Department of Electronics and Communication Engineering

Visvesvaraya National Institute of Technology, NAGUR 440010 INDIA

B. Tech. (Electronics and Communication Engineering)

COURSE BOOK

FEBRUARY 2016

i. General Information about the departments

The Department offers the following academic programs:

Course-work oriented programs

- 4-year B. Tech. program (Accreditated for five years (till July 2020) by NBA)
- 2-year M. Tech. program

Research programs

- Ph.D. program

Course Oriented Programs:

B. Tech. program: The B. Tech. program is a four-year course oriented undergraduate program. The course work is spread across all the semesters. The courses include a set of core courses offered by the department, a set of departmental electives and some free electives. Apart from this, a student must complete four courses in OC/HM category. Besides, a student must also complete a project in the final year towards the fulfillment of the degree requirements.

M. Tech. program: The M. Tech. program is a two-year course oriented graduate program. The student has to take a set of core courses and a set of electives. The course work is spread across the first two semesters with an option of taking electives in the third semester. This is followed by a project in the third and fourth semester in which the student can take up a project of his or her interest, supervised by a faculty member of the department.

Research Programs:

Ph. D. programs: A Ph. D. program is postgraduate research oriented programs. The scholar works in an area of his/her interest under the supervision of a faculty member(s) of the department. The scholar has to obtain a minimum number of credits by taking courses. The highlight of the program is the independent research work taken by scholar, leading to a dissertation at the end of the program.

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1.	Dr. K. D. Kulat	Ph. D.	kdkulat@ece.vnit.ac.in
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Vision and Mission of the Institute

Vision

To contribute effectively to the national endeavour of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country, incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation

Mission

The Mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. V.N.I.T. is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

Vision and Mission of the department

Department Vision

To be the epitome academic rigour still flexible to accommodate every student and faculty for Basic, current and future technologies in Electronics and communication Engineering.

Department Mission

To be a centre of excellence and provide best platform for students and staff for their growth.

Programme Educational Objectives (PEOs)

I. To develop the ability among students to understand the concept of Mathematics, Physics and core electronics subjects which will facilitate understanding of new technology.

II. To provide student with a strong foundation in the engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduates studies, R&D, consultancy and higher learning.

III. To build up skills to analyze the requirements of the electronics, understand the technical specifications, design and provide novel engineering solutions and efficient product design.

IV. To prepare graduates who possess the necessary foundation required to take up gainful employment in core sector and allied sector or prepare them for a successful career and work professional to meet the technical acquaintance of Indian and multinational companies.

V. To give exposures to emerging edge technologies, adequate training and opportunities to work as team on multidisciplinary projects with effective communication skills and leadership qualities.

Programme Outcomes (Pos)

1. The Department of Electronics and Communication Engineering has a strong focus on providing students with a strong background in mathematics, science and engineering. The department provides students with adequate practical training by way of laboratory sessions, design and problem based learning.

2. Students shall participate and succeed in competitive examinations such as GATE, GRE and TOEFL, PSUs and may admit to various programs like Master of Science (Abroad/India), Master of Technology (India) and Doctor of Philosophy (India/Abroad).

3. Students will be able to realize their ideas with the help of 'Incubation Centre' established within college premises and will be able to participate in National/International level project (Design/Coding) competitions organized by Industry/Institute.

4. With a help of technical and entrepreneur skills students will be able to employ appropriate techniques using hardware and software engineering tools for modern engineering applications and will demonstrate and ability to apply their knowledge of advanced mathematics and electronics

List of Core Courses

Course Code	Course Title	L-T-P	Credits	Category	Prerequisite	
					Code	Course Title
PHL 203	Electronic Materials	3-0-0	3	DC	Nil	Nil
MAL 201	Integral Transforms & Partial Differential Equations	3-1-0	4	DC	Nil	Nil
EEL 209	Linear Network Theory	3-0-0	3	DC	Nil	Nil
ECL 201	Electronic Devices	3-1-0	4	DC	Nil	Nil
ECL 202	Digital Logic Design	3-0-0	3	DC	Nil	Nil
ECP 201	Electronic Devices Lab.	0-0-2	1	DC	Nil	Nil
ECP 202	Digital Logic Design Lab.	0-0-2	1	DC	Nil	Nil
MAL 205	Numerical Methods and Probability Theory	3-1-0	4	DC	Nil	Nil
ECL 306	Microprocessors & Interfacing	3-0-0	3	DC	ECL 202	Digital Logic Design
ECL 308	Analog Circuit Design	3-0-0	3	DC	ECL201	Electronic Devices
ECL 210	Signals and Systems Analysis	3-1-0	4	DC	MAL 201	Integral Transforms & Partial Differential Equations
ECL 305	Electromagnetic Fields	3-1-0	4	DC	MAL102	Mathematics-II
ECP 306	Microprocessors & Interfacing Lab.	0-0-2	1	DC	ECL 202	Digital Logic Design
ECP 308	Analog Circuit Design Lab.	0-0-2	1	DC	ECL201	Electronic Devices
ECP 307	Electronic Product Engineering Workshop	0-0-2	1	DC	ECL308	Analog Circuit Design
ECP 210	Signals and Systems Analysis Lab	0-0-2	1	DC	Nil	Nil
ECL 301	Analog Communication	3-1-0	4	DC	MAL201, MAL205	Integral Transforms & Partial Differential Equations, Basic Numerical Analysis and Probability Theory
ECL 401	Hardware Description Languages	3-0-0	3	DC	ECL309	Finite Automata
EEL 310	Control Systems	3-0-0	3	DC	MAL201	Integral Transforms & Partial Differential Equations
ECL 405	Wave guides and Antennas	3-0-0	3	DC	ECL305	Electromagnetic Fields
ECL 204	Measurement & Instrumentation	3-0-0	3	DC	Nil	Nil

List of Core Courses

Course Code	Course Title	L-T-P	Credits	Category	Prerequisite	
					Code	Course Title
PHL 203	Electronic Materials	3-0-0	3	DC	Nil	Nil
MAL 201	Integral Transforms & Partial Differential Equations	3-1-0	4	DC	Nil	Nil
EEL 209	Linear Network Theory	3-0-0	3	DC	Nil	Nil
ECL 201	Electronic Devices	3-1-0	4	DC	Nil	Nil
ECL 202	Digital Logic Design	3-0-0	3	DC	Nil	Nil
ECP 201	Electronic Devices Lab.	0-0-2	1	DC	Nil	Nil
ECP 202	Digital Logic Design Lab.	0-0-2	1	DC	Nil	Nil
MAL 205	Numerical Methods and Probability Theory	3-1-0	4	DC	Nil	Nil
ECL 306	Microprocessors & Interfacinbg	3-0-0	3	DC	ECL 202	Digital Logic Design
ECL 308	Analog Circuit Design	3-0-0	3	DC	ECL201	Electronic Devices
ECL 210	Signals and Systems Analysis	3-1-0	4	DC	MAL 201	Integral Transforms & Partial Differential Equations

ECL 305	Electromagnetic Fields	3-1-0	4	DC	MAL102	Mathematics-II
ECP 306	Microprocessors & Interfacinbg Lab.	0-0-2	1	DC	ECL 202	Digital Logic Design
ECP 308	Analog Circuit Design Lab.	0-0-2	1	DC	ECL201	Electronic Devices
ECP 307	Electronic Product Engg. Workshop	0-0-2	1	DC	ECL308	Analog Circuit Design
ECP 210	Signals and Systems Analysis Lab	0-0-2	1	DC	Nil	Nil
ECL 301	Analog Communication	3-1-0	4	DC	MAL201, MAL205	Integral Transforms & Partial Differential Equations, Basic Numerical Analysis and Probability Theory
ECL 401	Hardware Description Languages	3-0-0	3	DC	ECL309	Finite Automata
EEL 310	Control Systems	3-0-0	3	DC	MAL201	Integral Transforms & Partial Differential Equations
ECL 405	Wave guides and Antennas	3-0-0	3	DC	ECL305	Electromagnetic Fields
ECL 204	Measurement & Instrumentation	3-0-0	3	DC	Nil	Nil
ECP 301	Analog Communication Lab	0-0-2	1	DC	MAL201, MAL205	Integral Transforms & Partial Differential Equations, Basic Numerical Analysis and Probability Theory
EEP 310	Control Systems Lab.	0-0-2	1	DC	MAL201	Integral Transforms & Partial Differential Equations

						Equations
ECP 401	Hardware Description Languages Lab.	0-0-2	1	DC	ECL309	Finite Automata
ECP 204	Measurement & Instrumentation Lab.	0-0-2	1	DC	Nil	Nil
ECL 303	Digital Communication	3-0-0	3	DC	ECL301	Analog Communication
ECL 304	Digital Signal Processing.	3-0-0	3	DC	MAL201	Integral Transforms & Partial Differential Equations
ECL 302	Device Modeling	3-0-0	3	DC	PHL203, ECL201	Electronic Materials, Electronic Devices
ECP 303	Digital Communication Lab.	0-0-2	1	DC	ECL301	Analog Communication
ECP 304	Digital Signal Processing Lab.	0-0-2	1	DC	MAL201	Integral Transforms & Partial Differential Equations
ECP 302	Device Modeling Lab.	0-0-2	1	DC	PHL203, ECL201	Electronic Materials, Electronic Devices
ECD 401	Project Phase – I	0-0-4	2	DC	Nil	Nil
ECD 402	Project Phase II	0-0-8	4	DC	ECD 401	Project Phase - I

List of Elective Courses

Course Code	Course Title	L-T-P	Credits	Category	Prerequisite	
CSL 311	Computer Architecture & Organisation	3-0-0	3	DE	ECL202	Digital Logic Design
ECL 309	Finite Automata	3-0-0	3	DE	ECL202	Digital Logic Design
ECL 403	Embedded Systems	3-0-0	3	DE	ECL 306	Microprocessors & Interfacinbg
CSL 312	Concepts in Operating Systems	3-0-0	3	DE	Nil	Nil
ECL 404	RF & Microwave Engg.	3-0-0	3	DE	ECL305	Electromagnetic Fields
ECP 404	**RF & Microwave Engg.Lab**	**0-0-2**	**1**	**DE**	**ECL305**	**Electromagnetic Fields**
ECL 415	Electronic System Design	3-0-0	3	DE	ECL201, ECL 308	Electronic Devices, Analog Circuit Design
ECP 403	Embedded Systems Lab.	0-0-2	1	DE	ECL 306	Microprocessors & Interfacinbg
ECL 402	Comm. Net. & Network Applications	3-0-0	3	DE	ECL303	Digital Communication
ECL 412	Advanced Digital Signal Processing	3-0-0	3	DE	ECL304	Digital Signal Processing

ECL 423	Image Analysis and Computer Vision	3-0-0	3	DE	ECL303	Digital Signal Processing
ECL 424	Optical Communication	3-0-0	3	DE	ECL 303	Digital Communication
ECL 434	Wireless Digital Communication	3-0-0	3	DE	ECL303	Digital Communication
ECL 407	Radar Engineering	3-0-0	3	DE	ECL305	Electromagnetic Fields
EEL 309	Power Electronics	3-0-0	3	DE	ECL308	Analog Circuit Design
ECP 402	Comm. Net. & Network Applications Lab.	0-0-2	1	DE	ECL303	Digital Communication
ECP 412	Advanced Digital Signal Processing Lab.	0-0-2	1	DE	ECL304	Digital Signal Processing
ECP 423	Image Analysis and Computer Vision Lab	0-0-2	1	DE	ECL303	Digital Signal Processing
EEP 309	Power Electronics Lab.	0-0-2	1	DE	ECL308	Analog Circuit Design
ECP 424	Optical Communication Lab.	0-0-2	1	DE	ECL303	Digital Communication
ECL 406	Mobile Communication Systems	3-0-0	3	DE	ECL303	Digital Communication
ECL 409	Radio Frequency Circuit Design	3-0-0	3	DE	ECL302	Device Modeling
ECL 411	Digital Image Processing	3-0-0	3	DE	ECL304	Digital Signal Processing
ECL 419	Wireless Sensor Networks	3-0-0	3	DE	ECL303	Digital Communication

