Indian Institute of Technology Bhubaneswar
Curriculum

Table of Contents

Indian Institute of Technology Bhubaneswar
Curriculum

Compliance Report

Components	Subjects	Credit Recommended	Credit Approved
1. Common Core	(i) English	4	4
	(ii) Basic Science and Mathematics	20	20
	(iii) General Sciences	6	6
	(iv) Engineering Sciences	27	27
2. Breadth Basket	(i) Breadth-1 (ii) Breadth-2 (iii) Breadth-3 (iv) Breadth-4	12-14	3/4 3 3/4 3/4
3. Miscellaneous	(i) Seminar (ii) Internship (iii) Project	14	2 2 10
4. Laterals	(i) Lateral-1 (ii) Lateral-2 (iii) Lateral-3	9-12	3 3/4 3/4
5. Verticals	Theory	58-68	2^{nd} year - 20
			3^{rd} year –23/24
			4^{th} year – 19/25
	Laboratory	18-24	18
TOTAL		**168-189**	**172/184**

Indian Institute of Technology Bhubaneswar
Curriculum

Curriculum for B.Tech. in Electronics and Communication Engineering

1. The curriculum for 1st and 2nd Semesters are same for all B Tech and dual degree programs.
2. For 7th and 8th Semester, the curriculum for B. Tech. program has a combination of core, elective subjects and final year B. Tech. project.
3. The recommended total credit range for B. Tech program is 168-189.

Indian Institute of Technology Bhubaneswar
Curriculum

1st Semester and 2nd Semester (Common to All Disciplines of Study)

SEMESTER – I					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Mathematics-1	MA1L001	3-1-0	4	4	4
Physics/ Chemistry	PH1L001/ CY1L001	3-1-0	4	4	5
Mechanics / English for Communications or Learning English	ME1L001/ HS1L001 or HS1L002	3-1-0/ 3-0-2 or 3-1-0	4	4/ 5 or 4	6/7 and 9
Electrical Technology / Introduction to Programing and Data Structures	EE1L001/ CS1L001	3-1-0	4	4	10
Introduction to Manufacturing Processes / Engineering Drawing and Graphics	ME1P001/ CE1P001	0-0-3/ 1-0-3	2/3	3/4	11/12
Physics Laboratory/ Chemistry Laboratory	PH1P001/ CY1P001	0-0-3	2	3	12
Electrical Technology Laboratory / Introduction to Programing and Data Structures Laboratory	EE1P001/ CS1P001	0-0-3	2	3	13
Extra Academic Activity-1	ID1T001	0-0-3	1	3	
		Total	22/23+1	25/27 or 26+3	
SEMESTER – II					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Mathematics-2	MA1L002	3-1-0	4	4	14
Chemistry/ Physics	CY1L001/ PH1L001	3-1-0	4	4	5
English for Communication or Learning English / Mechanics	HS1L001 or HS 1L002/ ME1L001	3-0-2 or 3-1-0/ 3-1-0	4	5 or 4/ 4	7 and 9/6
Introduction to Programming and Data Structures/ Electrical Technology	CS1L001/ EE1L001	3-1-0	4	4	10
Engineering Drawing and Graphics / Introduction to Manufacturing Processes	CE1P001/ ME1P001	1-0-3/ 0-0-3	3/2	4/3	12/11
Chemistry Laboratory/ Physics Laboratory	CY1P001/ PH1P001	0-0-3	2	3	12
Electrical Technology Laboratory / Introduction to Programing and Data Structures Laboratory	EE1P001/ CS1P001	0-0-3	2	3	13
Extra Academic Activity -2	ID1T002	0-0-3	1	3	
		Total	23/22+1	27 or 26/ 25+3	

Indian Institute of Technology Bhubaneswar
Curriculum

Syllabus for First Year Courses (Common to All Disciplines of Study)

SEMESTER – I

Subject Code: MA1L001	Subject Name: Mathematics-1	L-T-P: 3-1-0	Credit: 4
Pre-requisite(s): Nil			

Calculus: Rolle's theorem, Lagranges theorem, Cauchy's mean value theorem (Taylor's and Maclaurin theorems with remainders), Indeterminate forms, Concavity and convexity of a curve, points of inflexion, maximum, minimum of a function, 2nd derivative test for max min, Asymptotes and curvature, Cartesian curve tracing, polar curve tracing.
Calculus of Several Variables: Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, differentials, derivatives of composite and implicit functions, derivatives of higher order and their commutativity, Euler's theorem on homogeneous functions, harmonic functions, Taylor's expansion of functions of several variables, maxima and minima of functions of several variables, Lagrange's method of multipliers.
Vector Calculus: Double and triple integrals, Scalar and vector fields, level surfaces, directional derivative, Gradient, Curl, Divergence, line and surface integrals, theorems of Green, Gauss and Stokes. Beta and Gamma functions.
Ordinary Differential Equations: First order differential equations, exact, linear and Bernoulli's form, second order differential equations with constant coefficients, Euler's equations, particular integrals by: variation of parameters, undetermined coefficients, operator method, system of differential equations.

Text Books:
1. Narayan S. and Mittal P. K. *Differential Calculus and Integral Calculus*, S. Chand & Company Ltd.
2. Thomas G. B. and Finney R. L. *Calculus and Analytic Geometry*, Pearson
3. Kreyszig E. *Advanced Engineering Mathematics*, John Wiley & Sons
5. Simmons G. F. and Robertson J. S. *Differential Equations with applications and Historical notes*, Tata McGraw-Hill Publishing Company Limited, New Delhi, India

Reference Books:
1. Bartle R. G. and Sherbert D. R. *Introduction to Real Analysis*, Wiley India
2. Jain R. K. and Iyengar S. R. K. *Advanced Engineering Mathematics,* Narosa
3. Apostol T. M. *Calculus - Vol.2*, Wiley India
4. Ross S. L. *Differential Equations*, Wiley India
5. Coddington E. A. *An Introduction to Ordinary Differential Equations*, Prentice Hall

Subject Code: PH1L001	**Subject Name: Physics**	**L-T-P: 3-1-0**	Credit: 4

Pre-requisite(s): Nil

Classical Physics: Review of Newtonian mechanics, Lagrangian mechanics, constraints, principle of virtual work, D'Alembert's principle, Action Principle and Lagrange's equations, Velocity dependent potentials, Legendre Transformation and Hamiltonian equations, Central forces, Kepler's problem, Waves and Oscillations, Damped and Forced Oscillations, normal modes, Basics of Special Relativity, Galilean and Lorentz transformations, Time dilation and length contraction, relativistic kinematics and mass-energy equivalence. Electromagnetic Waves and Optics: Maxwell's equations, wave equation, plane electromagnetic waves, longitudinal and transverse waves, superposition, wave packets, two and three dimensional waves, energy- momentum, Poynting's theorem, electromagnetic boundary conditions, Laser, Young's experiment, interferometers, diffraction, Fraunhofer diffraction (single slit), dispersion. Wave Mechanics: Failure of classical physics, qualitative review of relevant experiments, de Broglie waves, uncertainty principle, wave function and Schrodinger equation, probability interpretation, particle on a chain, potential barrier and quantum tunneling, potential well, Harmonic oscillator, operator algebra, Hydrogen atom and angular momentum algebra.

Text/ Reference Books:

1. Crawford F.S. Waves, *Vol. 3, Berkely Physics Series*.
2. Goldstein, *Classical Mechanics*, Pole and Safko, Pearson Education Inc.
3. Saleh and Teich. *Fundamentals of Photonics*, Wiley-Interscience.
4. Ghatak A. *Optics*, McGraw-Hill.
5. Griffiths D.J. *Introduction to Quantum Mechanics*, Pearson Education Inc.
6. Pain H. J. *The Physics of Vibrations and Waves*, Wiley.
7. Resnick R. *Introduction to Special Relativity*, John Wiley (Asia).
8. Landau L. and Lifshitz E. *Mechanics*, Oxford
9. Zweibach B. *A First Course in String Theory*, Cambridge University Press
10. Hecht E. *Introduction to Optics*, Addison-Wesley.
11. Feynmann Lecture series on Physics.
12. Sakurai J. J. *Modern Quantum Mechanics*, Benjamin-Cummings.

Subject Code: CY1L001	**Subject Name: Chemistry**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-requisite(s): Nil

Energetics & Kinetics: (a) Basic Concepts and Laws of Thermodynamics; Entropy; Engineering Devices: Efficiency & Conversion; Thermochemistry; Bioenergetics. (b) Basic Rate Laws; Multistep Reactions; Activation Energy. (c) Transport of Ions and Gases in biofluids and across biomembranes; Equilibrium: Proton Equilibrium (aqueous & non-aqueous) including Buffers. Phase Equilibrium. Redox & Electrochemistry: Basic Concepts & Laws; Battery (Automobile to Ni-Cd and beyond); Fuel Cells; Latimer, Frost, and Pourbaix diagram; Corrosion. Bonding Models & Properties: (a) In Molecules, Supramolecules, Metals and Metal Complexes; (b) Implications on electrical, magnetic, and optical properties, (c) Absorption and Emission Spectroscopy.

Functional Materials - *Design & Application:* (a) Synthetic Polymers (carbon framework, silicon framework, fluorinated polymer), Bio & biodegradable polymers. (b) Surfactants. (c) Nanostructures, Soft materials and Thin Films. (b) Emerging applications in Energy harvesting, Memory Storage and Micro-fabrication. Industrial & Bio-inspired Chemistry: (a) Case studies on Industrial organics with emphasis to Drugs (b) Oxidation, Reduction, Catalytic hydrogenation and Electron transfer. Molecules in Daily Life: A short tour on molecules behind taste, smell, pain, colour and sex.

Text/Reference Books:

1. Brown L. and Holme, T. *Chemistry for Engineering Students*, Thomson Brooks.
2. Atkins P. and Paula J. D. Atkins' *Physical Chemistry*, Oxford.
3. Shriver, D. F. and Atkins, P. W. Atkins' *Inorganic Chemistry*, Oxford.
4. Morrison R. T. and Boyd R. N. *Organic Chemistry*, Prentice Hall.
5. Steed J. W. and Atwood J. L. *Supramolecular Chemistry*, John-Wiley.
6. Caruther W. *Reagents in Organic Chemistry*, Cambridge University Press.
7. Wiseman P. *An Introduction to Industrial Organic Chemistry*, Applied Science.
8. Hall N. *The New Chemistry*, Cambridge University Press.
9. Atkins P. Atkins' *Molecules* Cambridge University Press.
10. Cengel Y. A. and Boles M. A. *Thermodynamics-An Engineering Approach*, Tata McGraw- Hill

Subject Code: ME1L001	**Subject Name: Mechanics**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-requisite(s): Nil

Force systems: Moment of a force about a point and about an axis; couple moment; reduction of a force system to a force and a couple. Equilibrium: Free body diagram; equations of equilibrium; problems in two and three dimensions; plane frames and trusses. Friction: Laws of Coulomb friction, problems involving large and small contact surfaces; square threaded screws; belt friction; rolling resistance. Kinematics and Kinetics of particles: Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; central force motion. Properties of areas: Moments of inertia and product of inertia of areas, polar moment of inertia, principal axes and principal moments of inertia. Concept of stress and strain: Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; normal strain, shear strain, Hooke's law, Poisson's ratio, generalized Hooke's law; analysis of axially loaded members. Torsion: Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation. Flexural loading: Shear and moment in beams; load, shear and moment relationship; shear and moment diagrams; flexure formula; shear stress in beams; differential equation of the elastic curve, deflection of beams. Transformation of stress and strain: Transformation of stress and strain, principal stresses, principal strains, Mohr's circle for stress and strain. Combined loading: Axial and torsional; axial and bending; axial, torsional and bending. Column: Buckling of slender columns, Euler bucking load for different end conditions.

Text/Reference Books:

1. Vector Mechanics for Engineers: *Statics and Dynamics* - Ferdinand P. Beer, E. Russell Johnston, Jr. (TMH)
2. Engineering Mechanics: *Statics and Dynamics* - I.H. Shames (Pearson)

3. Engineering Mechanics - S. Timoshenko, D. H. Young (TMH)
4. Mechanics of Materials - Ferdinand Beer , E. Russell Johnston, Jr., J. DeWolf (TMH)
5. Elements of Strength of Materials - S. Timoshenko, D. H. Young (East West Press)
6. Mechanics of Materials - James M. Gere, Barry J. Goodno (CL Engg)
7. Engineering Mechanics - Stephan Timoshenko, D. Young (TMH)
8. Strength of Materials (Part 1) – S P Timoshenko (CBS)

Subject Code: HS1L001	**Subject Name: English for Communication**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-requisite(s): Nil

English for Communication is an amalgamation of Literature, Language and Communication. The Literature component of the course comprises of Prose and Poetry.

Poetry:

A selection of poetry pieces spanning from 16th century to the Post-Modern Period in English, American and Indian Literature are chosen to introduce to the students to the different poets from different ages and countries and also to acquaint them with the various poetic forms like Sonnet, Ballad, Elegy, Didactic, Dramatic, Nature, Lyric, Romantic, etc. The list is an indicative one. 16th century- 17th century- Geoffrey Chaucer, William Shakespeare, Edmund Spenser, Ben Johnson, Thomas Wyatt. 17th century- 18th century- John Milton, John Donne, George Herbert, John Dryden, Oliver Goldsmith. 18th century- 19th century- Alexander Pope, Thomas Gray, Robert Burns, William Blake, William Wordsworth, Samuel Taylor Coleridge, Lord Byron, P.B. Shelley, John Keats, Robert Bridges, Robert Southey, Samuel Johnson. 19th century- 20th century- Alfred Tennyson, Robert Browning, Walter de la Mare, Thomas Hardy, A.E. Housman, Rudyard Kipling, D.H. Lawrence, Wilfred Owen, D.G. Rossetti, Christina Rossetti, Emily Dickinson, Gerald Manley Hopkins, Charlotte Bronte, Lewis Caroll, Edward Fitzgerald, Walt Whitman. 20th century- Present- Ted Hughes, Louis MacNeice, W.B. Yeats, Stephen Spender, W.H. Auden, Nissim Ezekiel, Sarojini Naidu, Jayanta Mahapatra, Robert Frost, , Ezra Pound, E.E. Cummings, T.S. Eliot, Walt Whitman, A.K. Ramanujan, Kamala Das, Rabindranath Tagore, Jack Prelutsky, Chinua Achebe, Maya Angelou, Margaret Atwood, Leonard Cohen, Louise Erdrich, Leslie Marmon Silko.

Prose:

A selection of fictional and non-fictional prose pieces spanning from 17th century to the Post-Modern Period. Fiction and non-fictional pieces from English, American, Russian and Indian Literature are chosen to introduce the students to different writings from different ages and countries. The list is an inclusive one consisting of short stories, essays, excerpts, extracts from novels, biographies and memoirs, history, travel and other forms. 17th century-18th century: Charles Dickens, William Makepeace Thackeray, George Eliot, Thomas Hardy, Lewis Carroll, Arthur Conan Doyle, John Bunyan, Rudyard Kipling, H.G. Wells, R.L, Stevenson, Jane Austen, Emily Bronte, Charles Lamb, F.M. Dostoyevsky, Nikolai Gogol, Daniel Dafoe, Jonathan Swift, Lewis Carroll; 19th century-20th century: Oscar Wilde, O Henry, H.H. Munro, Mark Twain, Somerset Maughaum, Nathaniel Hawthorne, G.B. Shaw, G.K. Chesterton, Agatha Christie, Gerald Durrell, Will Durant, E.M. Forster, Aldous Huxley, Henry David Thoreau, Anton Chekov, Maxim Gorky, Leo Tolstoy, George Orwell, Rabindranath Tagore, M.K. Gandhi, J. Nehru, Virginia Woolf, Guy De Maupassant, Washington Irving, Margaret Fuller, Charles Darwin, Arthur Conan Doyle, F. Scott Fitzgerald, Ernest Hemingway, Edgar Allan Poe. 20th century-Present: J.M. Coetzee, R.K. Narayan, R.K. Laxman, A.P.J. Abdul Kalam, Khushwant Singh, Anita Desai, Yann Martel, Ken Kesey, Stephen King,

Thomas King, Richard Wright, N Scott Momaday, Chetan Bhagat, J. Krishnamurthy, Virginia Woolf, Gerald Vizenor, Alice Walker, Chinua Achebe, Jeffrey Archer, Issac Asimov, Roald Dahl, J.R.R. Tolkien, D.H. Lawrence, James Joyce, Oran Pamuk, Salman Rushdie, Bertrand Russell, Ruskin Bond, A.G. Gardiner, John Steinbeck.

