physical realizations of quantum gates.

Total: 44L

Text Book:

1. M. A. Nielsen and I. A. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, New Delhi, 2010.

REFERENCES BOOKS:

1. R. P. Feynman, R. B. Leighton, and M. Sands, The Feynman Lectures on Physics, vol.3, Addison Wesley/Narosa, New Delhi, 1998.
2. R. P. Feynman, R. W. Allen, and T. Hey, The Feynman Lectures on Computation, Westview Press/Perseus Book Group, 1999.
3. J. J. Sakurai, Modern Quantum Mechanics, Addison-Wesley/Pearson Education, 1994.
4. D. Bouwmeester, A. Ekert, A. Zeilinger (Eds.), The Physics of Quantum Information, Springer, 2000.
5. N. D. Mermin, Quantum Computer Science (Cambridge, 2007).
6. T. M. Cover and J. A. Thomas, Elements of Information Theory, 2d ed, (Wiley Interscience, 2006).
7. D. R. Stinson, Cryptography: Theory and Practice, 3d ed, (Chapman and Hall/CRC, 2006).
8. T. H. Cormen, C. E. Leiserson and R. L. Rivest, Introduction to Algorithms (MIT Press, 1990).
9. J. Preskill, Notes on Quantum Computation, http://www.theory.caltech.edu/people/preskill/ph229.
10. A. Yu. Kitaev, A.H. Shen, and M.N. Vyalyi, Classical and Quantum Computation, American Mathematical Society, Providence, 2002.

Course Outcomes:

After taking this course, the student will be able to understand:

1. Quantum description of the microscopic world
2. Logic gates that employ superposition and entanglement of quantum states
3. The most important classes of quantum algorithms for computation
4. The strategies and protocols that employ quantum features in communication and security.

UHSS701	Industrial Management and Entrepreneurship	3L: 0T: 0P	6 credits

Unit:1 [8L]

Meaning and Concept of Management, Principles and function of Management, Concept of Organisational Behaviour, Function of a Manager—Planning, Organizing, Coordinating and Controlling. Motivation—implication of Managers and application. Leadership and Decision Making: Qualities and Styles of Leadership.

Unit:2 [8L]

Individual Process in Organizations-Perception, attitude and personality, how they influence people. Group Process in Organizations, Group formation, Group effectiveness, Group Conflict.

Unit:3 [8L]

Evolution, Role and Status of Human Resource Management in India. Recruitment and Selection Process in Organization, Manpower Planning - Job Analysis-Job Specification-Selection Process-Test and Interview. Trade Union and Collective Bargaining, Factory Act.

Unit:4 [8L]

Entrepreneurship-Meaning, Types of entrepreneur, Qualities of an entrepreneur, Role of Entrepreneur, Factors affecting entrepreneurial growth. Entrepreneurship Development Programme-Concept, Objective and Importance, Engineer Entrepreneurship Training Programme Scheme.

Unit:5 [8L]

Small Scale Industry-Definition, Types of Small-Scale Industry, How to Set up Small Scale Industry, Role and Problem of Small-Scale Industry. Concept of Joint Stock Company, Private and Public Limited Company, IPR, Source of Finance for Entrepreneur-Bank, Government and Financial Institutions etc.

Total: 44L

Reference Books:

I) S.S. Khanka-OrganizationalBehavior,S.Chand& Company , New Delhi
II) S.S.Sarkar, R.K. Sharma and S.K. Gupta – Business Organization and Entrepreneurship Development, KalyaniPublishers, New Delhi
III) Arbinda Debnath – Principles of Management, BLG Publication, Guwahati
IV) L.M. Pradad - Principles and Practice of Management , S.Chand& Company New delhi
V) S.S. Khanka – Entrepreneurial Development,S.Chand& Company , New-Delhi
VI) M.B. Shukla –Entrepreneurship and Small Business Management, KitabMahal, Guwahati
VII) Kanchan Bhatia and Shweta Mittal – Management Concept and Practice, Variety Books Publishers & Distributors.