ECL 427	Broadband Communication	3-0-0	3	DE	ECL303	Digital Communication
ECP 409	Radio Frequency Circuit Design Lab.	0-0-2	1	DE	ECL302	Device Modeling
PHL208	Physics of semiconductor devices	3-0-0	3	DE	Nil	Nil
ECL310	CMOS Design	3-0-0	3	DE	ECL302	Device Modeling
ECL311	Automotive Electronics	3-0-0	3	DE	ECL204	Measurement & Instrumentation
ECL408	Biomedical Engineering	3-0-0	3	DE	ECL204	Measurement & Instrumentation
MAL408	Statistical Analysis & Queing Theory	3-0-0	3	DE	Nil	Nil
ECL413	Adaptive Signal Processing	3-0-0	3	DE	ECL304	Digital Signal Processing
ECP413	Adaptive Signal Processing Lab	0-0-2	1	DE	ECL304	Digital Signal Processing
ECL414	Electronic Product Design and Reliability	3-0-0	3	DE	ECP307	Electronic Product Engg. Workshop
ECL417	Multimedia Networks	3-0-0	3	DE	ECL303	Digital Communication
ECL418	Network Planning and Management	3-0-0	3	DE	ECL303	Digital Communication
ECL419	Wireless Sensor Networks	3-0-0	3	DE	ECL303	Digital Communication
ECL420	Smart Antennas	3-0-0	3	DE	ECL405	Wave guides & Antennas

ECL421	Advanced Sensors and Instrumentation	3-0-0	3	DE	ECL204	Measurement & Instrumentation
ECL426	Advanced Microprocessors & Interfacing	3-0-0	3	DE	ECL306	Microprocessors & Interfacing
ECP426	Advanced Microprocessors & Interfacing Lab	0-0-2	1	DE	ECL306	Microprocessors & Interfacing
ECP 309	Finite Automata Lab.	0-0-2	1	DE	ECL202	Digital Logic Design

List of Open Courses (Offered by the Department)

Course Code	Course Title	L-T-P	Credits	Prerequisite
ECL241	Overview of Communication Systems	3-0-0	3	BTech ECE students NOT allowed to register
ECL242	Sensors and Instrumentation Applications	3-0-0	3	BTech ECE students NOT allowed to register
ECL243	Introduction to Electronics and Instrumentation	1-0-0	1	ONLY for MSc (Chemistry) students

List of Courses (Core/Elective) Offered By the Department To Other Departments

Course Code	Course Title	L-T-P	Credits	Prerequisite	
ECL206	Electronic Devices and Circuits	3-0-0	3	Nil	Nil
ECP206	Electronic Devices and Circuits Lab	0-0-2	1	Nil	Nil
ECL207	Digital Circuits	3-0-0	3	Nil	Nil

ECP207	Digital Circuits Lab	0-0-2	1	Nil	Nil
ECL320	Linear Electronic Circuits	3-0-0	3	ECL206	Electronic Devices and Circuits
ECP320	Linear Electronic Circuits Lab	0-0-2	1	ECL206	Electronic Devices and Circuits
ECL321	Microprocessors	3-0-0	3	ECL207	Digital Circuits
ECP321	Microprocessors Lab	0-0-2	1	ECL207	Digital Circuits
ECL208	Analog Circuits	3-0-0	3	Nil	Nil
ECP208	Analog Circuits Lab	0-0-2	1	Nil	Nil
ECL209	Digital Circuits and Logic Design	3-0-0	3	Nil	Nil
ECP209	Digital Circuits and Logic Design Lab	0-0-2	1	Nil	Nil
ECL322	Signals and Systems	3-0-0	3	MAL201	Integral Transforms & Partial Differential Equations

CREDIT REQUIREMENTS FOR

B.TECH. (ELECTRONICS AND COMMUNICATION ENGINEERING)

Program Core (PC)		**Program Elective (PE)**	
Category	Credit	Category	Credit
Basic Science (BS)	18	Departmental Electives (DE)	33-48
Engineering Science (ES)	20	Humanities & Management (HM)	0-6
Humanities (HU)	05	Open Courses (OC)	0-6
Departmental Core (DC)	79-82		
Total	**122**	Total	**48**
Grand Total PC + PE			**170**

Details of credits:

III Semester				**IV Semester**			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
PHL 203	Electronic Materials	3-0-0	3	MAL 205	Numerical Methods and Probability Theory	3-1-0	4
MAL 201	Integral Transforms & Partial Differential Equations	3-1-0	4	ECL 306	Microprocessors & Interfacing	3-0-0	3
EEL 209	Linear Network Theory	3-0-0	3	ECL 308	Analog Circuit Design	3-0-0	3
ECL 201	Electronic Devices	3-1-0	4	ECL 210	Signals and Systems Analysis	3-1-0	4
ECL 202	Digital Logic Design	3-0-0	3	ECL 305	Electromagnetic Fields	3-1-0	4
ECP 201	Electronic Devices Lab.	0-0-2	1	ECP 306	Microprocessors & Interfacing Lab.	0-0-2	1
ECP 202	Digital Logic Design Lab.	0-0-2	1	ECP 308	Analog Circuit Design Lab.	0-0-2	1
				ECP 307	Electronic Product Engg. Workshop	0-0-2	1
				ECP 210	Signals and Systems Analysis Lab.	0-0-2	1
ELECTIVE (NIL)				**ELECTIVE (NIL)**			
	Total No. of Credits		**19**		**Total No. of Credits**		**22**

V Semester				VI Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
ECL 301	Analog Communication	3-1-0	4	ECL 303	Digital Communication	3-0-0	3
ECL 401	Hardware Description Languages	3-0-0	3	ECL 304	Digital Signal Processing.	3-0-0	3
EEL 310	Control Systems	3-0-0	3	ECL 302	Device Modeling	3-0-0	3
ECL 405	Wave guides and Antennas	3-0-0	3	ECP 303	Digital Communication Lab.	0-0-2	1
ECL 204	Measurement & Instrumentation	3-0-0	3	ECP 304	Digital Signal Processing Lab.	0-0-2	1
ECP 301	Analog Communication Lab	0-0-2	1	ECP 302	Device Modeling Lab.	0-0-2	1
EEP 310	Control Systems Lab.	0-0-2	1				
ECP 401	Hardware Description Languages Lab.	0-0-2	1				
ECP 204	Measurement & Instrumentation Lab.	0-0-2	1				
ELECTIVE* (Any one)				**ELECTIVE* (Any THRE theory, any ONE lab)**			
CSL 311	Computer Architecture & Organization	3-0-0	3	ECL 403	Embedded Systems	3-0-0	3
ECL 309	Finite Automata	3-0-0	3	CSL 312	Concepts in Operating Systems	3-0-0	3
ECP 309	Finite Automata Lab	0-0-2	1	ECL 404	RF & Microwave Engg.	3-0-0	3
PHL 208	Physics of semiconductor devices	3-0-0	3	ECP 404	RF & Microwave Engg. Lab	0-0-2	1
ECL310	CMOS Design	3-0-0	3	ECL 415	Electronic System Design	3-0-0	3
ECL311	Automotive Electronics	3-0-0	3	ECL408	Biomedical Engineering	3-0-0	3
ECL414	Electronic Product Design and Reliability	3-0-0	3	ECP 403	Embedded Systems Lab.	0-0-2	1
ECL421	Advanced Sensors and Instrumentation	3-0-0	3	ECL420	Smart Antennas	3-0-0	3
OC	OC	3-0-0	3	ECL426	Advanced Microprocessors & Interfacing	3-0-0	3
HM	HM	3-0-0	3	ECP426	Advanced Microprocessors & Interfacing Lab	0-0-2	1
				OC	OC	3-0-0	3
				HM	HM	3-0-0	3
	Total No. of Credits (20 + 3)	=	**23**		**Total No. of Credits (12+10)**	=	**22**

*Notes for DE + OC + HM

- Credits offered for registration from 5^{th} to 8^{th} semester = 53
  Credits to be earned = 48

- The registration for electives (DE) shown is maximum possible in that semester.
  Hence, total no. of credits is also maximum possible.
  Student need not register for courses with sum of credits = 53 - 48 = 5

VII Semester				VIII Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
ECD 401	Project Phase – I	0-0-4	2	ECD 402	Project Phase II	0-0-8	4
ELECTIVE* (Any SIX theory and any THREE labs)				**ELECTIVE* (Any SIX theory and any ONE lab)**			
ECL 402	Comm. Net. & Network Applications	3-0-0	3	ECL 406	Mobile Communication Systems	3-0-0	3
ECL 412	Advanced Digital Signal Processing	3-0-0	3	ECL 409	Radio Frequency Circuit Design	3-0-0	3
ECL 423	Image Analysis and Computer Vision	3-0-0	3	ECL410	Satellite Communication	3-0-0	3
ECL 424	Optical Communication	3-0-0	3	ECL 411	Digital Image Processing	3-0-0	3
ECL 434	Wireless Digital Communication	3-0-0	3	ECL 419	Wireless Sensor Networks	3-0-0	3
ECL 407	Radar Engineering	3-0-0	3	ECL 427	Broadband Communication	3-0-0	3
EEL 309	Power Electronics	3-0-0	3	ECP 409	Radio Frequency Circuit Design Lab.	0-0-2	1
ECP 402	Comm. Net. & Network Applications Lab.	0-0-2	1	MAL408	Statistical Analysis & Queing Theory	3-0-0	3
ECP 412	Advanced Digital Signal Processing Lab.	0-0-2	1	ECL413	Adaptive Signal Processing	3-0-0	3
ECP 423	Image Analysis and Computer Vision Lab	0-0-2	1	ECP413	Adaptive Signal Processing Lab	0-0-2	1
EEP 309	Power Electronics Lab.	0-0-2	1	ECL417	Multimedia Networks	3-0-0	3
ECP 424	Optical Communication Lab.	0-0-2	1	ECL418	Network Planning and Management	3-0-0	3
OC	OC	3-0-0	3	ECL419	Wireless Sensor Networks	3-0-0	3
HM	HM	3-0-0	3	OC	OC	3-0-0	3
				HM	HM	3-0-0	3
	Total No. of Credits (2 + 21)	=	**23**		**Total No. of Credits (4+19)**	=	**23**

*Notes for DE + OC + HM

- Credits offered for registration from 5^{th} to 8^{th} semester = 53
  Credits to be earned = 48

- The registration for electives (DE) shown is maximum possible in that semester.
  Hence, total no. of credits is also maximum possible.
  Student need not register for courses with sum of credits = 53 - 48 = 5

PHL 203- ELECTRONIC MATERIAL
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course introduces the fundamentals of various material used for making electronic devices.

2. This covers the concept of various properties of the material and their applications in designing electronic devices and components.

3. At the end students will be able to understand the behavior of various materials towards developing various sensors, conducting materials, semiconducting materials, magnetic materials etc..

Syllabus:

Dielectric properties of insulators in static fields, Polarization, Dielectric constant, Dielectric behavior of materials, Ferroelectric, Piezoelectric and Pyroelectric materials, Dielectric properties of insulators in alternating fields, Complex dielectric constant, Dipolar relaxation, Dielectric loss, Loss tangent, Dielectric break down, different types of capacitor, multilayer capacitors, Ferroelectric polymers. Conductivity of pure metals and alloys, Temperature coefficient of resistivity, High conductivity materials, Fixed and variable resistors, Resistors used in electronic circuits, Magnetic materials classification, Soft and Hard magnetic materials, Ferrites, Magnetic cores of transformers, Relays, memory elements, Magnetic resistors and Magnetic tapes mutliferroic materials Superconductivity,Type-I and Type-II superconductors, High temperature superconductivity,Applications of superconductivity.

TEXT BOOKS

1. Dekkar A.J.;Electrical Engineering Materials; Prentice Hall of India Publications, 1992
2. Seth S.P.; A course in Electr cal Engineering Materials; (Third edition) Dhanpatrai Publications, 2003

REFERENCE BOOKS

1. Joshi M.A.; Electronic components and materials; SPD Publications
2. Pillai S.O.; Solid State Physics; New Age Publication, 1999
3. Kasap S.O.; Principles of Electronic Materials and Devices; Tata-Mcgraw-Hill, 2002

MAL201-INTEGRAL TRANSFORM AND PARTIAL DIFFERENTIAL EQUATION
[(3-1-0); Credits: 4]

Course Outcomes:

1. This course introduces the mathematical analysis required for electronic communication systems.

2. This covers the concept of various transforms such as Laplace, Fourier, Z transform and their applications in the field of Electronics and Communication Engineering.