Communication:

Because communication is so important in business, businesses want and need people with good communication skills. Business communication is a blend of skills like writing and speaking well, displaying proper etiquettes and listening attentively. Communications through technology greatly enhances one's ability to communicate effectively and articulately. For example, E-mails often result in a sender's language skills being placed in front of different people simultaneously; while audio and video will reveal the calibre of one's verbal and diplomatic strengths. The communication aspect of the English for Communication Course includes:

1. The Basics of Business Communication
2. Importance of Listening
3. Barriers in the Communication Process
4. Business Letters (Letter of Inquiry, Complaint, Cover Letter)
5. Resume Writing
6. Memo and Memo Reports
7. Report Writing
8. Fax and E Mail

English Laboratory:

Objective: The laboratory component included in the course provides an ideal platform for students to prepare themselves into confident and self-assured individuals. The Lab course is designed to inculcate confidence and clarity in presentation and expression of thought, views and ideas through practice and exercises. It constitutes six basic components to improve listening, reading and writing skill of the students.

Lessons:

1. Pronunciation (Basic sounds of English like Long/Short Vowels; All consonants)
2. Stress Intonation (Rising and Falling)
3. Speaking- Oral Presentations, Group Discussions, Story Telling, Role Plays
4. Listening – Importance and Practice
5. Reading- Practice
6. Writing (Paragraph writing, good writing and bad writing with samples, Indianism), Grammar (Basic- Articles, Prepositions, Verbs, Common Errors , etc)

Text/Reference Books:

1. John Seely, *The Oxford Guide to Writing and Speaking*, OUP
2. Krishna Mohan and Meenakshi Raman, *Effective English Communication*, TMH
3. R.W.Lesikar and John.D. Pettit, *Business Communication: Theory and Application*, All India Traveller Bookseller
4. Francis Soundaraj, *Speaking and Writing for Effective Business Communication*, Macmillan.
5. Herta A. Murphy, et al., *Effective Business Communication*, Tata Mc-Graw Hill: New Delhi
6. Ronald B. Adler and George Rodman, *Understanding Human Communication*, Oxford University Press: New York

Indian Institute of Technology Bhubaneswar
Curriculum

Subject Code: HS1L002	Subject Name: Learning English	L-T-P: 3-1-0	Credit: 4

Pre-requisite(s): Nil

The Learning English Course is designed to improve the English Listening, Speaking, Reading and Speaking skills of students.

I. Prose

A selection of fictional and non-fictional prose pieces spanning from 17th century to the Post-Modern Period. Fiction and non-fictional pieces from English, American, Russian and Indian Literature are chosen to introduce the students to different writings from different ages and countries. The list is an inclusive one consisting of short stories, essays, excerpts, extracts from novels, biographies and memoirs, history, travel and other forms.

17th century- 18th century- Charles Dickens, William Makepeace Thackeray, George Eliot, Thomas Hardy, Lewis Carroll, Arthur Conan Doyle, John Bunyan, Rudyard Kipling, H.G. Wells, R.L, Stevenson, Jane Austen, Emily Bronte, Charles Lamb, F.M. Dostoyevsky, Nikolai Gogol, Daniel Dafoe, Jonathan Swift, Lewis Carroll.

19th century- 20th century- Oscar Wilde, O Henry, H.H. Munro, Mark Twain, Somerset Maughaum, Nathaniel Hawthorne, G.B. Shaw, G.K. Chesterton, Agatha Christie, Gerald Durrell, Will Durant, E.M. Forster, Aldous Huxley, Henry David Thoreau, Anton Chekov, Maxim Gorky, Leo Tolstoy, George Orwell, Rabindranath Tagore, M.K. Gandhi, J. Nehru, Virginia Woolf, Guy De Maupassant, Washington Irving, Margaret Fuller, Charles Darwin, Arthur Conan Doyle, F. Scott Fitzgerald, Ernest Hemingway, Edgar Allan Poe.

20th century- Present- J.M. Coetzee, R.K. Narayan, R.K. Laxman, A.P.J. Abdul Kalam, Khushwant Singh, Anita Desai, Yann Martel, Ken Kesey, Stephen King, Thomas King, Richard Wright, N Scott Momaday, Chetan Bhagat, J. Krishnamurthy, Virginia Woolf, Gerald Vizenor, Alice Walker, Chinua Achebe, Jeffrey Archer, Issac Asimov, Roald Dahl, J.R.R. Tolkien, D.H. Lawrence, James Joyce, Oran Pamuk, Salman Rushdie, Bertrand Russell, Ruskin Bond, A.G. Gardiner, John Steinbeck.

II. Writing- Paragraph, Essay, Précis, Dictation, Comprehension, Letter Writing

III. English Tutorial- Practice Listening and Speaking English

IV. English Practice- Grammar Assignments and Workbook (Everyday English Level I/II)

Text/Reference Books:

1. John Seely, *The Oxford Guide to Writing and Speaking*, OUP
2. Krishna Mohan and Meenakshi Raman*, Effective English Communication*, TMH
3. R.W.Lesikar and John.D. Pettit, *Business Communication: Theory and Application*, All India Traveller Bookseller
4. Francis Soundaraj, *Speaking and Writing for Effective Business Communication*, Macmillan.
5. Herta A. Murphy, et al., *Effective Business Communication*, Tata Mc-Graw Hill: New Delhi
6. Ronald B. Adler and George Rodman, *Understanding Human Communication*, Oxford University Press: New York

Subject Code: EE1L001	**Subject Name: Electrical Technology**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-requisite(s): Nil

Introduction: Sources of energy; General structure of electrical power systems, Power transmission and distribution via overhead lines and underground cables, Steam, Hydel, and Nuclear power generation; DC Networks: Kirchhoff's laws, node voltage and mesh current methods, Delta-star and star-delta conversion, Superposition principle, Thevenin's, Norton's theorems and Maximum power transfer theorem; Single phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, solution of R,L,C series circuits, the j operator, complex representation of impedances, phasor diagram, power factor, power in complex notation, solution of parallel and series – parallel circuits; Three phase AC Circuits: Three phase EMF generation, delta and Y – connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits, Three phase four wire circuits; Magnetic Circuits: Ampere's circuital law, B – H curve, solution of magnetic circuits, hysteresis and eddy current losses; Transformers: Construction, EMF equation, ratings, phasor diagram on no load and full load, equivalent circuit, regulation and efficiency calculations, open and short circuit tests, auto-transformers; DC Machines: Construction, EMF and Torque equations, Characteristics of DC generators and motors, speed control of DC motors and DC motor starters; Electrical Measuring Instruments: DC PMMC instruments, shunt and multipliers, multimeters, Moving iron ammeters and voltmeters, dynamometer, wattmeter, AC watthour meter, extension of instrument ranges.

Text/Reference Books:

1. E. Hughes*, "Electrical Technology,"* Pearson Education, 2010.
2. V. Del Toro, *"Electrical Engg Fundamentals,"* PHI Learning, 2009.
3. I. J. Nagrath and D. P. Kothari, *`Basic Electrical Engineering'* TATA Mc Graw Hill Education, 2009.
4. D. A. Bell, *"Electric Circuits,"* 7th Ed., Oxford Higher Education, 2009.

Subject Code: CS1L001	**Name: Introduction to Programming and Data Structure**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-requisite(s): Nil

Digital computer fundamentals, concepts of algorithms and introduction to programming – examples; Constants and variables – data types, operators and expressions - type conversions, types of expressions; Assignment statements, input-output statements - concepts of data formats; Control statements: branching – if-else statements; iteration – while, do-while, for statements. nested control structures, switch, break and continue statements; Functions and recursion – examples; concepts of parameter passing by values and by reference; Arrays – single and multidimensional, examples – searching and sorting; Introduction to pointers, character strings and arrays, pointers and arrays; Structures, linked lists, dynamic allocation, stacks and queues, binary trees and tree traversals; Data files – creating, opening, closing and operating data files; (The programming language C to be used as the basis language).

Text Books:
1. B. Gottfried, "*Schaum' s Programming with C*," Tata McGraw-Hill.
2. E. Balaguruswamy, "*Programming in ANSI C*," Tata McGraw-Hill.
3. Y. Kanetkar, "*Let us C*," BPB Publications.
4. S. Lipschutz, "*Data Structures, Schaum's Outlines Series*," Tata McGraw-Hill.

Reference Books:
1. Brian W. Kernighan and Dennis M. Ritchie, "*The C Programming Language*," Prentice Hall of India.
2. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, "*Fundamentals of Data Structures in C*," W. H. Freeman and Company.

Subject Code: ME1P001	**Name: Introduction to Manufacturing Processes**	**L-T-P: 0-0-3**	**Credit: 2**

Pre-requisite(s): Nil

Machining:
- Introducing to various machine tools and demonstration on machining
- Making a steel pin as per drawing by machining in centre lathe
- External screw thread on lathe
- Making a cast iron Vee block by shaping
- Making a regular polygon prism (MS)/ hexagon by milling machine
- Slot fitting by milling machine
- Study of machining in machining in machining centre (CNC)
- Study of Electro discharge machining (EDM)

Foundry Practice:
- Orientation, demonstration and practice on metal casting
- Practicing sand moulding using split and uneven parting line pattern
- Practice on CO2 moulding and machine moulding
- Mechanised sand preparation and melting practice

Welding Practice:
- Practice on electric arc welding
- Practice on oxy-acetylene gas welding
- Introduction and demonstration on submerged arc welding

Metal Forming:
Demonstration of deep drawing and other forming process

Text/Reference Books:
1. Chapman W.A.J., *Workshop Technology - Part I*, CBS Publishers.
2. Chapman W.A.J., *Workshop Technology - Part II*, CBS Publishers.
3. Hajra Choudhury S.K., *Elements of workshop Technology Vol. I*, Media Promoters.
4. Hajra Choudhury S.K., *Elements of workshop Technology Vol. II*, Media Promoters.

Subject Code: CE1P001	**Subject Name: Engineering Drawing and Graphics**	**L-T-P: 1-0-3**	**Credit: 3**
Pre-requisite(s): Nil			
Introduction to IS code of drawing; Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute; Projection of lines – traces, true length; Projection of planes and solids; sold objects – cube, prism, pyramid, cylinder, cone and sphere; Projection on Auxiliary planes; Isometric projection, isometric scale; Section of solids – true shape of section; Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.			
Text/Reference Books: Bhatt N.D.*Elementary Engineering Drawing*, Charotar Publishing House. Gill P.S.*Engineering Drawing & Engg. Graphics*, S. K. Kataria & Sons. Lakshminarayan L.V. and Vaish R.S.*Engineering Graphics*, Jain Brothers.			
Subject Code: PH1P001	**Subject Name: Physics Laboratory**	**L-T-P: 0-0-3**	**Credit: 2**
Pre-Requisite(s): Nil			
To determine the damping constant of the pendulum for different eddy damping current. To verify Malus's Law of polarization of light. To determine the wave length of the prominent lines of mercury source by a plane transmission diffraction grating and to calculate the resolving power and dispersive power of the grating. To study the intensity distribution of Fraunhofer diffraction pattern by a single slit and measure the width of the slit for a given wavelength of laser light. To determine the wavelength of the given source using the Michelson interferometer. To determine the wave length of the given source using Fresnel's biprism. To find out the resonance and beat time period of the coupled pendulum and find out the spring constant. To study the interference pattern and determine the radius of curvature of the plano convex lens using Newton's rings apparatus.			
Text/Reference Books: 1. Ghatak *A. Optics*, McGraw-Hill. 2. Pain H. J. *The Physics of Vibrations and Waves*, Wiley.			

Subject Code: CY1P001	**Subject Name: Chemistry Laboratory**	**L-T-P: 0-0-3**	**Credit: 2**
Prerequisite(s): Nil			
Experiment-1: Determination of the surface tension and parachor of a homologous series. Experiment -2: Measurement of the coefficient of viscosity of ethanol & ethanol -water system. Experiment -3: Studies on acid-base conductometric titration. Experiment- 4: Studies on PH metric titration of strong base with strong acid.			

Experiment -5: Estimation of sulphate ion in tap water by nepheloturbidimetric analysis.
Experiment - 6: Spectrophotometric determination of acid dissociation constant (pka) of methyl red (MR) an acid base indicator.
Experiment -7: Determination of solubility and solubility product of a sparingly soluble salt at room temperature by conductometric method.
Experiment- 8: Potentiometric titration of a given sodium carbonate solution with aquesous hydrochloric acid solution.
Experiment -9: kinetics of ester hydrolysis.
Experiment -10: Detection of functional groups in an organic compound for solid sample.
Experiment-11: Detection of functional groups in an organic compound for liquid sample.
Experiment -12: Thin layer chromatography (TLC).

Text/Reference Books:
1. Nad, A. K.; Mahapatra, B. and Ghoshal A. *An advanced course in practical chemistry*, New Central Book Agency (P) Ltd.
2. Elias A. J. *A collection of general chemistry experiments*, University Press.
3. Maity S. and Ghosh N. *Physical Chemistry Practical*, New Central Book Agency (P) Ltd.

Subject Code: EE1P001	**Subject Name: Electrical Technology Laboratory**	**L-T-P: 0-0-3**	**Credits: 2**
Prerequisite(s): Electrical Technology			
Experiments as per the topics in the syllabus for the course `Electrical Technology' (EE1L001) will be conducted in the laboratory class.			
Text Books: 1. E. Hughes, *"Electrical Technology,"* Pearson Education, 2010. 2. V. Del Toro, "Electrical Engg Fundamentals," PHI Learning, 2009.			
Reference Books: 1. I. J. Nagrath and D. P. Kothari, `*Basic Electrical Engineering'* TATA McGraw Hill Education, 2009. 2. D. A. Bell, *"Electric Circuits,"* 7th Ed., Oxford Higher Education, 2009.			

Subject Code: CS1P001	**Subject Name: Introduction to Programming and Data Structures Laboratory**	**L-T-P: 0-0-3**	**Credit: 2**
Prerequisite(s): Introduction to Programing and Data Structures			
Familiarization of a computer and the environment; Execution of sample programs related to Expression evaluation, Conditionals and branching, Iteration, Functions, Recursion, Tail-recursion, Arrays, String manipulation, Structures, Linked lists, Doubly-linked lists and Binary Trees. Execution of programs involving abstract data types like Stacks and Queues.			

Indian Institute of Technology Bhubaneswar
Curriculum

Semester-II

Subject Code: MA1L002	Subject Name: Mathematics-II	L-T-P: 3-1-0	Credit: 4

Pre-requisite(s): Nil

Linear Algebra: Vector spaces, subspaces, span, Linear dependence, independence of vectors, basis, dimension, linear transformations, range, kernel, rank, nullity of linear transformation, space of all linear transformations, Operator equations, matrix associated with a linear map, linear map associated with a matrix, elementary row operations, solution of algebraic equations, consistency conditions. Matrix inversion by row operations, Eigenvalues and eigenvectors, Hermitian and skew Hermitian matrices, orthogonal and unitary matrices, application to reduction of quadrics.
Complex Analysis: Limit, continuity, differentiability and analyticity of functions Cauchy-Riemann equations (cartesian and polar), Harmonic functions, Elementary complex functions, Line integrals, upper bounds for moduli of contour integrals, Cauchy's integral theorem, Cauchy's integral formula, derivatives of analytic functions, Power series, Taylor's series, Laurent's series, Zeros and singularities, Residue theorem, evaluation of improper integrals by residue theorem.

