# B. Tech. Degree

IN

# ELECTRONICS AND COMMUNICATION ENGINEERING


**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**SYLLABUS FOR**
**CREDIT BASED CURRICULUM**

## (From 2019-2020 Batch Onwards)

**NATIONAL INSTITUTE OF TECHNOLOGY PUDUCHERRY**
**KARAIKAL – 609609**
**INDIA**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**
**NATIONAL INSTITUTE OF TECHNOLOGY, PUDUCHERRY**
**KARAIKAL - 609 609.**

## SEMESTER I

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| HM 121 | English Communication Skills | English | 2 | 0 | 2 | 3 |
| MA121 | Differential Calculus and Algebra | Maths | 3 | 0 | 0 | 3 |
| PH121 | Engineering Physics | Physics | 3 | 0 | 0 | 3 |
| HM124 | Basic Energy, Environment, and Agricultural Engineering | Basic Engineering | 3 | 0 | 0 | 3 |
| ME121 | Engineering Mechanics | | 3 | 0 | 0 | 3 |
| ME123 | Engineering Graphics | | 3 | 0 | 0 | 3 |
| PH123 | Engineering Physics Laboratory | Physics | 0 | 0 | 3 | 2 |
| | NSS/NSO/NCC (C) | | 0 | 0 | 0 | 0 |
| | **Total** | | **17** | **0** | **5** | **20** |

## SEMESTER II

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| HM122 | Technical Communication in English | English | 2 | 0 | 2 | 3 |
| MA122 | Integral Calculus and Differential Equations | Maths | 3 | 0 | 0 | 3 |
| CH122 | Chemistry | Chemistry | 3 | 0 | 0 | 3 |
| CS122 | Basics of Programming | | 2 | 0 | 0 | 2 |
| ME122 | Basics of Civil and Mechanical Engineering | Basic Engineering | 2 | 0 | 0 | 2 |
| EC102 | Basics of Electrical and Electronic Engineering | | 2 | 0 | 0 | 2 |
| CH124 | Chemistry Laboratory | Chemistry | 0 | 0 | 3 | 2 |
| ME124 | Basic Workshop Practice | Basic Engineering | 0 | 0 | 3 | 2 |
| CS124 | Basics of Programming Laboratory | | 0 | 0 | 3 | 2 |
| | NSS/NSO/NCC (C) | | 0 | 0 | 0 | 0 |
| | **Total** | | **14** | **0** | **11** | **21** |

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**SEMESTER III**

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| MA221 | Transforms and Complex Analysis | Maths | 3 | 0 | 0 | 3 |
| EC201 | Signals and Systems | DC | 3 | 0 | 0 | 3 |
| EC203 | Network Theory | DC | 3 | 0 | 0 | 3 |
| EC205 | Engineering Electromagnetics | DC | 3 | 0 | 0 | 3 |
| EC207 | Transmission Lines and Waveguides | DC | 3 | 0 | 0 | 3 |
| EC209 | Digital Circuits and Systems | DC | 3 | 0 | 0 | 3 |
| EC211 | Devices and Networks Laboratory | DC | 0 | 0 | 3 | 2 |
| EC213 | Digital Electronics Laboratory | DC | 0 | 0 | 3 | 2 |
| **Maths-1, C-3; DC (T)-5, C -15; DC (L)-2, C-4;** | | **TOTAL** | **18** | **0** | **6** | **22** |

**SEMESTER IV**

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| MA222 | Probability and Random Processes | Maths | 3 | 0 | 0 | 3 |
| EC202 | Digital Signal Processing | DC | 3 | 0 | 0 | 3 |
| EC204 | Control Systems | DC | 3 | 0 | 0 | 3 |
| EC206 | Antennas and Wave Propagation | DC | 3 | 0 | 0 | 3 |
| EC208 | Electronics Circuits | DC | 3 | 0 | 0 | 3 |
| EC210 | Microprocessors and Microcontrollers | DC | 3 | 0 | 0 | 3 |
| EC212 | Electronic Circuits Laboratory | DC | 0 | 0 | 3 | 2 |
| EC214 | Microprocessors and Microcontrollers Laboratory | DC | 0 | 0 | 3 | 2 |
| **Maths-1, C-3; DC (T)-5, C -15; DC (L)-2, C-4;** | | **TOTAL** | **18** | **0** | **6** | **22** |

**SEMESTER V**

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| EC301 | Communication Theory | DC | 3 | 0 | 0 | 3 |
| EC303 | Analog Integrated Circuits | DC | 3 | 0 | 0 | 3 |
| EC305 | Statistical Theory of Communication | DC | 3 | 0 | 0 | 3 |
| EC307 | Data Structures and Algorithms | DC | 3 | 0 | 0 | 3 |
| ECXXX | Dept. Elective | DE | 3 | 0 | 0 | 3 |
| ECXXX | Global Elective | GE | 3 | 0 | 0 | 3 |
| EC309 | Analog Integrated Circuits and Laboratory | DC | 0 | 0 | 3 | 2 |
| EC311 | Digital Signal Processing Laboratory | DC | 0 | 0 | 3 | 2 |
| **DC (T)-4, C -12; DC (L)-2, C-4; DE-1, C-3; GE-1, C-3** | | **TOTAL** | **18** | **0** | **6** | **22** |

**SEMESTER VI**

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| EC302 | Digital Communication | DC | 3 | 0 | 0 | 3 |
| EC304 | VLSI Design | DC | 3 | 0 | 0 | 3 |
| EC306 | Mobile Communication | DC | 3 | 0 | 0 | 3 |
| EC308 | Machine Learning and Pattern Recognition | DC | 3 | 0 | 0 | 3 |
| ECXXX | Dept. Elective | DE | 3 | 0 | 0 | 3 |
| HM321 | Engineering Ethics and Precepts of Constitution of India | HM | 2 | 0 | 0 | - |
| EC310 | Communication Engineering Laboratory | DC | 0 | 0 | 3 | 2 |
| EC312 | VLSI Design Laboratory | DC | 0 | 0 | 3 | 2 |
| **HM-1, C-NIL; DC (T)-4, C-12; DC (L)-2, C-4; DE-1, C-3** | | **TOTAL** | **17** | **0** | **6** | **19** |

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**SEMESTER VII**

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| HM421 | Industrial Economics and Management | HM | 3 | 0 | 0 | 3 |
| EC401 | Microwave Electronics and MIC | DC | 3 | 0 | 0 | 3 |
| EC403 | Communication Networks | DC | 3 | 0 | 0 | 3 |
| ECXXX | Department Elective | DE | 3 | 0 | 0 | 3 |
| ECXXX | Department Elective | DE | 3 | 0 | 0 | 3 |
| ECXXX | Global Elective | GE | 3 | 0 | 0 | 3 |
| EC405 | Microwave and MIC Laboratory | DC | 0 | 0 | 3 | 2 |
| EC491 | Project Work - Phase 1 | Project | 0 | 0 | 3 | 3 |
| | | **TOTAL** | **18** | **0** | **6** | **23** |

**HM-1, C-3; DC (T)-2, C-6; DC (L)-1, C-2; DE-2, C-6; GE-1, C-3; Project, C-3**

**SEMESTER VIII**

| Code | Course of Study | Type | L | T | P | C |
|---|---|---|---|---|---|---|
| ECXXX | Dept. Elective | DE | 3 | 0 | 0 | 3 |
| ECXXX | Global Elective | GE | 3 | 0 | 0 | 3 |
| ECXXX | Global Elective | GE | 3 | 0 | 0 | 3 |
| EC492 | Project Work - Phase 2 | Project | 0 | 0 | 12 | 6 |
| **DE-1, C-3; GE-2, C-6; Project, C-6** | | **TOTAL** | **9** | **0** | **12** | **15** |

# List of Dept. Electives

**SEMESTER - V**

| Code | Course of Study | L | T | P | C |
|---|---|---|---|---|---|
| EC321 | Digital Signal Processors and Applications | 3 | 0 | 0 | 3 |
| EC323 | Advanced Microprocessors | 3 | 0 | 0 | 3 |
| EC325 | Information Theory and Coding | 3 | 0 | 0 | 3 |
| EC327 | Advanced Microcontrollers | 3 | 0 | 0 | 3 |
| EC329 | Digital Image Processing | 3 | 0 | 0 | 3 |

**SEMESTER-VI**

| Code | Course of Study | L | T | P | C |
|---|---|---|---|---|---|
| EC322 | Speech Processing | 3 | 0 | 0 | 3 |
| EC324 | Embedded System Design | 3 | 0 | 0 | 3 |
| EC326 | Adaptive Signal processing | 3 | 0 | 0 | 3 |
| EC328 | Computer Organization and Architecture | 3 | 0 | 0 | 3 |

**SEMESTER-VII**

| Code | Course of Study | L | T | P | C |
|---|---|---|---|---|---|
| EC421 | Fiber Optic Communication | 3 | 0 | 0 | 3 |
| EC423 | Analog CMOS Design | 3 | 0 | 0 | 3 |
| EC425 | Deep Learning and Neural networks | 3 | 0 | 0 | 3 |

**SEMESTER-VIII**

| Code | Course of Study | L | T | P | C |
|---|---|---|---|---|---|
| EC422 | Communication Switching Systems | 3 | 0 | 0 | 3 |
| EC424 | Microwave Integrated Circuit design | 3 | 0 | 0 | 3 |
| EC426 | Broadband Access Technologies | 3 | 0 | 0 | 3 |
| EC428 | Principles of Radar | 3 | 0 | 0 | 3 |
| EC430 | Satellite Communication | 3 | 0 | 0 | 3 |
| EC432 | Design of Cognitive Radio | 3 | 0 | 0 | 3 |
| EC434 | Introduction to MEMS | 3 | 0 | 0 | 3 |
| EC436 | Biomedical Signal and Image Processing | 3 | 0 | 0 | 3 |
| EC438 | RF and Microwave Engineering | 3 | 0 | 0 | 3 |
| EC440 | Wireless Networks | 3 | 0 | 0 | 3 |
| EC442 | Robotics Engineering | 3 | 0 | 0 | 3 |
| EC444 | Error Control Coding | 3 | 0 | 0 | 3 |

# List of Global Electives

| Code | Course of Study | L | T | P | C |
|---|---|---|---|---|---|
| EC351 | Applied Electronics | 3 | 0 | 0 | 3 |
| EC352 | Communication Systems | 3 | 0 | 0 | 3 |
| EC353 | Electronic Devices | 3 | 0 | 0 | 3 |
| EC354 | CMOS VLSI Design | 3 | 0 | 0 | 3 |
| EC355 | Digital Electronics | 3 | 0 | 0 | 3 |
| EC356 | Digital Image processing | 3 | 0 | 0 | 3 |
| EC357 | Digital Signal Processing | 3 | 0 | 0 | 3 |
| EC358 | Embedded Systems | 3 | 0 | 0 | 3 |
| EC359 | Communication Networks | 3 | 0 | 0 | 3 |
| EC360 | Introduction to Robotics | 3 | 0 | 0 | 3 |
| EC361 | Satellite Communication | 3 | 0 | 0 | 3 |
| EC362 | Wireless Communication | 3 | 0 | 0 | 3 |
| EC363 | Optical Communication | 3 | 0 | 0 | 3 |
| EC364 | Microprocessors and its Applications | 3 | 0 | 0 | 3 |
| EC365 | Information Theory and Coding | 3 | 0 | 0 | 3 |
| EC367 | Machine Learning and Pattern Recognition | 3 | 0 | 0 | 3 |

## HM 121- English Communication Skills (2-0-2) 3

**Objectives**

To equip students in understanding and putting into practice the basic sub-skills of English language in their academic and professional lives

**Topics Covered:**

**Unit 1: Essentials of Communication**
Definition, Importance, Process of Communication, Factors of Communication - Sender, Receiver, Channel, Code etc., Filters and Barriers, Verbal and Non-verbal Communication, Channels.
**Unit 2: Listening Comprehension**
Importance of Listening skills in Technical World, Types of Listening - Listening for information, inference and evaluation; Note Taking, Barriers to listening - Physical, Psychological, Linguistic, and Cultural; Methods to overcome the barriers.
**Unit 3: Writing Skills**
Mechanics of Technical Writing, Paragraph Writing - Coherence, Cohesion, Linkers, Unity; Report Writing- Oral and Written Reports, Summary writing, Paraphrasing.
**Unit 4: Writing for Special Purposes**
Business Proposals, Business Correspondence: Enquiry, complaint, sales letters; Textual Schematization, Linguistic interpretation of diagrammatic representation of data – Graphs, Tables, Charts etc.
**Unit 5: Functional Skills**
Presentation Skills, Group Discussions, Pamphlet and brochure designing, Seminar Skills.

**Outcome**

- The students will:
    - Understand the basics of communication with an emphasis on its practical aspects.
    - Integrate language with content specific subject knowledge through task based activities
    - Showcase the knowledge of the various uses of English in their professional and everyday environment.

**Activities for Practice:**

Activities designed on the basis of theory syllabus such as pair work activities, role plays, Jam sessions, mock interviews, group discussions, data interpretation and linguistic analysis practice, writing and listening practice etc.,

**Text Books Suggested**

1. Meenakshi Raman and Sangeeta Sharma, *Technical Communication: Principles and Practice*, OUP Publication, 2014.
2. John Sealy. *The Oxford Guide to effective writing and Speaking*, OUP publication, 2007.

**Reference Books Suggested**

1. David Lindsay, *A Guide to Scientific Writing*, Macmillan, 1995.
2. C. Bovee & C.A. Paul. *Business Communication Today*, Pearson, 2018.
3. Raymond V Lesikar and Marie E. Flatley. *Basic Business Communication*, Tata Mc-Graw Hill, 2005.
4. Comfort, Jeremy, et al. *Speaking Effectively: Developing Speaking Skills for Business English*. Cambridge University Press, Cambridge: Reprint 2011.

**MA121 DIFFERENTIAL CALCULUS AND ALGEBRA (3-0-0) 0**

**Objectives:**

- To learn mathematical concepts and methods.
- To acquire fundamental knowledge and apply in engineering disciplines.

**Topics Covered:**

**Unit-I:**

Matrix Theory: Elementary row and column operations on a matrix, Rank of matrix, Normal form, Inverse of a matrix using elementary operations, Consistency and solutions of systems of linear equations using elementary operations, linear dependence and independence of vectors, Characteristic roots and vectors of a matrix, Caley - Hamillton theorem (statement only) and its applications, canonical form by linear and orthogonal transformations.

**Unit-II:**

Sequences: Sequences of real numbers, Limit of a sequence, Convergent and divergent sequences, Sub sequence, Cauchy's sequence, Monotone convergence theorem (without proof), Sequence with recurrence relations.

**Unit-III:**

Infinite series: Convergence Tests for positive term series, Comparison, Root, Ratio and Raabe's tests, Alternating series, Leibnitz's rule, Absolute and Conditional Convergence.

**Unit-IV:**

Differential Calculus: Rolle's theorem, Mean value theorem, Taylor's and Maclaurin's theorems (without proof) with remainders, Functions of several variables, Partial Differentiation, Total Differentiation, Euler's theorem and generalization, maxima and minima of functions of several variables (two and three variables), Lagrange's method of Multipliers, Change of variables, Jacobians.

**Unit-V:**

Vector Calculus: Scalar and Vector fields, Vector Differentiation, Level surfaces directional derivative, Gradient of scalar field, Divergence and Curl of a vector field, Laplacian, Line and surface integrals, Green's theorem in plane, Gauss Divergence theorem, Stoke's theorem (without proof).

**Course Outcomes:**

After completion of the course, students are able to solve industrially applicable problems.

**Text Books:**

1. Erwyn Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 8th Edition.

**Reference Books:**

1. B.S.Grewal, *Higher Engineering Mathematics*, Khanna Publications, 2002.
2. M.D. Greenberg, *Advanced Engineering Mathematics*, 2nd Edition, Pearson Education Inc., 2002.
3. C.Y. Hsiung and G. Y. Mao, *Linear Algebra*, World Scientific Publishing Co. Inc., 1999.
4. T.M. Apostol, *Calculus*, Volume I & II, 2nd Edition, John Wiley & Sons (Asia), 2005.

**PH121 ENGINEERING PHYSICS (3-0-0) 3**

**Objectives:**

- To enable the students to refresh their basics of Physics and orient themselves in implementation of concepts in engineering.
- To give an exposure on basics of quantum mechanics and statistical physics.
- To provide fundamentals of Solid state physics, which give foundation for engineering Physics and Materials Science.
- To enable the students to get exposure on different types advanced materials in engineering, properties and application in the field of engineering

**Unit 1: Waves and Oscillations:** Wave motion- Travelling wave in one dimension-Wave equation examples-Superposition of waves and standing waves-Simple harmonic motion - energy of SHM examples: Simple pendulum, LC circuit-damped oscillations-forced oscillations and resonance conditions; Absorption coefficient-reverberation-reverberation time -Sabine's formula-Acoustics of buildings. Theory of interference of light- Newton's rings, Diffraction Grating - Polarization-Applications.

**Unit 2: Quantum mechanics:** Inadequacy of classical mechanics-Wave and particle duality of radiation-de Broglie concept of matter waves-Heisenberg's uncertainty principle-Schrodinger wave equation-Interpretation of wave function- Eigen values and Eigen functions-Superposition principle-Particle confined in one dimensional infinite square well potential, (potential barrier, tunneling-notion only)-Harmonic oscillator.

**Unit 3: Solid state Physics:** Crystalline and amorphous solids-system of crystals symmetry operation single crystal-defects in solids-Miller indices-atomic radius coordination number Atomic packing factor calculation-Bragg's law. Drude theory of electrical conductivity, Free electron theory (classical and quantum), band theory of solids,

**Unit 3: Semiconductor physics and devices**
Semiconductor materials- crystal growth- film formation- lithography- etching and doping-Conductivity- charge densities - E-K relation- Fermi level- Continuity equation- Hall Effect and its applications. P-N junction diodes - biasing-diode equation -V-I characteristics- Capacitances-Diode model -Various types of diodes - Zener diode, Varactor diode, photo diode and LED. Transistors BJT-modes of operation - CE, CB and CC configuration and I/O characteristics.

**Unit 5: Fundamentals of Lasers** Spontaneous and stimulated emissions-Einstein's coefficients-Population inversion and lasing action, Coherence-Properties and types of lasers-Applications;

**Outcomes:**

- Fundamental knowledge of students obtained in school will get refreshed while handling topics with mathematical approach.
- Students will also get an exposure on topics of modern physics and connectivity of thermodynamics, statistical physics and quantum physics providing.
- Student will get exposure on physics of materials science for the advancements in the materials science.

**Text books:**

1. M.N. Avadhanulu and P.G. Kshirsagar, A text book of Engineering Physics, S. Chand and Company, New Delhi (2014).
2. R.K. Gaur and S.L. Gupta, Engineering Physics, DhanpatRai Publications (P) Ltd., 8thedn., New Delhi (2001)
3. V. Rajendran, Materials Science, Tata McGraw-Hill-2011
4. R. A. Serway and J. W. Jewett, Physics for Scientists and Engineers, 9th edition, Cengage Learning.2014
5. Anthony R. West, Solid State Chemistry and its Applications, John Wiely and sons 2nd Edition. 2014
6. Arthur Beiser, Concepts of Modern Physics., Tata McGraw-Hill, New Delhi (2010).
6. J. Millman and C.C. Halkias: Electronic devices and Circuits, McGraw Hill, 1976

**Reference books:**

1. Halliday, Resnic and Walker, Fundamentals of Physics, 9th Ed., John Wiley & sons (2011).
2. Walter Greiner, Ludwig Neise, Horst Stocker and D. Rischke, Thermodynamics and Statistical Mechanics, Springer (1997).
3. Richard P. Feynman, The Feynman Lectures on Physics - Vol. I, II and III: The New Millennium Edition (2012).
4. Rolf. E. Hummel, Electronic Properties of Materials, Springer (2001).