3. At the end students will be able to understand and analyze the basics of partial differential equations, applications of first order and second order differential equations and D'Alembert solution of wave equation.

Syllabus: Laplace Transforms: Definition of Laplace Transforms, Linearity property, condition for existence of Laplace Transform, first and second shifting properties, transforms of derivatives and integrals, evaluation of integrals by Laplace Transform. Inverse Laplace Transform, convolution theorem, Laplace Transform of periodic functions, unit step function and Dirac delta function. Applications of Laplace Transform to solve ordinary differential equations.
Fourier Series and Fourier Transforms: Fourier series, half range sine and cosine series expansions, exponential form of Fourier series.
Fourier integral theorem, Fourier transform, Fourier Sine and cosine Transforms, Linearity, scaling, frequency shifting and time shifting properties, convolution theorem.
Z-transform: Z - transform, Properties of Z-transforms, Convolution of two sequences, inverse Z-transform, Solution of Difference equations.
Partial differential equations: Formation of first and second order equations, Solution of first order linear equations: Lagrange's equation, particular solution passing through a given curve. Higher order equations with constant coefficients, classification of linear second order PDEs, method of separation of variables, Solution of One dimensional wave equation, heat equation, Laplace equation (Cartesian and polar forms), D'Alembert solution of wave equation.

TEXT/REFERENCE BOOKS

1. Kreyszig, E.; Advanced Engineering Mathematics (Eighth Edition); John Wiley & Sons.
2. Jain, R.K. and Iyengar, S.R.K.; Advanced Engineering Mathematics; Narosa Publishers.
3. Thomas, G.B. and Finney, R.L.; Calculus and Analytic Geometry

EEL 209-LINEAR NETWORK THEORY (3-0-0); Credits: 3]

Course Outcomes:

1. This course introduces the fundamentals of network analysis and synthesis.

2. This covers the concept of circuit elements, lumped circuits, circuit laws and reduction and Analyse AC steady-state responses and transient response of resistance, inductance and capacitance in terms of impedance.

3. At the end students will be able to understand the transient response of series and parallel A.C. circuits and concept of coupled circuits and two port networks.

Syllabus:

Node and Mesh Analysis: Node and mesh equation, matrix approach of complicated network containing voltage and current sources, and reactances, source transformation and duality. Network theorem: Superposition, reciprocity, Thevenin's, Nortons, 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 unbalance circuit and power calculation.

Laplace transforms and properties: Partial fraction, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.

Two four port network and interconnections, Behaviour of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

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 integral solutions.

Two four port network and interconnections, Behaviour of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

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

ECL 201-ELECTRONIC DEVICES
[(3-1-0); Credits: 4]

Course Outcomes:

1. This course introduces the fundamentals of semiconductor devices, such as diode, BJT, DIAC, LED, UJT etc.

2. To study the V-I characteristics, biasing, small signal analysis, etc. for various electronic devices.

3. The student will be able to apply various devices into electroniccircuits and can compute various parameters.

4. At the end student will be able to study and design various power devices including applications of these devices in to power amplifications.

Syllabus:

Semiconductor diodes V-I characteristics, Modeling for various circuit applications, rectifier, Clipping and clamping circuits RC filters, Bipolar junction transistor (BJT), V-I characteristics, Biasing, Small signal low frequency amplifier. LED photodiode, optocoupler, V-I characteristics, optoelectronic circuits. Power devices, power diode, IGBT, SCR TRIAC, Switching Devices, DIAC, UJT characteristics and applications. Power amplifiers: Class A, B, AB,C, Efficiency calculations, Push pull complimentary symmetry ,Feedback amplifier, Oscillators.

TEXT BOOKS

"Electronic Devices and Circuits", "Millman Halkias", "TMH", 2000
"Electronic Devices and Circuits", "David A. Bell", "PHI", 4th Edition

REFERENCE BOOKS

1."Electronic devices and Circuit Theory", "R. Boylestad", "Pearson Education", 9th Edition
2."Electron devices", "S. Poornachandra, Sasikala", "Scitech", 2nd Edition

ECL 202-DIGITAL LOGIC DESIGN
[(3-0-0); Credits: 3]

Course Outcomes:

1. Differentiate between Analog and Digital Electronics Domain. Make Truth Tables and electrical circuits of Logic Gates

2. Apply minimization techniques to Boolean expressions. Conceptualize combinatorial circuits and Sequential circuits and their design.

3. Design state machines and using memory cell design ROM and RWM.

Syllabus:
Motivation for digital systems-logic and Boolean algebra, propositions, truth tables, minimization of combinational circuits. Karnaugh maps and tabulation procedure, implementation of sum of product and product of sum in hardware. Decoders, multiplexers, and code converters, adders: ripple and carry look ahead addition. Storage elements, flip-flops and latches: D,T, J/K flip-flops, shift register, counter. Asynchronous and synchronous design using state and excitation tables, FSM implementation. Overview of VLSI designs process. PAL, CPLD, FPGA, ASIC Structure overview, Introduction to hardware description language for digital circuit implementation.

TEXT BOOKS

"Switching & Finite Automata Theory", "Kohavi Zvi", TMH
"Digital Design", "M.Morris Mano", Prearson Education

REFERENCE BOOKS

1. "Fundamentals of Digital Logic with VHDL Design", "Stephen Brown, Vranesic Z", TMH
2. "VHDL Primer", "Bhaskar J", B.S.Publication

ECL 210-SIGNALS & SYSTEMS ANALYSIS
[(3-1-0); Credits: 4]

Course Outcomes:

1.This Course will introduce you to the fundamental ideas of signals and system analysis. Applications of these ideas include audio and image processing, communications,control, machine learning, and finance.

2.The topics well cover in the course include basic properties of signals and systems, the processing of signals by linear systems, Fourier series and transforms, sampling,discrete-time processing of continuous-time signals.

3.This course will serve as a central building block for students interested in further studying information processing in any form.

Syllabus:
Elements of Signal Space Theory: Different types of signals, Linearity, Time invariance and causality, Impulse sequence, Impulse functions and other singularity functions.
Convolution: Convolution sum, Convolution integral and their evaluation, Time domain representation and analysis, of LTI systems based on convolution and differential equations.
Multi Input-Output Discrete and Continuous Systems: State model representation, Solution of state, equations, State transition matrix.
Transform Domain Considerations: Laplace transforms and Z-transforms, Application of transforms to discrete and continuous systems analysis, Transfer function, Block diagram representation, DFT.
Fourier series and Fourier Transform: Sampling theorem, Discrete Fourier transform (DFT), Estimating Fourier Transform using (DFT).

TEXT/REFERENCE BOOKS

1.Signals and Systems - Continuous and Discrete:;,"Ziemer, R.F., Tranter, W.H. and Fannin, JD.R",Prentice Hall ; 1998,4th Edition

2.Signals and Systems,"Oppenheim, A.V., Willsky, A.S. and Young, I.T",Prentice Hall ; 1983 Edition

3.Signals and Systems,"Roberts, M.J",Tata McGraw-Hill ; 2003Edition

ECL 204- MEASUREMENT & INSTRUMENTATION [(3-0-0); Credits: 3]

Course Outcomes:

The students are expected to learn:

1. How to get an accurate measurement any physical quantity using various calibration methods.

2. The fundamentals of measuring systems including the particular limitations and capabilities of a number of specific measuring devices (pressure transducers, strain gages, thermocouples, etc.) and equipment (oscilloscope, data acquisition card, etc.).

3. The experimental process applied in the laboratory for different physical quantity measurement.

Syllabus: Accuracy and precision, Significant figures, Types of errors, statistical, Probability of errors, Limiting errors. Functional elements of an instrument, Active and Passive transducers, Analog and Digital mode of operation, Null deflection methods, Input and output configuration of measuring instrument and instrument system. Wheat stone bridge : Basic operation, measurement errors, Thevenin's equivalent circuit, Guarded Wheat-stone bridge, Kelvin bridge: Effects of connecting leads, Kelvin double Bridge. AC Bridges and their application: Condition and application of the balance equation. Maxwell's bridge, Hay Bridge, Schering Bridge, Wein Bridge unbalanced condition. PMMC galvanometer, DC ammeters , Ohmmeter: Series and shunt type, VOM, watt hour meter, instrument transformers power factor meter, Q- meter. Transducers as input elements to instrumentation system. Basic methods of Force measurement, Torque measurement of rotating shafts, shaft power measurement (Dynamometers) Pressure and Sound Measurement : Standards and calibration, Basic methods of pressure measurement, high pressure and low-pressure measurement, sound measurement. Temperature and Heat Measurement: Standards and calibration, Thermal expansion methods, Thermocouples (Thermoelectric sensors), Resistance thermometers Junction semiconductors sensors, Digital thermometers. Heat-flux sensors, Radiation types. Strain Measurement: Bonded and un-bonded electrical strain gauges, gauge factor, temperature compensation methods. Introduction, Amplified DC meter, AC voltmeter using rectifiers, Electronic multi-meter, Digital voltmeters, Q meter. Oscilloscope : Introduction, Oscilloscope block Diagram, Cathode Ray tube (CRT), CRT circuits, Deflection systems, Delay line. Multiple trace , Simple frequency counters. Strip XY recorder, CRO, signal conditioning Techniques used in various transducers, Gain clipping, filtering, amplification, data logger. IEEE 488 Bus: Principles of operation, protocols.

TEXT BOOKS

1. Electronic instrumentation & Measurement techniques,"Cooper ,

Helfrick",Prentice Hall India
2. Measurement System : Application & design,Doelbin E.D,McGraw Hill,Edition

REFERENCE BOOKS

1. Electronic Instrumentation,Kogalsusha. Terman, Petil Edition
2. Electronic Instrumentation, Kalsi, Tata Mc-Grawhill Edition
3. Electronic Measurement & Instrumentation,Oliver,Tata Mc-Grawhill Edition Electronic Measurement and Measuring Instruments, Sawhney A.K

ECL 308-ANALOG CIRCUIT DESIGN
[(3-0-0); Credits: 3]

Course Outcomes:
1. Through the course student is able to do the Analysis, design, and applications of modern analog circuits using integrated bipolar transistor and field effect transistor.
2. They also demonstrate the use of analog circuit analysis to analyze the operation and behaviour of various modern analog integrated circuits

Syllabus: Differential amplifier, configurations, DC & AC analysis, constant current bias, current mirror, cascaded differential amplifier stages, level translator. OPAMP, inverting, non-inverting, differential amplifier configurations, negative feedback, voltage gain, input & output impedance, Bandwidth. Input offset voltage, input bias and offset current, Thermal drift, CMRR, PSRR, Frequency response. Linear applications, DC, ac amplifiers, summing differential amplifier, instrumentation amplifier, V to I and I to V converters, Integrator, Differentiator. First / Second order low/ high/ bandpass, band reject active filters, All pass filter, phase shift oscillator, Wein bridge oscillator, Square wave and triangular waveform generators. Non linear applications, Comparators, Schmitt Trigger, Clipping and Clamping circuits, Absolute value circuits, Peak detectors, Sample and hold circuits, Log and antilog amplifiers.
Study of ICs LM-741, LM-555, LM-566, LM-565, LM-339, LM-723.

TEXT BOOKS
1.Operational amplifiers, Design and applications","Tobey, Graeme, Huelsman", McGraw Hills, Edition

2. Operational Amplifiers and Linear Integrated Circuits,Gaikwad R.A, PHI
1990 Edition

REFERENCE BOOKS
1.Design with OPAMPS and Analog Ics,Fransis S.,"McGraw Hills, 1998.",Second Edition
OPAMPS and Linear Ics,"Fiore J.M., delmer-Thomson",USA 2001.