Course Outcomes:

After taking this course, the student will be able to understand:

1. Start-up their own entrepreneurial activities or own ventures.
2. Developed their own Organizational Behavior which is very much important to run any kind of organization or survive themselves in the corporate world.
3. Create jobs not only for them but also for others. So, they will not be job checker but also job maker.

Semester VIII

UECE811	A. Optical Communication	3L: 0T: 0P	6 credits

Module-1

Introduction to Optical fiber communication, Basic Optical communication system, Ray theory of Transmission, Optical waveguide [**4L**]

Module-2

Different types of optical fibers, step index fiber, Graded index fiber, Signaldegradation on optical fiber due to dispersion and attenuation, Grin rod lenses, fiber couplers [**3L**]

Module-3

Optical sources - LEDs and Lasers, Photo-detectors –junction photodiodes, pin-diodes, APDs, photo transistor, detectorresponsivity, noise in optical receivers. Optical link design –Link power budget, Rise time budget. [**8L**]

Module-4

Power launching and coupling-Sources and their output patterns, Power coupling calculation, equilibrium numerical aperture, coupling arrangements- lensing schemes for coupling improvement, Laser-Fiber coupling. [**5L**]

Module-5

Fiber Optic inter connective devices- Isolator, Circulator, Attenuator, WDM Mux/Demux ,Principles of WDM Mux/ Demux and applications, Coupler- 2x2 fiber coupler, star coupler, Mach-Zehnder interferometer multiplexers, Fiber Bragg gratings, Optical amplifiers - EDFA, Raman amplifier.

[**6L**]

Module-6

Fiber Optic Networks- Network model, Network topology, Token ring and FDDI, Network operation.

[**4L**]

Total: 30L

Text/Reference Books

1. J. Keiser, Optical Fibre communication, McGraw-Hill, 4th Ed. 2010 (Indian Edition).
2. J.M Senior, Optical Fiber Communications: Principles and Practice, PHI, 3rd Ed
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the principles fiber-optic communication
2. Understand the properties of the optical fibers and optical components.
3. Understand operation of lasers, LEDs, and detectors
4. Analyse system performance of optical communication systems
5. Understand optical networks

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UECE811	B. Spread Spectrum Communications	3L: 0T: 0P	6 credits

Module-1: *Introduction:*Origins of Spread SpectrumCommunications – Advantages of Spectrum spreading –Types of techniques used for spread spectrum – Processing gain and other fundamental parameters – Jamming methods – Linear Feedback shift register sequence generation – M-sequence and their statistical properties – Correlation properties – Non-linear sequences – Gold codes –Kasami sequences. [**6L**]

Module-2:*Spread Spectrum Techniques:*Coherent direct sequence systems – Model of a DS/BPSK system – Uncoded bit error probability for arbitrary jammer waveforms – Chernoff bound – Performance under constant power broadband noise jammer – Pulse jammer – Partial band jammer – Multitone jammer – Coded DS/BPSK system. [**10L**]

Module-3: *Frequency Hopping SS System:*Non-coherent FH system model – coherent FH systems– Frequency synthesis –Performance of FH/QPSK and FH/DPSK systems in partial band jamming – Time hopping SS technique. [**10L**]

Module-4:*Synchronization of SS Receivers:*Acquisition and tracking in DS SS – FH SS receivers – Sequential estimation – Matched filter techniques of acquisition and tracing –Delay locked loop – Tau-Dither loop. [**10L**]

Module-5:*Application:*Code division multiple access – Satellite communication – Anti jam military communication – Low probability of intercept communication – Mobile communication. [**4L**]

Total: 40L

Text/Reference Book:

1. R.C. Dixon, “Spread spectrum systems”, John Wiley, 1984.
2. M.K. Simon, J.K.Omura, R.A. Schiltz and B.K.Levitt, “Spread spectrumcommunication”, Vol-I, II & IV, computer science press, USA, 1985.
3. G.R.Cooper and, C. D.MacGillem, “Modern communications and spread spectrum”,McGraw Hill, 1986.