**HM124 BASIC ENERGY, ENVIRONMENT AND AGRICULTURAL ENGINEERING (3-0-0) 3**

**Unit-I:** Present energy resources in India and its sustainability - Different type of conventional power plant-Energy demand scenario in India - Advantage and disadvantage of conventional Power Plants – Conventional vs. non-conventional power generation - Basics of Solar Energy- Solar thermal and Solar photovoltaic systems

**Unit-2:** Power and energy from wind turbines-Types of wind turbines-Biomass resources- Biomass conversion technologies- Feedstock pre-processing and treatment methods- Introduction to geothermal energy and tidal energy.

**Unit-3:** Air pollution - Sources, effects, control, air quality standards -Air pollution act, air pollution measurement. Water pollution-Sources, impacts, control, and measure –Quality of water for various purposes-Noise pollution - Sources, impacts, control, measure.

**Unit-4:** Pollution aspects of various industries- Impacts of fossil fuels and transport emissions – impacts - Municipal solid waste generation and management - Swachh Bharat Mission – Challenges and activities - Environment and forest conservation – Greenhouse gases and global warming- climate change

**Unit-5:** Introduction to agriculture engineering -Major crops of India–Types and categories of crops-Types of farming and cultivation procedures-Different monsoon seasons-Types of irrigation systems-Major draughts-Agricultural machinery-Dairy farming and its economic importance

**TEXT BOOKS**

1. B. H. Khan, Non-Conventional Energy Resources-The McGraw –Hill Second edition, 2009.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice Hall, 2nd Edition, 2003.
3. G.L. Asawa, Elementary Irrigation Engineering, New Age International, First Edition, 2014
4. Sukhpal Singh, Agricultural Machinery Industry in India, Allied Publishers, New Delhi, 2010
5. Dilip R. Shah, Co-Operativization Liberalization and Dairy Industry In India, A.B.D. Publishers, 2000

**REFERENCES**

1. Unleashing the Potential of Renewable Energy in India –World bank report.
2. G. Boyle, Renewable energy: Power for a sustainable future, Oxford University press, 2004.

**ME121 ENGINEERING MECHANICS (3-0-0) 3**

**Objective:**

- Inculcate the fundamental knowledge to compute forces and their responses when the bodies are in rest and in motion.
- Inculcate the knowledge of the friction and its influence on mechanical structures

**Topics Covered:**

**Fundamentals:** Mechanics and its relevance, concepts of forces, laws of mechanics parallelogram law, Lami's theorem, Law of polygon, concept of free body diagram, centroids, center of gravity, area moment of inertia, mass moment of inertia – simple and composite planes, simple truss analysis, Numerical problems.

**Friction:** Laws of friction, static friction, rolling friction, application of laws of friction, ladder friction, wedge friction, body on inclined planes, simple screw jack – velocity ratio, mechanical advantage, efficiency, Numerical problems.

**Statics:** Principles of statics, types of forces, concurrent and non-concurrent forces, composition of forces, forces in a plane and space, simple stresses and strains, elastic coefficients, Numerical problems.

**Kinematics:** Fundamentals of rectilinear and curvilinear motion, application of general equations, concept of relative velocity, analytical and graphical techniques, Numerical problems.

**Kinetics:** Principles of dynamics, Equations of dynamic equilibrium, Alembert's principle, conservation of momentum and energy, Numerical problems.

**Outcomes:**

1. Draw the free body diagram of a given physical system and compute the resultant of a given coplanar system of forces
2. Estimate the centroid of composite figures and bodies
3. Estimate area moment of inertia and mass moment of inertia of composite figures and bodies
4. Explain concepts of friction and principle of virtual work
5. Summarize power transmission through belts
6. Interpret kinematics and kinetics of a particle in rectilinear motion and solve simple problems.
7. Interpret kinematics and kinetics of a particle in curvilinear motion solve simple problems.

**Text Books:**


1. S. Timoshenko and D. H.Young, Engineering Mechanics, McGraw Hill, 2006.
2. Singer Ferdinand L, Engineering Mechanics, Harper & Row Publishers, 3rd Edition, 1975
3. Beer, F. P., Johnston, E. R., DeWolf, J. T., & Mazurek, D. F. (2015). Mechanics of materials. New York, NY: McGraw-Hill Education.


**Reference Books:**


1. A.K Tayal, Engineering Mechanics-Statics and Dynamics, Umesh Publications, 14th Edition, 2010.
2. S.S Bhavikatti, Engineering Mechanics, New Age International, 6th Multicolor Edition, 2015


**ME123 ENGINEERING GRAPHICS (3-0-0) 3**

**OBJECTIVE:**

Irrespective of engineering discipline, it has become mandatory to know the basics of engineering graphics. The student is expected to possess the efficient drafting skill depending on the operational function in order to perform day to day activity.

- To provide engineering drawing knowledge.
- Enables the knowledge about different types of lines their usage
- Enables the knowledge on 2D & 3D geometrical entities

**Fundamentals:** Drawing standard - BIS, dimensioning, lettering, type of lines, scaling conventions. Geometrical constructions: Dividing a given straight line into any number of equal parts, bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and hexagon – conic sections – ellipse – parabola – hyperbola - cycloid – trochoid.

**Orthographic projection:** Introduction to orthographic projection, drawing orthographic views of objects from their isometric views – Orthographic projections of points lying in four quadrants, Orthographic projection of lines parallel and inclined to one or both planes Orthographic projection of planes inclined to one or both planes.

**Projections of simple solids:** axis perpendicular to HP, axis perpendicular to VP and axis inclined to one or both planes. Sectioning of solids: Section planes perpendicular to one plane and parallel or inclined to other plane.
**Intersection of surfaces:** Intersection of cylinder & cylinder, intersection of cylinder & prism, and intersection of prisms. Development of surfaces: Development of prisms, pyramids and cylindrical & conical surfaces. Isometric and perspective projection:
**Isometric projection**: and isometric views of different planes and simple solids, introduction to perspective projection, perspective projection of simple solids prisms, pyramids and cylinders by visual ray method and vanishing point method.

(Usage of engineering instruments is mandatory)

**OUTCOMES:**

- Upon completion of the course the student will be able to
- Perform free hand sketching of basic geometrical constructions and multiple views of objects.
- Do orthographic projection of lines and plane surfaces.
- Draw projections and solids and development of surfaces.
- Prepare isometric and perspective sections of simple solids

**TEXT BOOKS:**

1. Bhatt,N. D and Panchal,V.M.,Engineering Drawing, Publication: Charotar Publishing House, 2010.
2. Natarajan, K. V., A text book of Engineering Graphics, Publication: Dhanalakshmi Publishers, Chennai, 2006.
3. Venugopal, K. and Prabhu Raja, V., Engineering Drawing and Graphics + AutoCAD, Pub.: New Age International, 2009.

**REFERENCE BOOKS:**

1. Jolhe, D. A., Engineering drawing, Publication: Tata McGraw Hill, 2008
2. Shah, M. B. and Rana, B. C., Engineering Drawing, Pub.: Pearson Education, 2009.
3. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
4. Luzzader, Warren.J. and Duffjohn M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005

**PH123 ENGINEERING PHYSICS LABORATORY (0-0-3) 2**

**Objectives and outcome:**

- To enable the students to understand fundamentals of measurement, error analysis and its impact on results.
- Exposure and to understand basic experiments in different areas of Physics.
- Experiments emphasising the topics covered in the course PH101.
- Fundamentals of measurements, error detection, error analysis and usage of scientific calculator in engineering.

**List of Experiments:**

1. Simple harmonic motion.
2. Sonometer- frequency of tuning fork/AC (Melde's technique).
3. Determination of Young's modulus- Searle's dynamical method.
4. Modulus of rigidity using torsion pendulum.
5. Measurement of temperature using thermocouple.
6. Specific heat of liquids by Newton's law of cooling.

7. Determination of magnetic field along the axis of a circular coil.

8. (i) Conversion of Galvanometer into ammeter and voltmeter. (ii) Calibration of voltmeter-Potentiometer.

9. Series LCR circuit-resonance phenomenon.

10. Newton's rings- determination of radius of curvature of a lens.

11. Determination of wavelength, spot size and divergence of laser.

12. I-V Characteristics of a PN junction diode and Zener diode.

13. Input and output characteristics of a npn transistor in CE mode.

14. Determination of resistivity and band gap of a semiconductor.

15. Charge-discharge characteristics of RC circuit.

16. Introduction to CRO- Lissajous figures.

17. Determination of Planck's constant

18. Verification of Photo-electric effect.

**Any 10-12 experiments will be chosen from the above list, subjected to availability of instruments and number of students registered ( 2-3 students per instrument, i.e. maximum accessibility).**

**Reference books:**

1. C.L Arora, B.Sc. Practical Physics, S. Chand & Co. (2012).
2. Singh Harnam and Hemne P.S., B.Sc. Practical Physics, S. Chand & Company (2002)
3. J.D. Wilson and Cecilia A. Hernandez-Hall, Physics laboratory experiments, 7th edition, Cengage Learning (2009).
4. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press (1997).

**SEMESTER II**

**HM 122 TECHNICAL COMMUNICATION IN ENGLISH (2-0-2) 3**

**Objective:**

- To inculcate in the students the required technical communication skills, and soft skills in order to make them articulate, and effectively apply this knowledge in the world of academics and industry outside.

**Unit 1: Introduction to Speech Production**
Mechanics of Speech, Mental Process of Speaking, Organs of Speech, Introduction to basic speech production, Pronunciation and articulation practice.
**Unit 2: Introduction to Reading Skills**
Importance of Reading skills, Reading strategies, Reading for information, inference and evaluation. (News papers, Scientific Research, Desired reading materials), Note Making, Reading Practice - technical and general texts including excerpts from prose and poetry.
**Unit 3: Academic Reading Skills**
Reading technical reports/articles, Primary and Secondary literature, Structure of a research article, Glossary, Index, Reference and Bibliography etc.
**Unit 4: Soft Skills**
Relationship between Soft skills and Communication Skills, Leadership Skills, Team management Skills, Interview Skills, Telephone etiquettes.
**Unit 5: Language Project**
A team-based survey and assessment report on real life language utility in different sectors of society as per the teacher's instruction.

**Outcomes**:

The students will be able to:

- Integrate language with content specific subject knowledge through task based activities, and learn to articulate themselves effectively along with demonstration of good soft skills.
- Understand the concept of research & evaluate the importance of documentation in it.
- Apply their technical skills in real life situations and create meaningful output through building a language project report

**Activities for Practice:**

Activities designed on the basis of theory syllabus such as listening skills practice, reading strategies practice; reading for research, reference skills, soft skills pronunciation and speech production practice etc.

**Text Books Suggested:**

1. Meenakshi Raman and Sangeeta Sharma, *Technical Communication: Principles and Practice*, OUP Publication, 2014.
2. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill,2005.
3. K. Alex, *Soft Skills*, S Chand Publications, 2010.
4. C. Bovee & C.A. Paul. *Business Communication Today*, Pearson, 2018.

**Reference Books**

1. David Lindsay, *A Guide to Scientific Writing*, Macmillan, 1995.
2. Richard A Boning, *Multiple Reading Skills*, McGraw Hill, 1990.
3. Dhamija and Sasikumar, *Spoken English,* McGraw Hill Education, *2015*

**MA122 INTEGRAL CALCULUS AND DIFFERENTIAL EQUATIONS (3-0-3) 3**

**Objectives:**

- To learn mathematical concepts and methods.
- To acquire fundamental knowledge and apply in engineering disciplines.

**Unit-I:**
Integral Calculus: Beta and Gamma integrals, Double and triple integrals, surface areas by double integrals, Volumes by double and triple integrals change of variables in double and triple integrals.
**Unit-II:**
Ordinary differential equations of first order: Separable equations, equations reducible to separable form, exact equations, integrating factors, linear first order equations, Bernoulli's equation, Orthogonal trajectories, Newton's law of cooling, Law of Natural growth and Decay.
**Unit-III:**
Higher order Ordinary differential equations: Higher order linear equations with constant coefficients, Euler and Cauchy's equations, method of variation of parameters, system of linear Differential equations with constant coefficients.
**Unit-IV:**
Fourier series: Expansion of a function in Fourier series for a given range, Half range sine and cosine expansions.
**Unit-V:**
Fourier Transforms: Complex form of Fourier series, Fourier sine and cosine transformations, Simple illustrations, Finite Fourier sine and Cosine transforms, Two-dimensional steady state heat flow equation, Heat equation, Wave equation - Fourier series solution.

**COURSE OUTCOMES:**

After completion of the course, students are able to solve industrially applicable problems.

**Text Books:**

1. Erwyn Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 10th Edition, 2010.
2. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publications, 42nd Edition, 2012.

**Reference Books:**

1. T.M. Apostol, *Calculus*, Volume I & II, 2nd Edition, John Wiley & Sons (Asia), 2005.
2. M.D. Greenberg, *Advanced Engineering Mathematics*, 2nd Edition, Pearson Education Inc., 2002.

**CH122 CHEMISTRY (3-0-0) 3**

**Objectives:**

Enabling the Students to learn the basic principles of electrochemistry, Corrosion studies, Organic Chemistry, Spectroscopy, Coordination and Applied Chemistry.

**UNIT I - Electrochemistry and Corrosion**
Introduction to Electrochemistry, Electrolytic and galvanic cells - EMF, Reference Electrode - Weston standard cell, hydrogen electrode, calomel electrode, glass electrode, reversible and irreversible cells, concentration cell – HydrogenOxygen fuel cells. Corrosion: Dry and wet corrosion - General mechanism, Types of corrosion, Factors affecting corrosion - Corrosion protection – Electro and Electroless Plating.

**UNIT II - Organic Chemistry and UV-Vis Spectroscopy**

Carbon-carbon bond properties, homolytic and heterolytic cleavage of carbon-carbon bonds, SN1 and SN2, E1and E2reactions, aromatic nucleophilic substitution, aromatic electrophilic substitution, Baeyer-Villiger oxidation, MPV reduction. UV-Visible Spectroscopy: origin of UV and visible spectra, colour in organic compounds, absorption by organic and inorganic molecules, Woodward-Fieser rules for calculating absorption maximum in dienes and α, β-unsaturated carbonyl compounds.

**UNIT – III Coordination Chemistry**

Formation and types of metal complexes, EAN rule, 16 and 18 electron rule, crystal field theory, CFSE, color and magnetism of transition metal ions, metal carbonyls (Ni & Fe) - bonding and structure, Organometallic compounds in catalysis - hydrogenation, hydroformylation and polymerization of olefin, Chemistry of hemoglobin, Bohr effect.

**UNIT – IV Water**

Sources, hard and soft water, estimation of hardness by EDTA method, softening of water - zeolite process, demineralization by ion exchangers, boiler feed water, internal treatment methods, specifications for drinking water, BIS and WHO standards, treatment of water for domestic use, desalination, reverse osmosis, electro dialysis.

**UNIT – V Fuels and Lubricants**

Fuels - classification, examples and relative merits, types of coal, determination of calorific value of solid fuels - Bomb calorimeter - Theoretical oxygen demand, proximate and ultimate analysis of coal, manufacture of metallurgical coke, flue gas analysis, problems, Lubricants – definition, theories of lubrication, characteristics of lubricants – viscosity, viscosity index, oiliness, pour point, cloud point, flash point, fire point and carbon residue, additives to lubricants.

**Text Books**

1. P.C. Jain and M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2015.
2. J. March, Advanced Organic Chemistry, Wiley Eastern, New Delhi, 2012.
3. W. Kemp, Organic Spectroscopy, Palgrave, New York, 2008.

**Reference Books**

1. R. Gopalan, D. Venkappayya and N. Sulochana, Engineering Chemistry, Vikas Publishing House, New Delhi, 2017.
2. J.C. Kuriacose, J. Rajaram, Chemistry in Engineering and Technology, Vol I & II, Tata McGraw Hill publishing Company Ltd, New Delhi, 1984.
3. P.W. Atkins, Physical Chemistry, Oxford University Press, 2006.
4. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry - Principles of Structure and Reactivity, Harper Collins College Publishers, New York, 2011.

**CS122 BASICS OF PROGRAMMING (2-0-0) 2**

**Objectives**

- To learn the fundamentals of computers.
- To learn the problem solving techniques in writing algorithms and procedures.
- To learn the syntax and semantics for C programming language.
- To understand the constructs of structured programming such as conditions, iterations, arrays, functions and pointers.
- Analyze complex engineering problems to develop suitable solutions.

**Unit- I Fundamentals of Computers, Algorithms and Structured Programming**
Introduction to computers – Computer Organization – Characteristics – Hardware and Software –Modes of operation – Types of programming languages – Developing a program, Algorithms – Characteristics – Flowcharts - Principles of Structured programming – Sequential, Selective structures - Repetitive structures –Bounded, Unbounded and Infinite iterations.

**Unit-II Overview of C and Branching**
Introduction to C – C character set – Identifiers and Keywords – Data types – Constants – Variables – Declarations – Expressions – Statements – Symbolic constants – Operators– Library functions. Data input and output: Single character input and output – Entering input data – Writing output data – gets and puts functions. Control statements: Conditional- Branching- Looping- unconditional: Break-continue-goto.

**Unit-III Functions and Arrays & Strings**
Functions: Overview- Defining a Function- Accessing a Function- Function Prototypes- Passing Argument to a Function- Recursion- Storage Classes: Automatic Variables- External (Global) Variables-Static Variables- Register variables. Arrays: Defining an Array- Processing an Array- Passing Array to function- Multidimensional Arrays.

**Unit IV Strings and Pointers**
Strings: Defining a String- NULL Character- Initialization of Strings- Reading and Writing a String- Processing Strings- Character Arithmetic- Library Functions for Strings. Pointers: Pointer Declaration- Passing Pointers to a Function-Pointers and One-dimensional Array- Dynamic Memory Allocation- Operations on Pointers- Pointers and Multidimensional Arrays- Array of Pointers, Command line arguments.

**Unit-V Structures, File Management and Preprocessors**
Basic of Structures, structures and functions, array of structures, structure data types, type definition, defining, opening and closing of files, input and output operations. Introduction to preprocessors, compiler control directives.

**Outcomes**
- Understand the organization of a computer.• Knowledge of the syntax and semantics of C programming language.
- Ability to code a given logic in C language.
- Knowledge in using C language for coding a given algorithm.

**Text Books**


1. Brian W Kerningan and Dennis M. Ritchie, "The C Programming Langauge", Second Edition, PHI, 2012.
2. Byron Gottfried, "Programming with C", Third Edition, Tata McGraw Hill Education, 2010.
3. R.G. Dromey, "How to Solve it By Computers?", First edition, Prentice Hall, 2001.


**Reference Books**


1. J.R. Hanly and E.B. Koffman, "Problem Solving and Program Design in C", Sixth Edition, Pearson Education, 2009.
2. Paul Deital and Harvey Deital, "C How to Program", Seventh Edition, Prentice Hall, 2012.
3. Yashavant Kanetkar, "Let Us C", Twelfth Edition, BPB Publications, 2012.