MAL 205-NUMERICAL METHODS AND PROBABILITY THEORY
[(3-1-0); Credits: 4]

Course Outcomes:

1. To study Basics of Numerical Analysis: Solutions of algebraic and transcendental equations by Iteration method, method of false position, Newton-Raphson method and their convergence.

2. Details about the random variables, various methods for numerical analysis.

3. To study random processes, autocorrelation and cross correlation applicable in the field of electronics and communication engineering.

Syllabus:

Numerical Analysis: Solutions of algebraic and transcendental equations by Iteration method, method of false position, Newton-Raphson method and their convergence. Solutions of system of linear equations by Gauss elimination method, Gauss Seidal method, LU decomposition method. Newton-Raphson method for system of nonlinear equations. Eigen values and eigen vectors : Power and Jacobi methods. Numerical solution of ordinary differential equations: Taylor's series method, Euler's modified method, Runge-Kutta method, Adam's Bashforth and Adam's Moulton, Milne's predictor corrector method. Boundary value problems: Shooting method, finite difference methods. Probability theory: Random variables, discrete and continuous random variable, probability density function; probability distribution function for discrete and continuous random variable joint distributions. Definition of mathematical expectation, functions of random variables, The variance and standard deviations, moment generating function other measures of central tendency and dispersion, Skewness and Kurtosis. Binomial, Geometric distribution, Poisson distribution, Relation between Binomial and Poisson's distribution, Normal distribution, Relation between Binomial and Normal distribution. Random processes, continuous and discrete, determinism, stationarity, ergodicity etc. correlation functions, autocorrelation and cross-correlation, properties and applications of correlation functions.

TEXT BOOKS

1.Jain, Iyengar and Jain : Numerical Methods for Engineers and Scientists, Wiley Eastern
2.V.K. Rohatgi and A.K.M. Ehsanes Sateh: An Introduction to Probabability and Statistics, John Wiley & Sons.

REFERENCE BOOKS

1. S. D. Cante and C. de Boor, Elementary Numerical Analysis, an

algorithmic approach, McGraw-Hill.
2. Gerald and Wheatley : Applied Numerical Analysis, Addison-Wesley.
3. Spiegel, M.R.; Theory and problems of Probability and statistics; McGraw-Hill Book Company; 1980.
4. K.S. Trivedi: Probability Statistics with Reliability, Queuing and Computer Science applications, Prentice Hall of India Pvt. Ltd.

ECL 306-MICROPROCESSORS & INTERFACING
[(3-0-0); Credits: 3]

Course Outcomes:

1. Through this course the students will be able to identify the internal registers and memory organization for assembly language programming.

2. They are able to design interface circuits for microprocessors and also interface controlling devices and data acquisition systems.

3. This course helps the students to develop assembly language codes for microprocessor-based systems.

Syllabus:

Architecture of Intel's 8085 microprocessor, Addressing modes of 8085 and its timing diagrams, Machine cycle, T-states, Bus structure. Instruction set of 8085, Grouping of instructions, Instruction cycle and their timing diagrams, Assembly language programming. Stacks and sub routines, related instructions, Interrupts and associated instructions, Expanding interrupts, ALP for stacks and interrupt service routines. Memory Interfacing, I/O mapped and memory mapped modes, interfacing of input and output devices, Multiplexed and matrix interfacing. Study and Interfacing of (at least four of the following) peripherals with 8085: Peripherals: 8255, 8254, 8251, 8259, 8257/37, and 8279.

TEXT/REFERENCE BOOKS

1. "Microprocessors Architecture, Programming and applications with 8085", Gaonkar R.S, Penram Publishing, Edition
2. Microprocessors and Microcontrollers, Uffenbeck J, Prentice Hall of India Edition

ECL 309-FINITE AUTOMATA
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course provides techniques help to understand of structure, behaviour, limitations and capability of logical machines used for wide variety of applications.

2. It helps to formulate digital logical design methods and to develop algorithms that can be useful for wide range of applications.

Syllabus:

Review of combinational circuit design and optimization; functional decomposition and symmetric functions; identification of symmetric functions. Threshold logic; synthesis of threshold networks. Fault detection in combinational circuits; Boolean differences and Path sensitization. Synchronous sequential circuits and iterative networks; memory elements and their excitation functions; synthesis of synchronous sequential circuits; Moore and Mealy machines; Applications to controller design; finite state machine flow charts, tables, ASM charts. Machine minimization. Asynchronous Sequential circuits; synthesis; state assignment; minimization.

TEXT BOOKS

1. Switching and Finite Automata Theory, Zvi Kohavi,TMH,2 edition
2. Digital Circuits and Microprocessor, Herbert Taub, TMHE dition

REFERENCE BOOOKS

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

PHL208-PHYSICS OF SEMICONDUCTOR DEVICES
[(3-0-0); Credits: 3]

Course Outcomes:
1.This course provides understand the physics and properties of various semiconductor devices.

2. It helps to formulate background for designing and use of these devices in electronics industries.

Syllabus: Physics and properties of semiconductors: Crystal structure energy bands, carrier concentration at thermal equilibrium, carrier transport phenomenon, phonon spectra, optical thermal and high field properties of semiconductors. Basic equation for device operation.
P-n junction diode, basic device technology, depletion region and depletion capacitance, current voltage characteristics, junction breakdown, heterojunctions. Schrodinger wave equation for a finite potential step, metal semiconductor contacts, energy band relations, depletion layer, Schottky effect, current transport processes, thermionic emission, diffusion, tunneling current, minority carrier injection ratio, characterization of barrier height, measurement of barrier height, device structures, ohmic contact. Photonic devices: radiative transitions, LED and semiconductor lasers, photoconductor, photodiode, solar cells.

TEXT/REFERENCE BOOKS
1. Physics of semiconductor devices, S.M. Sze, John Wiley and Sons, 2001.
2. Semiconductor physics and devices, S.S. Islam, Oxford University press.

EEL 310-CONTROL SYSTEMS
[(3-0-0); Credits: 3]

Course Outcomes:
1. Students will learn the modelling of linear dynamic systems via differential equations and transfer functions utilizing state-space and input-output representations.

2. They can analysis of control systems in the time and frequency domains and using transfer function and state-space methods.

3. Through the successful completion of the course, the student will be able to:
a. Learn various systems exhibiting control mechanisms and understand their operation,
b. Represent Mathematical model of Feedback Control Systems.
c. Evaluate the concept and significance of a Control System model and its applicability.

Syllabus: Introduction to need for automation and automatic control. Use of Feedback, Broad spectrum of system application. Mathematical modelling, Diff. Equations, transfer functions, block diagram, signal flow graphs, Application to elementary system simplifications, Effect of feedback on parameter variation, disturbance signal, servomechanisms and regulators. Control system components, Electrical, Electromechanical, hydraulic, pneumatic and other components. Their functional analysis and input output representation.Time response of systems, First order and second order system, standard inputs concept of gain and time constants. Steady state error, type of control system, approximate methods for higher order system.Root location and its effect on time response, Elementary idea of Root Locus, effect of adding pole and zero in proximity of imaginary axis.Stability control systems , conditions of stability, characteristic equation, Routh Hurwitz criterion, special cases for determining relative stability.Frequency response method of analysing linear system. Nyquist and Bode plots stability and accuracy analysis from frequency responses, open loop and close loop frequency response. Nyquist criterion, Effect of variation of gain and addition of pole and zero on response plot, stability margins in frequency response.State variable method of analysis, characteristic of system state, choice of state representation in vector matrix, different standard form, relation between transfer function and state variable.

TEXT BOOKS

1. Nagrath & Gopal ; Control System Analysis
2. D'Azzo Houpis; Linear System Analysis; 1975.Huelsoman, McGraw Hill, Logakusha.

REFERENCE BOOKS

1. Kuo. B. C.; Automatic Control Systems; Prentice Hall, 1991.
2. Noman Nise; Control System Engineering; John Wiley & Sons,INC 2000.
3. Gopal M.; Control Systems : Principle of Design.

ECL 301-ANALOG COMMUNICATION
[(3-1-0); Credits: 4]

Course Objectives:

1.The course is designed to covers the fundamentals, principles, concepts, and techniques of analog and digital communication systems like various modulation techniques, digital data transmission, communication technologies, time-domain and frequency domain multiplexing techniques, noise analysis, information theory and various channel coding.

Syllabus:

Review of Signal Analysis using Fourier series representation of periodic signals, Fourier transform, Properties of Fourier transform, Convolution, Analysis of Linear time invariant systems. Transmission of signals through systems: Criteria for distortion less transmission, ideal filters, distortions in practical systems, power and energy of signals. Amplitude modulation: Need of modulation, AM DSB-SC, SSB-SC and vestigial side band modulation and demodulation, AM transmitter (broadcast and low power), FDM, Noise in AM systems. Angle modulation: FM and PM, reactance FET modulator Armstrong method, Foster-Seely discriminator, PLL detector, Stereophonic FM, Spectrum of FM, Narrow band and wide band FM, FM transmitter (broadcast and low power). Noise in FM systems.. Radio receivers: TRF and super-heterodyne receiver, AGC, FM receiver, sensitivity, selectivity, image frequency rejection measurements, communication receiver and its special features. Transceivers for wireless mobile communication devices. Analog pulse modulation: Sampling theorem, PAM, PWM, PPM, generation & Detection of these pulse modulated signals, TDM

TEXT BOOKS

"Introduction to Analog & Digital Communication Systems", "Haykin Simon", John Wile
"Modern Analog & Digital Communication Systems", "Lathi B.P", John Wiley

REFERENCE BOOKS

1."Electronic Communication Systems", "Kennedy", TMH
2."Communication Electronics Principles and Applications", "Frenzel", TMH, 3rd Edition
3."Electronic Communication Modulation and Transmission", "Schoenbeck", PHI

ECL 302-DEVICE MODELLING
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course offers an introduction to numerical modelling of semiconductor devices and to deal with advanced concepts in semiconductor electronic devices.
2. Through the course, student will understand the physical, electrical, and optical properties of semiconductor materials and their use in microelectronic circuits.
3. Course enables students to analyze the relation of atomic and physical properties of semiconductor materials to device and circuit performance issues.
4. By the end of course, student understand the connection between device-level and circuit-level performance of microelectronic systems.
5. Students can perform analysis of device structures and behaviours using modelling software.

Syllabus:

Introduction to SPICE Simulation, Analysis of complex electronic circuits, simulation and analysis using SPICE, AC/DC operation, DC sweep transfer function, frequency response, feedback control analysis, transient response, device models, simulation and analysis of electronic circuits and systems. Review of semiconductor physics, The pn junction, , The built-in voltage, Depletion width and junction capacitance, Diode current/voltage characteristic, Minority carrier charge storageMOS transistors, Threshold voltage and the body effect, Current/voltage characteristics, Subthreshold current, Short channel effect and narrow width effect, Drain induced barrier lowering Channel length modulation, Hot carrier effects, Effective mobility and velocity saturation SPICE models, MOS inverter circuits Bipolar transistors, Current gain, Gummel plots and output characteristics, Recombination in the emitter/base depletion region, Charge storage and forward transit time, Cut-off frequency, TTL gates. Basic SPICE Models, Ebers-Moll and basic Gummel-Poon model, Small-signal model, Parameter extraction

TEXT BOOKS

"Solid State Electronic Devices", "B.G.Streetman and S.Banerjee", Prentice Hall India

"Analysis and Design of Digital Integrated circuits", "D.A.Hodges, and H.G.Jackson" , McGrraw-Hill International

REFERENCE BOOKS

1."Introduction to VLSI circuit and systems", "J.P.Uyemura", John Wiley and Sons

2."Fundamentals of Modern VLSI devices", "Y.Taur, T.H.Ning", Cambridge University Press

"Principles of CMOS VLSI design , A systems perspective", "Eshraghian K", Addison Wesley.

CSL 311-COMPUTER ARCHITECTURE AND ORGANIZATION
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course helps to learn:

a. How computers work, basic principles,

b. How to analyse their performance,

c. How computers are designed and built.

d. It gives understanding of issues affecting modern processors (caches, pipelines etc.).

Syllabus: Basic Structure of Computers, Functional units, software, performance issues software, machine instructions and programs, Types of instructions, Instruction sets: Instruction formats, Assembly language, Stacks, Ques, Subroutines.