Course Outcomes:
At the end of the course the students will be able to

1) Understand the different categories of spread spectrum techniques, importance of such techniques.
2) Learn different jamming techniques and its influence on the performance.
3) Learn applications based onspread spectrum techniques.

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UECE811	C. Optical Signal Processing and Optical Processing	3L: 0T: 0P	6 credits

Review of Basics: Characterization of a General signal, examples of signals, Spatial signal. Basic laws of geometrical optics, Refractions by mirrors, the lens formulas, General Imaging conditions, the optical invariant, Optical Aberrations. [5L]

Nonlinear optics: Nonlinear optical coefficients, second order and third order susceptibility tensors. Third order optical nonlinear phenomena -FWM OPC, intensity dependent refractive index, self-focusing, SIT, nonlinear F-P Etalon, Optical bistability, Optical transistor, SEED, optical logic gates, implementation and their application in optical computers. [10L]

Mathematical transforms in signal processing: Fresnel transform, Hilbert transform, Radon transform, Mellin transform, two dimensional Fourier transforms and their properties, convolution and correlation, Effect of lens on wavefront, FT properties of single lens, optical transform function. Maximum information capacity and optimum packing density, System coherence. [10L]

Spatial Filtering: Time and space integrating architecture, spectrum analysis, Vanderlugt filter, image spatial filtering, Magnitude Spatial Filters, Phase Spatial Filters, Real valued Spatial Filters, Interferometric techniques for constructing Spatial Filters, SLMs - AO, MO, EO, LC based SLMs. [10L]

Optical Numerical Processing: Simple arithmetic, evaluation of polynomials, optical implementation of Matrix vector multiplication, Matrix-matrix multipliers, differentiation, integration and solutions of partial differential equations. Introduction to optical neural network. [10L]

Total: 45L

Text/Reference Book:

1. B G Boone, Signal Processing Using Optics: Fundamentals, Devices, Architectures, and Applications, Oxford Univ Press, 1st edition (1998)
2. D G Feitelson, Optical Computing: A Survey for Computer Scientists, MIT Press (2001) 22
3. Anthony VanderLugt, Optical Signal Processing, John Wiley & Sons (2005)
4. John Shen, The Principles of Nonlinear Optics, Wiley & Sons, 1st edition (2002)
5. Joseph Goodman, Introduction to Fourier Optics, Roberts and Company Publishers, 3rd edition (2016)
6. T. S. Yu, SugandaJutamulia, Optical Signal Processing, Computing, and Neural Networks, Francis Krieger Publishing Company; 2nd edition
7. D. Casasent, "Optical data processing-Applications", Springer-Verlag, Berlin,
8. H.J. Caulfield, "Handbook of holography", Academic Press New York 1979
9. P.M. Dufffieux, "The Fourier Transform and its applications to Optics", John Wiley and sons
10. J. Horner," Optical Signal Processing ", Academic Press 1988.

Course Outcomes:

At the end of the course the students will be able to

1. Understand the basic theory of nonlinear optics including sum and difference frequency generation
2. Analyse the origin of optical bistability and its implications
3. Examine different mathematical transforms used in optical signal processing and compute the transforms of given functions
4. Construct spatial filtering geometries based on the Fourier transform property of lens
5. Analyse the role of various light modulators in signal processing
6. Describe the basic concepts of optical computing and optical neural networks and their practical implementation

UECE812	A. Information Theory and Coding	3L: 0T: 0P	6 credits

Module-1: *Introduction to information theory*: Uncertainty and information, Average mutual information and entropy, Information measures for continuous random variables, Relative entropy. [**10L**]

Module-2: *Source Coding*: Source coding theorem, Huffman coding, Shannon-Fano coding, Arithmetic coding, Lempel-Ziv Algorithm, Run length encoding, Rate distortion function, Optimum quantizer design. [**10L**]