**ME122 BASICS OF CIVIL AND MECHANICAL ENGINEERING (2-0-0) 2**

## Objectives:

- To introduce the concepts, significance and importance of Power Plant Engineering, Internal Combustion Engines, Refrigeration and Air Conditioning
- To introduce the concepts of Surveying, Civil Materials, and Building Components

**Topics Covered:**

**Unit I**
**Powerplant Engineering**: Introduction – Definition, Forms Units and Sources of Energy, Classification of Powerplants – Working principle of Steam, Gas, Diesel, Hydro-electric and Nuclear Power plants – Merits and Demerits.
**Unit II**
**Internal Combustion Engines:** Introduction – Basic units of automobile, classification and application of I.C engines, components of I.C Engines, Working principle of Petrol and Diesel Engines – Four stroke and Two stroke cycles and their comparison.
**Unit III**
**Refrigeration and Air Conditioning:** Terminology of Refrigeration and Air Conditioning, Principle of vapor compression and absorption system – Layout of typical domestic refrigerator – Window and Split type room air conditioner.
**Unit IV**
**Civil Engineering Materials:** Bricks – Stones – Sand – Cement – Concrete – Steel Sections. Bridges, Types of Bridges, Dams and Classification of Dams.
**Unit V**
**Building Components and Structures:** Foundations – Types, Bearing Capacity, Requirement of good foundations. Superstructure: Brick masonry – Stone masonry – beams – columns – lintels – roofing – flooring – plastering.

## Outcomes:

- Upon completion of this course, the students can able to understand the power plant engineering, IC Engines, R&AC, Surveying, Civil Materials and Building Components.

## Text Books:


1. Seetharaman S., Basic Civil Engineering‖, Anuradha Agencies, (2005).
2. Venugopal K. and Prahu Raja V., Basic Mechanical Engineering‖, Anuradha Publishers, Kumbakonam, (2000).


## Reference books:


1. Rajput, R K, Engineering Materials, S Chand & Co. Ltd., New Delhi, 2002.
2. El.Wakil, M.M., Power Plant Technology, Mc Graw Hill Book Co.,1985.
3. Hajra Choudhry, et. al., Workshop Technology Vol I and II, Media Promoters Publishers Pvt. Ltd., Bombay, 2004.
4. Shanmugam G and Palanichamy M S, ―Basic Civil and Mechanical Engineering‖, Tata McGraw Hill Publishing Co., New Delhi, (1996).
5. Ramamrutham S., ―Basic Civil Engineering‖, Dhanpat Rai Publishing Co. (P) Ltd. (1999). Nagpal, Power Plant Engineering, Khanna Publishers, Delhi, 1998. 7.Shantha Kumar S R J., Basic Mechanical Engineering‖, Hi-tech Publications, Mayiladuthurai, (2000).

**EC102 BASICS OF ELECTICAL AND ELECTRONIC ENGINEERING (2-0-0) 2**

**Objectives:**

1. To make the students understand the fundamentals of electronic devices.
2. To train them to apply these devices in mostly used and important applications.
3. To enable the students to gain knowledge about electrical engineering

**Unit-1:**
Transistors: Field Effect Transistor (JFET) - operation- V-I characteristics, MOSFET- operation- V-I characteristics - MOSFET as amplifier and switch- Capacitance-equivalent model. UJT - VI Characteristics.

**Unit-2:**
Power devices: Operation and characteristics - Thyristor Family - Power diodes - Power transistors - GTOs and IGBTs.

**Unit-3:**
Working and applications of DC machines – DC generators, DC motors; Transformers, Induction motors, Stepper motor, AC series motor.

**Unit-4:**
Electronic and digital measurements: Electronic voltmeter, current measurement with electronic instruments, Digital voltmeter, Analog and digital multi-meters. CRO, DSO, Function generators, Signal generators.

**Course Outcomes:**

Students are able to

1. Analyze the characteristics of FET, MOSFET and UJT.
2. Classify and analyze the various circuit configurations of Transistor and MOSFETs.
3. Illustrate the qualitative knowledge of Power electronic Devices.
4. To understand the basic operation of the electrical machines.
5. To gain the knowledge on electrical and electronics instruments.

**Text Books:**


1. A.S. Sedra & K.C. Smith, Microelectronic Circuits (5/e), Oxford, 2004.
2. J. Millman and C.C. Halkias: Electronic devices and Circuits, McGraw Hill, 1976.
3. Huges, “Electrical and Electronics Technology”, Pearson, 10th Edition, 2011.
4. Theraja B.L., Theraja A.K., “A Textbook of Electrical Technology: Volume 2
5. A.J. Bouwens, ‘Digital Instrumentation’, Tata McGraw Hill, 1997.


**Reference Books:**


1. Floyd, Electronic Devices, 9th ed, Pearson, 2012.
2. Millman J. and Halkias C.C., 2002 ‘Integrated Electronics”, McGraw Hill. India.
3. David A.Bell, 1998 “Electronic Devices and Circuits”, Prentice Hall of India.
4. G.K.Mithal, 2000 “Electronic devices and circuits”, khanna publishers, Delhi, India.
5. Allen mottershead, 2002 “Electronic devices and circuits”, Prentice Hall of India.
6. Smarajit Ghosh “Fundamentals of Electrical and Electronics Engineering”, PHI, 2nd Edition, 2010.

**CH124 - CHEMISTRY LABORATORY (0-0-3) 2**

**Objectives:**

- Enabling the Students to understand the basics concept of Instrumentation technique, corrosion studies, coal analysis and estimation of water samples.

**List of Experiments:**

1. Percentage purity of bleaching powder
2. pH metric titration
3. Conductometric titration
4. Potentiometric titration
5. Determination of corrosion rate of mild steel in acid medium by weight loss method
6. Estimation of total alkalinity in the given water sample
7. Estimation of carbonate, noncarbonated and total hardness in the given water sample
8. Estimation of dissolved oxygen in waste water
9. Estimation of Fe2+ by external indicator
10. Estimation of proximate analysis of Coal.

**Reference Book**

1. Laboratory Manual, Department of Chemistry, NITPy

**ME124 BASIC WORKSHOP PRACTICE (0-0-4) 2**

**Objective:**

- Introduction to the use of tools and machinery in Carpentry, Welding, Foundry, Fitting and Sheet Metal Working.

**List of Experiments:**

**1. Department of Mechanical Engineering; (Any Three Experiments)**

Carpentry: Wood sizing exercise in planning, marking, sawing, chiseling, and grooving to make

a. Half - Lap Joint
   Welding: Exercise in arc welding for making
a. Lap Joint
   Fitting: Preparation of joints, markings, cutting, and filling for making
a. Square Fitting
   Sheet Metal: Making of small parts:
b. Tray/Dust Pan

**II. Department of Electrical and Electronics Engineering; (Any Three Experiments)**

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.

**III. Department of Electronics and Communication Engineering;**

1. Identification and checking of basic electronic equipment and components
2. Introduction to function generator, cathode ray oscilloscope and regulated power supply.
3. Construction of simple electronic circuit using bread board and printed circuit board (PCB).

**IV. Department of Civil Engineering;**

1) Identification of Rock sample using hand lens
2) Demonstration of Brick Bonds
3) Field measurement of given building or marked boundary using tape

**OUTCOMES:**

- Ability to fabricate carpentry components,
- Ability to use welding equipment's to join the structures.
- Ability to fabricate sheet metal, components,
- Ability to identify and make electrical and electronics circuits.

**REFERENCE BOOKS:**

1. Laboratory Manual Prepared by the Department.

**CS124 - BASICS OF PROGRAMMING LABORATORY (0-0-3) 2**

**Objectives**

- Design algorithms for simple problems.
- Sharpen programming skill in C Language.

**List of Exercises**

1. Programs using sequence construct
2. Programs using selection construct
3. Programs using Iterative construct
4. Programs using nested for loops
5. Programs using functions with Pass by value
6. Programs using functions with Pass by reference
7. Programs using recursive functions
8. Programs using one dimensional Array
9. Programs using two dimensional Arrays
10. Programs using Pointers and functions
11. Programs using Pointers and Arrays
12. Programs using Pointers and structures
13. Programs using structures and arrays
14. Programs to perform I/O operations on files.
15. Programs to perform error handling during I/O operations on files.
16. Programs to perform random access to files.

**Outcomes**

- Ability to write program in C language
- Ability to test and debug the programs for critical errors
- Ability to analyze and optimize programs

**SEMESTER III**

**MA221 TRANSFORMS AND COMPLEX ANALYSIS (3-0-0) 3**

**Pre-Requisite: None**

**Objectives:**

The objective of this subject is to expose student to understand the importance of transform techniques and complex variables to solve real world problems. It also focuses the partial differential equations and its applications in science and engineering.

**Topics Covered:**

**Unit-I:** Laplace Transformations: Laplace transform, Inverse Laplace transform, properties of Laplace transforms, Laplace transforms of unit step function, impulse function and periodic function, convolution theorem.

**Unit-II:** Solution of ordinary differential equations with constant coefficients and system of linear differential equations with constant coefficients using Laplace transform.

**Unit-III:** Z- Transforms, Inverse Z- transform, properties, Damping rule, Shifting rule, initial and final value theorems, Convolution theorem. Applications of Z-Transforms: Solution of difference equations using Z- transforms.

**Unit-IV:** Complex variable, Analytic functions, Cauchy-Riemann equations (cartesian and polar), Properties of analytic functions, Construction of analytic functions given real or imaginary part, Conformal mapping of standard elementary functions and bilinear transformation.

**Unit-V:** Cauchy's integral theorem, Cauchy's integral formula and for derivatives, Taylor's and Laurent's expansions (without proof), Singularities, Residues, Cauchy's residue theorem, Contour integration involving unit circle.

**Text Book**

1. Erwyn Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 10th Edition, 2011.

**Reference Book**

1. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publications, 42nd Edition, 2013.
2. R.V. Churchill, *Complex Variables and its Applications*, McGraw Hill, 1960.

**EC201 SIGNALS AND SYSTEMS (3 - 0 - 0) 3**

**Pre-Requisite: None**

**Objectives:**

The aim of the course is for:

1. Understanding the fundamental characteristics of signals and systems.
2. Understanding the concepts of vector space, inner product space and orthogonal series.
3. Understanding signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provide.
4. Development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

**Topics Covered:**

**Unit-1: Mathematical Preliminaries**
Vector spaces - Inner Product spaces - Schwartz inequality - Hilbert spaces - Orthogonal expansions - Bessel's inequality and Parseval's relations
**Unit-2: Signals**
Continuous-time signals, classifications - Periodic signals - Fourier series representation - Hilbert transform and its properties
**Unit-3: Laplace and Fourier transforms**
Continuous - time systems - LTI system analysis using Laplace and Fourier transforms
**Unit-4: Sampling and Filters**
Sampling and reconstruction of band limited signals - Low pass and band pass sampling theorems - Aliasing, Anti-aliasing filter - Practical Sampling-aperture effect
**Unit-5: Z-transform**
Discrete-time signals and systems - Z-transform and its properties - Analysis of LSI systems using Z - transform.

**Course Outcomes:**

Students will be able to

1. Apply the knowledge of linear algebra topics like vector space, basis, dimension, inner product, norm and orthogonal basis to signals.
2. Analyse the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.
3. Classify systems based on their properties and determine the response of LSI system using convolution. Analyze system properties based on impulse response and Fourier analysis.
4. Apply the Laplace transform and Z- transform for analyze of continuous-time and discrete-time signals and systems.

**Text Books:**

1. A.V. Oppenheim et al, Signals and Systems (2/e), Pearson 2003.
2. M. Mandal and A. Asif, "Continuous and Discrete Time Signals and Systems, Cambridge, 2007.

**Reference Books:**

1. D.C. Lay, Linear Algebra and its Applications (2/e), Pearson, 2000.
2. K. Huffman & R. Kunz, Linear Algebra (2/e), Pearson, 1971.
3. S.S. Soliman& M.D. Srinath, Continuous and Discrete Signals and Systems, Prentice- Hall, 1990.

**EC203 NETWORK THEORY (3 - 0- 0) 3**

**Pre-Requisite: None**

**Objectives:**

1. To make the students capable of analysing any given electrical network.
2. To make the students learn how to synthesize an electrical network from a given impedance/admittance function.
3. To make the student learn to apply network theorems.

**Topics Covered:**

**Unit -1: Introduction**

Network concept-Elements and sources. Kirchoff's laws. Tellegen's theorem. Network quilibrium equations. Node and Mesh method. Source superposition. Thevenin's and Norton's theorems.

**Unit -2: Network Theorems**

First and second order networks-State equations-Transient response. Network functions. Determination of the natural frequencies and mode vectors from network functions. Millman Theorem.

**Unit -3: Steady state analysis**

Sinusoidal steady-state analysis. Maximum power-transfer theorem. Resonance. Equivalent and dual networks. Design of equalizers, Substitution Theorem.

**Unit -4: Two port networks**

Two-port network parameters. Interconnection of two port networks. Barlett's bisection theorem. Image and Iterative parameters. Design of attenuators. Network graph theory, Tree, Cutset, Incident Matrix.

**Unit -5: RLC Networks**

Two-terminal network synthesis. Properties of Hurwitz polynomial and Positive real function. Synthesis of LC, RC and RL Networks, Foster Forms and Cauer Forms.

**Course Outcomes:**

1. Able to analyze and synthesize electrical circuits
2. Understand the concept of Resonance phenomena.
3. Implement networks in various forms.

**Text Book:**

1. Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd.,2008.

**Reference Books:**

1.Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition. 2007.
2.Kuo F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India., 2008.

**EC205 ENGINEERING ELECTROMAGNETICS (3 - 0 - 0) 3**

**Pre-Requisite: None**

**Objectives:**

To impart core concepts of Electromagnetics and wave propagation which is essential for subsequent courses on transmission line and waveguides, antennas and wireless communication, microwave engineering.

**Topics Covered:**

**Unit -1: Electrostatics**

Coulomb's law – Vector Form - Electric Field Intensity - flux Density - Gauss's law and applications - Electrostatic potential - Poisson's and Laplace equations - Method of images.

**Unit -2: Electrostatic fields in matter**

Electric properties of matter – Electric current – Current density – point form of ohm's law – continuity equation for current. Dielectrics and dielectric polarization - Capacitors with dielectric substrates - Boundary conditions for electric fields - Force and energy in dielectric systems.

**Unit-3: Magnetostatics**

Magnetic fields of steady currents -Biot- Savart's and Ampere's laws and simple applications - Magnetic flux density, Inductance of loops and solenoids, The Lorentz force equation for a moving charge and applications – Magnetic moment – Magnetic vector potential - Magnetic boundary conditions, Magnetic properties of matter.

**Unit-4: Electrodynamics**

Flux rule for motional emf - Faraday's law - Self and mutual inductances - Maxwell's equations in integral form and differential form - Poynting theorem -Poynting Vector

**Unit-5: Electromagnetic wave propagation**

Wave Equation -Uniform plane waves - Reflection and refraction - Wave polarization –types - Dependence on Polarization - Brewster angle.

**Course Outcomes:**

Students are able to

1. Understand basic Electrostatic theorems and laws and to derive them.
2. Discuss the behaviour of Electric fields in matter and Polarization concepts.
3. Understand the basic Magnetostatic theorems and laws and to derive them, to infer the magnetic properties of matter.
4. To derive and discuss the Maxwell's equations. and familiar with Electromagnetic wave propagation and wave polarization.

**Text Books:**


1. Hayt,WH. And Buck,J.A.,"EngineeringElectromagnetics",7thEdition,TMH, 2009.
2. D.J. Griffiths, Introduction to Electrodynamics (4/e), Addison-Wesley, 2012


**Reference Books:**


1. R.E. Collin, "Foundations for Microwave Engineering", 2nd edition, Mc Graw–Hill, 2009.
2. R.E. Collin, "Antennas and Radio wave Propagation", Mc Graw-Hill, 1985.
3. E.C. Jordan & K.G. Balmain "Electromagnetic Waves and Radiating Systems" PHI Learning, 2nd edition 2011.
4. Mathew N.O.Sadiku,"ElementsofEngineeringElectromagnetics",5thEdition, Oxford University Press, 2009.
5. Narayana Rao, N., "Elements of Engineering Electromagnetics", 6th Edition, Pearson Education, 2009.

**EC207 TRANSMISSION LINES AND WAVE GUIDES (3-0-0)3**

Pre-Requisite: Engineering Electromagnetics

**Objective:** To impart knowledge on basics and essential features of transmission lines, waveguides and resonators and also to give an introduction to microwave integrated circuit design.

**Topics Covered:**

Unit-1: Transmission line: Transmission line equations -Voltage and current waves-Characteristic impedance–SWR –Reflection Coefficient -Solutions for different terminations-Transmission-line loading.

Unit-2: Impedance Matching Techniques: Impedance transformation and matching-Quarter-wave and half-wave transformers -Binomial and Tchebeyshev transformers-Single, double and triple stub matching.

Unit-3: Graphical Tool: The circle diagram for the dissipationless line –The Smith Chart – Application of the Smith Chart

Unit-4: Waveguides and Resonators: Classification of guided wave solutions-TE, TM and TEM waves -Field analysis -Rectangular and circular waveguides-Excitation of waveguides-Rectangular, circular and cylindrical cavity resonators.

Unit-5: Planar Transmission Lines: Microstrip lines–stripline-slot line-coplanar waveguide-fin line - Microstrip MIC design aspects-Computer-aided analysis and synthesis.

**Course Outcomes:**

Students are able to

1. Apply concepts to find SWR and reflection coefficient for different terminations.
2. Apply the knowledge to find matching sections.
3. Find and analyse the transmission lines and their parameters using the Smith Chart
4. Classify the Guided Wave solutions-TE, TM, and TEM. Analyse and design rectangular waveguides and understand the propagation of electromagnetic waves.
5. Comparatively analyse the field propagation planar transmission lines

**Text Books:**


1. D.M.Pozar, “Microwave Engineering”, 4th edition, Wiley, 2011.
2. J.D.Ryder, “Networks, Lines and Fields”, 2nd edition, PHI Learning, New Delhi, 2011.


**References:**


1. R.E.Collin, “Foundations for Microwave Engineering”, 2nd edition, Mc Graw–Hill, 2009.
2. E.C. Jordan & K.G. Balmain “Electromagnetic Waves and Radiating Systems” PHI Learning, 2nd edition 2011.

**EC209 DIGITAL CIRCUITS AND SYSTEMS (3 - 0 - 0) 3**

**Pre-Requisite: None**

**Objectives:**

Modern electronics is based on digital logic design, in this course basics of digital logic designing are covered which includes Boolean algebra, propositions, truth tables, minimization of combinational circuits. Karnaugh maps and tabulation procedure, implementation of sum of product and product of sum in hardware.

**Topics Covered:**

**Unit-1: Boolean algebra**
Review of number systems- representation- conversions, error detection and error correction. Review of Boolean algebra- theorems, sum of product and product of sum simplification, Simplification of Boolean expressions- Implementation of Boolean expressions using universal gates.
**Unit-2: Combinational logic circuits**
Adders, subtractors, parity generator, decoders, encoders, multiplexers, demultiplexers, Realisation of boolean expressions- using decoders-using multiplexers. Memories – ROM-Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs.
**Unit-3: Sequential circuits**
Latches, flip flops, edge triggering, asynchronous inputs. Shift registers, Universal shift register, applications. Binary counters – Synchronous and asynchronous up/down counters, mod-N counter, Counters for random sequence.
**Unit-4: Synchronous circuit analysis and design:**
Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machine
**Unit-5: Logic families:**
Introduction to TTL and ECL logic families: Basic working of a TTL NAND gate-characteristics of a TTL NAND gate- important specifications – Basic working of ECL gate- – DTL- RTL- CMOS and ECL family of logic circuits.