Text books:

1. Strang G. *Linear Algebra and its applications, Cengage Learning*
2. Churchill R.V. and Brown J.W. *Complex Variables and Applications*, Mc-Graw Hill
3. Kreyszig E. *Advanced Engineering Mathematics*, John Wiley & Sons

Reference Books:

J1. ain R. K. and Iyengar S. R. K. *Advanced Engineering Mathematics*, Narosa
2. Krishnamurthy V., Mainra V. P. and Arora J.L. *An Introduction to Linear Algebra*, Affiliated East-West Press Pvt Ltd New Delhi
3. Axler S. *Linear Algebra Done Right*, UTM, Springer
4. Poole D. *Linear Algebra*: *A Modern Introduction*, Brooks/Cole

All other courses are same as Semester-I Courses.

SEMESTER – III to VIII

SEMESTER - III					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Breadth I		3-0-0	3	3	
Math III (Probability & Statistics)	MA2L003	3-1-0	4	4	
Introduction to Material Science and Engineering	ID2L001	2-0-0	2	2	
Introduction to Bio Science and Technology	ID2L002	2-0-0	2	2	
Introduction to Electronics	EC2L001	3-1-0	4	4	19
Signal and Systems	EC2L002	3-1-0	4	4	19
Introduction to Electronics Lab	EC2P001	0-0-3	2	3	19
Signal and Systems Lab	EC2P002	0-0-3	2	3	20
Project Seminar	EC2S001	0-0-3	2	3	20
		Total	**25**	**28**	
SEMESTER - IV					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Lateral 1		3-0/1-0	3/4	3/4	
Breadth 2		3-0/1-0	3/4	3/4	
Environmental Science Technology and Management	ID2L003	2-0-0	2	2	
Network Theory	EE2L001	3-1-0	4	4	21
Digital Electronic Circuits	EC2L004	3-1-0	4	4	21
Analog Communication	EC2L009	3-1-0	4	4	22
Digital Electronics Circuit lab	EC2P004	0-0-3	2	3	22
Analog Communication Lab	EC2P005	0-0-3	2	3	22
		Total	**24/26**	**26/28**	
SEMESTER - V					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Lateral 2		3-0/1-0	3/4	3/4	
Breadth 3		3-0/1-0	3/4	3/4	
Electromagnetic waves and Radiating Systems	EC3L005	3-1-0	4	4	23
Digital Communication	EC3L006	3-1-0	4	4	23
Microprocessor and Microcontroller	EC3L007	3-1-0	4	4	23
Digital Communication Lab	EC3P003	0-0-3	2	3	24

Microprocessor and Microcontroller Lab	EC3P004	0-0-3	2	3	24
		Total	**22/24**	**24/26**	
SEMESTER - VI					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Lateral 3		3-0/1-0	3/4	3/4	
Breadth 4		3-0/1-0	3/4	3/4	
Digital Signal processing	EC3L003	3-1-0	4	4	25
Control Systems	EE3L003	3-1-0	4	4	26
VLSI Design	EC3L009	3-0-0	3	3	26
Digital Signal Processing Lab	EC3P002	0-0-3	2	3	27
Control Systems Lab	EE3P003	0-0-3	2	3	27
VLSI Lab	EC3P005	0-0-3	2	3	27
		Total	**23/25**	**26/28**	
SEMESTER - VII					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Communication Networks and Switching	EC4L011	3-0-0	3	3	28
RF and Microwave Engineering	EC4L012	3-0-0	3	3	28
Elective 1		3-0-0	3	3	30 – 35
Elective 2		3-0-0	3	3	30 – 35
Electronic System Design Lab	EC4P001	0-0-3	2	3	28
Industrial Training Defence	EC4T001	0-0-0	2	3	29
Project 1	EC4D001	0-0-6	4	6	29
		Total	**20/22**	**24/26**	
SEMESTER - VIII					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Elective 3		3-0-0	3	3	36 – 46
Elective 4		3-0-0	3	3	36 – 46
Elective 5		3-0-0	3	3	36 – 46
Elective 6		3-0/1-0	3	3	36 – 46
Project 2	EC4D002	0-0-9	6	9	29
RF and Microwave Engineering Lab	EC4P002	0-0-3	2	3	29
		Total	**20**	**24**	

List of Elective Courses

Subject Name	Code	L-T-P	Credit	Contact Hour
Elective – 1, 2				
Compiler Design	CS4L001	3-0-0	3	3
Artificial Intelligence	CS6L019	3-0-0	3	3
Semiconductor Devices	EC4L001	3-0-0	3	3
Opto-Electronics	EC4L002	3-0-0	3	3
Advanced Communication Engineering	EC6L001	3-1-0	4	4
Image and Video Processing	EC6L002	3-1-0	4	4
Statistical Signal Processing	EC6L005	3-0-0	3	3
Remote Sensing Systems	EC6L011	3-0-0	3	3
Antenna Theory	EC6L013	3-0-0	3	3
Speech Signal Processing	EC6L028	3-0-0	3	3
Renewable and Distributed Energy Sources	EE6L006	3-0-0	3	3
Industrial Instrumentation	EE6L007	3-0-0	3	3
Energy Storage Systems	EE6L011	3-0-0	3	3
Elective – 3, 4, 5, 6				
Networks and Systems Security	CS6L002	3-0-0	3	3
Information Theory and Coding	EC6L003	3-1-0	4	4
Advanced Digital Signal Processing	EC6L004	3-1-0	4	4
Optical Communication	EC6L012	3-0-0	3	3
Photonic Network	EC6L014	3-0-0	3	3
Biomedical Signal Processing	EC6L015	3-0-0	3	3
Computational Electromagnetics	EC6L016	3-0-0	3	3
Semiconductor Device Modeling	EC6L017	3-0-0	3	3
Satellite Communication	EC6L018	3-0-0	3	3
Fiber Optic Sensors	EC6L019	3-0-0	3	3
Wireless and Mobile Communication	EC6L020	3-0-0	3	3
Microwave Design and Measurement	EC6L021	3-0-0	3	3
Modern Radar Systems	EC6L022	3-0-0	3	3
Adaptive Signal Processing	EC6L023	3-0-0	3	3
Array Signal Processing	EC6L024	3-0-0	3	3
Multimedia Network	EC6L025	3-0-0	3	3
Pattern Recognition	EC6L027	3-0-0	3	3
Natural Language Processing	CS6L027	3-0-0	3	3
Embedded Systems	EC4L008	3-0-0	3	3
Computer Vision	EC6L030	3-0-0	3	3
Smart Grid Technology	EE6L014	3-0-0	3	3

Syllabus for each course is given in the following pages.

Indian Institute of Technology Bhubaneswar
Curriculum

B. Tech (3rd Semester – 6th Semester Core Courses)

SEMESTER – III

Subject Code: EC2L001	Name: Introduction to Electronics	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): None

Introduction to Electronic Devices: passive devices, Diode, bipolar junction transistor (BJT), metal oxide semiconductor field-effect transistor (MOSFET); Diode: basic structure and types, operating principle, current-voltage characteristic, large and small signal models; Diode Applications: rectifier circuits, zener voltage regulator Regards, clipper and clamper circuits; BJT and their Application: structure and modes of operation; NPN and PNP transistor in active mode, DC analysis, BJT as a switch and amplifier, small signalequivalent circuits, single stage CE amplifier; MOSFET and Applications: switch and amplifier; Operational Amplifier and applications: Basics, summing amplifier, inverting and non-inverting configuration, voltage follower, differentiator and integrator; Feedback: Basic concepts of feedback, ideal feedback topologies; Oscillators: Basic principle of sinusoidal oscillation, phase-shift oscillator, wien-bridge oscillator; Digital Electronics: Boolean algebra and rules of simplification and combinational circuits.

Text Books:

1. S. Sedra and K. C. Smith, "Microelectronic Circuits," Oxford University Press, India, 2005.
2. A. Malvino and D. J. Bates; "Electronic Principles," Tata McGraw Hill, India, 2007.

Reference Books:

1. R C Jaeger, T N Blalock, Microelectronic Circuit Design; Tata McGraw Hill, India, 2006.

Subject Code: EC2L002	Name: Signals and Systems	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Mathematics – I

Objective and overview, signal and system types and classifications, LTI system: Causality, stability, step response, impulse response and convolution integral; Periodic signal analysis: Fourier series and properties; Aperiodic signal analysis : Fourier Transform - its properties and sinusoidal steady state analysis of systems; Discrete-time Fourier transform; Fourier transform for periodic signals; Time and frequency characterization of signals and systems: magnitude-phase representation of Fourier transforms; Unilateral and Bilateral Laplace Transforms and properties: Analysis and characterization of LTI systems using Laplace transform; System function and block diagram representation, Bode plot; Discrete signals: Sampling, digitization and reconstruction of analog signals; Fourier transform of discrete signals: DFT, z-transforms; Discrete systems, transfer functions and convolution; Analog filter design: Butterworth, Sallen Key, frequency transformation and scaling.

Text Books:

1. A. Papoulis and S. U. Pillai, "Probability, Random Variables, and Stochastic Processes," McGraw Hill, 2001.
2. A. V. Oppenheim, A. S. Willsky and H. Nawab, "Signals and Systems," 2nd Ed., Prentice-Hall, 1996.

Reference Books:

1. A. V. Oppenheim, Ronald W. Schafer and John R. Buck,"Discrete-Time Signal Processing," 2nd Ed., Prentice Hall, 1999.
2. J. G. Proakis, and D. K. Manolakis,"Digital Signal Processing," 4th Ed., Prentice Hall, 2006.

Subject Code: EC2P001	Name: Introduction to Electronics Lab	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Introduction to Electronics

Familiarization with electronic components; Familiarization and usage with oscilloscope, signal generator, multimeter; Frequency-response of R-C, C-R and R-L networks; Square-wave testing, V-I characteristics of PN junction diode and zener diode; Voltage Rectifiers; Common-Emitter amplifiers; Analog circuits using OP-AMP; logic gates.

Text Books:

- S. Sedra, K. C. Smith, "Microelectronic Circuits," Oxford University Press, India, 2005.
- A Malvino, D J Bates; "Electronic Principles," Tata McGraw Hill, India, 2007.

Reference Books:

- R C Jaeger, T N Blalock, "Microelectronic Circuit Design," Tata McGraw Hill, India, 2006.

Subject Code: EC2P002	**Subject Name: Signals and Systems Laboratory**	**L-T-P: 0-0-3**	**Credits: 2**

Pre-requisite(s): Signals and Systems

Basic MATLAB Programming: Manipulation of Vectors, Arrays and Matrices, Arithmetic Operations, Logical Operations, Loops, M-files & Functions, Mathematical Functions; Graphics and 3-D Visualization: Plotting of One-dimensional and Two-dimensional Signals, Plotting Symbolic Functions, 3-D Plotting; Mathematical Functions: Finding Roots of Polynomials, Computing Integration and Differentiation, Solving Differential and Difference Equations, Polynomial Curve Fitting, Recording, Storing, Reading, and M-File; Functions: Recording and Playing Signals, Storing and Reading Data in Different Formats, Creating M-Functions for Generating Different Elementary Signals, Creating M-Functions for Computing Different Statistical Parameters; Analysis of Systems: Finding Convolution, Finding Laplace and Inverse Laplace Transforms, Finding Z-and Inverse-Z Transforms, Zero-Pole Analysis; Analysis of Signals and Systems: Sampling of Signals, Fourier Series of Signals, Finding Magnitude and Phase Spectrum of Signals, Frequency Response of System; Convolution and Filtering, Creating GUI in MATLAB, MATLAB Simulink Modelling.

Texts/References:

- A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems," 2ndEd., Pearson Prentice Hall, 2008.
- S. Haykin and B. V. Veen, "Signals and Systems," 2ndEd., Wiley India, 2007.
- H. P. Hsu, "Signals and Systems – Schaum's Outline Series," McGraw Hill, 1995.

Subject Code: EE2S001	**Subject Name: Project Seminar**	**L-T-P: 0-0-3**	**Credits: 2**

Pre-requisite(s): None

SEMESTER – IV

Subject Code: EE2L001	Name: Network Theory	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Electrical Technology, Signals and Systems

Nodal and Loop Analysis: Review, modified nodal analysis; Network Theorems: Substitution theorem, Compensation theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem, Tellegen's theorem; Transient analysis of RLC circuit and higher order circuits; Frequency domain analysis of dynamic circuits using Fourier series, Fourier transforms and Laplace transforms; Network functions: poles and zeros, driving point and transfer functions, restrictions on poles and zeros for network functions, time domain behaviour, frequency response plots; Two-port networks and passive filters: z-parameters, y-parameters, h-parameters, and ABCD parameters; reciprocity and symmetry in two-port networks; Introduction to network topology: Graph theory: Tree, Co-tree, fundamental cut-set, fundamental loop analysis of network; State variable analysis of networks.

Text Books:

1. M. E. Valkenburg, "Network Analysis," 3rd Ed., Pearson Prentice Hall, 2006.
2. F. F. Kuo, "Network Analysis and Synthesis," 2nd Ed., Wiley India, 2007.

Reference Books:

3. W. H. Hyat, J. E. Kemmerly and S. M. Durbin, "Engineering Circuit Analysis," 6th Edition, Tata McGraw Hill, 2007.
4. R. A. DeCarlo and P-M Lin, "Linear Circuit Analysis," 2nd Ed., Oxford University Press, 2007.

Subject Code: EC2L004	Name: Digital Electronic Circuits	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Introduction to Electronics

Logic gates – AND, OR, NOT, XOR, XNOR, NAND, NOR; Combinational logic circuits: Switching functions, Boolean algebra – axioms and laws, minimization of switching functions – algebraic method, K-map, Quine-McCluskey's method; Number systems & representation – binary, octal, decimal and hexadecimal, code conversion of numbers. Addition and subtraction of binary and decimal numbers; Comparators, multiplexer-demultiplexer, codes and code conversion, PLA; Universal logic gates – NAND-NOR, circuit realization; TTL logic family – circuit operations, fan-in and fan-out, noise margin, tri-state, open-collector circuits; CMOS – circuit operations, fan-in and fan-out, noise margin; TTL-to-CMOS and CMOS-to-TTL interfacing; IC555 chip circuit operation and applications; Astable, monostable, bistable multivibrators – discrete component and IC555 based circuits; Different types of flip-flops – RS, JK, D and T flip-flops; gated, master-slave and edge triggered flip-flops; Different types of Registers; Counters - asynchronous and synchronous counters, design of synchronous counter; Finite state machine – Moore and Mealey models; Synchronous sequential circuit synthesis: state transition diagrams, state tables, minimization, state assignments, realization with different types of flip-flops; Analysis of synchronous sequential circuits; Concepts of asynchronous sequential circuits - races.

Text Books:

1. S. Lee, "Digital Circuits and Logic Design," 1st Ed., Prentice Hall India, 2008.
2. D. P. Leach, A. P. Malvino and G. Saha, "Digital Principles and Applications," 8th Ed. McGraw Hill Education, 2014.
3. M. Morris Mano, "Digital Logic and Computer Design," 1st Ed., Prentice Hall, 1979, 15th Reprint 2013.

Reference Books:

1. Z. Kohavi and N. K. Jha, "Switching and Finite Automata Theory," 3rd Ed., Cambridge Univ Press, 2011.

Subject Code: EC2L009	Name: Analog Communications	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Signals and Systems

Introduction: Signals, Fourier Series, Complex Fourier Spectrum, Fourier Transform, Convolution, Parseval's Theorem, Linear Systems; Analog Modulation: Concept Of Modulation, Amplitude modulation: Double-Sideband Suppressed Carrier, Double-Sideband Full Carrier, Single Sideband and vestigial sideband modulation; Demodulation: Carrier Recovery in AM, coherent Demodulation, Envelope Detector, Square-Law Demodulator; Integrated Circuit Modulators And Demodulators, Superheterodyne Receiver; Angle Modulation: Frequency Modulation, Phase Modulation, Narrow Band Angle Modulation, Wideband FM, Modulators, Demodulators, Broadcast FM And Stereo, QAM; Effects Of Noise In Analog Modulation Systems, Sampling, Pulse amplitude modulation, pulse width modulation, pulse position modulation, PCM.