Processor organisation, Information representation, number formats.

multiplication & division ALU design, Floating Point arithmetic, IEEE 754 floating point formats

Control Design, Instruction sequencing, Interpretation, Hard wired control - Design methods, and CPU control unit. Microprogrammed Control - Basic concepts, minimizing microinstruction size, multiplier control unit. Microprogrammed computers - CPU control unit

Memory organization, device characteristics, RAM, ROM, Memory management, Concept of Cache & associative memories, Virtual memory,.

System organization, Input - Output systems, Interrupt, DMA, Standard I/O interfaces

Concept of parallel processing, Pipelining, Forms of parallel processing, interconnect network

TEXT BOOKS

1.Computer Organisation,V.Carl Hammacher,Fifth Edition.
2.Structured Computer Organisation,A.S.Tanenbum,PHI,Third edition

REFERENCE BOOKS

1. Computer Organisation and Microprogramming,"Y.Chu, II, Englewood Chiffs, N.J.",Prentice Hall,Edition
2. Computer System Architecture,M.M.Mano,Edition
3. Computer Organisation and Programming,C.W.Gear,"McGraw Hill, N.V",Edition
4. Computer Architecture and Organisation,Hayes J.P,PHI,Second edition

EEL 309-POWER ELECTRONICS
[(3-0-0); Credits: 3]

Course Outcomes:
1. This course is designed to present the basic concepts of power electronics devices, and control.
2. The converter analysis, design, modelling, and control of switching converters will be presented as relevant to different applications.

Syllabus: Semiconductor devices used in power electronics: SCR, ASCR, RCT , LASCR, TRIAC, IGBT, Power MOSFET, GTO, Triggering devices: UJT, PUT,construction characteristics, ratings, Applications.ce treatment should deal with, Application.Thermal equivalent circuit, Heat sink calculation, protection requirements and methods.
Thyristor as power controller, phase angle control, Extinction angle control, Symmetrical angle control, time ratio control, pulse width modulation, Burst-Integral cycle, Turn on methods: Circuits for single phase line communicated converter, single phase converter , single phase inverter, Digital methods,. Turn off (commutation) Methods: type A, B, C, D, E and F.
Uncontrolled Rectifiers: single phase: (M-2), (B-2),(M-3), B-6; Single phase/three phase half control(one quadrant operation); Single phase full wave converter, Three phase converter, three pulse, six pulse, (Bridge & midpoint type), Semi converter, Dual converter operation, Single phase bridge, therr phase bridge (circulating & non circulating).
Invertors : Types-series, parallel, bridge, PWM voltage source inverter (CSI), Current source invertors (CSI), Filters-Types, calculation. Commutations methods, transistorized power controllers circuits
Choppers: Types A, B, C, D, E Multiphase, line filter; one, two and four quadrant operation of choppers, commutation methods: AC Regulator: Single phase and three phase Manual, Auto solid state, servo control, uninterrupted power supply (UPS), switched mode power supplied (SMPS).

TEXT BOOKS

1. Sen P. C. ; Morden Power Electronics; Wheeler Publishers,1998
2. Singh. M. G., K.B. Khanchandani; Power Electronics; Tata MaGraw Hill, 2000.

REFERENCE BOOKS

1. Bose. B. K.; Morden Power Electronics and AC Drives; Pearson education India, Indian Reprint, 2003
2. Ned Mohan, etal; Power Electronics; John Willey, 2000.
   Lander C. Y; Power Electronics: McGraw Hill International, 1993

ECL 415-ELECTRONIC SYSTEM DESIGN
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course helps the students to understand the principles and operation of advanced electronic circuits and devices such as bipolar junction transistor, operational amplifier, filters, digital logic gates, ADC and DAC, 555 Timer and Instrumentation amplifiers.
2. It also emphasizes the importance of modelling the behaviour of complex electronic circuits and devices using systematic mathematical techniques.
3. Students will be able to design, analysis and simulation advanced electronic circuits using PSPICE software tools.

Syllabus: Design of Power supply system: Unregulated D.C. power supply system with rectifiers and filters. Design of emitter follower regulator, series regulators, overload protection circuits for regulators.

Design of SMPS: Step up and step down.

Design of class A small signal amplifiers: Emitter follower, Darlington pair amplifiers with and without Bootstrapping , Two stage direct coupled amplifier. Design of class A , Class AB, audio power amplifier with drivers.

Design of sinusoidal oscillators: OPAMP based Wein bridge and Phase Shift oscillators with AGC circuits, Transistor based Hartley, Colpits and Crystal oscillators, Evaluation of figure of merit for all above oscillator circuits.

Design of constant current sources, Design of function generators, Design of tuned amplifiers. Design of A/D and D/A converters

Design of Butterworth, Chebyshev filters upto sixth order with VCVS and IGMF configuration.

TEXT BOOKS

1. Regulated Power supply Handbook. Texas Instruments.
2. Electronics : BJT's, FETS and Microcircuits Anielo.

REFERENCE BOOKS

1. Monograph on Electronic circuit Design : Goyal & Khetan.
2. Operational Amplifiers: Tobey, Grame, Huelsman

ECL 304-DIGITAL SIGNAL PROCESSING

[(3-0-0); Credits: 3]

Course Outcomes:

1. This course is designed to provide students with a comprehensive treatment of the important issues in design, implementation and applications of digital signal processing concepts and algorithms.

2. It helps the students to develop skills for analyzing and synthesizing algorithms and systems that process discrete time signals, with emphasis on realization and implementation.

Syllabus: Discrete time signals; Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals.
Discrete time systems; attributes, Z- Transform, Analysis of LSI systems, frequency analysis, Inverse Systems
Signal flow graph representation, DF1, DF2, parallel and cascade form. Finite word-length effects in Digital Filters
Discrete Fourier Transform (DFT), Fast Fourier Transform algorithms.
Design of FIR Digital Filters: Window method, Park-McClellan's Method
Design of IIR Digital Filters: Butterworth, Chebyschev approximations. Lowpass, Bandpass Bandstop and Highpass filters. Bilinear, impulse invariant frequency

TEXT BOOKS

1. Discrete Time Signal Processing,Oppenheim & Schafer, PHI Ltd, Third Edition

2. Digital Signal Processing: Principles Algorithms and Applications,Proakis John and Manolakis D.G.Prentice Hall 1992.Edition

REFERENCE BOOKS

1. Digital Signal Processing, Cavicchi Thomas J,Wiley 2002 Edition
2. Digital Signal Processing A Computer -Based Approach, Mitra S.K,Tata McGraw- Hill

ECL 303-DIGITAL COMMUNICATION
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course is useful to present the basic principles that underline the analysis and design of digital communication systems.
2. The subject of digital communication involves the transmission of information in digital form from a generating source to one or more destinations.
3. The course also covers the analysis and design of communication systems are affected by the characteristics of the physical channels through which the information is transmitted.

Syllabus:

Introduction to digital communication. Comparison of analog and digital communication. Advantages and disadvantages of digital communication.

Source Coding of Analog Sources: PCM-TDM, Practical PCM-30 system, Delta modulation, Adaptive DM, DPCM, ADPCM. Source coding of digital sources: Information, entropy, Shannon's source coding theorem, Huffman algorithm, prefix codes. Generalized digital communication system, geometric interpretation of signals, performance of matched filter receiver and correlator receive in the presence of white noise. Threshold setting and error probability. Base band transmission: Line coding fundamentals, transmission formats, spectral requirements. Media used for digital communication; storage and transmission, guided and unguided. types of noise and other impairments. Inter-symbol interference, Nyquist's results for ISI, Eye pattern and adaptive equalization. Pass-band transmission methods: Binary ASK, PSK and FSK, Quadrature multiplexing, QPSK and QAM methods. Geometric interpretation of signals, performance of matched filter receiver and correlator receive in the presence of white noise. Spread spectrum methods: Properties of PN sequences, DSSS system, slow and fast FHSS. Block diagrams and performance analysis, carrier and symbol synchronization.

Case studies of transmission methods in telecommunications and computer networking. For example ISDN, XDSL, 802.3 LANs, WiFi LANs, GSM and CDMA mobile wireless networks. Error control coding: Shannon's channel capacity theorem, significance of the theorem. Linear block codes generation and decoding, Hamming distance considerations, Cyclic codes and their applications, Convolutional codes and Viterbi decoding algorithm.

Data link layer protocols; ARQ and sliding window protocols; flow control methods; elementary analysis of protocol correctness and performance; Case studies of HDLC and PPP.

TEXT BOOKS

1. Introduction to Analog & Digital Communication Systems;Haykin Simon;John Wiley,Edition
2. Modern Analog & Digital Communication Systems; Lathi B.P,John WileyEdition

REFERENCE BOOKS

1. Digital communication ,Haykin Simon,WileyEdition
2. Communication systems ,"Haykin, Simon",Wiley,(4e)
3. Digital communication,"Proakis, John",Tata- McGraw-Hill,(3e)

ECL 305-ELECTROMAGNETIC FIELDS
[(3-1-0); Credits: 4]

Course Outcomes:

1. This course defines capacitors, inductors and resistors in terms of its primary electric and magnetic quantities like electric charge, electric potential, electric current, electric and magnetic flux.
2. It also explains universal concepts in three-dimension real world, i.e., electro-magnetic wave propagation in free-space.
3. The students will learn to define electric and magnetic fields, calculate electric and magnetic fields from stationary and dynamic charge and current distributions, solve simple electrostatic boundary problems, describe simple models for electromagnetic interaction with media, be able to choose adequate models and solution methods for specific problems, solve problems analytically and numerically.

Syllabus:

Vector calculus: Cartesian, Cylindrical and spherical co-ordinate systems, differential lengths, surfaces and volumes, Electrostatics: Coulomb's law, Electric field, intensity, electric flux density, Gauss's law and applications, divergence and divergence theorem, potential difference and potential gradient, Electric dipole and dipole moment, Energy in electric field. Steady magnetic fields: Biot Savart's law, Amperes circuital law and application, Curl and Stroke's theorems, Magnetic flux density and magnetic flux, scalar and vector magnetic potentials, Maxwell's equations and time varying fields, Faraday's law, displacement current, Maxwell's Equations in point & integral form, Retarded potentials. Uniform Plane waves: Maxwell's equation in phasor form, wave equation in general medium and perfect dielectric mediums, Solution of wave equations, intrinsic impedance, velocity and wavelength, conductors and dielectrics, depth of penetration, Poynting's vector theorem. Reflection of Electromagnetic Waves: Reflection of Electromagnetic waves: Normal incidence, standing waves, laws of reflection, reflection of obliquely incident waves, Brewsters angle.

TEXT/REFERENCE BOOKS

1. Engineering Electromagnetics, Hayt Jr.,Tata McGraw Hill Edition
2. Electromagnetic Fields & Radiating Systems,Jorden & Ballman, PHI Edition
3. Elements of Electromagnetics,Sadiku,Oxford publications Edition

CSL312-CONCEPTS IN OPERATING SYSTEMS
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course is about models of Operating Systems from the uni-processor / multiprocessor perspectives.
2. It attempts to provide the frame of reference on which the existing designs have emerged, and the future design possibilities are likely to evolve.
3. In this course, the emphases would be on the paradigm that views an Operating System environment in the collective interplay of processes requiring economic resources.
4. In this course we would also develop to gain knowledge about the Operating Systems concepts such as process, main memory management, secondary memory management, CPU and disk scheduling etc.