**Course Outcomes:**

The expected outcome after learning this course are that a student must be able to design a digital circuit, understand the differences between combinational and sequential circuits and will be able to implement the circuit.

**Text Books:**


1. Wakerly J F, Digital Design: Principles and Practices, Prentice-Hall, 4thEd.
2. R P Jain, Modern Digital Electronics 4th Edition, Tata Mcgraw Hill Education Private Limited
3. D. D. Givone, Digital Principles and Design, Tata Mc-Graw Hill, New Delhi, 2008.


**Reference Books:**


1. D.P. Leach, A. P. Malvino, Goutam Guha, Digital Principles and Applications, Tata Mc-Graw Hill, New Delhi, 2011
2. M. M. Mano, Digital Design, 3rd ed., Pearson Education, Delhi, 2003
3. R.J. Tocci and N.S. Widner, Digital Systems - Principles& Applications, PHI, 10th Ed., 2007
4. T. L. Floyd and Jain ,Digital Fundamentals, 8th ed., Pearson Education, 2003

**EC211 DEVICES AND NETWORKS LABORATORY (0 - 0 - 3) 2**

**List of Experiments:**

1. PN Junction Diode and Zener diode Characteristics
2. Characteristics study of Bipolar Junction Transistor (BJT)
3. Characteristics study of UJT
4. Characteristics study of JFET
5. Thevenin and Substitution theorems
6. Superposition and Maximum power transfer theorems
7. Frequency Response study of RLC circuits
8. Constant K High pass and low pass Filter
9. Attenuators
10. Equalizers

**EC213 DIGITAL ELECTRONICS LABORATORY (0 – 0 – 3) 2**

**List of Experiments:**

1. Study of logic gates and verification of Boolean Laws.
2. Design and implementation of adders and subtractors
3. Design and implementation of code converters.
4. Design and implementation of Multiplexers and De-multiplexers
5. Design and implementation of Encoder and Decoder.
6. Design and implementation of parity generator and checker.
7. Design and implementation of 2-bit , 4 bit and 8-bit magnitude comparators.
8. Study of flip-flops.
9. Design and implementation of synchronous counters using flip-flops.
10. Design and implementation of asynchronous counters using flip-flops.
11. Design and implementation of ring and Johnson counter using flip-flops.
12. Design and implementation of shift registers.
13. Simulation of combinational logic circuits using Verilog.
14. Simulation of sequential logic circuits using Verilog

**SEMESTER IV**

**MA222 PROBABILITY AND RANDOM PROCESSES (3-0-0) 3**

**Pre-Requisite: None**

**Objectives:**

- To introduce the fundamental concepts and theorems of probability theory.
- To apply elements of stochastic processes for problems in real life.

**Topics Covered:**

**Unit I:** Definitions of Probability, Conditional Probability, Baye's theorem, Random variable, Probability mass function, Density function, Distribution Function, Jointly distributed random variables, Marginal and conditional distributions, Joint probability distribution of functions of random variables. Binomial Distribution, Poisson Distribution, Normal Distribution, Moment Generating Functions.

**Unit II:** Population and samples, the sampling distribution of the mean ($\sigma$ known and $\sigma$ unknown), Sampling distribution of the variance, Point estimation, Maximum likelihood estimation, Method of moments, Interval estimation, Point estimation and interval estimation of mean and variance.

**Unit III:** Tests of hypothesis, Hypothesis tests concerning one mean and two means. Hypothesis tests concerning one variance and two variances.

**Unit IV:** Random processes: Stationarity and ergodicity, Strict sense and wide sense stationary Processes, Covariance functions and their properties, Spectral representation, Wiener-Khinchine theorem.

**Unit V:** Gaussian processes: Processes with independent increments, Poisson processes, Low pass and Band pass noise representations.

**Text Books**

1. Erwyn Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 8th Edition, 2010.
2. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publications, 42nd Edition, 2013.

**Reference Book**

1. S. C. Gupta, V.K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand, 2000.
2. E. Wong, *Introduction to Random Processes*, Springer Verlag, 1983.
3. W. A. Gardner, *Introduction to Random Processes*, (2/e), McGraw Hill,1990.
4. A. Papoulis, *Probability, Random variables and Stochastic Processes*, McGraw Hill, 2002.
5. Larry Wasserman, *All of Statistics: A Concise Course in Statistical Inference (Springer Texts in Statistics)*, Springer, 2005

**EC202 DIGITAL SIGNAL PROCESSING (3 - 0 - 0) 3**

**Pre-Requisite: EC201**

**Objective:**

The subject aims to introduce the mathematical approach to manipulate discrete time signals, which are useful to learn digital tele-communication.

**Topics Covered:**

**Unit-1: Signals and Systems**
Review of LSI system theory- DTFT-Frequency response of discrete time systems-All pass inverse and minimum phase systems.
**Unit-2: Discrete Fourier Transform**
Relationship of DFT to other transforms- FFT- DIT and DIF FFT algorithm-Linear filtering using DFT and FFT.
**Unit-3: FIR and IIR**
Frequency response-FIR filter types- Design of FIR filters- Mapping formulas-Frequency transformations-Direct form realization of FIR systems-Lattice structure for FIR systems.
IIR filter types-IIR filter design- Bilinear transformation- impulse invariance transformation-Structures of IIR filters-Finite word length effects- Limit cycle oscillations
**Unit-4 Multi-rate signal processing and Applications of DSP**
Sampling rate conversion by an integer and rational factor-Poly phase FIR structures for sampling rate conversion-interpolation- decimation-Homomorphic filtering-Applications of DSP in speech and image processing-Homomorphic de-convolution, Applications in speech and image processing
**Unit-5 Introduction to DSP Processor**
Difference between DSP and other microprocessor architectures, Analog Device DSPs. TMS320C54X architecture

**Course Outcomes:**

Students will be able to

1. Analyse discrete-time systems in both time & transform domain and also through pole-zero placement.
2. Analyse discrete-time signals and systems using DFT and FFT.
3. Design and implement digital finite impulse response (FIR) filters.
4. Design and implement digital infinite impulse response (IIR) filters.
5. Understand and develop multirate digital signal processing systems.

**Text Books:**


1. Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck (2/e), Discrete Time Signal Processing, Prentice Hall Publication New Jersey
2. Dimitris G Manolakis, and John G. Proakis, Digital Signal Processing : Principles, Algorithms, and Applications (4/e), Pearson
3. Sen M. Kuo and Woon-seng Gan, Digital signal Processor. Architectures, Implementations, and Applications, Pearson and Prentice Hall (2005)


**Reference Books:**


1. Doug Smith, Digital Signal Processing Technology: Essentials of the Communications Revolution, ARRL
2. S. Salivahanan, A Vallavaraj, and C Gnanapriya, Digital Signal Processing, TMG Publication
3. Sophocles J. Orfanidis, Introduction to Signal Processing, Prentice Hall Signal Processing Series

**EC204 CONTROL SYSTEMS (3 - 0- 0) 3**

**Objectives:**

1. To teach the mathematical modelling of control system.
2. To familiarize the students with the need for modelling of systems.
3. To represent the system in various ways mathematically.
4. To teach them the various techniques of stability analysis.

**Topics Covered:**

**Unit -1: Introduction**
Block-diagram algebra. Time response of poles. Ruth – Hurwitz criterion. Basic feedback loop. Asymptotic tracking and performance.
**Unit -2: Stability analysis**
Root loci. Properties. Stability range from the loci, Sensitivity of system Design using root loci, proportional controller, phase lead controller and PD controller. Mechanical Systems-Electrical Systems
**Unit -3: Frequency domain analysis**
Frequency domain techniques. Bode and Nyquist plots. Phase and gain margins. Frequency domain specifications. Controller design.
**Unit-4: State Space analysis**
State - space techniques. Canonical form for SISO continuous-time and discrete-time systems. Solution of state equations. State models of MIMO systems. Stability analyses-Lyapunov criterion for stability.
**Unit-5: Controller design**
Controllability and observability. Design of state feedback controllers. Full order and reduced order observers. Design of observers for continuous-time and discrete-time systems.

**Course Outcomes:**

1. Able to model the control systems.
2. Able to test the stability of control system using various methods
3. Able to design stable systems.

**Text Books:**

1. K. Ogata : Modern Control Engineering, (5/e), PHI, 2009.
2. R.C. Dorf& R.H. Bishop, Modern Control Systems (8/e), Pearson, 1999.

**Reference Books:**

1. B.C. Kuo : Automatic Control Systems, (9/e), PHI, 2009.
2. K. Morris : An Introduction to Feedback Control, Academic Press, 2001

**EC206 ANTENNAS AND PROPAGATION (3-0-0)3**

**Objective:** To impart knowledge on fundamentals of antenna theory and to analyse and design a state of art antenna for wireless communications.

**Topics Covered:**

Unit-1: Radiation fundamentals: Radiation mechanism, Current distribution on a thin wire antenna, Fundamental Parameters of Antennas –Radiation pattern, Radiation power density, Radiation intensity, Directivity, Antenna efficiency, Gain, Bandwidth, Input impedance, Effective length, Antenna temperature, Friis transmission equation.

Unit-2: Radiation Integrals, Auxiliary Potential Functions, Reciprocity relations, Duality, Linear antennas –Small dipole, Finite length dipole, Half-wavelength dipole. Loop Antennas.

Unit-3: Antenna array: Array factorization -Array parameters -Broad side and end fire arrays -Yagi-Uda arrays -Log-periodic arrays -Phased Array Antenna

Unit-4: Antennas types: Fields as sources of radiation -Horn antennas -Babinet's principle -Parabolic reflector antenna -Lens Antenna -Microstrip antennas.

Unit-5: Wave Propagation: Propagation in free space -Propagation around the earth, surface wave propagation -structure of the ionosphere -propagation of plane waves in ionized medium -Determination of critical frequency –MUF –Fading -tropospheric propagation -Super refraction.

**Course Outcome:**

Students are able to

1. Select the appropriate portion of electromagnetic theory and its application to antennas.
2. Distinguish the receiving antennas from transmitting antennas, analyse and justify their characteristics.
3. Assess the need for antenna arrays and mathematically analyse the types of antenna arrays.
4. Distinguish primary from secondary antennas and analyse their characteristics by applying optics and acoustics principles.
5. Outline the factors involved in the propagation of radio waves using practical antennas

**Text Books:**


1. Balanis, "Antenna Theory", 3rd edition, Wiley Publishers, 2012.
2. John D. Kraus, Ronald J. Marhefka & Ahmad S. Khan, "Antennas and Wave Propagation", McGraw –Hill, 5th Edition, 2017.


**Reference Books:**


1. R.E. Collin, "Antennas and Radio Wave Propagation", McGraw -Hill,1985.
2. W.L. Stutzman & G.A. Thiele : Antenna Theory and Design, 3rd edition, Wiley Publishers, 2012

**EC208 ELECTRONIC CIRCUITS (3 - 0 - 0) 3**

**Pre-Requisite: None**

**Objectives:**

The aim of the course is for:

1. Understanding the fundamental characteristics of Rectifiers.
2. Understanding the working principle of BJT and MOSFET transistor models.
3. Understanding the concepts of MOSFET and BJT biasing.
4. Understanding the working principle of BJT and MOSFET amplifiers.
5. Development of the mathematical skills to solve problems involving analysis of amplifier gain, output voltage and current.

**Topics Covered:**

**Unit 1: Rectifiers and Transistor Biasing**
Diode Circuits-Clippers and Clampers-Rectifier circuits and filters-Voltage Regulators-BJT Biasing Circuits: Types, Q Point, Bias stability, Stability factors-Concept of DC and AC load lines- Fixing of operating point. Low and high frequency models Small signal analysis of CE, CB and CC configurations using small signal hybrid π model

**Unit 2: BJT Amplifiers**
Transistor Amplifying action-small signal analysis of CE amplifier-AC load line-Voltage swing limitations, common collector and common base amplifiers-Differential amplifiers-CMMR-Darlington amplifier-Cascaded stages-Cascode amplifier-Frequency response of CE amplifier-Emitter follower.

**Unit 3: JFET and MOSFET Amplifiers**
Small signal analysis of JFET amplifiers- Small signal analysis of MOSFET and JFET-Common source amplifiers-Voltage swing limitations- -Source follower and common gate amplifiers-BiMOS amplifiers.

**Unit 4: Feedback Amplifiers**
Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion, feedback topologies and its effect on input and output impedance, feedback amplifier circuits,Tuned amplifiers.

**Unit 5: Oscillators**
Oscillators-Classification of oscillators, Barkhausen criterion, Analysis of RC phase shift and wein bridge oscillators,Working of Hartley, Colpitts and Crystal oscillators- Square wave and triangular wave generators.

**Course Outcomes:**

Students will be able to

1. Apply the knowledge of diode, BJT and MOSFET to electronics circuit analysis.
2. Analyze the characteristics of BJT and MOSFET based biasing circuits and their stability conditions.
3. Classify basic amplifier circuits based on their properties and determine their output voltage, current, resistance and gain. Analyze amplifier circuits by the use of small signal and large signal transistor models. Study analyze the oscillator circuits.

**Text Book:**

1. A.S. Sedra & K.C. Smith, Microelectronic Circuits (5/e), Oxford, 2004.

**Reference Books:**

1. Floyd, Electronic Devices, 9th ed, Pearson, 2012.
2. Millman J. and Halkias C.C., 2002 'Integrated Electronics", McGraw Hill. India.
3. David A.Bell, 1998 "Electronic Devices and Circuits", Prentice Hall of India.
4. G.K.Mithal, 2000 "Electronic devices and circuits", khanna publishers, Delhi, India.
5. Allen mottershead, 2002 "Electronic devices and circuits", Prentice Hall of India.

**EC210 MICROPROCESSORS AND MICROCONTROLLERS (3 - 0 - 0) 3**

**Pre-Requisite: EC209**

**Objective:**

This subject deals about the basics 16-bit microprocessor, 8-bit and 16-bit microcontrollers, their architecture, internal organization and their functions, peripherals, interfacing an external device with the processors/ controllers.

**Topics Covered:**

**Unit-1:**
Microprocessor based personal computer system. Software model of 8086. Segmented memory operation. Instruction set. Addressing modes. Assembly language programming. Interrupts. Programming with DOS and BIOS function calls.
**Unit-2:**
Hardware detail of 8086. Bus timing. Minimum Vs Maximum mode of operation. Memory interface. Parallel and serial data transfer methods. 8255 PPI chip. 8259 Interrupt controller. 8237 DMA controller.
**Unit-3:**
Microcontroller. Von-Neumann Vs Harvard architecture. Programming model. Instruction set of 8051 Microcontroller. Addressing modes. Programming. Timer operation.
**Unit-4:**
Mixed Signal Microcontroller: MSP430 series. Block diagram. Address space. On-chip peripherals -analog and digital. Register sets. Addressing Modes. Instruction set. Programming. FRAM Vs flash for low power and reliability.
**Unit-5:**
Peripheral Interfacing using 8051 and Mixed signal microcontroller. Serial data transfer - UART, SPI and I2C. Interrupts. I/O ports and port expansion. DAC, ADC, PWM, DC motor, Stepper motor and LCD interfacing.

**Course Outcomes:**

Students are able to

1. Recall and apply a basic concept of digital fundamentals to Microprocessor based personal computer system.
2. Identify a detailed s/w & h/w structure of the Microprocessor.
3. Illustrate how the different peripherals (8255, 8251 etc.) are interfaced with Microprocessor.
4. Distinguish and analyze the properties of Microprocessors & Microcontrollers.
5. Analyze the data transfer information through serial & parallel ports.

**Text Books:**


1. Ramesh S. Gaonkar, "Microprocessor-Architecture, Programming and Applications with the 8085" Penram International Publisher, 5th Ed.,2006.
2. J.L. Antonakos, An Introduction to the Intel Family of Microprocessors, Pearson, 1999.
3. Barry B. Brey, The Intel Microprocessors, (7/e), Eastern Economy Edition, 2006.
4. M.A. Mazidi & J.C. Mazidi, Microcontroller and Embedded systems using Assembly & C. (2/e), Pearson Education, 2007.
5. John H. Davies, "MSP430 Microcontroller Basics", Elsevier Ltd., 2008.


**Reference Books:**


1. Kenneth J Ayala, The 8051 Microcontroller, (3/e), Thomson Delmar Learning, 2004.
2. I. Scott MacKenzie and Raphael C.W. Phan. The 8051 Microcontroller. (4/e), Pearson education, 2008.

**EC212 ELECTRONIC CIRCUITS LAB (0 – 0 – 3) 2**

**List of Experiments:**

1. Full wave rectifier with filters
2. Bridge rectifier with filters
3. Stability of Q point
4. Single stage RC coupled CE amplifier
5. UJT Characteristics
6. UJT Relaxation Oscillator
7. Integrator and Differentiator
8. Darlington emitter follower
9. RC phase shift oscillator
10. Wien Bridge Oscillator
11. Differential Amplifier
12. Clipper and Clamper
13. Transistor as a Switch

**EC214 MICROPROCESSORS AND MICROCONTROLLERS LABORATORY (0 - 0 - 3) 2**

**List of Experiments:**

Intel 8086 – 16bit μP- Emulator.

1. Addressing modes of 8086 Microprocessor.
2. Block move and simple arithmetic operations.
3. Identification and displaying the activated key using DOS and BIOS function calls.

Intel 8051 (8-bit Microcontroller) - Proteus VSM Simulator and Trainer Kit.

4. Addressing modes of 8051 Microcontroller.
5. Delay generation - i) Nested loop and ii) Timers.
6. Toggling the ports and counting the pulses.
7. LCD Interfacing.
8. Generation of different waveforms using DAC (0808)
9. ADC interfacing.

Mixed-Signal Microcontroller – 16bit – MSP430 series

10. PWM generation and speed control of Motors using MSP430.

**SEMESTER V**

**EC301 COMMUNICATION THEORY (3 - 0 - 0) 3**

**Pre-Requisite: EC201 & MA222**

**Objective:**

To develop a fundamental understanding on communication systems with emphasis on analog modulation techniques.

**Topics Covered:**

**Unit -1: Amplitude Modulation.**
Basic blocks of Communication System. AM, Linear Modulation - DSB-SC, SSB and VSB. Methods of generation and detection - Frequency-Division Multiplexing.
**Unit -2: Angle Modulation**
Frequency and Phase modulation. Transmission Bandwidth of FM signals, Methods of generation and detection. Super heterodyne receiver.
**Unit -3: Power amplifiers**
Design of Class A, B, AB, C and D power amplifiers. Use of power amplifiers in Transmission.
**Unit - 4: Circuits for Modulation and Demodulation**
Circuits for generation and detection of AM, DSBSC, SSBSC - Collector modulator class C amplifier, Balanced modulator, switching modulator, ring modulator and envelope detector. Circuits for generation and detection of FM signal - Varactor diode FM modulator, Armstrong Method of FM Generators and FM discriminators.
**Unit - 5: Noise**
Noise and its types - Noise in CW modulation systems - SNR calculations for synchronous detection of DSB and SSB and envelope detection of AM, SNR calculations for angle modulation system. Pre-emphasis and de-emphasis. Threshold effect.