Textbooks:

1. J. G. Proakis and M.Salehi, "Fundamentals of Communication Systems," Prentice Hall, 2004.
2. S.Haykin, "Communication Systems," John Wiley & Sons, 5th Ed., 2009.

Reference Books:

1. B.P. Lathi and Z. Ding, "Modern Digital and Analog Communication Systems,"4th Ed., Oxford University Press, 2009.
2. Louis E. Frenzel, "Principles of Electonic Communication Systems," 3rd Ed., Tata McGraw-Hill, 2008.
3. Dennis Roddy and John Coolen, "Electronic Communications," 4th Ed., Pearson, 2008.

Subject Code: EC2P004	Name: Digital Electronics Circuits Laboratory	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Digital Electronic Circuits

Truth tables of Logic gates; Half Adder and Full Adder; Multiplexer and De-multiplexer; Comparators; Encoders; Schmitt Trigger; Multivibrators: Astable, Monostable and Bi-stable; Flip Flops: S-R, J-K and D; Asynchronous and Synchronous Counters: Up-Down, Ripple counter, Ring counter;

Text Books:

1. S. Lee, "Digital Circuits and Logic Design" Prentice Hall India, 2008.
2. D. P. Leach, A. P. Malvino and G. Saha, "Digital Principles and Applications," Tata McGraw Hill, 2005.
3. M. Morris Mano, "Digital Logic and Computer Design," Prentice Hall, 2006.

Reference Book:

1. Z. Kohavi and N. K. Jha, "Switching and Finite Automata Theory," Tata McGraw Hill, 2004.

Subject: EC2P005	Name: Analog Communication Lab	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s):

Carrier modulation and Demodulation; AM: DSB, SSB, Envelope detector, mixer; FM: Modulation and demodulation; Superheterodyne receiver; Sampling, Pulse amplitude modulation, pulse width modulation, pulse position modulation.

Text Book:

1. S. Haykin, "Communication Systems", 4th Ed., John Wiley and Sons, 2006.

SEMESTER – V

Subject Code: EC3L005	Name: Electromagnetic Waves and Radiating Systems	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Mathematics – 1, Mathematics – 2

Vectors analysis: Vector algebra, vector calculus - divergence, gradient, curl, Laplacian; Coordinate systems - Cartesian, cylindrical and spherical; Electrostatics: Coulomb's law, Gauss's law, electric scalar potential, Laplace and Poisson's equations, conduction and polarization, boundary conditions, resistance and capacitance; Magnetostatics : Biot-Savart law, Ampere's law, magnetic vector potential, Lorentz force, magnetization, boundary conditions, magnetic energy and inductance; Electrodynamics : Maxwell's equations, Faraday's induction, displacement current, Plane wave propagation in free space and in materials; Poynting vector, reflection and transmission of plane waves at media boundary, Transmission lines, Smith chart; Advanced Topics: Antenna fundamentals, dipole antenna, Microstrip transmission lines, Waves along guiding structures

Text Books:

1. J. D. Kraus and D. A. Fleisch, "Electromagnetics:with Applications," McGraw Hill, 1999.
2. D. K. Cheng, 'Field and Wave Electromagnetics,' Addison-Wesleyseries, 1989.

Reference Books:

1. W. H. Hayt, "Engineering Electromagnetics", 5th Ed., TMH, 1999.
2. J. A. Edminister, "Schaum's Outline of Theory and Problems in Electromagnetics," 1984.

Subject Code: EC3L006	Name: Digital Communications	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Analog Communications

Introduction to Digital Communications, Nyquist Sampling Theorem, Information Sources, Random process, Quantization, Pulse Code Modulation, Delta Modulation,Signal Space Representation: Orthogoal expansion of signals, Gram-Schmidt Procedure, Representation of digitally modulated signals; Digital Transmission over the AWGN Channel, Matched Filters, ML and MAP Receivers, Power Density Spectra and Probability of Bit Error; Modulation for Bandwidth-Limited Channels: Intersymbol interference, Equalization, error performance;Passband Digital Transmission via Carrier Modulation: BPSK, QPSK, MPSK, BFSK, MFSK, CPFSK, OQPSK, MSK, GMSK and Continuous phase modulation, , Communication over fading channels, Spread spectrum systems: direct sequence modulation and frequency hopping Case study — code division multiple access (CDMA); Multichannel and multicarrier systems: OFDM; Introduction to information theory: Entropy, Channel Capacity in AWGN;

Text Books:

1. J. G. Proakis and M.Salehi, "Fundamentals of Communication Systems," Prentice Hall, 2004.
2. S.Haykin, "Communication Systems," John Wiley & Sons, 5th Ed., 2009.

Reference Books:

1. B.P. Lathi and Z. Ding, "Modern Digital and Analog Communication Systems," 4th Ed., Oxford University Press, 2009.
2. U. Madhow, "Fundamentals of Digital Communication," Cambridge Univ. Press, 2008.
3. T. M. Cover and J. A. Thomas, "Elements of Information Theory," Wiley Student Edition, 1999, Reprint 2009.

Subject Code: EC3L007	Name: Microprocessor and Microcontrollers	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Digital Electronic Circuits

Historical background; organization and architectural features of microprocessor and microcontrollers; the instruction set: instruction format, addressing modes; assembly language programming of 8085 and 8051; interfacing of memory devices; data transfer techniques and I/O ports; interfacing of keyboard and display devices; programmable interrupt and DMA controllers; interfacing of sensors, transducers, actuators, A/D and D/A Converters, analog signal conditioning circuits, data acquisition systems; standard interfaces - RS232, USB;

development aids and troubleshooting techniques; Microprocessor Programming: Modular programming; Structured programming. Embedded C programming; Exception handling and programming: types of exception; exception vector table; stacks and its role in exception processing; Interrupts and Interrupt service routines; Interrupt priority. Basic I/O and I/O Programming: I/O organization and structure, I/O ports and their configuration; serial interface; Polling techniques; interrupt-driven I/O; ARM Processor Fundamentals: Basic features and comparison of ARM, PIC, AVR, Arduino, Raspberry Pie microcontrollers, ARM architecture, I/O pins, Ports, timers, interrupts, memory organization, pipelining and Hazards, ARM processor families, ARM instruction set, addressing modes, assembly language programming of ARM; Advanced Microprocessor Features: protected mode, real address mode, system management mode, memory models and management, paging and virtual memories, support for multitasking operating systems: privilege levels and protection, input-output architecture.

Text Books:

1. R. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, 6th Edition, Penram Intl. Publishing (India) Pvt. Ltd., 2013
2. K. J. Ayala, The 8051 Microcontroller Architecture, Programming and Applications, Penram Intl. Publishing (India) Pvt.Ltd., 2007.

Reference Books:

1. M. A. Mazidi, Microcontroller and Embedded Systems, Pearson Education, 2008.
2. R. Kapadia, "8051 Microcontroller and Embedded Systems,"Jaico Publishing House, 1st Ed., 2004.
3. Steve Furber, "ARM System –On –Chip architecture,"Addision Wesley, 2000.
4. DanielTabak, "Advanced Microprocessors," Mc Graw Hill. Inc., 1995
5. James L. Antonakos, "The Pentium Microprocessor," Pearson Education, 1997.
6. John .B. Peatman, "Design with PIC Microcontroller," Prentice Hall, 1997.

Subject:EC3P003	**Name: Digital Communication Lab**	**L-T-P: 0-0-3**	**Credits: 2**

Pre-requisite(s): Digital Communication

Delta modulation and demodulations; PAM, PPM and PWM modulation and demodulation; Frequency division multiplexing (FDM) and Time division multiplexing (FSM), PSK, FSK modulations.

Text Books:

1. M. Salehi, J. G. Proakis, "Fundamentals of Communication Systems", 1st Ed., Prearson Education, 2006.
2. S. Haykin, "Communication Systems", 4th Ed., John Wiley and Sons, 2006.

Reference Books:

1. P. Lathi, Zhi Ding, "Modern Digital and Analog Communication Systems", 4th Ed., Oxford University Press, 2009.
2. Roddy, J. Coolen, "Electronic Communications", 4th Ed., Pearson Education, 2008.

Subject Code: EC3P004	**Name: Microprocessor and Microcontrollers Lab**	**L-T-P: 0-0-3**	**Credits: 2**

Pre-requisite(s): Microprocessor and Microcontrollers

Familiarization with 8/16 bit microprocessors/microcontroller kits and interfaces; Experiments related to interfacing ADC, DAC, Motors, Timers, Serial and Parallel ports; Assembly and machine language programming, signal generators, interfacing basic I/O devices like keypad, LED display, usage of timers and USART peripherals, multi-port device access, stepper motor movement control, DC motor speed control, bootstrap programming and interfacing various peripherals for embedded applications; building a complete microcontroller-based system; ARM Processor Programming Experiments; Embedded C Language Programming Experiments.

Texts/ Reference Books:

1. R. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, 6th Edition, Penram Intl. Publishing (India) Pvt. Ltd., 2013
2. K. J. Ayala, The 8051 Microcontroller Architecture, Programming and Applications, Penram Intl. Publishing (India) Pvt.Ltd., 2007.

SEMESTER – VI

Subject Code: EC3L003	**Name: Digital Signal Processing**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite(s): Signals and Systems

Introduction to DSP, Signals and Systems Characterization, FIR and IIR : Recursive and Non Recursive, Z-Transform, Discrete Time Signals and Systems in Frequency Domain, Sampling, Quantization, Discrete Fourier Transform, Fast Fourier Transform, Short-time Fourier Transform, Digital Filter Structure, Analog Filter Design, Digital Filter Design.

Text Books:

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications, 4th Ed., Pearson, 2012.
2. A. V. Oppenheim and R. W. Shafer, "Discrete-Time Signal Processing," Prentice Hall, 2009.

Reference Books:

1. R. G. Lyons, "Understanding Digital Signal Processing," 3rd Ed., Prentice Hall, 2010.
2. V. K. Ingle and J. G. Proakis, "Digital Signal Processing using MATLAB," Thomson Learning, 2000.

Subject Code: EE3L003	**Name: Control Systems**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite(s): Signals and Systems

Introduction to Control Systems: Definition, Examples of control systems, Open loop and closed-loop control systems, Review of Laplace and inverse Laplace transforms; System Modeling: Signal flow graph, Block diagram, Transfer function, Poles and zeros, Block diagram reduction using signal flow graph and block diagram reduction techniques, Mechanical, electrical and electromechanical systems, First and second order models; Transient Response and Steady State Error Analysis: Definitions of transient response parameters, analysis of second order system as prototype, Routh-Hurwitz stability criterion, Classification of systems based on steady state characteristics, Steady state error coefficients; Root Locus Method: Definition of root locus, Properties of root locus, Sketching of root locus, Effect of open loop poles and zeros, Root locus design concepts; Frequency Response Analysis: Bode diagram, Polar plot, Nichols plot, Nyquist stability criterion: nonmathematical description of Nyquist criterion, interpretation of stability, Relative stability – Gain and Phase margin, Closed loop frequency response – M and N contours, Nichols chart; Compensation Techniques: Compensation techniques: lag, lead and lag-lead compensation, PD, PI and PID controllers, Cascade compensation based on root locus method, Introduction to feedback compensation; State Space Analysis: Concepts of state, state variables, and state model, State models for linear continuous-time systems, Diagonalization, Solution of state equations, Concepts of Controllability and Observability. Nonlinear Systems: Common physical nonlinearities, Phase plane method, Singular points, Stability of nonlinear systems, Phase trajectories, Describing function method and stability analysis, Lyapunov's stability criterion.

Text Books:

1. R. Stefani, B. Shahrian, C. Savant & G. Hostetter, "Design of Feedback Control Systems", Oxford University Press, 2002.
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 1997.

Reference Books:

1. B. C. Kuo& F. Golnaraghi, "Automatic Control Systems", John Wiley, 2003.
2. M. Gopal, "Control Systems: Principles and Designs", 2nd Edition, McGraw Hill, 2002.
3. R. C. Dorf & R. H. Bishop, "Modern Control Systems", Prentice Hall, 2000.

Subject Code: EC3L009	**Name: VLSI Design**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Semiconductor Devices, Digital Electronics

Introduction: Design hierarchy, layers of abstraction, integration density and Moore's law, VLSI design styles, packaging styles, design automation principles; Fabrication Technology: Basic steps of fabrication, bipolar, CMOS and Bi-CMOS fabrication processes, layout design rules; MOS and Bi-CMOS characteristics and circuits: MOS transistor characteristics, MOS switch and inverter, Bi-CMOS inverter, latch-up in CMOS inverter, super-buffers, propagation delay models, switching delay in logic circuits, CMOS analog amplifier; Logic Design: switch logic, gate restoring logic, various logic families and logic gates, PLA; Dynamic Circuits: Basic concept, noise considerations, charge sharing, cascading dynamic gates, domino logic, clocking schemes; Sequential Circuits: Basic regenerative circuits, bi-stable circuit elements, CMOS SR latch, clocked latch and flip-flops; Low-power Circuits: low-power design through voltage scaling, estimation and optimization of switching activity, reduction of switched capacitance, adiabatic logic circuits; Subsystem Design: design of arithmetic building blocks like adders, multipliers, shifters, area-speed-power tradeoff; Semiconductor Memories: SRAM, DRAM, non-volatile memories; Bipolar ECL Inverter: Features of ECL gate, logic design in ECL, single-ended and differential ECL gates; Testability of VLSI: Fault models, scan-based techniques, BIST, test vector generation; Physical Design: Brief ideas on partitioning, placement, routing and compaction.

Text Books:

1. S. Kang and Y Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design," 3rd Ed., Tata McGraw Hill, New Delhi, 2003.

2. J. P. Uyemura, "Introduction to VLSI circuits and Systems," John Wiley, New Delhi, 2002.

Reference Books:

1. L Wang, C.Wu and X. wen, VLSI Test Principles and Architecture, Morgan Kaufmann, San Francisco, 2006.

Subject Code: EC3P002	**Name: Digital Signal Processing Laboratory**	**L-T-P: 0-0-3**	**Credits: 2**

Pre-requisite(s): Digital Signal Processing

Fourier transform; Z-transform; Discrete Fourier transform (DFT); Fast Fourier transform (FFT); Infinite impulse response (IIR) and Finite impulse response (FIR) filter designs.

Texts/Reference Books:

1. J. G. Proakis and D. G. Manolakis, "*Digital Signal Processing: Principles, Algorithms and Applications, 4th Ed.*, Pearson, 2012.
2. A. V. Oppenheim and R. W. Shafer, "*Discrete-Time Signal Processing,*" Prentice Hall, 2009.
3. R. G. Lyons, "*Understanding Digital Signal Processing," 3rd Ed.*, Prentice Hall, 2010.
4. V. K. Ingle and J. G. Proakis, "*Digital Signal Processing using MATLAB,*" Thomson Learning, 2000.

Subject Code: EE3P003	**Name: Control Systems Lab**	**L-T-P: 0-0-3**	**Credits: 2**

Pre-requisite(s): Control Systems

Transfer function evaluation of a DC motor; Study of an AC servomotor; Study of digital control systems; DC servo motor position control; Closed loop speed control of DC motor; Study of temperature control systems; Feedback control of magnetic levitation system; PID stabilization of an inverted cart-pendulum system; Study of coupled tank system; PID stabilization of a twin rotor MIMO system; PID control of two link flexible manipulator.