Syllabus:

Introduction to Operating Systems, simple batch Systems, time sharing systems etc., computer system structures, I/O structure, storage structure, operating system structures, operating system services, system calls
Process management, Concept of a process, operations on a process, interprocess communication, CPU scheduling, scheduling criteria, scheduling algorithms, process synchronization, critical section problem, synchronization primitives, semaphores, monitors, deadlocks, deadlock prevention, avoidance and detection
Storage Management, memory management, logical vs. physical address space, paging and segmentation, virtual memory, demand paging, page replacement algorithms, thrashing
File system interface, file concept, access methods, directory structure, protection, file-system implementation, allocation methods, free-space management
I/O Systems, I/O hardware, secondary-storage structure, disk structure, disk scheduling, disk management
Protection and security, goals of protection, domain of protection, access matrix, capability based systems, security issues, authentication, encryption

TEXT/REFERENCE BOOKS

1.Operating System Concepts,"Galvin P.B., Silberchatz A",Wesley
2.Operating Systems,Stallings W,"PHI, New Delhi"
3. Modern Operating Systems,Tanenbaum A.S,"PHI, New Delhi"

ECL403-EMBEDDED SYSTEMS

[(3-0-0); Credits: 3]

Course Outcomes:

1.The aim of this course is to provide the student with a detailed understanding of Microcontrollers and Embedded systems.

2.The course covers fundamentals of Architecture, Assembly Language Programming, Instruction set, Serial Communication and Interfacing techniques of 8051 Microcontroller.

3.By the end of course, students are able to design an application specific embedded system.

Syllabus:

Introduction to embedded systems, microcontrollers 8051 family, architecture, register set, instruction set, programming, interrupts, stack, timers on-chip and off chip peripherals interfacing and programming, Keys, keyboards, LEDs, 7Seg multiplexed display interfacing, ADC,DAC, Stepper motor LCD dot matrix interfacing, Serial communication, sensors and actuators, instrumentation amplifier, Design examples , introduction to ARM, features, architecture, instruction set features, Concepts of RTOS.

TEXT BOOKS

1.M A Mazidi, J G Mazidi, R D McKinlay, The 8051 Microcontroller and Embedded Systems Using Assemble and C, Pearson/Prentice Hall, 2nd Ed

2.Kenneth Ayala, The 8051 Microcontroller, Cengage learning, India, 2004 3rd Ed

REFERENCE BOOKS

1. Lyla B Das; Embedded Systems and Integrated Approach, Pearson, India, 2013, first edition,

2. K M Bhurchandi, A K Ray, Advanced microprocessors and Peripherals, McGraw Hill Education India, 2012, 3rd ed

3. Rajkamal, Microcontrollers, Archi, Progr, interfacing and Sys design, Pearson, India, 2nd ed, 2012

4. K V Shibu, Introduction to Embedded Systems, Tata McGraw Hill Education, India, 2009

ECL 401-HARDWARE DESCRIPTION LANGUAGE
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course covers an introduction to hardware description languages and associated methodologies for digital system design.
2. It also provides in-depth coverage includes applications to the simulation and synthesis of digital systems.
3. The students will get familiar with the process of digital integrated circuit synthesis, together with place and route, starting from HDL code to silicon/gate array level.

Syllabus: Modeling digital systems, Hardware design environment, Design Flow, Hardware description languages, Various design styles. Introduction to VHDL, Elements of VHDL, Basic concepts in VHDL, Simulation, Synthesis. Dataflow modeling, Concurrent signal assignment, delays, Behavioral modeling, processes. Design organization, Structural specification of hardware, parameterization, hierarchy, abstraction, configurations, utilities. Subprogram, packages, libraries, Basic I/O, Programming mechanics Synthesis, RTL description, constraints attributes, FPGA, CPLD structure, technology libraries.
Introduction to Verilog Programming

TEXT BOOKS

VHDL programming", " J.Bhaskar" TMH.
VHDL", "Perry D", TMH.

REFERENCE BOOKS

1. "VHDL", "Nawabi Z", PHI.
2. "Principles of CMOS VLSI design. A systems perspective", "Eshraghian K, NHE Weste", Addison Wesley
Basic VLSI Design", "Pucknell D.A., Eshraghian K"

ECL 405-WAVEGUIDES AND ANTENNAS
[(3-0-0); Credits: 3]

Course Outcomes:

1. The course provides students an introduction to radiation theory, antennas, radiation fields, radiation resistance and gain.
2. It helps to understand transmitting arrays, plane-wave approximation of radiation fields, plane-wave propagation, reflection, and transmission.
3. It introduces Doppler Effect, evanescent waves and tunnelling, dispersion, phase and group velocities, waveguides and resonant cavities, antenna reception and link budgets.

Syllabus:

Revision of Maxwell's equations for time varying fields and physical significance of Curl, Divergence and Gradient. Waves between parallel planes, TE, TM,& TEM and their characteristics. Attenuation in parallel plane guides wave impedances. TE, TM waves and impossibility of TEM mode in Rectangular waveguide. Different characteristics like group velocity, phase velocity, guide wavelength and wave impedances. Transmission line equations and their solutions. Transmission line parameters, Characteristic impedances, Propagation constant, Attenuation constant, Phase constant, Waveform distortion, Distortion less transmission lines, Loading of transmission lines, Reflection coefficient and VSWR. Equivalent circuits of transmission lines, Transmission lines at radio frequency. Open circuited and Short circuited lines, Smith Chart, Stub matching. Scalar and vector potentials related potentials, field due to a current element, power radiated and radiation resistance for field due to a dipole, power radiated and radiated resistance. Reciprocity theorem applied to antennas. Antenna terminology: Gain, Aperture, Radiation intensity, Directivity, Directive gain, Beam width, Radiation patterns, FBR, Antenna bandwidth etc. Concept of antenna arrays, Two element arrays and their directional characteristics, Linear array analysis, Broadside and end fire arrays, Principles of pattern multiplication & their application. Polynomial representation, Binomial arrays, Design of broadcast array for a specific pattern, Chebyshev array synthesis. Analysis of power patterns of various antennas like Parabolic reflectors, Lens antenna, folded dipole, Turnstile antenna, Yagi antenna, Log-periodic antenna, Horn antenna & feeding, Traveling wave antenna, Printed antennas, Case grain antenna, Patch & Micro strip antennas, Superconducting antenna, Rhombic, Helical, Open ended waveguide radiator, Small design problems & applications. Signal processing antennas or smart antenna, DOA, Principle beam formation & Digital beam formatting, Switched beam systems, Adaptive antennas, introduction to concepts of various signal processing algorithms, Principle of special filtering, Antenna diversity, TRB, SRB and Nulling of interference. Introduction to antenna measurement methods: measurement of Gain, Radiation pattern, Time domain gating, Antenna noise temperature & G/T, Impedance & Bandwidth. Introduction to measurement of cellular radio handset antenna.

TEXT BOOKS

1. "Antennas and Wave Propagation", K.D.Prasad, Khanna or Satya Publications
2. "Electromagneting waves and radiating systems", Jhordan & Balmin, Pearson

REFERENCE BOOKS

1. "Electromagnetic field theory and transmission lines", Raju, Pearson
2. "Antennas and wave propagation", Raju, Pearson
3. "Antennas for all applications", Kraus,TMH
4. "Elements of electromagnetism", Sadiku, Oxford
5. "Electromagnetic Waves", Shevgaonkar,TMH

ECL 412-ADVANCED DIGITAL SIGNAL PROCESSING [(3-0-0); Credits: 3]

Course Outcomes:

1. The course covers fundamental theory including the Discrete Fourier Transform, and Fast Fourier Transform algorithms; it then progresses into the design of digital filters.
2. The goal of advanced digital signal processing course is to provide the students a comprehensive coverage of signal processing methods and tools, including leading algorithms for various applications.

Syllabus:

Introduction to Speech processing, Speech production model, Linear predictive coding for speech, Yule-Walker equations, Short Time Fourier Transform (STFT) , analysis of speech signals using STFT.

Multi rate signal processing, decimator, interpolator, poly-phase decomposition, Noble identities, application to Discrete multi-carrier transmission, sigma-delta ADC.Data compression, lossy and lossless compression, LZW compression, Arithmetic coding, Discrete Cosine Transform (DCT) and its application to still image compression, audio compressionIntroduction to Wavelet transform: Properties of wavelet transform, DWT, filter implementation of DWT, applications of DWT for image denoising and Scaling functions as signaling pulses in communication

Introduction to commercial DSP processors & DSP architecture

TEXT BOKS

1.Introduction to data compression,Khalid Sayood,Elsevier,Second

2.Digital signal processing a computer basedapproach, S.K.Mitra, TMH, Third

REFERENCE BOOKS

1.Digital signal processing & applications, Dag stranneby and William walker, Elsevier, Second

Wavelet Transforms: Introduction to Theory and Applications, A.M.Rao & A.S.Bopardikar, Pearson Edition

ECL 404-RF & MICROWAVE ENGINEERING [(3-0-0); Credits: 3]

Course Outcomes:

1. To study the basics of RF and microwave spectrum.
2. To study various microwave tubes and different semiconductor devices.
3. To understand the measurement of various RF related parameters and to study the applications of microwaves.

Syllabus:

Introduction: RF & Microwave spectrum, Historical Background, Typical application of RF & Microwaves, Microwave Tubes: Limitation of conventional tubes in microwaves, Two cavity and multicavity Klystron, Reflex Klystron, Magnetron,Travelling wave tube, Backward wave oscillator working principles, characteristics. Semiconductor Microwave Device: Tunnel diode,Gunn diode, IMPATT diode,TRAPATT diode, Microwave bipolar transistor,hetrojunction bipolar transistor, Parametric amplifier, Passive Components : S- matrix, Directional coupler, Bethe-hole coupler, Magic tee, Hybrid ring,Circulator,Isoletor. Microwave Measurement: Measurement of VSWR-Low, Medium and High, Measurement of power, Bolometer, Frequency measurement, Impedence measurement. Application of Microwaves: Introduction to satellite communication, Radar, Industrial application of microwaves.

TEXT BOOKS

1. Microwave Devices & Circuits S.Y.Liao Pearson Education/PHI
2. Microwave Engineering ,Monojit Mitra ,Dhanpath Rai New Delhi

REFERENCE BOOKS

1. Microwaves ,K.C.Gupta ,New Age Publishers
2. Microwave Engineering ,Kulkarni ,Dhanpat Rai New Delhi

ECL434-WIRELESS DIGITAL COMMUNICATION
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course provides the students deep knowledge in modern digital communication systems at the theoretical & practical level and introduces the most advanced standards, the future of digital wireless communication systems & networks.
2. The course will focus on modern digital wireless communication systems including the cellular concept, mobile radio environment, signals generation, modulation & processing.
3. At the end of course, students will should able to work in the communication industry & in mobile communication networks.

Syllabus:

Introduction to wireless digital communication systems; block diagram of a typical RF transceiver, radio propagation and cellular engineering concepts; frequency reuse, frequency management and channel assignment, handoff and handoff strategies, trunking theory, coverage and capacity improvements, medium access techniques, FDMA, TDMA, CDMA, SDMA. Modulation methods: Basic digital modulation methods; ASK, PSK and FSK; Quadrature multiplexing and its applications; advanced modulation methods QPSK, QAM, MSK, GMSK, applications of differential coding, OFDM, MIMO.
Spread Spectrum methods: basics; generation and properties of PN sequences, DS-SS system analysis; slow and fast FH-SS system; performance analysis.
Interference measurement and reduction, co-channel and other interference, Diversity methods for Mobile Wireless Radio Systems, concepts of diversity branch and signal paths, combining and switching methods, C/N and C/I ratio improvements, average Pe improvements

TEXT BOOKS

1. Wireless Communication: Principles and Practices ,Theodore Rappaport, Pearson Education 2nd edition
2. Wireless Digital Communication, Feher, PHI

REFERENCE BOOKS

1. Digital communication, John Proakis, Tata- McGraw-Hill, 3rd edition
2. Digital communication, Simon Haykin ,Wiley
3. Communication systems, Simon Haykin ,Wiley, 4th edition

ECL 423-IMAGE ANALYSIS AND COMPUTER VISION [(3-0-0); Credits: 3]

Course Outcomes:

1. Through this course students will learn about the difficulties associated with automated image content recognition and understand the imaging issues from the perspective of quantitative image analysis will provide students with a balanced view of modern microscopy studies.
2. The course will cover a broad range of computer vision techniques and provides students with appropriate training to allow them to select and apply methods that are most relevant to their research.
3. It introduces the student to computer vision algorithms, methods and concepts which will enable the student to implement computer vision systems with emphasis on applications and problem solving.