Module-3: *Channel capacity*: Introduction, Channel models (DMC, BSC, BEC), Channel transition matrix, Channel capacity, Entropy function. [**7L**]

Module-4: *Channel coding*: Channel coding theorem, Noisy channel coding theorem, Information capacity theorem, Sphere packing problem, Parallel Gaussian channels, Water filling algorithm, The Shannon limit. [**13L**]

Total: 40L

Text/Reference Book:

1. Cover, Thomas and Joy, "Elements of Information Theory", John Wiley & Sons, 2012.
2. Robert, "Information Theory", Dover special priced titles, 2007.
3. Roth, "Introduction to Coding Theory", Cambridge University Press, 2006.
4. Lin and Costello, "Error-Control Coding", Prentice Hall, 1983.

Course Outcomes:
At the end of the course the students will be able to

1. Understand the concept of information.
2. Learn and analyse the source coding theorem and techniques.
3. Categorise different types channels and channel models.
4. Learn the channel capacity of a given channel.
5. Understand the information capacity theorem.

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UECE812	B. Error Correcting Codes	3L: 0T: 0P	6 credits

Module-1:*Block codes*: The digital communication channel, Introduction to block codes, Single-parity-check codes, Product codes, Repetition codes, Hamming codes, Minimum distance of block codes, Soft-decision decoding. [**10L**]

Module-2: *Linear codes*: Definition of linear codes, Generator matrices, The standard array, Parity check matrices, Error syndromes, Error detection and correction. [**8L**]

Module-3: *Cyclic codes*: Definition of cyclic codes, Polynomials, Generator polynomials, Encoding cyclic codes, Decoding cyclic codes, Factors of $x^n + 1$, Parity-check polynomials, Dual cyclic codes. [**12L**]

Module-4:*Linear-feedback shift registers for encoding and decoding cyclic codes*: Linear-feedback shift registers, The polynomial-division register, Registers for decoding, Registers for error detection and correction, The Meggitt decoder. [**10L**]

Total: 40L

Text/Reference Book:

1. Peterson and Weldon, "Error correcting codes", Mitt Press, 1972.
2. Lin and Costello, "Error-Control Coding", Prentice Hall, 1983.
3. Blahut, "Theory and Practice of Error Control Codes", Addison-Wesley, 1984.

Course Outcomes:
At the end of the course the students will be able to

1.Understand the different categories of coding schemes.
2. Learn different coding techniques.
3. Understand linear-feedback shift registers.

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UECE812	C. Signal Detection and Estimation Theory	3L: 0T: 0P	6 credits

Module-1: *The statistical foundation*: Decision theory: Bayes's rule, Minimum average cost, Binary decision, Bayes strategy, Neyman-Pearson criterion, Operating characteristics and sufficient statistics. [**10L**]

Module-2: *Detection of a known signal*: Gaussian noise, Density function of Gaussian noise, Stationary noise, Detection in Gaussian noise, The likelihood ratio, The sufficient statistics, The Matched filter. [**9L**]

Module-3:*Narrowband signals and their detection*: Narrowband noise, Complex representation and the complex autocovariance function, Detection of a signal of random phase, Signals of random phase.[**6L**]

Module-4: *Estimation of signal parameters*: The theory of estimation, Maximum-a-posteriori probability estimators, Maximum likelihood estimators, Estimating the mean of a Gaussian distribution, Bayes estimates, The quadratic cost functions, Estimation of Arrival time, Asymptotic variance of maximum-likelihood estimators, The Cramer-Rao inequality, Estimation of signal parameters in Gaussian noise. [**15L**]

Total: 40L

Text/Reference Book:

1. Van Trees and Harry L, "Detection, Estimation and Modulation Theory - I", vol. – 1, John Wiley & Sons., 1968.
2. D. Middleton, "An Introduction to Statistical Communication Theory", McGraw Hill, 1960.
3. W. B. Davenport and W. L. Root, "An Introduction to the Theory of Random Signals and Noise", McGraw Hill, 1958.
4. C. W. Helstrom, "Statistical Theory of Signal Detection", Pergamon Press, Oxford, 1960.
5. A. Papoulis, "Probability, Random Variables and Stochastic Processes", McGraw Hill, 1984.