**Course Outcomes:**

Students are able to

1. Apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.
2. Apply the basic knowledge of transistor and describe the power amplifiers.
3. Evaluate the communication system performance in the presence of noise and summarize the merits and demerits of all the conventional analog modulation system.
4. Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for modulators, demodulator and communication systems using CAD tool.

**Text Books:**


1. S. Haykins, “Communication Systems” (4/e), Wiley, 2001.
2. B. Carlson, “Introduction to Communication Systems” (4/e), McGraw-Hill, 2009.


**Reference Books:**


1. Kennedy, Davis, “Electronic Communication Systems” (4/e), McGraw Hill, 1999.
2. J. Smith, Modern, “Communication Circuits” (2/e), McGraw Hill, 1997.
3. J. S Beasley & G.M. Miler, “Modern Electronic Communication” (9/e), Prentice-Hall, 2008

**EC303 ANALOG INTEGRATED CIRCUITS (3 - 0 - 0) 3**

**Pre-Requisite: EC208**

**Objective:**

This subject introduces the theoretical & circuit aspects of Op-amp, which is the backbone for the basics of Linear integrated circuits.

**Topics Covered:**

**Unit-1: Operational Amplifiers**
Differential amplifiers, DC and AC characteristics. Applications-Inverting and Non Inverting amplifiers, Differentiators and Integrators, Summing and Difference amplifier, Voltage to current converters, Precision rectifiers. Log and antilog amplifiers. Four quadrant multipliers. Instrumentation amplifier.
**Unit-2: Active filters.**
Filter classification. Standard approximations. Butterworth, Chebyshev and Bessel filters. Switched capacitor filter.
**Unit-3: Oscillators using opamps**
Schmitt trigger, Astable, Monostable and Bistable Multivibrators using opamps and 555 timer. Triggering circuits for bistable and monostable multivibrators. Programmable timer.
**Unit-4: Data converters.**
Analog multiplexer. A/D and D/A converters and its type. PLL-Applications of PLL. Frequency synthesizers. Coherent synthesizers using PLL. Direct digital synthesis. Phase noise in oscillators.
**Unit-5: Voltage regulators.**
Regulators using opamps. IC regulators. Protection circuits. Foldback current limiting. Current boosting of IC regulators. Switching regulators.

**Course Outcomes:**

The expected outcome after learning this course are that a student must be able to design a op amp based circuits as per requirements.

**Text Books:**


1. S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits (3/e) TMH, 2003
2. R. Gayakwad, Op-amps and Linear Integrated Circuits (4/e), PHI


**Reference Books:**


1. D.A. Bell, Solid state Pulse Circuits (4/e), PHI
2. D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000

**EC305 STATISTICAL THEORY OF COMMUNICATION (3 - 0 - 0) 3**

**Pre-Requisite: MA222**

**Objective:**

The subject aims to make the students to understand the statistical theory of telecommunication, which are the basics to learn analog and digital tele-communication.

**Topics Covered:**

**Unit - 1: Introduction**
Information measure. Discrete entropy. Joint and conditional entropies. Uniquely decipherable and instantaneous codes. Kraft-Mc millan inequality. Noiseless coding theorem. Construction of optimal codes.
**Unit - 2: Fundamental Limits in Information Theory**
Discrete Memoryless Channels. Mutual information and channel capacity. Shannon's fundamental theorem. Entropy in the continuous case. Shannon-Hartley law.
**Unit -3: Parameter Estimation**
Binary hypothesis testing. Baye's, minimax and Neyman-Pearson tests. Random parameter estimation-MMSE, MMAE and MAP estimates. Non-random parameters – ML estimation.
**Unit -4: Coherent signal detection**
Coherent signal detection in the presence of additive white and non-white Gaussian noise. Matched filter.
**Unit -5: Filters used in Communication systems**
Discrete optimum linear filtering. Orthogonality principle. Spectral factorization. FIR and IIR Wiener filters.

**Course Outcomes:**

Students are able to

1. Show how the information is measured and able to use it for effective coding.
2. Summarize how the channel capacity is computed for various channels.
3. Use various techniques involved in basic detection and estimation theory to solve the problem.
4. Summarize the applications of detection theory in telecommunication.

**Text Books:**

1. R.B. Ash, Information Theory, Wiley, 1965.
2. Thomas Thomas M. Cover, Joy A. Thomas Elements of Information Theory, John Wiley and Sons, 2nd Edition 2006.

**Reference Books:**

1. H.V. Poor: An Introduction to Signal Detection and Estimation, (2/e), Spring Verlag.1994.
2. M. Mansuripur: Introduction to Information Theory, Prentice Hall. 1987.
3. J.G. Proakis et al: Digital Signal Processing, (4/e), Pearson Education, 2007.

**EC307 DATA STRUCTURES AND ALGORITHMS (3 - 0 - 0) 3**

**Objectives**

- To introduce basic data structures and their applications in the real world scenario.
- To be able to analyze and choose the best data structure for a given application.

**Unit – 1 Introduction:**
Development or Algorithms - Notations and analysis, LINKED LISTS: Introduction to Data Structures, Pointers- Basic Operations- Applications- Dynamic storage management - Circular Linked Lists- Doubly Linked List.
**Unit - 2 Stacks and Queues:**
STACKS: Basic Stack Operations- Stack Applications. QUEUES: Operations- Queue Applications
**Unit - 3 Trees:**
Binary Trees - Binary search trees -Applications, Treetraversals-preorder-inorder-postorde-Height balanced trees — Red black trees.
**Unit - 4 Graphs:**
Graphs -Representation- Graph traversals-BFS-DFS- Topological sort- spanning trees.
**Unit - 5 Searching, Sorting and Hashing:**
Searching Techniques: Linear search - Binary search - Sorting Techniques: Selection sort- Bubble sort- Insertion sort- Hash table methods.

Outcomes
• Develop programs to implement linear and nonlinear data structures.
• Analyze and Identify suitable data structure design techniques for problem solving.

Text Books
I. J.P. Tremblay and P. G.Sorenson. "An Introduction to Data Structures with applications". Second Edition, Tata McGraw Hill, 1981.
2. Richard Gileberg, Behrouz A. Forouzan. “Data Structures: A Pseudo code Approach with C”, Second Edition, 2007.
Reference Books
1. G.A.V. Pai, “Data Structures and Algorithms", Second Edition, Tata McGraw Hill, 2009.
2. DebasisSamanta. “Classic Data Structures”, Second Edition, PHI Learning, 2009.

**EC309 ANALOG INTEGRATED CIRCUITS LABORATORY (0 – 0 – 3) 2**

**List of Experiments:**

1. Differential amplifier
2. Measurement of Op-Amp parameters
3. Inverting non-inverting amplifiers, Adder, Subtractor
4. Integrator, Differentiator
5. Instrumentation Amplifier using Op-amps
6. Op-amp in comparator application
7. Waveform Generators –Sine, square, Triangular and Ramp
8. Astable and Monostable Multivibrators using op-amp and 555IC
9. Low Pass Filter and High Pass Filter realizations using op-amps
10. Band Pass Filter and Band Stop Filter realizations using op-amps

**EC311 DIGITAL SIGNAL PROCESSING LABORATORY (0 - 0 - 3) 2**

**List of Experiments:**

1. Generation of various discrete time signals.
2. Study of linear and circular convolution.
3. Study of auto and cross correlation.
4. Finding DFT and IDFT using FFT algorithm
5. Spectrum analysis using FFT
6. Design of FIR filter using window method.
7. Design of FIR filter using frequency sampling method
8. Design of IIR filter using bilinear and impulse invariance method.
9. Study of up sampler and down sampler
10. Study of equalizers.

**SEMESTER VI**

**EC302 DIGITAL COMMUNICATION (3 - 0 - 0) 3**

**Pre-Requisite: EC301**

**Objectives:**

1. To understand the key modules of digital communication systems with emphasis on digital modulation techniques.
2. To get introduced to the concept and basics of information theory and the basics of source and channel coding/decoding.

**Topics Covered:**

**Unit -1: Pulse Modulation**
Base band transmission. Pulse Modulation techniques – PAM, PPM, PDM. Pulse code modulation (PCM), DM, Destination SNR in PCM systems with noise.
**Unit -2: Baseband Pulse Transmission**
Matched filter, Intersymbol Interference, Nyquist criterion for zero ISI, Raised cosine spectrum, Baseband M-ary PAM Transmission, Correlative-level coding, Equalization; zero-forcing and adaptive linear equalizers.
**Unit -3: Passband Digital Transmission**
Digital modulation techniques – binary ASK, FSK, and PSK. Signal space diagram. Error probabilities. M-ary PSK, M-ary FSK, QAM, MSK and GMSK. Optimum detector. Signal constellation, error probability.
**Unit -4: Error Control Coding**
Linear block codes, Encoding and decoding. Cyclic codes. Convolutional codes. Viterbi decoding. TCM.
**Unit -5: Spread-Spectrum Modulation**
Spread spectrum (SS) techniques; direct S.S and frequency hop S.S. Processing gain and jamming margin. CDMA

**Course Outcomes:**

Students are able to

1. Apply the knowledge of statistical theory of communication and explain the conventional digital communication system.
2. Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.
3. Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.
4. Describe and analyze the digital communication system with spread spectrum modulation.
5. Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for digital modulators and demodulator using hardware components and communication systems using CAD tool.

**Text Books:**

1. J.G. Proakis, “Digital Communications” (5/e), McGraw – Hill,2007.
2. S. Haykin, “Communication Systems” (4/e), Wiley,2001.

**Reference Books:**

1. B. Sklar, “Digital Communications: Fundamentals & Applications”, (2/e),Pearson Education, 2001.
2. A.B. Carlson :“Communication Systems”, (5/e), McGraw Hill, 2009.
3. R.E. Zimer& R.L. Peterson: “Introduction to Digital Communication”, (2/e), Prentice Hall, 2001.

**EC304 VLSI DESIGN (3 - 0 - 0) 3**

**Pre-Requisite:EC209**

**Objectives:**

1. To introduce various aspects of Digital VLSI circuits
2. To teach the layout issues for CMOS Digital circuits.
3. To make them understand the testing issues.

**Topics Covered:**

**Unit -1: Introduction**
VLSI design methodology, VLSI technology- NMOS, CMOS and BICMOS circuit fabrication. Layout design rules. Stick diagram. Latch up, Non-idealities of MOSFET.
**Unit -2: Combinational circuits**
Characteristics of MOS and CMOS switches. Implementation of logic circuits using MOS and CMOS technology, multiplexers and memory, MOS transistors, threshold voltage, MOS device design equations. CMOS inverters, propagation delay of inverters, Pseudo NMOS, Dynamic CMOS logic circuits, power dissipation.
**Unit -3: Memory System**
Memory cell: Layout of SRAM, DRAM.ROM Implementation, Timing constraints, Min-Max Delay, Computation of interconnect delay, Techniques for driving large off-chip capacitors, long lines, Implementation of PLD, EPROM, EEPROM,
**Unit -4: FPGAs and ASICs**
An overview of the features of advanced FPGAs, LUTs, Comparison of ASICs, FPGAs, PDSPs and CBICs. Fault tolerant VLSI architectures
**Unit -5: Testing**
VLSI testing -need for testing, Fault Modelling, Single and Multiple stuck at fault, manufacturing test principles, design strategies for test, chip level and system level test techniques.

**Course Outcomes:**

1. Able to design CMOS Digital Circuits.
2.Able to Layout CMOS Circuits.
3.Understand the timing issues related to combinational and sequential circuits.

**Text Books:**


1. N.H.E. Weste et al, CMOS VLSI design, (3/e), Pearson, 2005.
2. J. Smith, Application Specific Integrated Circuits, Pearson, 1997.


**Reference Books:**


1. Pucknell & Eshraghian, Basic VLSI Design, PHI, (3/e).
2. Uyemura, Introduction to VLSI Circuits and Systems, Wiley, 2002.

**EC306 MOBILE COMMUNICATION (3 – 0 - 0) 3**

**Pre-Requisite: EC301**

**Objective:**

To understand the basics of wireless digital communication used for mobile telephony. To study the basic methodologies of cellular system designing. To study various modulation mechanisms.To understand the wireless channel characterization.To understand the various multiplexing mechanisms.To understand the interference measurement and reduction techniques.

**Topics Covered:**

**Unit-1: Cellular concept**
Frequency reuse – co-channel interference - adjacent channel interference - power control for reducing interference - improving capacity in cellular systems - cell splitting - sectoring - hand off strategies - channel assignment strategies - call blocking in cellular networks
**Unit-2: Mobile Radio Propagation**
Reflection, Diffraction, Fading. Multipath propagation. Statistical characterization of multipath fading.Diversity techniques for mobile wireless radio systems concept of diversity branch and signal paths - combining methods - selective diversity combining - maximal ratio combining-equal gain combining
**Unit-3: Propagation models**
Path loss prediction over hilly terrain. Practical link budget design using Path loss models. Indoor and outdoor Propagation models
**Unit-4: Multiple access techniques**
FDMA, TDMA, SDMA and CDMA. Spread spectrum. Power control. WCDMA. Capacity of multiple access schemes
**Unit-5: Mobile communication Standards**
Overview of second generation cellular wireless systems: GSM and IS-95 standards, 3G systems: UMTS & CDMA 2000 standards and specifications OFDM and MC-CDMA. WLAN technology. Ad hoc networks. Bluetooth.

**Course Outcome:**

Describe the cellular concept and analyze capacity improvement Techniques. Mathematically analyze mobile radio propagation mechanisms. Summarize diversity reception techniques. Analyze and examine the multiple access techniques and its application.

**Text Books:**

1. Kamilo Feher, ‘Wireless Digital Communications’, PHI
2. Rapport T.S., ‘Wireless Communications, Principles and Practice’, Prentice Hall

**Reference Books:**

1. Lee W.C.Y., ‘Mobile Cellular Telecommunication’, MGH
2. Proakis J.G., ‘Digital Communications’, MGH

**EC308 MACHINE LEARNING AND PATTERN RECOGNITION (3 - 0 - 0) 3**

**Pre-Requisite: EC202**

**Objectives:**

1. This course is named due to its historical reasons. The term Machine Learning is more widely used to denote the general body of statistical techniques for automatically detecting and modelling patterns in data. Pattern Recognition may at times refer to the use of a more conventional subset of these techniques, such as Neural Networks.
2. This course is used as an introduction to Machine Learning.
3. The course tells about things which involves understanding the principles behind machine learning.
4. Over time of this course we will consider the issues of representation, modelling, learning through conditioning, inference through marginalisation, inference and learning algorithms and application to data.

**Topics Covered:**

**Unit-1: Introduction**
Introduction: Pattern Similarity and PR Tasks (Classification, Regression and Description) - Classes Patterns and Features - PR approaches (Data Clustering, Statistical Classifier -Neural network)
**Unit-2: Revision of Probability Theory and Distributions**
Probability densities - Expectations and covariance - Bayesian probabilities - The Gaussian distribution - Decision Theory - Minimizing the misclassification rate - Relative entropy and mutual information - The beta distribution - Gaussian distribution - Bayes' theorem for Gaussian variables
**Unit-3: Supervised Learning**
Linear Regression Models: Linear Basis Function Models - Bias-Variance Decomposition - Bayesian Linear Regression - Bayesian Model Comparison
**Unit-4: Linear Discriminant Analysis**
Discriminant Functions -Probabilistic Generative Models - Probabilistic Discriminative Models- Neural Networks: Deep Learning: Feed-forward Network Functions - Network Training - Error Back propagation -Kernels, Support Vector Machines -Naïve Bayes - Graphical Models: Bayesian Networks - Conditional Independence - Markov Random Fields
**Unit-5: Unsupervised Learning**
Clustering, Mixture Models, Expectation-Maximisation: *K*-means Clustering, Mixtures of Gaussians, Latent Variables, Component Analysis: Principal Component Analysis, Probabilistic PCA, Kernel PCA, SVD, Hidden Markov Models: Markov Models, Hidden Markov Models

**Course Outcome:**

1. Students will learn about pattern recognition techniques by machines
2. Learn the applications about pattern Recognition

**Text Books:**

1. Pattern Recognition Concepts, Methods and Application. P. Marques De Sa,Springer. 2001
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 2006

**HM321- ENGINEERING ETHICS AND PRECEPTS OF CONSTITUTION OF INDIA (2-0-0) -**

**Objectives**

To create an awareness on Engineering Ethics and Human Values.
To understand social responsibility of an engineer.
To appreciate ethical dilemma while discharging duties in professional life.
To introduce Indian Constitution

**Topics Covered:**

**Unit-1:** Engineering Ethics - Senses of 'Engineering Ethics' – Variety of Moral Issues – Types of Inquiry – Moral Dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional Roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories. Valuing Time – Co-operation – Commitment.

**Unit-2:** Engineering as Social Experimentation - Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law – The Challenger Case Study.

**Unit-3:** Safety, Responsibilities and Rights - Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – The Three Mile Island and Chernobyl Case Studies.
**Unit-4:** Global Issues - Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership.

**Unit-5:** Constitution of India – Preamble – Fundamental Rights and Duties- Role of Parliament and Legislatures in Federal Setup, Law and Justice – Human Rights and Protection of Human rights- Place of Official Languages and Education pertinent to Concurrent List – Perspectives of Indian issues on Trade and Commerce - Role parliament to impose restriction of Trade, Commerce and Intercourse.

**REFERENCES:**

1. Magbook Indian Polity and Governance, Arihant Experts, 2018 Edition.

2.S.K.Kapoor, Human Rights Edition:Seventh,Year Of Publication: 2017

3. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd..

New Delhi

**EC310 COMMUNICATION ENGINEERING LABORATORY (0 - 0 - 3) 2**

**List of Experiments:**

1. Generation and Demodulation of AM signal
2. Generation and Demodulation of DSB-SC signal
3. Generation and Demodulation PAM signal
4. Generation and Demodulation of PWM signal.
5. Generation of PPM signal.
6. Generation and Demodulation ASK signal.
7. Generation and Demodulation of FSK signal.
8. Encoding and decoding of Pulse Code Modulation
9. Simulation of Analog Modulation Systems.
10. Simulation of Pulse Modulation Systems.
11. Simulation of Digital Modulation Systems.
12. Design of Mixer
13. Encoding and decoding of Delta Modulation
14. Study and analysis of Line Encoding Techniques

**EC312 VLSI DESIGN LAB (0 - 0 - 3) 2**

**List of Experiments:**

1. MOSFET characteristics
2. Oscillator design using Inverters
3. Logic gate implementation using CMOS Logic.
4. Combinational circuit implementation using CMOS Logic
5. Sequential Circuit implementation using CMOS Logic
6. Timing and Power dissipation Adders and subtractors
7. Timing and Power dissipation MUX & DEMUX
8. Timing and Power dissipation Encoders & Decoders
9. Implementation of Counters.
10. Implementation of FSM

**SEMESTER VII**

**HM421 INDUSTRIAL ECONOMICS AND MANAGEMENT (3 - 0 - 0) 3**

**Pre-Requisite: None**

**Objective:**

This course is intended for the students to understand the economic concepts that are in vogue in industries and this course also facilitates the students to understand about the functional areas of management.