Texts/Reference Books:

1. B. C. Kuo, 'Automatic Control Systems', Wiley, 2003
2. K. Ogata, Modern Control Engineering, Prentice Hall, 1997
3. R. C. Dorf and R. H. Bishop, 'Modern Control Systems', Pearson Education, Inc, 2008.
4. W. A. Wolovich, 'Automatic Control Systems', Saunders College, 1994
5. R. T. Stefani, 'Design of Feedback Control Systems', Oxford University Press, 2002.

Subject Code: EC3P005	**Name: VLSI Laboratory**	**L-T-P: 0-0-3**	**Credits:2**

Pre-requisite(s): VLSI Design

Analog circuits simulation using SPICE; Simple analog and digital circuits, mixed signal simulation using mixed signal simulators; Layout extraction for analog& mixed signal circuits; Parasitic values estimation from Layout; Net list extraction; Design and simulate operational amplifier performance parameters; Design of various routing - local routing, area routing, channel routing and global routing; Design and simulation of gate-level modeling; Design and implement reducing power consumption in memories, Design of NMOS and CMOS inverters -DC and transient characteristics and switching times, Estimation of resistance, capacitance and inductance, Design of multiplexers, decoders and comparators, Design of designing digital filters using FPGA.

Text/Reference Books:

1. S. Kang and Y Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design," 3rd Ed., Tata McGraw Hill, New Delhi, 2003.
2. J. P. Uyemura, "Introduction to VLSI circuits and Systems," John Wiley, New Delhi, 2002.

SEMESTER – VII

Subject Code: EC4L011	Name: Communication Networks and Switching	L-T-P: 3-0-0	Credits: 3

Prerequisite: Analog and Digital Communications

Introduction to Communication Networks; Communication Switching: Circuit Switching, Message and Packet Switching, Connectionless and Connection oriented packet switching; Communication Process and Layered Architecture: Communication between computers and layering concept, OSI Layers, Protocols; Standards: Physical Layer, Data link layer- HDLC, Network layer – X. 25, Transport and Session layers, Application and Presentation layers; Local Area Networks: LAN topologies, access mechanisms and media, contention based LANS, Token passing LANS; Metropolitan Area Networks: Distributed Queue Dual Bus (DQDB), Fiber Distributed Data Interface (FDDI); Internet and Internet Protocol Suite: Internet, IPV4, IP addressing, ICMP, IPV6, Transport control protocol, UDP protocol suite; Routing: Concept, Techniques – Next-hop specific, Network-specific and Host-specific, routing algorithms, Protocols- RIP, OSPF, Link state routing, BGP; Flow-based routing, Hierarchial routing; Digital Switching: Space switching, Multistage switching, Time multiplexed space and time switching, time and space switches; Frame relay; ATM: Concepts and Header, virtual path, virtual channel, ATM adaptation layer (AAL); Narrowband and Broadband ISDN: Data rates, Access channel types, reference points, services and standards, B-ISDN; Synchronous Digital Hierarchy; Network Security.

Texts Books:

1. B. A Forouzan, "Data Communications and Networking," 4th Ed., McGraw Hill, 2012.
2. D. Bertsekas and R. Gallager, "Data Networks," 2nd Ed., PHI learning, 2011.

Reference Books:

1. A. S. Tanenbaum, "Computer Networks," 4th Ed., Prentice Hall, 2009.

Subject Code: EC4L012	Name: RF and Microwave Engineering	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Electromagnetic waves and Radiating Systems

Review of electromagnetics: Maxwell's equations, plane wave solutions;Transmission lines: coaxial lines, rectangular waveguides, Microstrip; Network analysis: scattering matrix, transmission matrix formulations;Matching networks: Lumped element designs and limitations, single and double-stub tuned designs, Quarter-wavelength transformers, multi-section matching transformers; Active microwave circuit design: characteristics of microwave transistors, mixers and detectors, Oscillators; Amplifier design: LNA and Power amplifiers, gain and stability, design for noise figure, Single-stage amplifier design; Antenna Analysis and Design: Dipole, Monopole, Loop, Antenna arrays and Pattern synthesis, Complex Wire Antennas (Helical, Spiral, LPDA, Turnstile), Aperture antennas, Broadband and Ultra-wideband Antennas; Noise in microwave circuits: dynamic range and noise sources, equivalent noise temperature, system noise figure considerations.

Text Books:

1. David M. Pozar, 'Microwave Engineering,' 3rd. ed., John Wiley & Sons, 2005.

Reference Books:

1. Guillermo Gonzalez, Microwave Transistor Amplifiers, 2nd. ed., Prentice-Hall, 1997.
2. Thomas H. Lee, Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits, 1st Edition, Cambridge University Press, 2004.

Subject Code: EC4P001	Name: Electronic System Design Laboratory	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Digital Electronic Circuits

The objective of the electronic system design (ESD) laboratory is to pursue industrially relevant research in innovative design of electrical and electronic system technologies and assembling in PCB for signal, image and video processing, communication and wireless sensors, power generation and distribution, energy and health monitoring applications. The design of electrical and electronic systems includes: audio amplifier, AC/DC voltage regulator, inverter, data acquisition system, process control timer, communication systems, wireless Transceiver, microcontroller based system, DSP based system, digital system, and PCB layout design.

Texts/Reference Book:

1. S. Sedra and K. C. Smith, "Microelectronic Circuits," Oxford University Press, India, 2005.
2. A. Malvino and D. J. Bates; "Electronic Principles," Tata McGraw Hill, India, 2007.

Subject Code: EC4T001	**Subject Name: Industrial Training Defence**	**L-T-P: 0-0-3**	**Credits: 2**
Subject Code: EC4D001	**Subject Name: B.Tech. Project – I**	**L-T-P: 0-0-6**	**Credits: 4**

SEMESTER – VIII

Subject Code: EC4P002	**Name: RF and Microwave Laboratory**	**L-T-P: 0-0-3**	**Credits: 2**

Pre-requisite(s):RF and Microwave Engineering

I:Basic microwave measurement techniques for power, frequency, wavelength, standing wave ratio,impedance, S parameters and noise

1. Measurement of frequency and wavelength using frequency meter
2. Measurement of SWR and impedance using slotted line
3. Measurement of S parameters using Vector Network Analyzer
4. Measurement of power using Gunn Diode
5. Measurement of noise

II. Characterization of some basic microwave components.

1. Stub Tuner - λ/4 transformer (impedance matching and tuning)
2. Klystron tube (microwave generation and tuning)
3. Cavity Resonators (resonant frequency)
4. Directional Couplers (insertion loss, directivity)
5. Dipole Antenna (radiation pattern and gain)

Text Books:

1. David M. Pozar, 'Microwave Engineering,' 3rd. Ed., John Wiley & Sons, 2005.

Reference Books:

1. Guillermo Gonzalez, Microwave Transistor Amplifiers, 2nd. ed., Prentice-Hall, 1997.
2. Thomas H. Lee, Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits, 1st Edition, Cambridge University Press, 2004.

Subject Code: EC4D002	**Subject Name: B.Tech. Project – II**	**L-T-P: 0-0-9**	**Credits: 6**

Indian Institute of Technology Bhubaneswar
Curriculum

Syllabus for Electives – I, II (Semester VII)

Subject Code: CS4L001	**Name: Compiler Design**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Introduction to Programing and Data Structures, Formal Languages & Automat Theory

Introduction: Overview and phases of compilation; Lexical Analysis: Non-deterministic and deterministic finite automata (NFA & DFA), regular grammar, regular expressions and regular languages, design of a lexical analyser as a DFA, lexical analyser generator; Syntax Analysis: Role of a parser, context free grammars and context free languages, parse trees and derivations, ambiguous grammar; *Top Down Parsing:* Recursive descent parsing, LL(1) grammars, non-recursive predictive parsing, error reporting and recovery; *Bottom Up Parsing*: Handle pruning and shift reduces parsing, SLR parsers and construction of SLR parsing tables, LR(1) parsers and construction of LR(1) parsing tables, LALR parsers and construction of efficient LALR parsing tables, parsing using ambiguous grammars, error reporting and recovery, parser generator; Syntax Directed Translation: Syntax directed definitions (SDD), inherited and synthesized attributes, dependency graphs, evaluation orders for SDD, semantic rules, application of syntax directed translation; Symbol Table: Structure and features of symbol tables, symbol attributes and scopes; Intermediate Code Generation: DAG for expressions, three address codes - quadruples and triples, types and declarations, translation of expressions, array references, type checking and conversions, translation of Boolean expressions and control flow statements, back patching, intermediate code generation for procedures; Run Time Environment: storage organizations, static and dynamic storage allocations, stack allocation, handlings of activation records for calling sequences; Code Generations: Factors involved, registers allocation, simple code generation using stack allocation, basic blocks and flow graphs, simple code generation using flow graphs; Elements of Code Optimization: Objective, peephole optimization, elimination of local common sub-expressions, redundant and un-reachable codes, flow of control optimization.

Text Books:

1. K. D. Cooper and L. Torczon, "Engineering a Compiler," Morgan Kaufman.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools," Pearson Education.

Reference Book:

1. Compiler Design in C by Holub – PHI.
2. Modern Compiler Design by Dick Grune et al – Wiley India.

Subject Code: CS6L019	**Name: Artificial Intelligence**	**L-T-P: 3-0-0**	**Credits: 3**

Prerequisite: None

Introduction to Artificial Intelligence: What is AI? Related Fields, Agents and Environments
Problem Solving: problem representation paradigms, state space, satisfiability vs optimality
Search Techniques: Principles of search, uninformed search, informed search, constraint satisfaction problems, adversarial search and games
Knowledge Representation: Knowledge representation : First order and non-monotonic logic; rule based, frame and semantic network approaches, mixed representations, Theorem Proving, knowledge bases and inference
Uncertainty Treatment : formal and empirical approaches including Bayesian theory, belief functions, certainty factors
Fuzzy Logic: Tagaki-Sugeno Fuzzy Logic;, Mamdani Fuzzy Logic, Fuzzy Bayesian Decision Method, Membership Functions, Fuzzification and Defuzzification, Fuzzy system Modeling
Planning and making decisions
Reinforcement learning: MDPs, Q-learning algorithm, applications, Bandits and Monte carlo tree search

Text books:

1. Russell and Norvig. Artifiicial Intelligence: A Modern Approach. Pearson Education (Low Priced Edition), 2004.
2. Nils J. Nilsson, Artificial Intelligence - A New Synthesis, Morgan Kaufmann Publishers, 2000
3. George F.Luger and William A. Stubblefield, AI: Strcutures and Strategies for Complex problem solving, 2nd edition, Benjamin Cummins Publishers

Reference books:

1. Mark Stefik, Introduction to Knowledge Systems, Morgan Kaufmann.
2. E. Rich and K.Knight, Artificial Intelligence, Tata McGraw Hill
3. E. Charniack and D. Mcdermott, Artificial Intelligence, Addison Wesley

Subject Code: EC4L001	**Name: Semiconductor Devices**	**L-T-P: 3-0-0**	**Credits: 3**

Prerequisite: Introduction to Electronics

Semiconductor Fundamentals, Crystal Structure, Energy bands, Intrinsic and extrinsic semiconductors, Fermi Level, Carrier concentrations at thermal equilibrium, Carrier transport phenomenon: drift and diffusion, Scattering, Excess carriers in semiconductors: generation, recombination and injection of carriers, transient and steady state response, Basic governing equations in semiconductors; Physical description of p-n junctions, Transport equations, current-voltage characteristics, deviations from simple theory, small-signal ac analysis, metal-semiconductor junctions, heterojunctions; BJT fundamentals, operation regions, BJT equivalent circuits and modelling frequency response of transistors, pnpn diodes, SCR; MOS structure, flat-band threshold voltages, MOS static characteristics, small signal parameters and equivalent circuit, charge sheet model, strong, moderate and weak inversion, short channel effects, scaling laws of MOS transistors, LDD MOSFET, NMOS and CMOS IC technology, CMOS latch-up phenomenon; optical absorption in a semiconductors, photovoltaic effect, solar cell, photoconductors, PIN photodiode, avalanche photodiode, LED, semiconductor lasers; Negative conductance in semiconductors, transit time devices, IMPATT, Gunn device, BiCMOS devices.

Text Books/Reference Books:

1. Ben G Streetman, S K Banarjee, Solid State Electronic Devices, 6th edition, PHI India, New Delhi, 2007.
2. R S Muller, T.I.Kamins, Device Electronics for Integrated Circuits, 3rd edition, Wiley-India, New Delhi, 2012.
3. S M Sze, K K Ng, Physics of Semiconductor Devices, 3rd edition, John Wiley, New Jersey, 2007.
4. P Bhattacharya, Semiconductor Optoelectronics, 2nd edition, Pearson, New Jersey, 1997.

Subject Code: EC4L002	**Name: Opto-Electronics**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Introduction to Electronics

Review of basic principles from physics, optical wave representation, interferometers, optical resonators, planar mirror resonators, modes of resonators, spherical mirror resonators, confinement, Gaussian beams, photons and matter, energy levels; Photon optics: interactions of photons and atoms, population inversion, spontaneous and stimulated emission; Lasers: gain mechanism, rate equations, pumping, gain and gain coefficient, laser oscillation theory, laser types, power and spectral distribution , polarization, mode selection, light emitting diodes, fabry-perot lasers, erbium-doped fiber amplifiers (EDFA); Photo detectors: properties of photo detectors, photoconductors, photodiodes. Avalanche photodiodes, phototransistors and noise mechanisms, signal-to-noise analysis, and modulation of optical signals, formats, and receivers; Noise and detection: types of noise and distortion which affects optical signals, methods of reducing effects of noise and distortion, optimal detection methods and devices; Overview of opto-electronic networks: FDDI, Fiber channel, sonnet.

Text Books:

1. Saleh and Teich, "Fundamentals of Photonics," Wiley Interscience, 2nd edition, 2007.

2. J. Senior, "Optical Fiber Communications. Principle and Practice," Prentice Hall, 2011.

Reference Books:

1. Wilson and Hawkes, "Optoelectronics: An Introduction, 3rd. Ed., Prentice Hall, 1997.

Subject Code: EC6L001	**Name: Advanced Communication Engineering**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite(s): Analog and Digital Communication

Noise in amplitude modulation, frequency modulation, pulse code, delta modulation, MPSK, MQAM and MFSK, CPFSK, OQPSK, CPM; Information theory and coding; Optimum reception of digital signals, Performance analysis of digital communication systems; Multi carrier communications, Multi-channel communications and Multi-user communications; Introduction to software defined radios, Spectrum sensing, Dynamic spectrum access and management, Distributed learning; Introduction to sensor networks, Deployment and configuration, Protocols routing and application;

Text Books:

1. J. G. Proakis and MasoudSalehi, "Fundamentals of Communication Systems," 1st Edition, Prearson Education, 2006.
2. Simon Haykin, "Communication Systems," John Wiley & Sons, 5th Ed., 2009.

Reference Books:

1. B.P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems," Oxford University Press, 4th Ed., 2009.
2. U. Madhow, "Fundamentals of Digital Communication," Cambridge Univ. Press, 2008.
3. Cauligi S Raghavendra, Krishna M Sivalingam, TaiebZnati, "Wireless Sensor Network", Springer, 2006.
4. HüseyinArslan,"Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Springer, 2007.
5. Kwang-Cheng Chen, RamjeePrasad,"Cognitive Radio Networks", John Wiley & Sons, 2009.

Subject Code: EC6L002	**Name: Image and Video Processing**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite(s): Digital Signal Processing

Introduction to digital image processing, intensity transformation, spatial filtering, frequency domain filtering, point and line detection, edge detection, Hough Transform, image restoration, color processing, thresholding, image segmentation, affine transformation, image transforms, multi-resolution image analysis, shape and texture representation and description, introduction to object recognition, image compression, JPEG, introduction to digital video, video compression standards, motion estimation.

Text Books/Reference Books:

1. Gonzalez and Woods, "Digital Image processing," 3rd Ed., Pearson and Prentice Hall, 2009.
2. W.K. Pratt, "Digital image processing," 4th Ed., Wiley India, 2007.
3. K.R. Castleman, "Digital image processing," 2nd Ed., Pearson, 2012.
4. A.K. Jain, "Fundamentals of digital image processing," Prentice Hall, 1989.