Course Outcomes:
At the end of the course the students will be able to

1. Summarize the fundamental concept on Statistical Decision Theory and Hypothesis Testing
2. Summarize the various signal estimation techniques with additive noise
3. Summarizer with Bayesian parameter estimation (minimum mean square error (MMSE), minimum mean absolute error (MMAE), maximum a-posterior probability (MAP) estimation methods.

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UECE813	A. Computer Vision (OE-5)	3L: 0T: 0P	6 credits

Introduction: overview of computer vision, related areas, and applications; overview of software tools; overview of course objectives.; introduction to OpenCV. [5L]

Module-I

Image formation and representation: imaging geometry, radiometry, digitization, cameras and projections, rigid and affine transformations. Image operations: Filtering: convolution, smoothing, differencing, and scale space. Feature detection: edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors.

[10L]

Module-II

Model fitting: Hough transform, line fitting, ellipse and conic sections fitting, algebraic and Euclidean distance measures. Camera calibration: camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.

[10L]

Module-III

Epi-polar geometry: introduction to projective geometry; epi-polar constraints; the essential and fundamental matrices; estimation of the essential/fundamental matrix. Model reconstruction: reconstruction by triangulation; Euclidean reconstruction; affine and projective reconstruction.

[10L]

Module-IV

Motion analysis: the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation; motion segmentation through EM. Motion tracking: statistical filtering; iterated estimation; observability and linear systems; the Kalman filter; the extended Kalman filter; Object recognition and shape representation: alignment, appearance-based methods, invariants, image eigenspaces, data-based techniques.

[10L]

Total: 45L

References:

1. Computer Vision: Algorithms and Applications, R. Szeliski, Springer, 2011.
2. Computer Vision: A Modern Approach, D. Forsyth and J. Ponce, Prentice Hall, 2nd ed., 2011.
3. Introductory techniques for 3D computer vision, E. Trucco and A. Verri, Prentice Hall, 1998.

Outcome of the course:

After the completion of the course students will be able to

Identify basic concepts, terminology, theories, models and methods in the field of computer vision.

- Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.
- Developed the practical skills necessary to build computer vision applications.
- To have gained exposure to object and scene recognition and categorization from images.

UECE813	B. RADAR and Electronic System Design (OE-5)	3L: 0T: 0P	6 credits

Introduction: Nature of Radar, Maximum Unambiguous Range, Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Related Problems. [**5L**]

Radar Equation: Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise and SNR, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment). Related Problems. [**5L**]

CW and Frequency Modulated Radar: Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar.

FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/Receding Targets), FM-CW altimeter, Measurement Errors, Multiple Frequency CW Radar. [**5L]**

MTI and Pulse Doppler Radar: Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance. Non-coherent MTI, MTI versus Pulse Doppler Radar. [**8L]**

Tracking Radar: Tracking with Radar, Sequential Lobing, Conical Scan, Mono-pulse Tracking Radar– Amplitude Comparison Mono-pulse (one- and two- coordinates), Phase Comparison Mono-pulse. Target Reflection Characteristics and Angular Accuracy. Tracking in Range, Acquisition and Scanning Patterns. Comparison of Trackers. [**7L**]

Detection of Radar Signals in Noise: Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation Function and Cross-correlation Receiver, Efficiency of Non-matched Filters, Matched Filter with Non-white Noise. [**5L**]

Radar Receivers: Noise Figure and Noise Temperature. Displays – types. Duplexers – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Series versus Parallel Feeds, Applications, Advantages and Limitations. [**5L**]

Total: 40L

TEXT BOOKS:

1. Introduction to Radar Systems – Merrill I. Skolnik, SECOND EDITION, McGraw-Hill, 1981.
2. Radar Principles – P. Z. Peebles, Wiley, 1999.
3. Radar Systems Analysis and Design – B. R. Mahafza, CRC Press.