**Topics Covered:**

**Unit-1: Microeconomics**
Microeconomics - Demand and supply - Forecasting techniques - Cost and revenues - Competitive nature of firms. Keynesian economics - Aggregate demand and supply.
**Unit- 2: Impact of LPG and Fiscal policy**
Impact of liberalization - privatization and globalization - Locating the firm in a global economy - Fiscal policy - Taxation-principles - Functions of banks.
**Unit 3 - Introduction of Management principles**
Introduction to management, evolution of scientific management, modern management. Principles. Elements of management, planning, organizing, staffing, directing, coordinating, reporting, budgeting.
**Unit 4: Technology and Production Management**
Technology management. Product design .Types of production system. Plant location-factors to be considered. Plantlayout. Types of layout. Inventory management
**Unit 5: HR Management**
Significance of HRM.HR planning job evaluation. Recruitment and selection. Placement and induction. Training. Performance appraisal. Compensation. Industrial relations.

**Course Outcomes:**

1. Know the concepts of Microeconomics and Keynesian economics.
2. Know the Impact of liberalization, privatization and globalization.
3 Equip with the nuances of management functions
4. Gain the insights of Marketing strategies and expertise in analyzing the risk and return of an investment.

**Text Books:**


1. M. Adhikari, Business Economics, Excel Books, 2004
2. S.K. Misra & V.K. Puri, Economic Environment of Business, HPH, 2003
3. P. Kotler, Marketing Management (12/e), Pearson, 2005.
4. L.M. Prasad, Priciples and Practice of Management, S.Chand& Sons.


**Reference Books:**


1. Dewett, K. K: Modern Economic Theory,Chand.S&co,1998.
2. Gupta C.B: Business Organisation and Management, Chand, S. & co,1998.
3. Philip Kotler: Marking Management, PHI, 1999.
4. P. Chandra, Financial Management Theory and Practice (3/e), TMH, 2004.
5. K. Ashwathappa, Human Resources and Personnel Management (3/e), TMH, 2005.
6. E.S. Buffa& R.K. Sarin, Modern Production/Operation Management (8/e), Wiley, 1994.

**EC401 MICROWAVE ELECTRONICS and MIC (3-0-0) 3**

**Pre-Requisite:** EC206

**Objective:**
To impart knowledge on basics of microwave measurements, microwave networks, sources, MIC components, Applications and Hazards.

**Unit-1: Microwave measurements**
Frequency – Wavelength – VSWR - Insertion loss - Attenuation measurement - Impedance determination - Antenna Radiation pattern measurement - S-parameter measurements - Network analyzer

**Unit-2: Microwave Network Basics & Devices**
Microwave network parameters - The Scattering matrix – Properties – formulation - Signal flow graph - Passive microwave devices.

**Unit-3: Klystron and Gunn Diode**
Reflex klystron – modes - admittance spiral - power output and efficiency, Gunn diode - Gunn diode as an oscillator

**Unit-4: MIC Components**
Filters – design overview, 3 dB hybrid - Directional coupler – circulator - Wilkinson power divider

**Unit-5: Applications and Hazards of Microwaves**
Applications of microwaves – RADAR - Communication Systems – Industrial – Medical - Microwave Radiation Hazards – HERP – HERO – HERF - Standards.

**Course Outcomes:**
**Students are able to**

1. Measure basic microwave parameters
2. Know the basics of S parameters and use them in describing the components
3. Understand the principles of Klystron, GUNN Oscillators
4. Design perspectives on M.I.C. components
5. Know the applications and realize the hazards of microwaves

**Text Books:**
1. S.Y. Liao, "Microwave Devices and Circuits", 3rdedition, PHI, 2008
2. D.M. Pozar, "Microwave Engineering", 4th edition, Wiley,2011.
3. Annapurna Das, Sisir K. Das, "Microwave Engineering", 2nd edition, TMH Co., Ltd.,2010.

**References:**
1. I.J. Bhal & P. Bhartia, "Microwave Solid state Circuit Design", 2nd edition, Wiley Publishers, 2003
2. R.E. Collin, "Foundations for Microwave Engineering", 2nd edition, Mc Graw–Hill, 2009.

**EC403 COMMUNICATION NETWORKS (3 - 0- 0) 3**

**Objectives:**

To get an understanding on the fundamentals of networks and issues involved.
To acquire an understanding on the set of rules and procedures that mediates the exchange of information between communicating devices.

**Topics Covered:**

**Unit 1: Layered architecture & Data Link Layer**
General issues in networking – Delays – Throughput- Architectural concepts in ISO's OSI layered model- Data link layer - Direct Link Networks- Error detection- Reliable Transmission- MAC Protocols – ALOHA- CSMA - LANs – IEEE 802.3- IEEE 802.5 - IEEE 802.11
**Unit 2 Network layer**
Datagram and Virtual circuit service – Routers – ICMP.- IPV4 and IPV6 - IP addressing- Sub netting- CIDR- DHCP – NAT – ARP - Routing Principles
**Unit 3: Transport layer**
Transport layer services - Connection Management - Transmission Control Protocol (TCP) - User Datagram Protocol (UDP) - Principles of reliable data transfer - Principles of congestion control - Flow control.
**Unit-4: Application layer**
Overview of HTTP, FTP, SMTP, DNS, Multimedia networking applications - streaming stored video and audio, internet phone, RTP.
**Unit-5: Queuing theory**
Discrete time and continuous time Markov chains- Poisson process- Queuing models for Datagram networks- Little's law - M/M/1 queuing systems

**Course Outcome:**

Compare and examine, OSI and TCP/IP protocol stacks Categorize services offered by all layers in TCP/IP protocol stack Analyze a network under congestion and propose solutions for reliable data transfer, examine the protocols operating at different layers of TCP/IP model.

**Text Books:**

1. J.F.Kurose&K.W.Ross, Computer Networking (3/e) Pearson.
2. W.Stallings, Wireless Communication and Networks, Pearson, 2003

**EC405 MICROWAVE AND MIC LABORATORY (0 - 0 - 3) 2**

**List of Experiments:**

The following List of experiments but not limited to

1. Characteristics of Attenuator.
2. Characteristics of Gunn diode Oscillator.
3. Determination of guide wavelength, frequency measurement.
4. Mode Characteristics of Klystron Oscillator.
5. Radiation Pattern of Horn Antenna.
6. Radiation Pattern of Parabolic Antenna.
7. Characteristics of Directional Coupler
8. Design and Analysis of Microstrip Line
9. Design and Analysis of Stripline
10. MIC Filter

**DEPARTMENT ELECTIVES**

**SEMESTER-V**

**EC321 DIGITAL SIGNAL PROCESSORS AND APPLICATIONS (3 - 0 - 0) 3**

**Pre-Requisite: EC202**

**Objective:**
To give an exposure to the various fixed point & a floating point DSP architectures and to develop applications using these processors.

**Topics Covered:**

**Unit-1: Introduction**
Difference between DSP and other microprocessor architectures-An overview of Motorola and Analog Device DSPs.

**Unit-2: Fixed and Floating Point DSP**
TMS320C54X fixed point architecture- TMS320C3X floating point DSP architecture- CPU-memory- buses and peripherals- Addressing mode..

**Unit-3: Programming Concepts**
Instruction set- Repeat operations - Pipeline operation-Pipeline conflicts- Interrupts.

**Unit-4: Interfacing**
Interfacing- serial interface- parallel interface- DMA operations- A/D and D/A converter interfaces.

**Unit-5: Applications**
DSP tools-DSP applications-MAC- filter design- implementation of DFT- echo cancellation-spectrum analyzer.

**Course Outcomes:**
Students are able to

1. Recognize the fundamentals of fixed and floating point architectures of various DSPs.
2. Learn the architecture details and instruction sets of fixed and floating point DSPs
3. Infer about the control instructions, interrupts, and pipeline operations.
4. Illustrate the features of on-chip peripheral devices and its interfacing along with its programming details.
5. Analyze and learn to implement the signal processing algorithms in DSPs
6. Learn the DSP programming tools and use them for applications

**Text Books:**


1. B. Venkataramani & M. Bhaskar, Digital Signal Processor, Architecture, Programming and Applications,(2/e), McGraw- Hill,2010
2. S. Srinivasan &Avtar Singh, Digital Signal Processing, Implementations using DSP Microprocessors with Examples from TMS320C54X, Brooks/Cole, 2004.


**Reference Books:**


1. Sen M. Kuo & Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004
2. C. Marven & G. Ewers: A Simple approach to digital signal processing, Wiley Inter science, 1996.
3. R.A. Haddad & T.W. Parson: Digital Signal Processing: Theory, Applications and Hardware, Computer Science Press NY, 1991.

**EC323 ADVANCED MICROPROCESSORS (3 - 0 - 0) 3**

**Pre-Requisite: EC210**

**Objective:**

To make the students to learn the advanced techniques in designing the advanced Microprocessors and give exposure to the cache organization, memory management, multitasking and bus interfacing.

**Topics Covered:**

**Unit-1: Introduction**
Software model for Pentium-Real and protected mode of operation- Instruction set-Addressing modes- Interrupts.
**Unit-2: Hardware details of Pentium**
Signal description- Pipelining-Branch prediction-.Cache memories-Floating point unit.
**Unit-3: Memory Management**
Segmentation-Memory management-Paging-Protection-Multitasking.Exceptions-Interrupts-Virtual 8086 mode-Protected mode applications.
**Unit-4: Special Processors**
Introduction-Power PC architecture –Organization-.Programming model- Instruction set.
**Unit-5: Bus Interface**
Introduction-ISA bus-Extended ISA and VESA local bus-PCI bus-USB bus-Serial bus standards- Parallel printer interface standards.

**Course Outcomes:**

Students are able to

1. Ability to design a high speed & high performance microprocessors.
2. Analyze and design the cache memory and pipelining structures.
3. Identify and apply various protected mode concepts like paging, multitasking etc. in high speed processors.
4. Recognize the need for recent Bus standards like PCI Express, USB etc.

**Text Books:**


1. John P Hayes, Computer Architecture and organization, McGraw-Hill 1998.
2. James L. Antonakos, The Pentium Microprocessor, (2/e), Pearson, 2002.


**Reference Books:**


1. John L. Hennessy & David A. Patterson Computer Architecture (3/e), Elsevier, 2003.
2. Barry B. Brey, The Intel Microprocessors, (7/e), Eastern Economy Edition , 2006.
3. A.K. Ray & K.M. Bhurchandi, Advanced Microprocessors and Peripherals, (2/e), Tata McGraw Hill, 2007.

**EC325 INFORMATION THEORY AND CODING**

**Pre-Requisite: None**

**Objectives**

To provide basic concepts of Information
To enable the students to propose, design and analyse suitable coding/decoding scheme for a particular digital communication application

**Unit 1**
Information theory- information and entropy-properties of entropy of a binary memory less source-source coding theorem-Shannon fano coding-Huffman coding –Lempel ziv coding-discrete memory less source-binary symmetric channel –mutual information-properties-channel capacity – channel coding theorem
**Unit 2**
Introduction to algebra-groups-fields-binary field arithmetic-construction of Galois field-basic Properties-computations-vector spaces-matrices-BCH codes-description-coding & decoding –Reed Solomon codes-coding & decoding
**Unit 3**
Coding –linear block codes-generator matrices-parity check matrices-encoder-syndrome and error correction-minimum distance-error correction and error detection capabilities-cyclic codes-coding and decoding
**Unit 4**
Coding –convolutional codes-encoder –generator matrix-transform domain Representation-state Diagram-distance properties-maximum likelihood decoding-Viterbi decoding-sequential decoding
**Unit 5**
Burst errors -Interleaved codes-Turbo coding- coding & decoding -Trellis codes- coding & decoding

**Text Books**

1. Simon Haykins,Communication Systems,John Wiley
2. Shi Lin,Costello D.J ., Errpr Control Coding-Fundamentals amd Applications,Prentice Hall Inc. Eaglewood Cliffs

**Reference Books**

1. Das J.Malik A.K., Chatterjee P. K. .,Principles of Digital Communications,New Age International
2. Simon Haykin,Digital Communications,John Wiley
3. Taub& Schilling, Principles of Communication System,TATA MC Graw Hill
4. Tomasi,Electronic Communications,Fundamentals Through Advanced,Pearson education
5. Sklon, Digital Communications Pearson education
6. Couch,Digital and Analog Communication System, Pearson education

**EC327 ADVANCED MICROCONTROLLERS (3 – 0 - 0) 3**

**Pre-Requisite: EC210**

**Objective**

This course is intended for the students to know more about the practical microcontrollers

**Topics Covered:**

**Unit - 1: PIC Microcontroller**
CPU Architecture – Instruction set – interrupts- Timers- I2C Interfacing –UART- A/D Converter – PWM and introduction to C-Compilers
**Unit - 2: AVR microcontroller**
Internal Architectural - Block diagram of controller (Atmega 8) - Functions - Configuration of Two 8-bit and One 16-bit Timers and Counters - 6-channel ADC Working - Initial programming configurations of Atmega8: port, counter, timer - Bootloader Circuit - ISP of Atmega
**Unit - 3: Open Source Embedded Development Board (Arduino)**
Arduino: Birth, Open Source community - Functional Block Diagram of Arduino - Functions of each Pin of Arduino - Arduino Development Board diagram - Designing of 1st sketch - Programming of an Arduino (Arduino ISP) - Arduino Boot loader - Serial port Interfacing - Initialization of Serial Port using Functions - Basic Circuit For Arduino
**Unit - 4: Arduino Interfacing**
Basic Interfacing and I/O Concept - Interfacing LED,Switch,7seg LED its and Code - Interfacing POT,LM35,Acelerometer (ADXL3C5C) and its Code - Interfacing keypad and Code for it - Initialization for serial port and code for it - Interfacing DC motor and its Code –
Interfacing 16x2 LCD and its code
**Unit - 5: Embedded system Applications (Arduino)**
Motor Driver L293D, IR Sensor - Interfacing L293D - Code for Line Follower Robot - Interfacing Accelerometer - Record Gestures, Code For Accelerometer based Robot - Interfacing of RF Tx/RF Rx - Interfacing of Relay Driver ULN2803 - Code for Home automation and its Control

**Course Outcomes:**

1. To know the architecture and programming of PIC microcontroller
2. To know the architecture and programming of AVR microcontroller
3. To know the programming, interfacing and applications of Aurduino

**Text Books**


1. John .B.Peatman , “Design with PIC Microcontroller”, Prentice Hall, 1997.
2. Steven F. Barrett**,** Daniel J. Pack**,** Atmel AVR Microcontroller Primer: Programming and Interfacing, Second Edition, Morgan & Claypool Publishers series
3. John Nussey, Arduino For Dummies 1st Edition, John Wiley & Sons
4. John Baichtal , Arduino for Beginners: Essential Skills Every Maker Needs, Pearson Education, Inc.

**EC 329 DIGITAL IMAGE PROCESSING (3 - 0 - 0) 3**

**Objective:**

1. This course develops an overview of the field of image processing and help to understand the fundamental algorithms and how to implement them.
2. Provide an experience in applying image processing algorithms to real problems.

**Topics Covered:**

**Unit-1: Digital Image Processing**
Examples of Digital Image Processing - Components of image processing -Elements of Visual perception - Image sensing and acquisition using single sensor - sensor strips and sensor arrays - Image sampling and quantization: Basic concepts of sampling and quantization - Spatial and Gray level representation - Aliasing and Moire Patterns
**Unit-2: Image Enhancement**
Spatial Domain: Grey level transformation - Image negatives - Log transformations - Power law transformations - Piecewise linear transformation - Histogram Processing - Enhancement using Arithmetic and Logic operation - Smoothing Spatial Filter - Linear filter, Order Statistics filter - Sharpening Spatial Filters. Frequency Domain: Introduction to the Fourier Transform and the Frequency Domain - Smoothing Frequency Domain Filters - Sharpening Frequency Domain Filters - Homomorphic Filtering
**Unit-3: Color image processing and image Restoration:**
Noise Models - Restoration in the Presence of Noise Only - Spatial Filtering - Mean Filters, Order-Statistics Filters - Adaptive Filters - Periodic Noise Reduction by Frequency Domain Filtering Linear - Position Invariant Degradations - Estimating the Degradation Function. Color Image Processing: Color Fundamentals - Color Models, Pseudo-color Image Processing - Intensity Slicing - Gray Level to Color Transformations - Basics of Full- Color Image Processing - Color Transformations - Smoothing and Sharpening - Color Segmentation
**Unit-4: Wavelets and Multi-resolution Processing**
Image Pyramids - Sub-band Coding -The Haar Transform - Multi-resolution Expansions - Wavelet Transforms in One Dimension - Wavelet Transforms in Two Dimension
**Unit-5: Image Compression, Segmentation and Morphological Image Processing**
Compression: Redundancy - Image Compression Models - Elements of Information Theory - Error-Free Compression -Lossy Compression - Image Compression Standards. Segmentation: Detection of Discontinuities - Edge Linking and Boundary Detection Thresholding - Region-Based Segmentation - Segmentation by Morphological Watersheds. Morphological Image Processing: Basic Concepts from Set Theory - Logic Operations Involving Binary Images - Dilation and Erosion - Opening and Closing, Hit-or-Miss Transformation - Basic Morphological Algorithms -Gray-Scale Morphology-Python and mini project

**Outcomes:**

1. Students learn about image processing tools
2. Apply the image processing for practical applications

**Text Books:**


1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd ed, Prentice Hall, 2008
2. R. C. Gonzalez, R. E. Woods, and S. L. Edins, Digital Image Processing with MATLAB, Prentice Hall, 2004
3. The FundamentalsImage Processing, Maria Petrou, Costas Petrou, Wiley Publisher, 2nd Edition, 2010
4. Fundamentals on Digital Image Processing, A. K. Jain, PHI, 2005

**SEMESTER-VI**

**EC322 SPEECH PROCESSING (3 - 0 - 0 )3**

**Objectives:**

1. The course covers the main aspects of speech processing by computer. Topics include: models of the vocal tract; identification and extraction of speech features; speech compression; the recognition of speech and speakers by computer; and control of speech synthesizers.
2. To understand the process of speech production and perception
3. Processing the speech for finding the speech and speaker information
4. Understand about the automatic recognition of speech

**Topics Covered:**

**Unit-1: Digital models for the speech signal**
Process of speech production - Acoustic theory of speech production - Lossless tube models - and Digital models for speech signals
**Unit-2: Time domain models for speech processing**
Time dependent processing of speech - Short time energy and average magnitude - Short time average zero crossing rate - Speech vs silence discrimination using energy & zero crossings - Pitch period estimation - Short time Autocorrelation function - Short time average magnitude difference function - Pitch period Estimation using autocorrelation function
**Unit-3: Short time Fourier analysis**
Linear Filtering interpretation - Filter bank summation method - Overlap addition method - Design of digital filter banks - Implementation using FFT - Spectrographic displays - Pitch detection - Analysis by synthesis -Analysis synthesis systems. Homomorphic speech processing: Homomorphic systems for convolution - Complex cepstrum - Pitch detection - Formant estimation – Homomorphic vocoder
**Unit-4: Linear predictive coding of speech**
Basic principles of linear predictive analysis - Solution of LPC equations - Prediction error signal - Frequency domain interpretation - Relation between the various speech parameters - Synthesis of speech from linear predictive parameters - Applications
**Unit-5: Speech Enhancement**
Spectral subtraction & filtering -Adaptive noise cancellation - Speech Synthesis: Principles of speech synthesis - Synthesizer methods - Synthesis of intonation - Speech synthesis for different speakers - Speech synthesis in other languages – Evaluation - Practical speech synthesis - Automatic Speech Recognition -Audio Processing: Auditory perception and psychoacoustics – Masking - frequency and loudness perception - spatial perception - Digital Audio, Audio Coding - High quality -lowbit- rate audio coding standards – MPEG - AC-3 - Multichannel audio - Stereo, 3D binaural and Multichannel surround sound.