Subject Code: EC6L005	**Name: Statistical Signal Processing**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Signal Processing

Review of Probability and Stochastic Process; Estimation Theory: Minimum-variance unbiased estimator (MVUE), Cramer-Rao Lower bound, Best Linear Unbiased Estimator, Maximum likelihood Estimator, General Bayesian Estimator**,** Detection Theory: Neyman Pearson Theorem, Receiver Operating Characteristics, Matched Filters, Composite Hypothesis Testing; Nonparametric Spectral Estimation: Estimation of power spectrum of stationary random signal using periodogram-various methods, Joint signal analysis and estimation of cross power

spectrum; Linear Signal Model: Synthesis of coloring filter and Analysis of whitening filter, Rational power spectra (AR, MA, ARMA), Relationship between filter parameters and autocorrelation sequences, Lattice-Ladder filter realization; Parametric Spectral Estimation: Order selection criterion of AR model , Minimum-variance, Maximum entropy and Maximum likelihood spectrum estimation Harmonic models and frequency estimation techniques Harmonic Decomposition, MUSIC algorithm, ESPRIT algorithm; Linear Optimum Filter: Optimum FIR Filter, PCA of optimum linear estimator and its frequency domain interpretation, Forward and Backward Linear prediction and optimum reflection coefficients Optimum causal and non-causal IIR Filters, De-convolution and Signal restoration Algorithms and Structure of Optimum Linear Filters Levinson Recursion for optimum estimate, Order-recursive algorithms for optimum FIR filters and its lattice structures.

Text Books/Reference Books:

1. S. M. Kay, Fundamentals of Statistical Signal Processing, Vol I: EstimationTheory, Vol II: Detection Theory, Prentice Hall, 1993/1998.
2. Harry L. Van Trees, Detection, Estimation, and Modulation Theory, Part I, Wiley-Inter science, 2001
3. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley, 1996.

Subject Code: EC6L011	**Name: Remote Sensing Systems**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): None

Electromagnetics basis: Electromagnetic waves, Polarization, Spectra and Fourier transform, Doppler effect, Angular distribution of radiation, Thermal radiation, diffraction, Interactions of electromagnetic radiation: Propagation through homogeneous materials, Reflection and emission from real materials, Propagation through the atmosphere Molecular absorption and scattering, Radiative transfer equation Electro optical remote sensing system: Spectral Imagery, VIR imaging systems, Thermal infrared imagers, Passive Microwave Systems: Antenna Theory, Microwave Radiometry, Ranging Systems: Laser profiling, Radar altimetry, Scattering Systems: Lidar, Microwave Scatterometry, Synthetic Aperture Radar, Data Processing: Image Processing, Classification and Segmentation, Applications of Remote Sensing Systems.

Text Books:

1. W. G. Rees, Physical Principles of Remote Sensing, Cambridge University Press; 3rd edition, 2013.

Reference Books:

1. Remote Sensing from Air And Space by R. C. Olsen, SPIE Press, 2007.
2. James B. Campbell, Randolph H. Wynne, Introduction to Remote Sensing, 5th Edition, Guilford Press, 2011.

Subject Code: EC6L013	**Name: Antenna Theory**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Electromagnetic Engineering or equivalent

Introduction, Definitions, EM radiation, Friis and Radar Equations, Basic antenna elements (Dipole, Monopole, Loop), Antenna arrays (Linear and End-fire arrays) and Pattern synthesis Complex Wire Antennas (Helical, Spiral, LPDA, Turnstile), Aperture antennas, Broadband and Ultra-wideband Antennas, Antennas in Communication Link Budgets, Introduction to Computational Methods (including Integral Equations, Method of Moments), Novel Antenna Concepts and Emerging Trends (e.g. Metamaterial Antennas, Fractal Antennas, Reconfigurable Antennas, Nanoantennas).

Text Books:

1. C.A. Balanis, "*Antenna Theory Analysis and Design*," 3rd Ed., John Willey & Sons, 2005.

Reference Books:

1. R. S. Elliott, "*Antenna Theory and Design*," revised Ed., Willey-Interstice & IEEE Press, 2003.
2. W. L. Stuzman and G. A. Thiele, "*Antenna Theory and Design*," 2nd Ed., John Wiley, 1997.
3. S. Silver, "*Microwave Antenna Theory and Design*," M.I.T. Radiation Laboratory Series, 1986.

Subject Code : EC6L028	**Name: Speech Signal Processing**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Signal Processing

Introduction, Physiological and Mathematical Models, Categorization of Speech Sounds; Discrete time speech signals, Fourier transform and Z-transform, convolution, filter banks. Spectral estimation, Pole-zero modeling and linear prediction (LP) analysis. Homomorphic deconvolution, cepstral analysis; Feature extraction, Static and dynamic features, robustness, feature selection. Mel frequency cepstral coefficients (MFCC), linear prediction cepstral coefficients (LPCC), Perceptual LPCC; Distance measures: Log spectral distance, cepstral distances, weighted cepstral distances, distances for linear and warped scales, Dynamic Time Warping for Isolated Word Recognition; Statistical models for speech recognition: Vector quantization model, Gaussian mixture model, Discrete and Continuous Hidden Markov modeling.

Texts/References Books:

1. Thomas F. Quatieri, "Discrete-Time Speech Signal Processing: Principles and Practice," Prentice-Hall, 2001.
2. L. Rabiner and B. Juang, "Fundamentals of Speech Recognition," Prentice-Hall, 1993.
3. B. Gold and B. Morgan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music," Wiley 2000.

Subject Code: EE6L006	**Name: Renewable and Distributed Energy Sources**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Electrical Technology or equivalent

Brief idea on renewable and distributed sources, their usefulness and advantages, Wind Energy: Estimates of wind energy potential, wind maps, instrumentation for wind velocity measurements, aerodynamic and mechanical aspects of wind machine design, conversion to electrical energy, aspects of location of wind farms, Solar Energy: Present and new technological developments in photovoltaic, estimation of solar irradiance, components of solar energy systems, solar-thermal system applications to power generation, heating, Hydel Power: Water power estimates, use of hydrographs, hydraulic turbine, characteristics and part load performance, design of wheels, draft tubes and penstocks, plant layouts, Brief idea of other sources viz., tidal, geothermal, gas-based, etc, Requirements of hybrid/combined use of different renewable and distributed sources, need of energy storage.

Texts/References Books:

1. M. J. Bollen and Fainan Hassan, *"Integration of Distributed Generation in the Power System,"* IEEE Press, 2011.
2. L. L. Lai and T. F. Chan, "*Distributed Generation: Induction and Permanent Magnet Generators,"* Wiley-IEEE Press, 2007.
3. C. Anderson and R. I. Howard, "*Wind and Hydropower Integration: Concepts, Considerations and Case,"* Nova Publisher, 2012.
4. A. E. Niemi and C. M. Fincher, "*Hydropower from Small and Low-Head Hydro Technologies,"* Nova Publisher, 2011.
5. D. Y. Goswami, F. Kreith and J. F. Kreider, "*Principles of Solar Engineering."* Taylor & Francis 2000.

6. G. N. Tiwari, "*Solar Energy Technology,"* Nova Science Publishers, 2005.

Subject Code: EE6L007	**Name: Industrial Instrumentation**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Measurement and Electronic Instruments

Introduction to Instrumentation system; Static and Dynamic characteristics of Instrument; Pressure measurement: Elastic transducers (Bourdon Gauge, Bellow and Diaphragm Gauge); Temperature measurement: Thermocouple, Resistance Temperature Detector (RTD), Thermistor, Radiation Pyrometer; Flow and pressure measurements: Differential Pressure flow meter, Variable area flow meter, Variable reluctance transducer, Turbine flow meter, Ultrasonic flow meter (Both transit time and Doppler Shift), Electromagnetic flow meter and Mass flow meter; Measurement of level: Capacitance based and Float based method; Measurement of strain: Strain Gauge; Position sensor: Linear Variable Differential Transformer (LVDT), Synchro; Load and torque cell; pH probe and viscosity measurement; Piezoelectric sensors; Ultrasonic sensors; Pollution measurement; Smart sensors; Actuators and Control valves; Signal conditioning; Pneumatic and Hydraulic Instrumentation system.

Text Books/References:

1. D. Patranabis, 'Principles of Industrial Instrumentation', Tata Mcgraw-Hill, 2001.
2. W. C. Dunn, 'Fundamentals of Industrial Instrumentation and Process Control', Mcgraw-Hill, 2005.
3. N. A. Anderson, 'Instrumentation for process measurement and control', CRC press, 1998.
4. E. Doebelin 'Measurement Systems: Application and Design', Mcgraw-Hill, 2003.

Subject Code: EE6L011	**Name: Energy Storage Systems**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Introduction to Electronics

Energy Storage Need of energy storage; Different modes of Energy Storage. Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage. Electrochemical Energy Storage Systems Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon nano-tubes in electrodes. Magnetic and Electric Energy Storage Systems Superconducting Magnet Energy Storage(SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon nano-tube.

Text Books/Reference Books:

1. R. Huggins, Robert 'Energy Storage', Springer, 2010.
2. Ter-Gazarian 'Energy Storage for Power Systems', Institution of Engineering and Technology, 1994.

Syllabus for Electives – III, IV, V, VI (Semester VIII)

Subject Code:CS6L002	Name: Networks and Systems Security	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Introduction to Programing and Data Structures

Introduction: computer security concepts, the OSI security architecture, security attacks, security services, security mechanisms, a model for network security: Basic cryptography: historical background, transposition/substitution, caesar cipher, introduction to symmetric crypto primitives, asymmetric crypto primitives, and hash functions, block ciphers, message authentication, symmetric-key encryption, public-key encryption, digital signatures; Secret key cryptography: applications, data encryption standard (des), encrypting large messages (ecb, cbc, ofb, cfb, ctr), multiple encryption des (ede), Public key cryptography applications, theory: Euclidean algorithm, Euler theorem, Fermat theorem, multiplicative and additive inverse, RSA, selection of public and private keys. Authentication: security handshake pitfalls, online vs. Offline password guessing, reflection attacks, per-session keys and authentication tickets, key distribution centers and certificate authorities. Real-time communication security: introduction to TCP/IP protocol stack, implementation layers for security protocols and implications, Network security applications: key distribution and user authentication , symmetric key distribution using symmetric encryption, key distribution using asymmetric encryption, certificates, public-key infrastructure, federated identity management, transport-level security, web security considerations, secure socket layer and transport layer security, transport layer security, https, secure shell (SSH), wireless network security, IEEE 802.11 wireless LAN overview, IEEE 802.11i wireless LAN security, wireless application protocol overview, wireless transport layer security, WAP end-to-end security, Electronic mail security: distribution lists, establishing keys, privacy, source authentication, message integrity, non-repudiation, proof of submission, proof of delivery, message flow confidentiality, anonymity, pretty good privacy (PGP), Firewalls and web security: packet filters, application level gateways, encrypted tunnels, cookies, web security problems.

Text Books:

1. William Stallings, "Network Security Essentials Applications and Standards" 5th Ed., Prentice Hall, 1997.
2. Kaufman, Perlman and Speciner, "Network Security: Private Communication in a Public World," 2nd Ed., Prentice Hall, 2002.

Reference Books:

1. W. Richard Stevens,"TCP/IP Illustrated, Vol. 1: The Protocols," US Edition,Addison-Wesley Professional Computing Series, 1993.
2. ERIC Cole, "Network Security Bible," Willey, 2013.
3. J. M. Kizza"Computer Network Security", 1998.

Subject Code: EC6L003	Name: Information Theory and Coding	L-T-P: 3-1-0	Credits: 4

Pre-requisite: Digital Communication

Introduction: Entropy and mutual information theory: joint entropy, conditional entropy, relationship between entropy and mutual information, chain rules for entropy, relative entropy, mutual information, jensen's inequality fano's inequality; An introduction to codes: coding: kraft inequality, optimal codes, bounds on optimal code length, kraft inequality for uniquely decodable codes, shannon and huffman codes, shannon, fano, elias codes, block codes, linear block codes, cyclic codes; Efficient encoding, information sources; average code word length; huffman encoding; noiseless coding: the noiseless coding theorem; Channel capacity: discrete memoryless channels and capacity, examples of channel capacity, symmetric channels, properties of channel capacity, channel coding theorem; Theory and practice of error-control

coding: trellis diagram and the viterbi algorithm, convolution coding in mobile communications and modern graph-based codes (turbo-codes and ldpc codes), the main coding theory problem.

Text Books:

1. T. M. Cover and J. A. Thomas, "Elements of Information Theory," 2nd Ed., Wiley-Inter Science, 2006.
2. S. Lin and D. J. Costello, "Error Control Coding," 2nd Ed., Pearson Prentice Hall, 2004.

Reference Books:

1. R. G. Gallager, "Information Theory and Reliable Communication," Wiley, 1968.
2. I Csiszar and J. Korner, "Information Theory: Coding Theorems for Discrete Memoryless Systems," AkademiaiKiado, December 1981.
3. T. S. Han, "Information-Spectrum Methods in Information Theory," Springer, 2002.
4. Andre Neubauer, Jurgen Freedenberg, Volker Kuhn, "Coding theory Algorithm, Architectures and Applications," Willey India Editions, 2007.
5. Ranjan Bose, "Information theory, Coding and Cryptography," TMH publication, 2008.
6. Roman, Steven, "Introduction to Coding and Information Theory", Springer, 2000.

Subject Code: EC6L004	**Name: Advanced Digital Signal Processing**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite(s): Digital Signal Processing

Multi-rate digital signal processing: decimation, interpolation, sampling rate conversion, digital filter banks, two-channel quadrature mirror filter bank, M-channel QMF bank, Linear prediction and optimum linear filters: forward and backward linear prediction, normal equations, AR lattice and ARMA lattice-ladder filters, Wiener filters, Power spectrum estimation: nonparametric and parametric methods, filter bank methods, Eigen analysis algorithms, Time-frequency analysis: uncertainty principle, Short-time Fourier transform, Wigner distribution, Kernel design, Gabor wavelets, multi-resolution analysis.

Texts/Reference Books:

1. Proakis and Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications," 4th Ed., Pearson, 2012.
2. Cohen, "Time-frequency Analysis," Prentice-Hall, 1995.
3. Vaseghi, "Advanced digital signal processing," 4th Ed., Wiley, 2008.
4. Vaidyanathan, "Multi-rate systems and filter banks," Pearson, 1992.

Subject Code: EC6L012	**Name: Optical Communication**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Analog and Digital Communications

Introduction:Fundamentals of Light, Optics, Optical Fibers, Dielectric waveguides: Attenuation, wavelength dispersion, modes, fields; Light sources and optical amplifiers: Semiconductor laser, light-emitting diode, rate equations, output power, modulation response, chirp, noise, optical amplifiers. Detectors: PIN-diode, avalanche diode, responsivity, bandwidth, noise. Transmission systems: Optical links, direct detection systems, soliton systems, coherent systems, multilevel signaling, dispersion limitations, attenuation limitations, additive noise, signal dependent noise, bit error rate, optical networks, Wavelength-Division-Multiplexing and challenges, Optical System Design and Performance analysis using software tools, Current issues & topics of optical fibre systems

Text Books:

1. G. Keiser, "Optical Fibre Communications", Tata McGraw-Hill Education, 4th Ed., 2008.
2. Govind Agrawal, "Fibre-Optic Communication Systems,'4th Ed., Wiley, 2010.

References:

1.J. Senior, "Optical Fibre Communications: Principles and Practice," 3rd Ed., Prentice Hall, 2008.
2.R. Ramaswami, K. N. Sivarajan, "Optical Networks: A Practical Perspective," 3rd Ed., Morgan Kaufmann, 2009.

3. S. C. Gupta, "Textbook on Optical Fiber Communication and Its Applications," PHI Learning, 2004.
4.John A,"Buck Fundamental of Optical Fiber,"Wiley-Interscience, 2004.