Course Objectives:

1. To become familiar with fundamentals of RADAR

2. To gain in depth knowledge about the different types of RADAR and their operations

3. To become familiar for signal detection in RADAR and various detection techniques

4. To become familiar with RADAR navigation techniques

Course Outcomes:

1. To understand the concept of Radar, its applications and different Radar performance factors
2. To understand the operation of FM - CW Radar
3. To understand the operation of MTI & Pulse Doppler Radar
4. To understand the concept of Navigation and types of radio navigation
5. To understand the concept of RADAR receivers.

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UECE813	C. Introduction to IoT and ARM Processors (OE-5)	3L: 0T: 0P	6 credits

Fundamentals of IoT: **[4L]**

Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.

Wireless Technologies for IoT: **[4L]**

WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols

Data Handling& Analytics: **[6L]**

Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications.

Applications of IoT: **[6L]**

Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

Introduction to ARM Cortex Architecture: **[12L]**

The ARM Architecture, Overview of ARM, Overview of Cortex Architecture, Cortex M3 Register Set and Modes, Cortex M3 Processor Core, Data Path and Instruction Decoding, ARM Cortex M3 Development Environment, Assembler and Compiler, Linkers and Debuggers, ARM, Thumb & Thumb2 instructions, Mixing ARM & Thumb Instructions, Memory hierarchy, Memory Mapping, Cache, Cortex M3 Peripherals – RCC, GPIO, Timer, System timer, UARTs, LCD, ADC, Cortex M3 interrupt handling – NVIC. Application development with Cortex M3 controllers using standard peripheral libraries.

Total: 40L

TEXT BOOKS:

1. HakimaChaouchi, ― "The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Wiley Publications
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, ― "The Internet of Things: Key Applications and Protocols", WileyPublications
3. Vijay Madisetti and ArshdeepBahga, ― "Internet of Things (A Hands-on-Approach)", 1 st Edition, VPT, 2014.
4. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016
5. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
6. "ARM System-on-Chip Architecture" by Steve Furber; 2nd Edition; Pearson
7. "ARM System Developer's Guide" by Andrew Sloss;The Morgan Kaufmann Series.
8. "Introduction to Microprocessor Based Systems Using the ARM Processor" by Kris Schindler; Pearson Learning Solutions; 2nd edition ;2012.
9. The Definitive Guide to the ARM® Cortex-M3 by Joseph Yiu; 2nd Edition; Newnes.

UECE814	A. Mixed Signal VLSI Design (OE-6)	3L: 0T: 0P	6 credits

Sample and hold circuits **[2L]**

Performance of sample-and-hold circuits – testing sample and holds, MOS sample-and-hold basics, examples of CMOS S/H Circuits, bipolar and BiCMOS Sample-and-Holds.

Switched Capacitor circuits **[4L]**

Basic building blocks – opamps, capacitors, switches, non-overlapping clocks, Basic operation and analysis of switched capacitor circuits, resistor equivalence of a switched capacitor, parasitic-sensitive integrator, parasitic-insensitive integrators, signal-flow-graph analysis, noise in switched-capacitor circuits, First-Order Filters – switch sharing, fully differential filters, biquad filters, Charge injection, switched-capacitor gain circuits, parallel resistor-capacitor circuit, resettable gain circuit, capacitive-reset gain circuit, correlated double-sampling techniques, other switched-capacitor circuits viz. amplitude modulator, full-wave rectifier, peak detectors, voltage-controlled oscillator.