**Course Outcome:**

Students know about the necessity of speech processing for finding speech information or speaker information

**Text Books:**

1. L. R. Rabiner and R. W. Schafer, “Digital Processing of Speech Signals," Pearson Education (Asia) Pte. Ltd., 2004.
2. L. R. Rabiner and B. Juang, “Fundamentals of Speech Recognition,” Pearson Education (Asia) Pte. Ltd., 2004.

**Reference Books:**

1. C Becchetti& L P Ricotti, “Speech Recognition Theory & C++ Implementation” John Wiley & Sons
2. D. O’Shaughnessy, “Speech Communication Human & Machine”, Universities Press.
3. B. Gold & N. Morgan “Speech & Audio Signal Processing”, John Wiley & Sons
4. D. O’Shaughnessy, “Speech Communications: Human and Machine,” Universities Press, 2001.
5. Z. Li and M.S. Drew, “Fundamentals of Multimedia,” Pearson Education (Asia) Pvt. Ltd., 2004.

**EC324 EMBEDDED SYSTEM DESIGN (3 - 0 - 0) 3**

**Pre-Requisite: EC210**

**Objectives:**

To introduce students to the modern embedded systems and to show how to understand and program such systems using a concrete platform.

**Topics Covered:**

**Unit-1: Introduction**
Overview of various types of microcontrollers -.Processor selection for embedded system-Selection of memory for embedded system- Devices and buses for device networks.
**Unit-2: 8 and 16 bit microcontroller**
Motorola 68HC11/ 68HC12 family of microcontrollers-Internal architecture- Addressing modes and instruction set- Interrupts.
**Unit-3: Software development**
Introduction- Integrated Development Environment- Role of compiler & debugger-gcc/g++ compiler commands- Writing Makefile-Role of Kernel-Writing Kernel program-GUI design and development using JAVA/HTML
**Unit-4: Real time operating systems**
Introduction- OS services-I/O subsystems-Network operating system- Real time embedded system OS- Architecture of RTOS-Interrupt & Exception routine in RTOS-Tasks & Synchronization & communication-OS security.
**Unit-5: Introduction & Fundamentals of ARM& Arduino**
Introduction to ARM processor-ARM core data flow model-GPIOs-Architecture- Arduino, Architecture- Programming structure- Built in functions-libraries.

**Course Outcomes:**

Students are able to

1. Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
2. Become aware of interrupts, hyper threading and software optimization.
3. Design real time embedded systems using the concepts of RTOS.
4. Analyze various examples of embedded systems.

**Text Books:**


1. Raj Kamal, Embedded Systems Architecture, Programming, and Design. (2/e), Tata McGraw Hill, 2008.
2. K.V. Shibu, Introduction To Embedded Systems, Tata McGraw, 2009.
3. Peter Barry and Patric Crowley, Intel architecture for Embedded system .


**Reference Books:**


1. Jonathan. W. Valvano, Embedded Microcomputer Systems, Real Time Interfacing, Published by Thomson Brooks/Col, 2002.
2. G.H. Miller, Microcomputer Engineering, 3d edition, Pearson Education.

**EC326 ADAPTIVE SIGNAL PROCESSING (3 - 0 - 0-3)**

**Objective:**

The course Adaptive Signal Processing presents its algorithms and architectures and explains their use in real world applications. As prerequisites it is assumed that students have studied discrete and continuous signals and systems, and introductory linear algebra.

**Topics Covered:**

**Unit-1: General Introduction**
Adaptive systems: Definition and characteristics, areas of applications - general properties - Open and closed loop adaptation - applications of closed loop adaptation. The adaptive liner combiner: General description -input signal and weight vectors - desired Response and error - the performance function - gradient and minimum mean square error - Example of performance surface - alternative expression of the gradient - de-correlation of Error and input components
**Unit-2: Theory of adaptation with stationary signals**
Properties of the quadratic performance surface: Normal form of the input correlation Matrix - eigen values and eigen vectors of the input correlation matrix - an example with two weights - geometrical significance of eigen vectors and eigen values. Searching the performance surface: Methods of searching the performance surface - basic ideas of gradient search methods - a simple gradient search algorithm and its solution - stability and rate of convergence
**Unit-3: Gradient estimation and its effects on adaptation**
Gradient component estimation by derivative measurement - the performance penalty - derivative measurement and performance penalties with multiple weights - variance of the gradient estimate
**Unit-4: Partial Characterization of a Discrete-Time Stochastic**
Process - Mean Ergodic Theorem - Correlation Matrix - Correlation Matrix of Sine Wave Plus Noise - Stochastic Models - Asymptotic Stationary of an Autoregressive Process - Yule-Walker Equations - Complex Gaussian Process - Power Spectral Density - Properties of Power Spectral Density - Transmission of a Stationary Process Through a Liner Filter - Cramer Spectral Representation for a Stationary Process - Power Spectrum Estimation - Other Statistical Characteristics of a Stochastic Process - Wiener filters:Linear Optimum Filtering - Statement of the problem - Principle of Orthogonally
**Unit-5: Minimum Mean-Square Error Adaptive algorithms and structures**
The LMS algorithms - RLS adaptive filters: Some Preliminaries - The Matrix Inversion Lemma - The Exponentially Weighted Recursive Least-Squares Algorithm - Selection of The Regularizing Parameter - Update Recursion for the sum of weighted Error Squares convergence analysis of the RLS Algorithm - Computer Experiment on Adaptive Equalization - Robustness of RLS filter

**Course Outcomes:**

Students will learn about the real world applications of signal Processing

**Text Books:**

1. Adaptive Filter Theory- S. Haykin,4th Edition, Pearson Education, 2008
2. Adaptive Filters, A. H. Sayed, John Wiely and Sons, 2008

**Reference Books:**

1. Adaptive filtering primer with MATLAB, Alexander D. Poularikas, Zayed M. Ramadan, CRC Press, 2006
2 Adaptive Signal Processing, B. Widrow and S.D. Stearns,Prentice Hall, Englewood Cliffs, NJ, 1985.

**EC328 COMPUTER ORGANIZATION AND ARCHITECTURE (3-0-0) 3**

**Objectives**

- To understand how computers are constructed out of a set of functional units and how the functional units operate, interact, and communicate.
- To make the students to understand the concept of interfacing memory and various I/O devices to a computer system using a suitable bus system.

**Topics Covered:**

**Unit 1:**
Introduction: Function and structure of a computer, Functional components of a Computer, Interconnection of components, Performance of a computer.
**Unit 2:**
Representation of Instructions: Machine instructions, Memory locations & Addresses, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures, Super scalar Architectures, Fixed point and floating point operations.
**Unit 3:**
Basic Processing Unit: Fundamental concepts, ALU, Control unit, Multiple bus organization, Hardwired control, Micro programmed control, Pipelining, Data hazards, Instruction hazards, Influence on instruction sets, Data path and control considerations, Performance considerations.
**Unit 4:**
Memory organization: Basic concepts, Semiconductor RAM memories, ROM, Speed - Size and cost, Memory Interfacing circuits, Cache memory, Improving cache performance, Memory management unit, Shared/Distributed Memory, Cache coherency in multiprocessor, Segmentation, Paging, Concept of virtual memory, Address translation, Secondary storage devices.
**Unit 5:**
I/O Organization: Accessing I/O devices, Input/output programming, Interrupts, Exception Handling, DMA, Buses, I/O interfaces- Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewall and Infinity band, I/O peripherals.

**Course Outcomes**

At the end of the course student will be able to

1. apply the basic knowledge of digital concept to the functional components of a Computer System.
2. analyze the addressing mode concepts and design the instruction set Architecture.
3. identify the functions of various processing units within the CPU of a Computer System.
4. analyze the function of the memory management unit and create suitable memory interface to the CPU.
5. recognize the need for recent Bus standards and I/O devices.

**Text Books**

1. C.Hamacher Z. Vranesie S. Zaky and Manjikian, "Computer Organization and Embedded Systems", 6th Edition, McGraw-Hill, 2012.
2. W. Stallings, "Computer Organization and Architecture - Designing for Performance", &b Edition, Prentice Hall of lndia,2010.

**Reference Books**

1. B,Parhami, "Computer Architecture, From Microprocessors to Supercomputers", Oxford University Press, Reprint 2014.
2. J. L. Hennessy and D. A. Patterson, "Computer Architecture, A Quantitative Approach", 5th Edition, Morgan Kaufmann, 2012.
3. J .P. Hayes, "Computer Architecture and Organization", 3rd Edition, McGraw-Hill, 1998. Recent literature in Computer Architecture and Organization.

**SEMESTER - VII**

**EC421 FIBER OPTIC COMMUNICATION (3 - 0 - 0) 3**

**Pre-Requisite: EC301**

**Objectives:**

To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

**Topics Covered:**

**Unit-1: Introduction**
Optical Fibers: Structure, Wave guiding, Step-index and graded index optical fibers, Modal analysis, Classification of modes, Single mode fiber and its practical measurement of numerical aperture.
**Unit-2: Dispersion**
Pulse dispersion: Material and waveguide dispersion, Polarization mode dispersion, Absorption, Scattering and bending losses, dispersion shifted fibers, dispersion compensating fibers. Practical measurement of bending losses.
**Unit-3: Fiber Connectors and Couplers**
Optical Power Launching and Coupling: Lensing schemes for coupling improvement, Fiber-to-fiber joints, Splicing techniques, Optical fiber connectors, OTDR.
**Unit-4: Sources and detectors**
Optical sources and detectors: Laser fundamentals, Semiconductor Laser basics, LEDs, PIN and Avalanche photodiodes, Diode characteristics, Noise and Detection, Thermal and shot noise, Signal to Noise Ratio.
**Unit-5: Design Considerations**
Design considerations of fiber optic systems: Analog and digital modulation, , Bit error rate, Optical receiver operation, Power Budget and rise time Budget, WDM, Simulation of EDFA design for DWDM.

**Course Outcomes:**

1. Able to understand propagation of signal through Fiber cable.
2. Able to understand the various modes of propagation and its importance.
3. Able to implement Fiber optics systems.

**Text Books:**


1. G. Keiser, Optical Fiber Communications (4/e), TMH, 2008.
2. Optical Fibre Communication: Principals and Techniques", John M. Senior, PHI New Delhi 3/e,2008


**Reference Books:**


1. MMK. Liu, Principles and Applications of Optical Communications, TMH, 2010.
2. G.P. Agrawal, Fiber Optic Communication Systems, (3/e), Wiley, 2002.
3. J. Gowar, Optical Communication Systems, (2/e), PHI, 2001.

**EC 423 ANALOG CMOS DESIGN (3 - 0 - 0 ) 3**

**Pre-Requisite: EC304**

**Objectives:**

1. To teach MOSFET Amplifier issues
2. To make student to learn design issues related to various MOS amplifiers

**Topics Covered:**

**Unit-1: Introduction**
MOS Capacitor-CV characteristics, Ideal MOSFET equation-Small Signal Model-AC Analysis-MOS Models-Spice Model, 2nd order effects.
**Unit-2: Current source**
Current source and Sinks-Current Mirror-Cascode Connection-Temperature Analysis, transient R esponse.
**Unit-3: Voltage source**
Voltage References, MOSFET Divider-Threshold Voltage References-Diode referenced, Bandgap Voltage References.
**Unit -4: Feedback Amplifier**
MOS Amplifiers-Feedback Amplifier-Various Topologies-Negative Feedback-Open loop and closed loop analysis.
**Unit -5: Operational Amplifier**
Differential Amplifier, Source coupled pair, Operational Amplifier, Characteristics, Cascode Input Op-Amp, Operational Transconductance Amplifier

**Course Outcomes:**

1. Able to design analog circuits**.**
2. Able to understand design issues related to stability of Opamps
3. Able implement designs using spice tool.

**Text Books:**

1. Design of Analog CMOS Integrated Circuits, by Behzad Razavi, McGraw-Hill 2000
2. CMOS Analog Circuit Design, Phillip E. Allen and Douglas R. Holberg, Oxford University Press

**Reference Books:**

1. Pucknell & Eshraghian, Basic VLSI Design, PHI, (3/e).
2. Uyemura, Introduction to VLSI Circuits and Systems, Wiley, 2002.

**EC425 DEEP LEARNING AND NEURAL NETWORK (3-0-0)3**

**Prerequisites:**

1. It is assumed the students have a working knowledge of calculus, linear algebra, and probability theory. It would be beneficial if the students have done a course on Machine Learning.
2. It is also assumed the students have some experience programming in a scientific computing environment. Python will be used throughout the course.

**Objective:**

This topics course aims to present the mathematical, statistical and computational challenges of building stable representations for high-dimensional data, such as images, text and data.

**Unit-1:** Introduction to machine learning and neural networks: supervised learning, linear models for regression, basic neural network structure, simple examples and motivation for deep networks. Neural networks: forward propagation, cost functions, error back propagation, training by gradient descent, bias/variance and under/over fitting, regularization
**Unit-2:** Convolutional Neural Networks, Deep Unsupervised Learning, Sequence Modeling: Recurrent and Recursive Nets, Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications
**Unit-3:** Deep Learning Research: linear factor models, autoencoders, structured probabilistic models for deep learning, Monte Carlo methods, confronting the partition function, Approximate Inference
**Unit-4:** Deep Generative Models: Boltzmann Machines, Deep Belief Networks, Deep Boltzmann Machines, Convolutional Boltzmann Machines, Directed Generative Nets
**Unit-5:** Lab-1: Neural networks. Exercise on neural networks. Solving problem with neural networks on tensorflow. Lab 2: Convolutional Neural Networks (CNNs). Exercise on CNNs. Solving a problem with CNNs on tensorflow. Lab 3: Recurrent Neural Networks (RNNs). Exercise on RNNs. solving a problem with RNNs on tensorflow.

**Course Outcomes:**
Upon successfully completion of course student will be able to

1. Understand motivation and functioning of the most common types of deep neural networks, convolutional architectures, invariance learning, unsupervised learning and non-convex optimization.
2. Understand the choices and limitations of a model for a given setting
3. Apply deep learning techniques to practical problems
4. Critically evaluate model performance and interpret results

**Text Book:**

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning, An MIT Press book Cambridge, MA, USA, 2015.
2. Skansi and Sandro. Introduction to Deep Learning from Logical Calculus to Artificial Intelligence, Springer Publication, 2018.
3. Nicholas Locascio and Nikhil Buduma. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, O'Reilly Media USA, 2017.

**References:**


1. R. O. Duda and P.E. Hart and D. G. Stork. Pattern Classification. Wiley-Interscience, 2nd Edition, 2001.
2. S. Theodoridis and K. Koutroumbas. Pattern Recognition. 4th Edition, Academic Press, 2008.
3. S. Russell and N. Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.
4. C. M. Bishop. Neural Networks for Pattern Recognition. Oxford University Press, 1995.
5. T. Hastie and R. Tibshirani and J. Friedman. The Elements of Statistical Learning, Springer, 2001.
6. D. Koller and N. Friedman. Probabilistic Graphical Models, MIT Press, 2009.

**SEMESTER-VIII**

**EC422 COMMUNICATION SWITCHING SYSTEMS (3 - 0 - 0) 3**

**Pre-Requisite: EC301**

**Objective:**

To understand the working principles of switching systems from manual and electromechanical systems to stored program control systems.

**Topics Covered:**

**Unit -1: Switching Systems and Signalling**
Basic elements of communication network. Switching systems. Signaling and signaling functions.
**Unit -2: Digital Telephone Network**
Digital telephone network.T1 Carrier systems. TDM hierarchy. Data under voice. Digital switching. Echo cancellers.
**Unit -3: Synchronous and Asynchronous Transmission**
Synchronous versus asynchronous transmission. Line coding .Error performance. TDM. TDM loops and rings.
**Unit -4: Switches**
Space and time divided switches. Multistage switches. Design examples. Path finding. Switching matrix control. Digital time division switch. Time Space switching. Time Space Time switching. Digital Switching in analog environment.
**Unit -5: ISDN, ADSL and Traffic Analysis**
Digital subscriber access - ISDN -ISDN services, ISDN architecture, ISDN channels and ISDN protocols - ADSL - Line code standards, ADSL MODEM - Traffic analysis

**Course Outcomes :**

Students are able to

1. Explain the working principle of switching systems involved in telecommunication switching
2. Assess the need for voice digitization and T Carrier systems
3. Compare and analyze Line coding techniques and examine its error performance
4. Design multi stage switching structures involving time and space switching stages
5. Analyze basic telecommunication traffic theory

**Text Books:**


1. J.C. Bellamy, Digital Telephony, (3/e), Wiley, 2000.
2. E. Keiser & E. Strange, Digital Telephony and Network Integration, (2/e), Van Nostrand, 1995.


**Reference Books:**


1. Thiagarajan Viswanathan, Telecommunication Switching Systems and Networks, PHI, 2006.
2. J.E. Flood, Telecommunications Switching, Traffic and Networks, Prentice Hall, 1995.
3. M.T. Hills, Telecommunication Switching Principles, London: Allen and Unwin, 1979.

**EC424 MICROWAVE INTEGRATED CIRCUIT DESIGN (3 - 0 – 0 ) 3**

**Pre-Requisite: EC206**

**Objective:**

To impart knowledge on design and analysis of various MIC components and circuits.

**Topics Covered:**

**Unit-1: Power dividers design:**
Design and realization of power dividers, hybrids, directional couplers etc using strip lines and microstrip lines.
**Unit-2 Advanced Filter design Techniques**
Kuroda identities. K and J inverters. Filter transformations. Realization using strip lines and microstrip lines.
**Unit-3: Transistor amplifiers design**
Power gain equations - Stability considerations – Analysis - Design using MICs.
**Unit-4: Transistor oscillators design**
Active devices for microwave oscillators - Three port S parameter characterization of transistors - Oscillation and stability conditions.
**Unit-5: Mixers & Phase Shifters design**
Single ended mixer - Balanced mixer -Image rejection mixer - Phase shifter design - PIN diode - Phase shifter.

**Course Outcome:**

1. Know the design of MIC Circuit.
2. Perform the complete design and layout of MIC components.

**Text Books:**


1. I.J.Bhal & P.Bhartia, “Microwave Solid state Circuit Design”, 2nd edition, Wiley Publishers, 2003
2. George D. Vendelin, Anthony M. Pavio & Ulrich L. Rohde “Microwave Circuit Design using Linear and Nonlinear Techniques”, 2nd edition, Wiley Publishers, 2005.

**EC426 BROADBAND ACCESS TECHNOLOGIES (3 - 0 - 0)3**

**Pre-Requisite:EC301**

**Objective:**

To impart fundamentals and latest technologies related to the design of broadband last mile-Access technologies for multimedia communication

**Topics Covered:**

**Unit -1: Introduction to Broadband technologies**
Phone line modem-ISDN.Broadband technologies. Cable, DLS, fiber and wireless access technologies.
**Unit -2: Digital subscriber lines**
ADSL,RADSL,IDSL,HDSL,SDSL,VDSL, Standards for XDSL and comparison.
**Unit -3: Cable modems**
Cable modems,DOCSIS, Hub operation, Access control, Framing, Security, data link and higher layers. ATM and IP-centric modem.
**Unit -4: Fiber access technologies and architectures**
Hybrid fiber-coax systems, SDV, EPON, GPON.FTTX comparison.
**Unit -5: Broadband wireless systems**
Direct broadcast satellite.MMDS.LMDS. WIDIS. 3G wireless systems. IMT2000.