Subject Code: EC6L014	Name: Photonic Network	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Optical Communication

Introduction to photonics networks, bandwidth management, internet growth, topology, osi reference model, photonic system technologies and issues, tdm and wdm multiplexing and demultiplexing. Routing. Wavelength blocking and conversion, Photonic network topologies and architectures, modulation and demodulation techniques, modulation related effects & nonlinear optical effects, photonic components, signal amplification and regeneration, link budget, network technologies and issues, Photonic network components: multiplexer/demultiplexer, switches/routers, cross connectors-converter, Network protocols: ip, g-ethernet, sdh/sonet, fddi, atm, etc., System performance and management, dispersion management, ber& sources of noise, power budgets; optical switching & routing, network safety, regulations & standards, current issues of photonic systems.

Text / Reference Books:

1. G. Prati "Photonic Networks: Advances in Optical Communications" Springer Verlag, 1997.
2. R. Ramaswami and K.N.Sivarajan, "Optical networks: A practical perspective," 2nd Ed., Morgan Kaufman, 2000.
3. U. Black, "Optical Networks: Third Generation Transport Systems," Prentice Hall, 2008.
4. R. Sabella and P. Lugli, "High speed optical communications," Kluwer, 1997.

Subject Code: EC6L015	Name: Biomedical Signal Processing	L-T-P: 3-0-0	Credits: 3

Prerequisite: Digital Signal Processing

Nature of biomedical signals, Artifacts removal, Event detection, Wave shape analysis, Frequency-domain characterization, Biomedical system modeling, Non-stationary signal analysis, Detection of region of interests in biomedical images, Shape and texture analysis, oriented pattern analysis, Image reconstruction of projections, Pattern classification and diagnostic decision, presentation of different case studies.

Text Books/Reference Books:

1. R. M. Rangayyan, "Biomedical signal analysis," Wiley, 2011.
2. R. M. Rangayyan, "Biomedical image analysis," CRC press, 2005.
3. D. C. Reddy, Biomedical signal processing: principles and techniques, Tata McGraw Hill, 2012.
4. Tompkins, Biomedical digital signal processing, Prentice Hall India, 1995.

Subject Code: EC6L016	Name: Computational Electromagnetics	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Electromagnetic Engineering, Introduction to Programming and Data Structure

Applications of electromagnetics in the 21st century. Numerical Methods: ODE solvers, Euler, Runge-Kutta. Review of Basic Electromagnetics: Electrostatics, Magnetostatics, Wave Equations. Numerical Techniques: Method of Moements, Finite Difference Method, Finite Element method, Charge Simulation Method, Monte carlo method. Time Varying Electromagnetic Fiels: Eddy currents & skin depth, introduction to wavelets, families of wavelets. Microwaves, Optics, Micromagnetics, Bio-electromagnetics. Tutorials and demonstration on PC, programming assignments.

Text/ Reference Books:

1. M.N.O. Sadiku, "Numerical Techniques in Electromagnetic," 2nd Ed., CRC Press.
2. E. Weber, "Electromagnetic Fields," Dover, 1951.

3. P. P. Silvester, and R. L. Ferrari, "Finite Elements for Electrical Engineers," Cambridge University Press 1996.
4. J. Kiusalaas, "Numerical Methods in Engineering with Python," Cambridge.

Subject Code: EC6L017	Name: Semiconductor Device Modelling	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Semiconductor Devices

Review of semiconductor physics: Quantum foundation, Carrier scattering, high field effects; P-N junction diode modeling: Static model, Large signal model and SPICE models; BJT modeling: Ebers - Moll, Static, large-signal, small- signal models. Gummel - Poon model. Temperature and area effects. Power BJT model, SPICE models, Limitations of GP model; Advanced Bipolar models: VBIC, HICUM and MEXTARM;MOS Transistors: LEVEL 1, LEVEL 2 ,LEVEL 3, BSIM, HISIMVEKV Models, Threshold voltage modeling, Punchthrough, Carrier velocity modeling, Short channel effects, Channel-length modulation, Barrier lowering, Hot carrier effects, Mobility modeling, Model parameters; Analytical and Numerical modeling of BJT and MOS transistors; Types of models for Heterojunction Bipolar Transistors, Compact modeling concepts, Modeling of HBTs, HBT noise models, Measurement and parameter extraction.

Text Books:

5. G. Massobrio, P. Antognetti, Semiconductor Device Modeling with SPICE, 2nd edition, McGraw-Hill, New York,1993.
6. M. Rudolph, Introduction to Modeling HBTs, Artech House, Boston, 2006.

Reference Books:

1. S. M. Sze, K. K. Ng, Physics of Semiconductor Devices, 3rd edition, John Wiley, New Jersey, 2007.
2. G. A. Armstrong, C. K. Maiti, Technology Computer Aided Design for Si, SiGe and GaAs Integrated Circuits,IET Series, London, 2007.

Subject Code: EC6L018	Name: Satellite Communication	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Electromagnetic Engineering, Communication Engineering

Introduction, general overview, types of satellite communications systems, historical developments, Link budgets: antennas, propagation, noise, c0/n0, c/n calculation, transmitters, propagation and rain, receivers, lnas, figure of merit, total system performance; Orbital mechanics: basic equations, special orbits, geometry and movement , constellations, real world effects; Rf and licensing issues : spectrum allocations, modulation, multiplexing, multiple access
Current and future trends; Spectrum sharing, additional noise issues, interference and coordination, telemetry and tracking, power limitations, reliability.

Text/Reference Books:

1. T. Pratt, C. Bostian and J. Allnutt, "*Satellite Communications," 2nd Edition*, Wiley India, 2006.
2. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "*Satellite Communication Systems Engineering," 2nd Edition*, Pearson Education, 2012.
3. G. Gordon and W. Morgan, "*Principles of Communications Satellites*,"
4. D. I. Dalgleish "*An Introduction to Satellite Communications*," IET Publisher, ISBN: 0863411320, 9780863411328
5. D. Roddy, " *Satellite Communication*," Tata McGraw-Hill Education.

Subject Code: EC6L019	Name: Fibre Optic Sensors	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Classification of sensors, modulation and demodulation mechanism of sensors, interferometric sensors, optical fibres Doppler systems, polarization modulation sensors, fibre optic sensors for

the measurement of temperature, pressure, displacement, turbidity, pollution, etc., multiplexed sensor systems, other sensor applications.

Text Books/References Books:

1. R. Kasyap, 'Fiber Bragg Gratings', Academic Press, 2009.
2. B. Glisic, D. Inaudi, 'Fibre Optic Methods for Structural Health Monitoring', Wiley, 2008.

Subject Code: EC6L020	**Name: Wireless and Mobile Communication**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Communication or equivalent

Review of Digital Communication: Block diagram of digital communication, Modulation Schemes (BPSK, M-PSK, M-QAM, M-FSK), Pulse Shaping, Bandwidth efficiency, MAP-Receivers, AWGN Channel and Performance analysis; Wireless Channels: Fading Wireless Channel Modeling , Rayleigh/Ricean Fading Channels ,BER Performance in Fading Channels , Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, RMS Delay Spread , Doppler Fading, Jakes Model, Jakes Spectrum , Impact of Doppler Fading, Types of Diversity – Frequency, Time, Space; Cellular Communications: Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes - Call Setup, Handover, Introduction to CDMA ,Walsh codes, PN Sequences , Multipath diversity, RAKE Receiver; MIMO/OFDM: Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, Introduction to OFDM , Multicarrier Modulation and Cyclic Prefix, OFDM Issues; Wireless Standards: GSM, GPRS, WCDMA, LTE, WiMAX.

Texts/References Books:

1. D. Tse and P. Viswanath, "Fundamentals of Wireless Communications," Cambridge University Press, 2005.
2. A. Goldsmith, "Wireless Communications," Cambridge University Press, 2005.
3. T. S. Rappaport, "Wireless Communications: *Principles and Practice*," 2nd Ed., Prentice Hall.

Subject Code: EC6L021	**Name: Microwave Design and Measurement**	**L-T-P: 3-0-0**	**Credit: 3**

This course will be an introduction to microwave circuit design and analysis techniques, with particular emphasis on applications for modern microwave communication and sensing systems. Also, it will cover fundamental measurement techniques for device and circuit characterization at microwave frequencies The specific content of the course may be as follows:

Review of electromagnetics: Maxwell's equations, plane wave solutions.

Types of transmission lines and their properties: coaxial lines, rectangular waveguides, Microstrip.

Network analysis: scattering matrix, transmission matrix formulations.

Matching networks: lumped element designs and limitations, single and double-stub tuned designs, Quarter-wavelength transformers, multisection matching transformers.

Active microwave circuit design: characteristics of microwave transistors, mixers and detectors, Oscillators.

Amplifier design: LNA and Power amplifiers, gain and stability, design for noise figure. Single-stage amplifier design.

Noise in microwave circuits: dynamic range and noise sources, equivalent noise temperature, system noise figure considerations.

Prerequisites: None.

Text Books:

1. David M. Pozar, Microwave Engineering, 3rd. ed., John Wiley & Sons, 2005.

Reference Books:

1. Guillermo Gonzalez, Microwave Transistor Amplifiers, 2nd. ed., Prentice-Hall, 1997.
2. Thomas H. Lee, Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits, 1st Edition, Cambridge University Press, 2004.

Subject Code: EC6L022	**Name: Modern Radar Systems**	**L-T-P: 3-0-0**	**Credits:3**

Pre-requisite(s): Communication Engineering

Introduction, Radar Basics, Radar Equation including its search and track forms, Displays, Receivers, Transmitters, Radar Antennas including Reflectors and Phased Array Antennas, Radar Cross Section, Statistical Models for Noise and Target RCS, General Characteristics of Clutter and Clutter Modeling, Clutter Reduction Techniques of Doppler and MTI, Pulse compression, Radar Measurements, Radar Tracking, Radar Detection and Target Classification, Constant False Alarm Rate Detectors, DPCA and STAP, Types of Radar and Emerging Trends.

Text Books:

1. M.A. Richards et al, Principles of Modern Radar, Basic Principles Vol. 1, 1st Ed.,, SciTech 2010.

Reference Books:

1. Skolnik, "Introduction to Radar Systems," 3rd Ed., Tata McGraw Hill, 2008.
2. H. Meikle, "Modern Radar Systems," 2nd Ed., ARTECH House, 2005.

Subject Code: EC6L023	**Name: Adaptive Signal Processing**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Signal Processing

Introduction to adaptive filters, optimal estimation, linear estimation: normal equation, orthogonality principle, linear models. Constrained linear estimation: minimum variance unbiased estimation, steepest descent algorithms, stochastic gradient algorithms: LMS algorithm, normalized LMS algorithm, RLS algorithm. Steady-state performance of adaptive filters, transient performance of adaptive filters, block adaptive filters, the least-squares criterion, recursive least-squares, lattice filters

Texts/Reference Books:

1. A. H. Sayed, "Fundamentals of Adaptive Filtering," Wiley, 2003.
2. S. Haykin, "Adaptive filter theory," Fourth edition, Pearson, 2012.
3. Widrow and Stearns, "Adaptive Signal Processing," Pearson, 2007.

Subject Code: EC6L024	**Name: Array Signal Processing**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Signal Processing, Probability and Statistics Processes

Introduction: Array Processing and Applications, Arrays and Spatial Filters: Uniform Linear Array, Array Steering, Array Performance, Linear Aperture, Synthesis of Linear Arrays and Apertures: Spectral Weighting, Array Polynomials, Minimum Beamwidth, Null Steering, Spatially Non-uniform Linear Arrays, Broadband Arrays, Planar Arrays and Apertures: Rectangular Arrays, Circular Arrays, Circular Apertures, Non-planar Arrays, Characterization of Space-time Processes: Snapshot Models, Space-time Random Process, Optimum Waveform Estimation: Optimum Beamformers, MVDR and MPDR Beamformers, LCMV and LCMP Beamformers, EigenspaceBeamformer, BeamspaceBeamformer, Broadband Beamformer, Adaptive Beamformers: Parametric Estimation, RLS, LMS, Gradient Algorithms, Parameter Estimation and

Direction of Arrival Estimation: Cramer-Rao Bounds, Maximum Likelihood Estimation, Capon methods, Subspace methods - MUSIC, Minimum-Norm and ESPRIT techniques.

Text Books:

1. Harry L. Van Trees, Optimum Array Processing (Part IV of Detection, Estimation, and Modulation Theory), Wiley-Interscience, 2002.

Reference Books:

1. D. E. Dugeon and D. H. Johnson, "Array Signal Processing: Concepts and Techniques," Prentice Hall, 1993.
2. P. Stoica and R. L. Moses, "Spectral Analysis of Signals," Prentice Hall, 2005.

Subject Code: EC6L025	**Name: Multimedia Network**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Communication or equivalent

Introduction: multimedia information representation – text, images, audio, video, digital coding techniques and standards, audio coding, image coding, video coding; Multimedia compression and resiliency, codecs, adaptive coding, error handling techniques, multimedia network services and applications; Wireless broadband, broadcast TV and video streaming, QOS, media transport protocols, session initiation protocol (sip), real-time streaming protocol (RTSP), real-time transport protocol (RTP), session description protocol (SDP), media transport - security issues/techniques and compression; Firewalls, NATS, IPSEC and secure RTP, header compression, next-generation multimedia network architecture standards: multiservice switching forum architecture.

Text/Reference Books:

1. Perkins, "RTP: Audio and Video for the Internet," Addison-Wesley, 2003.
2. Hwang, "Multimedia Networking: From Theory to Practice," Cambridge, 2005.
3. F. Halsall, Multimedia Communications Applications, Networks, Protocols and Standards, Addison Wesley, 2001.
4. K.R. Rao and Z.S. Bojkovic, "Packet Video Communications over ATM Networks," Prentice Hall, 2000.
5. C. -H. Wu and J.D. Irwin, "Emerging Multimedia Computer Communication Technologies," Prentice Hall, 1998.

Subject Code: EC6L027	**Name: Pattern Recognition**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital signal processing, Probability and stochastic processes

Introduction to pattern recognition; Bayesian decision theory : Classifiers, Discriminant functions, Decision surface, Normal density and discriminant functions, Parameter estimation methods: Maximum-Likelihood estimation, Gaussian mixture models, Expectation-maximization method, Bayesian estimation, Hidden Markov models: Discrete hidden Markov models, Continuous density hidden Markov models; Dimensionality reduction methods: Fisher discriminant analysis, Principal component analysis; Non-parametric techniques for density estimation: Parzen-window method, K-Nearest Neighbour method, Linear discriminant function based classifiers: Perceptron , Support vector machines, Non-metric methods for pattern classification: Non-numeric data or nominal data Decision trees, Unsupervised learning and clustering: Criterion functions for clustering Algorithms for clustering: K-means, Hierarchical and other methods, Cluster validation.

Text Books/References:

1. R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification," John Wiley, 2001.
2. S.Theodoridis and K.Koutroumbas, "Pattern Recognition," 4th Ed., Academic Press, 2009.

3. C.M.Bishop, "Pattern Recognition and Machine Learning," Springer, 2006.

Subject Code: CS6L027	**Name: Natural Language Processing**	**L-T-P: 3-0-0**	**Credits:3**

Pre-requisite(s): Introduction to Programing and Data Structures, Formal Languages & Automat Theory

Introduction to Natural Language Processing, Finite-state automata and transducers Computational morphology, N-gram language models; smoothing; interpolation; backoff Part-of-speech tagging, Syntactic parsing: rule-based parsing; CYK algorithm; Earley's algorithm, Computational semantics and lexical semantics, Computational lexicons: WordNet Word Sense Disambiguation and Induction, Roles and frames: FrameNet, Semantic Role Labeling, Discourse and dialogue, Statistical Machine Translation.

Text Books:

1. Jurafsky and Martin, "*Speech and Language Processing"*, Prentice Hall, 2009.
2. Manning and Schűtze, "*Foundations of Statistical Natural Language Processing,*" MIT Press, 1999.
3. Larry Wall, Tom Christiansen and Jon Orwant, "*Programming Perl,*" O'Reilly, 1996.