Comparators **[3L]**

Comparator specifications – input offset and noise, hysteresis; Opamp as a comparator – input-offset voltage errors, charge-injection errors, making charge-injection signal independent, minimizing errors due to charge-injection, speed of multi-stage comparators; Latched comparators, latch-mode time constant, latch offset, examples of CMOS, input-transistor charge trapping.

Data converters specifications **[2L]**

Ideal D/A converter, ideal A/D converter, quantization noise, deterministic approach, stochastic approach, signed codes, performance limitations, resolution, offset and gain error, accuracy and linearity

Nyquist rate digital-to-analog converters (DAC) **[4L]**

Decoder-based converters – resistor string converters, folded resistor-string converters, multiple resistor-string converters, signed outputs, • Binary-scaled converters – binary-weighted resistor converters, reduced-resistance-ratio ladders, R-2R-based converters, charge-redistribution switched-capacitor converters, current-mode converters, glitches • Thermometer-code converters – thermometer-code current-mode D/A converters.

Nyquist rate analog-to-digital converters (ADC) **[12L]**

Introduction to integrating converters, flash converters, issues in designing flash ADC, • Successive-approximation converters – DAC-based successive approximation, charger distribution A/D, resistor-capacitor hybrid, speed estimate for charge redistribution converters, error correction in successive-approximation converters, multi-bit successive approximation • Algorithmic (or cyclic) A/D Converter – ratio-independent algorithmic converter, • Pipelined A/D converters – one-bit-per-stage pipelined converter, 1.5 bit per stage pipelined converter, pipelined converter circuits, generalized k-bit-per-stage pipelined converters, Interpolating A/D converters, folding A/D converters, time-interleaved A/D converters

Oversampling ADCs **[8L]**

Oversampling without noise shaping, quantization noise modelling, white noise assumption, oversampling advantage, the advantage of 1-bit D/A converters • Oversampling with noise shaping, noise-shaped delta-sigma modulator, first-order noise shaping, switched-capacitor realization of a first-order A/D converter, second-order noise shaping, noise transfer-function curves, quantization noise power of 1-bit modulators, error feedback structure • System architectures – system architecture of delta-sigma A/D converters, system architecture of delta-sigma D/A converters, • Digital decimation filters – multi-stage, single stage, higher-

order modulators – interpolative architecture, Practical considerations – stability, linearity of two-level converters, idle tones, dithering, opamp gain.

Total: 35L

Text /References:

1. CMOS Mixed-Signal Circuit Design, 2nd ed. by R. Jacob Baker. Ph.D. - Pub: Wiley IEEE Press - ISBN-13: 978-0470290262
2. Understanding Delta-Sigma Converters – Richard Schreier and Gabor Temes, Wiley-IEEE Press, 2005.
3. CMOS Analog Circuit Design" by Phillip Allen and Douglas R. Holberg, Oxford University Pub; New Delhi
4. "Design of Analog CMOS Integrated Circuits" by Behzad Razavi.

Course Outcomes:

The course aims to teach advance design techniques for comparators, ADC/ DAC.

The objective of the course is to design and toimplement the product level design blocks for VLSI applicatio ns.

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UECE814	B. Analog IC Design (OE-6)	3L: 0T: 0P	6 credits

Introduction to Integrated Circuits: [**17L**]

Introduction to CMOS ICs, CMOS scaling; Second-order effects in MOS operation; Capacitors & Resistors in CMOS Technology; Short-channel effects;

Current References & Band Gap References: Wilson, Cascode, Wide Swing Cascode current Mirrors; Large signal and small signal Analysis; Brokaw's Cell: discussions

Band Gap References and Output Stages: Supply independent Bias circuits and Temperature independent circuits.

Multistage Amplifiers: [**18L**]

Cascode Amplifier Circuits: Small signal Analysis; Gain-Bandwidth Calculation; Effect of Noise.

Feedback amplifiers: Analysis and Gain; Bandwidth calculation; Loop gain and stability; Bode plots;

Single-stage opamps; Cascodeopamps; Two-stage opamps and compensation;

Fully differential opamps: Cascode, Folded Cascode, Telescopic Cascodeopamps.