Syllabus:

Review of basics of Digital image processing, Introduction about computer vision: What is computer vision, advantages and disadvantages of computer vision, general applications of computer vision

Feature detection and matching: Points and patches, edges, lines, Segmentations: Feature based alignment: 2D and 3D feature based alignments algorithms and applications, Pose estimation algorithms. Motion estimation: Differential motion analysis methods, optical flow, detection of specific motion patterns, image stitching, motion models for tracking, alignments, compositing. Image and video Compression techniques. Computational imaging: super resolution, blur removal, image matting and compositing, texture analysis and synthesis, stereo imaging, basic concepts, and applications.3D image processing techniques: basics of 3D images, 3D sensing, camera calibrations, and reconstructions, 3D from 2D image, surface based representations, point based representations, and volumetric based representations, and model based reconstruction, recovering textures from 3D images and applications of 3D imaging techniques, 3D shape recognition.

Object Recognition techniques Basics Colour image processing: Color fundamentals, color models, color transformation, color segmentation, smoothing, and sharpening. Case studies of computer vision projects such as content-based image retrieval, face recognition etc.

TEXT BOOKS

1. "Computer Vision: Algorithms and Applications" by "Richard Szeliski"Springer, 2010
2. "Computer Vision", "Shapiro and Stockman," Prentice Hall, 2001
3. "Image Processing, Analysis, and Machine Vision", "Sonka, Hlavac, and Boyle" Cengage Learning, 2009.

REFERENCE BOOKS

1. "Fundamentals Of Machine Vision", by "Harley R. Myler" PHI Learning (2003)
2. "Computer Vision: A Modern Approach" by "Forsyth, David A., Ponce, Jean" PHI Learning (2009)
3. "Pattern Recognition and Image Analysis" by", " Earl Gose Steve Jost and Richard Johnsonbaugh", PHI (2009)
4. "Fundamentals of Digital image processing", by "Anil K. Jain", PHI, 2010
5. "Digital image processing", by Rafael C. Gonzalez and Richard E. Woods," Pearson Education 3rd Edition.

ECL 406-MOBILE COMMUNICATION SYSTEMS (3-0-0); Credits: 3]

Course Outcomes:

1. This course provides an introduction to fundamental technologies of the mobile telecommunications.
2. Through this course, students examine fundamental concepts of mobile cellular communications and specifics of current and proposed cellular systems.
3. Course introduces fundamental concepts of physical layer such as propagation loss, multi-path fading and methods of reducing fading effects, Equalization and Diversity Techniques are included in the course.
4. At the end students should have knowledge about Cellular standards including 2G code-division multiple access (CDMA), IS-95A, 2.5G IS-95B, 2G time-division multiple access (TDMA), Global System for Mobile (GSM), and Evolution of GSM technologies towards 4G.

Syllabus:

The second generation (2G) systems: GSM: services, features, architecture, radio link, channel types, frames, call handling. CDMA IS95: forward and reverse channels, system architecture, call handling.

2.5G systems: GPRS: data rates, basic services, system architecture, protocols, coding schemes, mobility management, hardware and software components EDGE: evolution, advanced modulation methods, radio transmission and data rates, services and protocols.

The 3G systems: Introduction, evolution of 3G networks, ITU IMT 2000, CDMA 2000: bandwidth, chip rate, channels, spreading and modulation, power control, soft handoff, EV-DO, EV-DV

UMTS: radio access network, spreading and modulation, channels, core network.

Wireless LANs: IEEE 802.11 system and protocol architecture, physical layer and MAC, options like 802.11b, a g etc. and their purpose.

Bluetooth: User scenarios, layered architecture, link management, L2CAP, SDP, IEEE 802.15

TEXT/REFERENCE BOOKS

1."Mobile Communication", Jochen Schiller, Pearson Education, 2nd Edition
2."Wireless Communication: Principles and Practice", Theodore Rappaport, Pearson Education, 2nd Edition

ECL411-DIGITAL IMAGE PROCESSING
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course offers fundamentals of digital image processing and algorithms that are used.
2. At the end of the course the student should have a clear impression of the breadth and practical scope of digital image processing and have arrived at a level of understanding that is the foundation for most of the work currently underway in this field.
3. Students will be able to implement basic image processing algorithms using different tools such as MATLAB, Java.

Syllabus:

Elements of visual perception, Digital Image fundamentals, Basic image processing steps, Image Transforms, Image enhancement in spatial and frequency domain, linear gray level transformations, Histogram equalization and specification, smoothing & sharpening spatial filters. Image degradation models, image restoration, inverse filtering, Wiener filtering. Image reconstructions from projections, radon transform, projection theorem of computerized tomography. Morphological image processing, dilation, erosion, Basic morphological algorithms, thinning algorithms. Edge detection, Edge linking & Boundary Detection, watershed segmentation algorithm , Introduction to object recognition., color image processing ,RGB and HSI color models, Gray level to color transformation.

TEXT/REFERENCE BOOKS

1. Digital Image Processing,Gonzalez R.C. and Woods R.E,Pearson,Second
2. Digital Image Processing,Pratt W.K.,Wiley,Third
3. Fundamentals of Digital Image Processing,A.K.Jain,PHI

ECL410-SATELLITE COMMUNICATION
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course presents the fundamentals of satellite communications link design and provides an overview of practical considerations.
2. Existing systems are described and analyzed, including direct broadcast satellites, VSAT links, and Earth-orbiting and deep space spacecraft.
3. Topics include satellite orbits, link analysis, antenna and payload design, interference and propagation effects, modulation techniques, coding, multiple access, and Earth station design.

Syllabus:

Orbital aspects of satellite communication, Orbit mechanisms, Equation of orbit, Locating satellite in orbit, Orbital elements, Orbital area coverage, Look angles, Slant range,

Space craft subsystems, Attitude and orbit control system, Telemetry tracking and command system (TTC), Power subsystems, Antennas, Reliability

Satellite link design, System noise temperature, G/T ratio, Down link design, Uplink design, Link for specified (C/N) base-band noise signal.

Digital Satellite Links, Frequencies and channel allocations, Modulation techniques, QPSK, QAM, BER analysis, medium access methods for satellite communication.

Earth station technology, Earth station design for low system noise temperature. Equipment for earth stations, LNA and HPA.

VSAT systems- overview of VSAT systems, Access control protocols, multiple access selection, modulation, coding and interference issues

TEXT BOOKS

1. Satellite communication, "Timothy Pratt, Charles Bostian, Jeremy Allnut",John Willey and Sons Inc, 2nd edition
2. Satellite Communication Systems Engineering,"W. L. Pritchard, H.G. Suyderhoud, R.A. Nelson, ",Pearson Education, 2nd edition

REFERENCE BOOKS

1. Advanced Electronic communications, Wayne Tomasi, Prentice Hall of India Pvt. Ltd, 5th edition
2. Electronic Communication Systems, Frank.R. Dungan, International Thomson Publishing Company, 3rd edition
3. Satellite Communication,Roddy, 2nd edition
4. Satellite Communication Technology, Dr. K. Miya, 2nd edition

ECL 402-COMMUNICATION NETWORKS & NETWORK APPLICATIONS
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course provides students with an overview of the concepts and fundamentals of data communication and computer networks.
2. Through the course, students will be able to understand the fundamental concepts of computer networking and familiar with the basic taxonomy and terminology of the computer networking area.
3. The course introduces the student about to advanced networking concepts and gain expertise in some specific areas of networking such as the design and maintenance of individual networks.

Syllabus: Networks and services; network topologies; switching methods; network evolution; concept of layered architecture; the OSI model; the TCP/IP model; standardization and standards organizations. Study of telephone network; PCM-TDM based IDN; circuit switching; space and time division switching; signaling methods; store-and-forward switching. ISDN fundamentals; SS#7; Frame relay and ATM networks; SONET and SDH; LANs and MAC protocols; ALOHA, slotted ALOHA, CSMA and CSMA-CD protocols; IEEE 802.3 protocol and MAC frame format. Details of 802.3 hardware options; 100 Mbps and 1000 Mbps Ethernet LANs, switches, bridges and VPN; Wireless LANs; LAN applications; client-server architecture; Network Layer: services offered to the transport layer, internal organization as datagram or virtual circuit subnets; routing algorithms; congestion control; internetworking; Study of IPv4 and IP v6, DNS and Internet routing protocols. Transport Layer: Design issues; study of TCP; connection setup and removal; flow control; reliable and efficient delivery, timer management. The TCP/IP protocol stack: ICMP, IGMP, UDP, BOOTP, DHCP etc. Network applications: World Wide Web and HTTP; Web servers and browsers, Content Engines; FTP and TFTP; SMTP and MIME; DNS; multimedia networking; streaming stored audio and video; Internet audio and video communications. Network Security: Principles of cryptography; authentication; integrity, key distribution and certification; secure e-mail; Fire-walls Network management: issues in network management; infrastructure for NM, MIB, SNMP, RMON, ASN1

TEXT BOOKS

Communication Networks ; Leon-Garcia and Widjaja TMH 3e

Computer Networks, a systems approach Peterson and Davie- Morgan Kauffman Harcourt India 3rd edition

REFERENCE BOOKS

1. Computer Networks Tanenbaum A. S.; PHI. 4th edition
2. Data Comuncation and Networking B. Forouzan TMH 4th edition Data

and Computer Communication Stallings William PHI 6th edition Computer Networking, a top-down approach featuring the Internet; Kurose and Ross ; Addison Wesley (Low Price Edition) Computer Communications and Networking Technologies- Gallo and Hancock ;Thomson Learning 2nd edition

ECL409-RADIO FREQUENCY CIRCUIT DESIGN

[(3-0-0); Credits: 3]

Course Outcomes:

1. This course covers the analysis, design and simulation of radio frequency (RF) circuits and components for communication systems and industrial applications.
2. This course is useful to students for understanding fundamental RF circuit and system design skills and it introduces students the basic RF electronics utilized in the industry and how to build up a complex RF system from basis.

Syllabus: Characteristics of passive components for RF circuits. Passive RLC networks. Transmission lines. Two-port network modeling. S-parameter model. The Smith Chart and its applications.Active devices for RF circuits: SiGe MOSFET, GaAs pHEMT, HBT and MESFET. PIN diode. Device parameters and their impact on circuit performance. RF Amplifier design: single and multi-stage amplifiers. Review of analog filter design. Low-pass, high-pass, band-pass and band-reject filters. Bandwidth estimation methods. Voltage references and biasing.Low Noise Amplifier design: noise types and their characterization, LNA topologies, power match vs noise match. Linearity and large-signal performance.RF Power amplifiers: General properties. Class A, AB and C PAs. Class D, E and F amplifiers. Modulation of power amplifiers.Analog communication circuits: Mixers, phase-locked loops, oscillators and synthesizers.Design and performance characterization. Transreceiver design

TEXT/REFERENCE BOOKS

1. The Design of CMOS Radio Frequency Integrated Circuits,Lee Thomas H,Cambridge University Press.
2. Design of Analog CMOS integrated circuits,Razavi Behzad, McGraw Hill
3. VLSI for wireless communication,Bosco Leung,Pearson Education

ECL 407-RADAR ENGINEERING
[(3-0-0); Credits: 3]

Course Outcomes:

1. Through this course students are able to learn the fundamental issues involved in radar signal processing, the frequency and time domain methods of power and velocity measurements and algorithms for the enhancement of radar performance.
2. The course also provides how a Doppler radar can be used for precipitation measurements, study the statistical properties of the various algorithms used with Doppler radars.

Syllabus :
Radar range equation, CW and EM modulated radar. Moving target, Indicated and pulse dupler radar, Tracking radar. Transmitters, Magnetron Oscillator, Modulators, Line Pulsing modulator. Radar receiver, Receiver nise, Extraction of information from radar. Radar Antennas, Parabolic reflector, Scanning feed, Reflector cassegrain, Lens Antennas. Radar Clutter and interference-Radar Indicators.

TEXT/REFERENCE BOOKS
1. Introduction to Radar System,Skolink,McGraw HillEdition
2. Principles of Radar,Heities & Coates,McGraw HillEdition
Introduction to Radar System,Kingsley,McGraw HillEdition

ECL 427- BROADBAND COMMUNICATION

[(3-0-0); Credits: 3]

Course Outcomes:

1. This course provides an introductory overview on broadband communication networks.
2. The course covers major aspects of communication networks, such as network design, performance evaluation, protocols and technologies.
3. This course focuses on the network modelling by using mathematical tools, such as queuing theory and stochastic processes, and network optimization, which can provide guaranteed transmission performance with efficient usage of network resources.