Subject Code: EC4L008	**Name: Embedded Systems**	**L-T-P: 3-0-0**	**Credits: 3**

Prerequisite: Digital Electronics and Microprocessor

Embedded Processing Systems: Introduction, Components of Embedded Systems – Embedded Processor, Microcontrollers (PIC and ARM architectures), DSP and ASICs and SoC, Memory Devices: ROM and RAM family, Interfacing Memory, Simple I/O programming, Interrupts and their servicing, Timing Devices and Interfacing, Analog I/O Techniques, Introduction to HDL, Design of Embedded Processors and Components, Design Case Studies, Embedded Communication: Parallel Bus Standards, Serial Bus Standards, Networking Standards and Wireless Standards, Real Time Operating Systems (RTOS): Introduction, Memory Management, I/O Management and Device Drivers, Scheduling, Introduction to Software Design: Embedded System Life Cycle, Multicore and Heterogeneous Embedded Systems.

Text Books:

1. W. Wolf, Computers as Components: Principles of Embedded Computing System Design, 2nd Ed., Burlington, 2008.
2. T Noergaard, Embedded Systems Architecture: A comprehensive Guide for Engineers and Prgrammers, Elsevier,Oxford, 2005.

Reference Books:

1. Steve Heath, Embedded System Design, 2nd Edition, Newnes, Burlington, 2003.

Subject Code: EC6L030	**Name: Computer Vision**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Image & Video Processing

Introduction to computer vision, geometric camera models, light and shading, local image features: SIFT, HOG, texture and shape descriptors, active contour, segmentation, deformable models, RANSAC, image registration, learning and classification strategies, image classification, object detection and recognition, stereopsis, tracking, applications

Text Books/References:

1. Forsyth and Ponce, "Computer vision: a modern approach," 2nd Ed., Pearson, 2012.
2. Sonka, Hlavac and Boyle, "Digital image processing and computer vision," Cengage learning, 2008.
3. Rick Szeliski, "Computer Vision: Algorithms and Applications," Springer,2011.

Subject Code: EE6L014	**Name: Smart Grid Technology**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): None

Review of basic elements of electrical power systems, desirable traits of a modern grid, principal characteristics of the smart grid, key technology areas; Smart grid communication: Two way digital communication paradigm, network architectures, IP-based systems, Power line communications, advanced metering infrastructure; Renewable Generation: Renewable Resources: Wind and Solar, Microgrid Architecture, Tackling Intermittency, Distributed Storage and Reserves; Wide Area Measurement: Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self-Healing Systems, Application and Challenges; Security and Privacy: Cyber Security Challenges in Smart Grid, Defense Mechanism, Privacy Challenges.

Texts/Reference Books:

1. J. Momoh 'Smart Grid: Fundamentals of Design and Analysis' Wiley-IEEE Press, 2012.
2. P. F. Schewe 'The Grid: A Journey through the Heart of our Electrified World' Joseph Henry Press, 2006.

List and Syllabus of Lateral Courses for Other Schools

Subject Name	Code	L-T-P	Credit	Contact Hour
Lateral – 1 (Any one will be offered)				
Introduction to Signal Processing	EC2L008	3-0-0	3	3
Communication Systems	EC2L007	3-0-0	3	3
Lateral – 2 (Any one will be offered)				
Biomedical Systems	EC3L004	3-0-0	3	3
Lateral – 3 (Any one will be offered)				
Satellite Communication Engineering	EC3L008	3-0-0	3	3

Subject Code: EC2L008	**Name: Introduction to Signals and Systems**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): None

Introduction and Basics: Signals and Systems; Classification of Signals, System Properties; Linear Algebra Basics-Vectors, Orthogonality, Eigenvalues and Eigenvectors; Probability and Random Signals: Random variables; probability density functions (PDFs); Moments and Cumulants; Multivariate distributions; Time averages, Ensemble averages, Autocorrelation functions, Crosscorrelation function; Estimation of parameters of random signals; Linear prediction; Auto-regressive model; Nonlinear models of signals; Analysis of Nonstationary signals; Continuous Signals and Systems: Laplace Transform, Transfer Functions, Causality and Stability, Poles/Zeros; Differential Equations, Steady State and Transient Responses, and Convolution Integral; Discrete-Time Signals and Systems: LTI Systems; Z-transform; Digital filters; Difference Equations; Causality and stability; Convolution and Correlation; Discrete Fourier Transform (DFT), FFT and Window Function; Frequency Analysis of Signals and Systems; Data Acquisition: Sampling theorem; Sampling of Bandpass Signals; Quantization; A/D conversion; D/A conversion; Sampling and Reconstruction; Interpolation and Decimation; Digital Filter Design: Butterworth, Elliptic, Chebyshev low-pass filters. Filter Realizations; Conversion to high-pass, band-pass, band-stop filters. Discrete-time filters: IIR and FIR. Linear phase filters. Frequency sampling filters.

Text Books:

1. A. Papoulis and S. U. Pillai, "Probability, Random Variables, and Stochastic Processes," McGraw Hill, 2001.

2. A. V. Oppenheim, A. S. Willsky and H. Nawab, "Signals and Systems," 2nd Ed., Prentice-Hall, 1996.

Reference Books:

1. A. V. Oppenheim, Ronald W. Schafer and John R. Buck,"Discrete-Time Signal Processing," 2nd Ed., Prentice Hall, 1999.
2. J. G. Proakis, and D. K. Manolakis,"Digital Signal Processing," 4th Ed., Prentice Hall, 2006.

Subject Code:EC2L007	**Name: Communication Systems**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): None

Introduction, Communication process, Communication Signals, Fourier Transform and Properties Modulation techniques: Amplitude Modulation: Principle, DSB-FC, DSB-SC, SSB and VSB, AM Receiver; Frequency Modulation: Principle, Wideband FM, Narrowband FM, FM Receiver; Superheterodyne Receiver, Time-Division Modulation (TDM), PCM, PCM-TDM, PAM, PPM, PWM and Shift Keying: Amplitude Shift Keying (ASK) and Frequency Shift Keying (FSK); Random variables and Processes: Introduction, Random variables, statistical averages, random processes, mean correlation and covariance functions, PSD, Gaussian Process; Analog and Digital Receiver performance in AWGN.

Text Books:

1. Simon Haykin and Michel Moher, Communication Systems, 5th Ed., John Wiley, 2009.
2. Leon W. Couch, Digital and Analog Communication Systems, 4th Ed., Macmillan Coll Div., 1993.

Reference Books:

1. R, E. Ziemer and W. H. Tranter, "Principles of Communications, Systems, Modulation, and Noise," 5th Ed., Wiley, 2001.
2. P. L. Meyer, "Introductory Probability and Statistical Applications," 2nd Ed., Addison Wesley, 1970.
3. M. H. DeGroot, "Probability and Statistics," 4th Ed, Pearson, 2011.
4. B. P. Lathi, "Modern Digital and Analog Communication Systems," 4th Ed., Oxford, 2011.

Subject Code: EC3L004	**Name: Biomedical Systems**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): None

Introduction to Signals and Systems: Classification of signals, Systems and properties; Signal Processing Techniques: Convolution and Correlation, Interpolations, DFT, STFT, DCT, KLT, Wavelet Transform, Hilbert Transform, Singular Value Decomposition, Principal component Analysis (PCA), Independent Component Analysis (ICA), Random Signal Modeling, Spectral Estimation, Information-theoretic, Nonnegative Matrix Factorization, Total Variation, Sparse Representation, Empirical Mode Decomposition, and Variational Mode Decomposition; Anatomy and Physiology: Structure and function of the human biology including cells, tissues and organs of the following systems: Nervous, Cardiovascular, Respiratory, Muscular, Skeletal, Digestion and Endocrine and special Senses, Membrane Potentials and Action Potentials; Biomedical Signals: The nature of biomedical signals, introduction to the biosignals (ECG, PPG, EEG, EEG, ERG, EOG, EEG, EGG, VMG, VMG and internal body sounds (heart, lung and bowel); Analog Signal Processing: Biosensors, Instrumentation Amplifier, Analog Filter design, Sampling and Quantization, A/D Conversion, D/A Conversion, compressive sensing and Key Challenges in Wearable Medical Devices; Biosignal Signal Analysis: Removal of Artifacts-Time-domain Filters, Frequency-domain Filters, Adaptive Filters and Homomorphic Filtering; Event Detection and Classification, Modeling Biomedical Systems, Biosignal Watermarking and Compression;

Biomedical Applications: Brain Computer Interface, Physical Rehabilitation, Emotional and Biometric Recognition Systems

Text Books:

1. A. C. Guyton and J. E. Hall, "Textbook of Medical Physiology," 11th Ed., 2006.
2. S. J. Cooper, and D. K. Vaughan, "Human Physiology Course Handbook" UW-Oshkosh, 2015
3. Martini and Welch, "Fundamentals of Anatomy and Physiology Applications Manual," 10th Ed., Pearson Education, Benjamin Cummings, San Francisco, CA 2015.

Reference Books:

1. R. M. Rangayyan, "Biomedical Signal Analysis: A Case-Study Approach," Wiley India, 2009.
2. E. N. Bruce, "Biomedical Signal Processing and Signal Modeling," 1st Ed., Wiley-Interscience, 2000.
3. J. L. Semmlow, "Biosignal and biomedical image processing: MATLAB-based applications," 1st Ed., CRC, 2004.
4. M. Akay, "Time Frequency and Wavelets in Biomedical Signal Processing," 1st Ed., Wiley-IEEE Press, 1997.

Subject Code: EC3L008	**Name: Satellite Communication Engineering**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite: None

Overview of Principles of communication, modulation and receiver; Introduction to Satellite Communication: Principle, types of satellite communications systems, historical developments, Link budgets: antennas, propagation, noise, Carrier to noise ratio calculation, transmitters, propagation and rain, receivers, lnas, figure of merit, total system performance; Orbital mechanics: Basic equations, special orbits (LEO, MEO, GEO), geometry and movement , constellations, real world effects; Rf and licensing issues: spectrum allocations, modulation, multiplexing, multiple access; Current and future trends; Spectrum sharing, additional noise issues, interference and coordination, telemetry and tracking, power limitations, reliability.

Text Books:

1. T. Pratt, C. Bostian and J. Allnutt, "*Satellite Communications," 2nd Ed.,* Wiley India, 2006.
2. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "*Satellite Communication Systems Engineering," 2nd Ed.,* Pearson Education, 2012.

Reference Books:

1. G. D. Gordon and W. L. Morgan, "Communications Satellite Handbook," Wiley India, 2010.
2. D. Roddy, "*Satellite Communications," 4th Ed.,* Tata McGraw-Hill Education, 2006.

Complete List of Semester-wise Courses with Credits

Indian Institute of Technology Bhubaneswar
Curriculum

Course Name	Code	L-T-P	Credit	Contact Hours
SEMESTER - I				
Mathematics – 1	MA1L001	3-1-0	4	4
Physics / Chemistry	PH1L001 / CY1L001	3-1-0	4	4
Mechanics / English for Communications or Learning English	ME1L001 / HS1L001 or HS1L002	3-1-0/ 3-0-2 or 3-1-0	4	4/5 or 4
Electrical Technology / Introduction to Programing and Data Structures	EE1L001 / CS1L001	3-1-0	4	4
Introduction to Manufacturing Processes / Engineering Drawing and Graphics	ME1P001 / CE1P001	0-0-3/ 1-0-3	2/3	3/4
Physics Laboratory / Chemistry Laboratory	PH1P001 / CY1P001	0-0-3	2	3
Electrical Technology Laboratory / Introduction to Programing and Data Structures Laboratory	EE1P001 / CS1P001	0-0-3	2	3
Extra Academic Activity – 1	ID1T001	0-0-3	1	3
		Total	22/23 +1	25/26 +3
SEMESTER - II				
Mathematics – 2	MA1L002	3-1-0	4	4
Chemistry / Physics	CY1L001 / PH1L001	3-1-0	4	4
English for Communication or Learning English / Mechanics	HS1L001 or HS1L002 / ME1L001	3-0-2 or 3-1-0/3-1-0	4	5 or 4/4
Introduction to Programing and Data Structures / Electrical Technology	CS1L001 / EE1L001	3-1-0	4	4
Engineering Drawing and Graphics / Introduction to Manufacturing Processes	CE1P001 / ME1P001	1-0-3/ 0-0-3	3 / 2	4/3
Chemistry Laboratory / Physics Laboratory	CY1P001 / PH1P001	0-0-3	2	3

Introduction to Programing and Data Structures Laboratory / Electrical Technology Laboratory	CS1P001 / EE1P001	0-0-3	2	3
Extra Academic Activity – 2	ID1T002	0-0-3	1	3
		Total	23/22 +1	27 or 26/25 +3
SEMESTER - III				
Breadth 1		3-0-0	3	3
Math III (Probability & Statistics)	MA2L003	3-1-0	4	4
Introduction to Material Science and Engineering	ID2L001	2-0-0	2	2
Introduction to Bio Science and Technology	ID2L002	2-0-0	2	2
Introduction to Electronics	EC2L001	3-1-0	4	4
Signal and Systems	EC2L002	3-1-0	4	4
Introduction to Electronics Lab	EC2P001	0-0-3	2	3
Signal and Systems Lab	EC2P002	0-0-3	2	3
Project Seminar	EC2S001	0-0-3	2	3
		Total	**25**	**28**
SEMESTER - IV				
Lateral 1		3-0/1-0	3/4	3/4
Breadth 2		3-0/1-0	3/4	3/4
Environmental Science Technology and Management	ID2L003	2-0-0	2	2
Network Theory	EE2L001	3-1-0	4	4
Digital Electronic Circuits	EC2L004	3-1-0	4	4
Analog Communication	EC2L009	3-1-0	4	4
Digital Electronics Circuit lab	EC2P004	0-0-3	2	3
Analog Communication Lab	EC2P005	0-0-3	2	3
		Total	**24/26**	**26/28**
SEMESTER - V				
Lateral 2		3-0/1-0	3/4	3/4
Breadth 3		3-0/1-0	3/4	3/4
Electromagnetic waves and Radiating Systems	EC3L005	3-1-0	4	4
Digital Communication	EC3L006	3-1-0	4	4
Microprocessor and Microcontroller	EC3L007	3-1-0	4	4
Digital Communication Lab	EC3P003	0-0-3	2	3
Microprocessor and Microcontroller Lab	EC3P004	0-0-3	2	3
		Total	**22/24**	**24/26**
SEMESTER - VI				
Lateral 3		3-0/1-0	3/4	3/4
Breadth 4		3-0/1-0	3/4	3/4

Digital Signal processing	EC3L003	3-1-0	4	4
Control Systems	EE3L003	3-1-0	4	4
VLSI Design	EC3L009	3-0-0	3	3
Digital Signal Processing Lab	EC3P002	0-0-3	2	3
Control Systems Lab	EE3P003	0-0-3	2	3
VLSI Lab	EC3P005	0-0-3	2	3
		Total	**23/25**	**26/28**
SEMESTER - VII				
Communication Networks and Switching	EC4L011	3-0-0	3	3
RF and Microwave Engineering	EC4L012	3-0-0	3	3
Elective 1		3-0-0	3	3
Elective 2		3-0-0	3	3
Electronic System Design Lab	EC4P001	0-0-3	2	3
Industrial Training Defence	EC4T001	0-0-0	2	3
Project 1	EC4D001	0-0-6	4	6
		Total	**20/22**	**24/26**
SEMESTER - VIII				
Elective 3		3-0-0	3	3
Elective 4		3-0-0	3	3
Elective 5		3-0-0	3	3
Elective 6		3-0/1-0	3	3
Project 2	EC4D002	0-0-9	6	9
RF and Microwave Engineering Lab	EC4P002	0-0-3	2	3
		Total	**20**	**24**

Grand Total Credits: 181/188