Multi-Stage Opamps, and Analysis and comparison.

Analog Layout Considerations: Matched Layout; Inter-digitized Layout; Common Centroid Techniques; Layout for countering Latch-ups.

Case Study: Low Drop Out Regulators; PLL; Delta Sigma ADC; Gm-C Filters

Total: 35L

Text/References:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Boston: McGraw Hill, 2001.
2. P.E. Allen and D.R. Holberg, CMOS Analog Circuit Design, 2nd Ed., Oxford University Press, 2002.
3. P.R. Gray, P.J. Hurst, S.H. Lewis, and R.G. Meyer, Analysis and Design of Analog Integrated Circuits, 4th ed., New York: Wiley, 2001.
4. References: D.A. Johns and K. Martin, Analog Integrated Circuit Design, New York: Wiley, 1997.

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UECE814	C. Radio Frequency Integrated Circuits(RFIC) (OE-6)	3L: 0T: 0P	6 credits

1.Network analysis: Scattering (S) and ABCD parameters; Resonance in LC circuits, Series and Parallel resonance, Q-factors. Impedance transformations and matching- L-matches, Pi & T matches, Other matching Networks, Losses in Matching. [**4L**]

2. Characteristics of passive IC components at RF frequencies – Interconnects, resistors, capacitors, inductors and transformers – Transmission lines [**5L**]

Noise – classical two-port noise theory, noise models for active and passive components. [**3L**]

3. **High frequency amplifier design** – Zeros as bandwidth enhancers, shunt-series amplifier, f_T doublers, neutralization and uni-lateralization. [**6L**]

Low noise amplifier design – LNA topologies, power constrained noise optimization, linearity and large signal performance [**7L**]

4. **Mixers** – multiplier-based mixers, subsampling mixers, diode-ring mixers (5 hours) RF power amplifiers – Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations. [**7L**]

5. **Oscillators & synthesizers** – describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations. [**8L**]

Total: 40L

REFERENCES BOOKS:

1. Behzad Razavi, RF Microelectronics, Prentice Hall
2. T. H. Lee, Design of RF Integrated Circuits, 2nd Ed., Cambridge University Press, 2002.
3. B. Leung, VLSI for wireless Communications, Prentice Hall, 2001.
4. J. Rogers, C. Plett, Radio Frequency Integrated Circuit Design, Artech, 2003
5. A.A. Abidi, P.R. Gray, and R.G. Meyer, eds., Integrated Circuits for Wireless Communications, New York: IEEE Press, 1999.
6. R.Ludwig and P. Bretchko, RF Circuit Design, Theory and Applications, Pearson, 2000

Course Outcomes:

After taking this course, the student will be able to:

1. Design and analyze impedance matching networks in RF circuits
2. Model passive RF components
3. Design and analyze low noise amplifiers and power amplifiers
4. Design of RF mixers, oscillators and synthesizers

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PROJECT

UECE795	Project Stage –I

The object of Project Stage I is to enable the student to take up investigative study in the broad field of Electronics & Communication Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;

2. Working out a preliminary Approach to the Problem relating to the assigned topic;

3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;

4. Preparing a Written Report on the Study conducted for presentation to the Department;

5. Final Seminar, as oral Presentation before a departmental committee.

UECE895	Project Stage- II

The object of Project Stage II & Dissertation is to enable the student to extend further the investigative study taken up under **UECE795**, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under **UECE795**;

2. Review and finalization of the Approach to the Problem relating to the assigned topic;

3. Preparing an Action Plan for conducting the investigation, including team work;

4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;

5. Final development of product/process, testing, results, conclusions and future directions;

6. Preparing a paper for Conference presentation/Publication in Journals, if possible;

7. Preparing a Dissertation in the standard format for being evaluated by the Department;

8. Final Seminar Presentation before a Departmental Committee.

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