Syllabus: Satellite Communication Systems: Orbital aspects of satellite communication, Attitude and orbit control system, Telemetry tracking and command system (TTC), Power subsystems, Antennas, ReliabilitySatellite link design, System noise temperature, G/T ratio, Down link design, Uplink design, Link for specified (C/N) base-band noise signal.Digital Satellite Links, Frequencies and channel allocations, Modulation techniques, QPSK, QAM, BER analysis, medium access methods for satellite communication.Multi-carrier communication systems: DMT, OFDM, MIMO systems, space-time coding, WiFi, WiMax, UWB systems

TEXT BOOKS

1. Timothy Pratt, Charles Bostian, Jeremy Allnut,"Satellite communication" John Willey and Sons Inc. Second edition
2. W. L. Pritchard, H.G. Suyderhoud, R.A. Nelson, "Satellite Communication Systems Engineering" Pearson Education Second edition

REFERENCE BOOKS

1. Wayne Tomasi "Advanced Electronic communications" PHI Learning, Fifth edition
2. Frank.R. Dungan," Electronic Communication Systems" International ThomsonPublishing Company Third edition
3. J. Proakis, "Digital Communication" 4e, TMH
4. Simon Haykin, "Communication Systems", 4e, John Wiley

ECL424-OPTICAL COMMUNICATION
[(3-0-0); Credits: 3]

Course Outcomes:

1. This course designed to enable students to develop a full understanding of the components and the design and operation of optical fibre communication systems and introduces the principles of wavelength division multiplexed (WDM) systems, RF photonic systems and passive optical networks (PONs).
2. Students are able to understand the characteristics and limitations of system components like laser diodes, external modulators, optical fibre, and optical amplifiers.
3. By the end of this course students will be able to analyze the performance of both analog and digital optical fibre systems and calculate the system bandwidth, noise, probability of error and maximum usable bit rate of a digital fibre system.

Syllabus:

Optical Fibre: Basic concepts of optical communication. The nature of light. Light as an Electromagnetic Wave, Polarisation, Interference. Transmitting light on a Fibre Refractive index, Fibre refractive index profiles, Modes of propagation. Light Propagation in Multimode Fibre, Snell's Law Critical Angle, Numerical aperture.

Optical Sources: Light Emitting Diodes (LEDS), The Semiconductor Junction Diode, Construction and Operation of LED's , Heterojunctions (Practical LED's) , Characteristics of LED'S, Lasers, Principle of the LASER, Semiconductor Laser Diodes

Optical Detectors: Photoconductors, Photodiodes, P-N Diodes, P-I-N Diodes, Schottky-Barrier Photodiodes, Avalanche Photodiodes (APDS), Hetero-interface Photodetectors, Travelling Wave photodetectors, Phototransistors

Optical Communication Systems: Point-to-point Transmission Systems, Modulation techniques, On-off key, Multi state coding, Forward Error correction, Receiving the signal, Timing recovery, Bandwidth Occupancy

TEXT BOOKS

1. "Optical Fibre Communication Practice and Principles", Senior

REFERENCE BOOKS

1. "Fibre Optic Communication", D. C. Agrawal
2. "Optical Communication", Keiser

ECL413-ADAPTIVE SIGNAL PROCESSING
[(3-0-0); Credits: 3]

Course Outcomes:

1. The primary objective of this course is to develop the ideas of optimality and adaptation in signal processing.
2. The students will discuss the design, analysis, and implementation of digital signal processing systems that can be considered optimal in some sense.
3. Through this course students will be able to understand why adaptation is required if a system is to remain optimal in a continually changing environment and why an emphasis is placed on developing adaptive algorithms with applications to specific engineering problems.

Syllabus:

Vectors, Matrices and Eigen Analysis. Application to adaptive signal processing. Stochastic Processes, Ensemble average, mean, average power, auto and cross correlation functions, stationarity and white noise, Auto-regressive process. Least Squares and LMS algorithms, Normal equations, properties. Eigen System decomposition. Gradient search technique, convergence properties of LMS. Normalized LMS algorithm. Recursive solution techniques, RLS algorithm. Application to noise cancellation, modeling of physical processes, communications.

TEXT BOOKS

1. S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
2. B. Widrow and S.D. Stearns, Adaptive signal processing, Prentice Hall, 1984.

REFERENCE BOOKS

1. Widrow B., Stearns S.D.; Adaptive Signal processing; Prentice Hall, 1984
2. Treichler J.R.; Theory and Design of adaptive filters ; PHI, 2002

ECL 408-BIOMEDICAL ENGINEERING
[(3-0-0); Credits: 3]

Course Outcomes:

After successful completion of this course, students will be able to practice biomedical engineering to serve state and regional industries, hospitals, government agencies, ornational and international industries and work independently in particular areas such as biomedical electronics, medical instrumentation, medical imaging, biomedical signal processing, rehabilitation engineering, and neuro engineering

Syllabus:

Human body, physiology and sub system, Biochemistry Measurement of electrical activities in human body, Electrocardiography, Electroanephalography, Electromygraphy and interpretation of records. Measurement of non-electrical quantity in human body, Measurement of blood flow respiration rate and depth heart rate, blood pressure, temperature, pH impedance of various CSR. Biotelemetry X Ray and Radio isotrope instruments, A scan, B scan, fital monitoring, X ray component Tomography.

Cardiac pacemaker. Defibrillator, Neuropathophysiology of the Nervous System, Detection and treatment of nervous system disorder. Detection & treatment of nerway system disorders. Prosynthesis for hearing, visual, limb impairments students design & test a nueroprosthesis. Non inveasive diagnosis instrumentation. Blood pump Respiration controller. Latest trends in Biomedical Instrumentation. Electrical safety & Laser-Tissue interaction (Optical)

TEXT BOOKS

1. "Biomedical Inst. & Measurement", Cromwell, McGraw Hill
2. "Biomedical Engg. System", Cromwell, McGraw HILL

REFERENCE BOOKS

1. "Biomedical Phenomenon", Plonsay Robert, McGraw Hill
2. "Biomedical Engg", Khandpur, Tata McGraw Hill

ECL 310-CMOS DESIGN
[(3-0-0); Credits: 3]

Course Outcomes:

1. The course offer the students is to introduce the fundamental principles of VLSI (Very Large Scale Integrated) circuit design and layout, to cover the basic building blocks of large-scale CMOS digital integrated circuits, and to provide hands-on design experience using a professional IC design platform.
2. The course help the students to provides an overview of CMOS fabrication technologies, physical VLSI design issues (bottom-up design), basic CMOS logic gates, architectural building blocks and system design (top-down design), with a stronger emphasis on physical design principles.

Syllabus: CMOS Digital Circuits:
Inverters, Static logic gates, Transmission gates and Flip-Flops, Dynamic logic Gate. Memory Circuits.

CMOS Analog Circuits: MOS Analog models, Current Sources and sinks, References, amplifiers, Differential Amplifiers, Operational Amplifiers.

CMOS Mixed- Signal Circuits:
Data converter: Fundamentals and Converter architectures.

TEXT BOOKS

1. "CMOS Circuit design, Layout and Simulation", R. J.Baker, H W Li , D. E. Boyce, PHI EEE
2. "Principles of CMOS VLSI Design", Neil H. E. Weste, Kamran Eshraghian, Addison Wesley

ECL419- WIRELESS SENSOR NETWORKS
[(3-0-0); Credits: 3]

Course Outcomes:

1) This course provides an introduction to wireless sensors which have applications in many fields.
2) Students will be able to design wireless sensor networks for an application after completion of the course.
3) Students can know about emerging research areas in the field of sensor networks after successful completion of this course.

Syllabus: Introduction: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks: routing protocols; MAC protocols; Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee, Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols. Design Principles for WSNs ,Gateway Concepts Need for gateway ,WSN to Internet Communication, Internet to WSN Communication. Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.

TEXT BOOKS:

1. Fundamentals Of Wireless Sensor Networks Theory And Practice By Waltenegus Dargie , Christian Poellabauer. John Wiley & Sons Publications
2. Tinyos Programming By Philip Levis, And David Gay. Cambridge University Press.

REFERENCE BOOKS:

1. SENSORS HANDBOOK by Sabrie Soloman - Mc Graw Hill publication.
2. Feng Zhao, Leonidas Guibas, Wireless Sensor Networks, Elsevier Publications.
3. Kazem Sohrby, Daniel Minoli, Wireless Sensor Networks: Technology, Protocols and Applications, Wiley- Interscience

ECP 201-ELECTRONIC DEVICES LAB
[(0-0-2); Credits: 1]
Practicals based on ECL201 (Electronic Devices) course
ECP 202-DIGITAL LOGIC DESIGN LAB
[(0-0-2); Credits: 1]
Practicals based on ECL202 (Digital Logic Design) course
ECP 308-ANALOG CIRCUIT DESIGN LAB
[(0-0-2); Credits: 1]
Practicals based on ECL308 (Analog Circuit Design) course
ECP 306- MICROPROCESSORS & INTERFACING LAB
[(0-0-2); Credits: 1]
Practicals based on ECL306 (Microprocessors & Interfacing) course
ECP 204- MEASUREMENT & INSTRUMENTATION LAB
[(0-0-2); Credits: 1]
Practicals based on ECL204 (Measurement & Instrumentation) course
ECP 309- FINITE AUTOMATA LAB
[(0-0-2); Credits: 2]
Practicals based on ECL309 (Finite Automata) course
EEP 310- CONTROL SYSTEMS LAB
[(0-0-2); Credits: 1]
Practicals based on EEL 310 (Control Systems) course
ECP 301- ANALOG COMMUNICATION LAB
[(0-0-2); Credits: 1]
Practicals based on ECL301 (Analog Communication) course
ECP 302- DEVICE MODELING LAB
[(0-0-2); Credits: 1]
Practicals based on ECL302 (Device Modeling) course
EEP 309- POWER ELECTRONICS LAB
[(0-0-2); Credits: 1]
Practicals based on EEL 309 (Power Electronics) course
ECP 304- DIGITAL SIGNAL PROCESSING LAB
[(0-0-2); Credits: 1]
Practicals based on ECL304 (Digital Signal Processing) course
ECP 303- DIGITAL COMMUNICATION LAB
[(0-0-2); Credits: 1]
Practicals based on ECL303 (Digital Communication) course
ECP 401- HARDWARE DESCRIPTION LANGUAGE LAB
[(0-0-2); Credits: 1]
Practicals based on ECL401 (Hardware Description Language) course
ECP 403- EMBEDDED SYSTEMS LAB
[(0-0-2); Credits: 1]
Practicals based on ECL 403 (Embedded systems) course
ECP 412 ADVANCED DIGITAL SIGNAL PROCESSING LAB
[(0-0-2); Credits: 1]
Practicals based on ECL412 (Advanced Digital Signal Processing) course
ECP 423 IMAGE ANALYSIS AND COMPUTER VISION LAB
[(0-0-2); Credits: 1]
Practicals based on ECL423 (Image Analysis and Computer Vision) course

ECP 402 COMM. NET. & NETWORK APPLICATIONS LAB
[(0-0-2); Credits: 1]
Practicals based on ECL402 (Comm. Net. & Network Applications) course
ECP 409 RADIO FREQUENCY CIRCUIT DESIGN LAB
[(0-0-2); Credits: 1]
Practicals based on ECL409 (Radio Frequency Circuit Design) course
ECP 424 OPTICAL COMMUNICATION LAB
[(0-0-2); Credits: 1]
Practicals based on ECL 424 (Optical Communication) course
ECP 307 ELECTRONIC PRODUCT ENGINEERING WORKSHOPS
[(0-0-2); Credits: 1]
ECP 210 SIGNALS AND SYSTEMS ANALYSIS LAB
[(0-0-2); Credits: 1]
Practicals based on ECL210 (Signals and Systems Analysis) course