**Course Outcomes:**

Students are able to

1. Recall and identify the basics of broadband technology systems and differentiate the differences between the various wired and wireless technology system
2. Illustrate the aspects of last mile data transport on copper wire networks and flavors of DSL
3. Summarize the versions of cable network standard and MAC protocols for HFC networks Distinguish he cost effective broadband services for residential users and ATM based and Ethernet based passive optical networks
4. Outline the types of broadband wireless access technologies and their characteristics.

**Text Books:**


1. NikilJayant, Broadband last mile - Taylor and Francis group, 2005
2. N. Ransom & A.A. Azzam, Broadband Access Technologies, McGraw Hill, 1999.
3. M.P. Clarke, Wireless Access Network, Wiley, 2000.


**Reference Books:**


1. W.J. Woralski, ADSL and DSL Technologies, McGraw Hill, 1998.
2. S. Mervana& C. Le, Design and Implementation of DSL-based Access Solutions, Cisco Press, 2001.
3. W. Vermillion, End-to-End DSL Architecture, Cisco Press, 2003.

**EC428 PRINCIPLES OF RADAR (3 - 0 - 0) 3**

**Pre-Requisite: EC305 & EC302**

**Objective:**

To expose the students to the working principles of a radar from a signal processing perspective.

**Topics Covered:**

**Unit-1: Introduction**
Radar Block diagram and Operation, Radar equation. Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Signal to Noise Ratio, Matched filter impulse response, Integration of radar Pulses, Radar cross section, Cross section of small targets. Target scattering matrices, Area and volume targets. Radar Clutter-surface clutter, sea clutter and Land clutter, weather clutter, Transmitter Power, Pulse Repetition Frequency and Range ambiguities.
**Unit-2: Radar signals**
Radar signals Ambiguity function and its properties. Uncertainty principle. Pulse compression. linear FM pulse. Pulse compression by Costas FM and binary phase coding.
**Unit-3: Radar detection**
Optimum Bayesian decision rules. Detection criteria for different target models. Detector characteristics.
**Unit-4: Range and Doppler measurements**
Range and Doppler measurements and tracking, Range and Doppler frequency resolutions. Optimum receivers. Optimum filters for Doppler measurements. Coherent and non-coherent implementations.
**Unit -5: Angle measurement and tracking**
Angle measurement and tracking by conical scan and mono pulse. Optimum mono pulse systems.

**Course Outcomes:**

1. At the end of learning the course, one should be able to apply his mind in developing radar for any given frequency and apply practically.
2. Students are expected to be familiar with various radar detection and tracking systems.

**Text Books:**


1. P.Z. Peebles, Radar Principles, Wiley, 1998.
2. Merrill I. Skolink, Introduction to Radar Systems, (3/e), Tata MG Graw Hill, 2001


**Reference Books:**


1. N. Levanon, Radar Signals, Wiley, 2005.
2. D. Wehnar: High Resolution, Artech House Radar (1987).
3. D.K. Barton: Radar systems Analysis, Prentice Hall(1976).

**EC430 SATELLITE COMMUNICATION (3 - 0 - 0) 3**

**Pre-Requisite: EC301 and EC302**

**Objective:**

To impart knowledge on various aspects in the design of systems for satellite communication.

**Topics Covered :**

**Unit-1: Orbital Mechanics**
Frequency allocation for Satellite services - Elements of orbital mechanics - Equations of motion - Tracking and orbit determination. Orbital correction/control. Satellite launch systems. Multistage rocket launchers and their performance.
**Unit-2 Satellite Subsystems**
Orbital correction/control – Attitude Control - Station keeping - Thermal Control - TT&C Systems – Transponders - Satellite antennas. Reliability considerations
**Unit-3: Elements of communication satellite design.**
Satellite link design: Performance requirements and standards. Design of satellite links – DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite - based personal communication.
**Unit-4: Multiple access techniques**
FDMA,TDMA,CDMA. Random access techniques - Satellite onboard processing.
**Unit - 5: Earth Station design and tracking antennas**
Earth station design - Configuration. Antenna and tracking systems. Satellite broadcasting.

**Course outcomes**:

Students are able to

1. Able to understand how analog and digital technologies are used for satellite communication networks.
2. Able to understand the radio propagation channel for Earth station to satellite.

**Text Books:**


1. D. Roddy, “Satellite Communication”, 4$^{th}$edition, McGraw- Hill, 2009.
2. T. Pratt & C.W. Bostain, “Satellite Communication”, 2$^{nd}$ edition, Wiley Publishers, 2008.


**Reference Book:**


1. B.N. Agrawal, Design of Geo-synchronous Spacecraft, Prentice- Hall,1986.

**EC432 DESIGN OF COGNITIVE RADIO ( 3 - 0 - 0 ) 3**

**Pre-Requisite: EC201& EC202**

**Objective:**

This subject introduces the fundamentals of multi rate signal processing and cognitive radio.

**Topics Covered:**

**Unit-1: Filter banks**
Uniform filter bank. direct and DFT approaches. Introduction to ADSL Modem. Discrete multitone modulation and its realization using DFT. QMF. STFT. Computation of DWT using filter banks.
**Unit-2: DDFS**
ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC. Vector and rotation mode of CORDIC. CORDIC architectures.
**Unit-3: Block diagram of a software radio**
Digital down converters and demodulators Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Under sampling receivers, Coherent demodulation schemes.
**Unit-4: Concept of Cognitive Radio**
Benefits of Using SDR, Problems Faced by SDR, Cognitive Networks, Cognitive Radio Architecture. Cognitive Radio Design, Cognitive Engine Design,
**Unit-5: OFDM**
Basic OFDM System Model, OFDM based cognitive radio, Cognitive OFDM Systems, MIMO channel estimation, Multi-band OFDM, MIMO-OFDM synchronization and frequency offset estimation. Spectrum Sensing to detect Specific Primary System, Spectrum Sensing for Cognitive OFDMA Systems.

**Course Outcomes:**

Students are able to

1. Gain knowledge on multirate systems.
2. Develop the ability to analyze, design, and implement any application using FPGA.
3. Be aware of how signal processing concepts can be used for efficient FPGA based system design.
4. Understand the rapid advances in Cognitive radio technologies.
5. Explore DDFS, CORDIC and its application.

**Text Books:**


1. S. K. Mitra, Digital Signal processing, McGrawHill, 1998
2. J. H. Reed, Software Radio, Pearson, 2002.
3. U. Meyer-Baese , Digital Signal Processing with FPGAs, Springer, 2001.
4. Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems by HüseyinArslan, University of South Florida, USA, Springer.


**Reference Books:**


1. Cognitive Radio Networks by Kwang-Cheng Chen, Ramjee Prasad, Wiley, 2009-06-15.
2. Artificial Intelligence in Wireless Communications by Thomas W. Rondeau, Charles W. Bostian.

**EC434 INTRODUCTION TO MEMS (3 - 0 - 3) 3**

**Pre-Requisite: PH121 and EC102**

**Objective:**

**M**icro **E**lectro **M**echanical **S**ystems (MEMS) are miniature devices that are widely used in consumer products such as accelerometers used in cars to activate the airbags and in smart phones to flip images and play video games. This course will introduce the basics of MEMS design, fabrication, sensing and actuation mechanisms, characterization and reliability testing. The MEMS concepts are reinforced through labs that involve design and simulation of MEMS devices using an advanced MEMS simulation tool and testing of actual MEMS devices. The applications and challenges of existing MEMS devices will be discussed.

**Topics Covered:**

**Unit-1: Micro fabrication**
Silicon as MEMS material, Silicon doping and oxidation, Deposition and etching
**Unit-2: Micro machining**
Bulk micromachining, wet etching, Bulk micromachining-dry etching, Surface micromachining-processes, LIGA and electroplating
**Unit-3: Actuation and Sensing**
Electrostatic actuation (parallel plate), Electrostatic actuation (comb drive), Electrostatic sensing, Piezoelectric sensing, Thermoelectric sensing and actuation
**Unit-4: Design and Modelling**
Design considerations, Scaling in miniaturization, Finite Element analysis, Packaging & Assembly: wire bonding and encapsulation, Surface bonding and 3D packaging, Wafer level packaging, Signal integrity
**Unit-5: MEMS Testing and Reliabilities**
Accelerated testing, MEMS characterization: characterization techniques, Applications: Acoustic MEMS: Microphones, Opitcal MEMS: micro-mirrors, Microfluidics

**Course Outcomes:**

Upon completion of this course, you will have gained the following:

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
3. An ability to identify, formulate, and solve engineering problems
4. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Text Books:**

1. Fundamental of MEMS by N.P.G.S Mahalik, TMH
2. Foundations of MEMS by Chang Liu (2nd edition), 2012, PHI

**Reference Books:**

1. MEMS and Microsystems (2nd edition) by Tai-Ran Hsu, 2008. Wielly& sons
2. Microsystem design by Stephen Senturia, Springers

**EC436 BIOMEDICAL SIGNAL AND IMAGE PROCESSING (3-0-1-3)**

**Pre-Requisite: EC201& EC364**

**Objective:**

- This course emphasis on fundamentals of digital signal processing and problems in biomedical research and clinical medicine, which includes principles and algorithms for processing both deterministic and random signals. Topics include data acquisition, imaging, filtering, coding, feature extraction, and modelling.
- The aim of the course is a series of labs that provide practical experience in processing physiological data, with examples from cardiology, speech processing, and medical imaging. The labs are done in MATLAB® during weekly lab sessions that take place in an electronic classroom. Lectures cover signal processing topics relevant to the lab exercises, as well as background on the biological signals processed in the labs.

**Topics Covered:**

**Unit-1: Biomedical Signals and Images**
ECG - Speech Signals - Speech Coding - Imaging Modalities - X-ray – MRI – fMRI - Fundus Image
**Unit-2: Fundamentals of Deterministic Signal and Image Processing**
Data Acquisition - Digital Filtering - DTFT -DFT - Image Processing
**Unit-3: Probability and Random Signals**
PDFs Classification: Bayes' rule - detection, statistical classification - Time averages - Ensemble averages - Autocorrelation Functions - Cross-correlation Functions - Random signals and linear systems - power spectra - cross spectra - Wiener filters - Blind source separation - PCA – EVD – SVD - ICA
**Unit-4: Image Segmentation and Registration**
Image Segmentation (statistical classification, morphological operators, connected components) - Image Registration (Rigid and non-rigid transformations, objective functions, Joint entropy, optimization methods)
**Unit-5: Laboratory Projects, Tools: MATLAB**

1. ECG Filtering and Frequency Analysis of the Electro-gram Design filter to remove noise from electrocardiogram (ECG) signals and then design a system to detect life-threatening ventricular arrhythmias. The detector is tested on normal and abnormal ECG signals.
2. Speech Coding Implement, test, and compare two speech analysis-synthesis systems. These systems utilize a pitch detector and a speech synthesizer based on the source-filter model of speech production.
3. Image Segmentation Process clinical MRI scans of the human brain to reduce noise, label tissue types, extract brain contours, and visualize 3-D anatomical structures.
4. Image Registration Explore the co-registration of medical images, focusing on 2-D to 2-D (slice to slice) registration and using non-linear optimization methods to maximize various measures of image alignment.
5. ECG: Blind Source Separation Separate fetal and maternal ECG signals using techniques based on second- and higher-order statistical methods. Techniques include Wiener filtering, principal component analysis, and independent component analysis.

**Outcomes:**

- After studying this course student will learn about the biomedical signals and the method for processing them for the wellbeing of the human being.
- Students will learn more about the signal processing tools.

**Text Books:**

1. Clifford, G., F. Azuajae, and P. McSharry. Advanced Methods and Tools for ECG Data Analysis. Norwood, MA: Artech House, 2006. ISBN: 9871580539661.
2. Rabiner, L. R., and R. W. Schafer. Digital Processing of Speech Signals. Upper Saddle River, NJ: Prentice-Hall, 1978. ISBN: 9780132136037.

3. Gonzalez, R., and R. E. Woods. Digital Image Processing. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 2002. ISBN: 9780201180756.
4. Epstein, C. L. Mathematics of Medical Imaging. Upper Saddle River, NJ: Prentice Hall, 2003. ISBN: 9780130675484.

**Reference Books:**

1. Webb, S. The Physics of Medical Imaging. New York, NY: Taylor & Francis, 1988. ISBN: 9780852743492.
2. Westbrook, C., C. Kaut Roth, and T. Talbot. MRI in Practice. 3rd ed. Malden, MA: Blackwell Science, Inc., 2005. ISBN: 9781405127875
3. Macovski, A. Medical Imaging Systems. Upper Saddle River, NJ: Prentice Hall, 1983. ISBN: 9780135726853.

**EC438 RF AND MICROWAVE ENGINEERING**

**Objectives:**

1. To study about multi- port RF networks and RF transistor amplifiers
2. To study passive microwave components and their S- Parameters.
3. To study Microwave semiconductor devices & applications.
4. To study Microwave sources and amplifiers.

**Topics Covered**

**Unit 1: Two Port Network Theory**
Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters, Different types or interconnection of Two port networks, High Frequency parameters, Formulation of s parameters, Properties of s parameters, Reciprocal and lossless Network, Transmission matrix, RF behavior of Resistors, Capacitors and Inductors

**Unit 2: RF Amplifiers and Matching Networks**
Characteristics of Amplifiers, Amplifier power relations, Stability considerations, Stabilization Methods, Noise Figure, Constant VSWR, Broadband, High power and Multistage Amplifiers, Impedance matching using discrete components, Two component matching Networks, Frequency response and quality factor, T and Pi Matching Networks, Microstrip Line Matching Networks.

**Unit 3: Passive and Active Microwave Devices**
Terminations, Attenuators, Phase shitters, Directional couplers, Hybrid Junctions, Power dividers, Circulator, Isolator, Impedance matching devices: Tuning screw, Stub and quarter wave transformers. Crystal and Schottkey diode detector and mixers, PIN diode switch, Gunn diode oscillator, IMPATT diode oscillator and amplifier, Varactor diode, Introduction to MlC.

**Unit 4: Microwave Generation**
Review of conventional vacuum Triodes, Tetrodes and Pentodes, High frequency effects in vacuum Tubes, Theory and application of Two cavity Klystron Amplifier, Reflex Klystron oscillator, Traveling wave tube amplifier, Magnetron oscillator using Cylindrical, Linear, Coaxial Voltage tunable Magnetrons, Backward wave Crossed field amplifier and oscillator.

**Unit 5: Microwave Measurements**
Measuring Instruments - Principle of operation and application of VSWR meter, Power meter, Spectrum analyzer, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Q-factor, Dielectric constant, Scattering coefficients, Attenuation, S-parameters.

**Text Books:**

1. Samuel Y Liao, “Microwave Devices & Circuits” , Prentice Hall of India, 2006.

2. Reinhold.Ludwig and Pavel Bretshko 'RF Circuit Design", Pearson Education, Inc., 2006

**Reference Books:**

1. Robert. E.Collin-Foundation of Microwave Engg –Mc Graw Hill.
2. Annapurna Das and Sisir K Das, "Microwave Engineering", Tata Mc Graw Hill Inc., 2004.
3. M.M.Radmanesh , RF & Microwave Electronics Illustrated, Pearson Education, 2007.
4. Robert E.Colin, 2ed "Foundations for Microwave Engineering", McGraw Hill, 2001
5. D.M.Pozar, "Microwave Engineering.", John Wiley & sons, Inc., 2006.

**EC440: WIRELESS NETWORKS (3-0-0) 3**

**Objectives**

- To understand the concepts of sensor networks
- To understand the MAC and transport protocols for wireless networks
- To understand the concepts of MANETs
- To understand the applications of ad-hoc and sensor networks

**Topics Covered**

**Unit-I Wireless Local Area Networks (WLAN)**
Wireless LANs: IEEE 802.11 WLANs - protocol architecture, physical layer, MAC layer, analysis, deployment of 802.11 infrastructures – IEEE 802.11ah for Internet of Things
**Unit-II Mobile Ad-hoc Networks (MANETs)**
Introduction to MANETs: Characteristics of MANETs, Applications of MANETs, Challenges. MAC Protocols - Routing in MANETs: reactive and proactive routing, power-aware routing, performance comparison; Quality of Service - Other Routing Protocols.
**Unit-III Wireless Sensor Networks (WSNs)**
Wireless Sensor Networks (WSNs): Overview/Architectures; Data Gathering; MAC Protocols; Power control; Localization – Under Water Sensor Networks – Body Area Networks
**Unit- IV Wireless Personal Area Networks (WPAN)**
IEEE 802.15.4. WPANs- Bluetooth- ZigBee - protocol architecture, physical layer, MAC layer, analysis - Introduction to IEEE 802.15.4e
**Unit-V Mobile TCP & IP**
Mobile Network and Transport Layer protocols - Mobile IP; Traditional TCP, Mobile TCP, Indirect TCP, Snooping TCP, TCP/IP protocol stack over IEEE 802.11b

**Text Books**

1. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks", Prentice Hall Education, 2012.
2. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, 2005.
3. Charles E Perkins, "Ad Hoc Networking", Addison Wesley, 2001.
4..D. Bertsekas and R. Gallager, "Data Networks", Prentice Hall of India, 2/e, 2000.
5 Recent IEEE, Elsevier and Springer Journal papers

**EC442 ROBOTICS ENGINEERING ( 3- 0- 0 ) 3**

**Objectives:**

1. To study the various parts of robots and fields of robotics.
2. To study the various kinematics and inverse kinematics of robots.
3. To study the Euler, Lagrangian formulation of Robot dynamics.
4. To study the trajectory planning for robot.
5. To study the control of robots for some specific applications.

**Topics Covered**

**Unit - 1: Basic Concepts**

Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov‟s laws of robotics – dynamic stabilization of robots.

**Unit - 2: Power Sources and Sensors**

Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.

**Unit - 3: Manipulators, Actuators and Grippers**

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

**Unit - 4: Kinematics and Path Planning**

Solution of inverse kinematics problem – multiple solution Jacobian work envelop – hill Climbing Techniques – robot programming languages

**Unit - 5: Case Studies**

Mutiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.

**Course Outcomes:**

Upon completion of the course, the student should be able to:

1. Explain the basic concepts of working of robot
2. Analyze the function of sensors in the robot
3. Write program to use a robot for a typical application
4. Use Robots in different applications

**Text Books:**


1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., “Industrial Robotics”, Mc Graw-Hill Singapore, 1996.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.


**References:**


1. Deb. S.R.,“Robotics Technology and flexible Automation”, John Wiley, USA 1992.
2. Klafter R.D., Chimielewski T.A., Negin M., “Robotic Engineering – An integrated approach”, Prentice Hall of India, New Delhi, 1994.
3. Mc Kerrow P.J. “Introduction to Robotics”, Addison Wesley, USA, 1991.
4. Issac Asimov “Robot”, Ballantine Books, New York, 1986.
5. Barry Leatham – Jones, “Elements of industrial Robotics” PITMAN Publishing, 1987.
6. Mikell P.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, “Industrial Robotics Technology, Programming and Applications “, McGraw Hill Book Company 1986.
7. Fu K.S. Gonzaleaz R.C. and Lee C.S.G., “Robotics Control Sensing, Vision and Intelligence”

**EC444 ERROR CONTROL CODING (3-0-0)3**

**Objectives:**

- Apply the knowledge of Galois Field arithmetic in analyzing cyclic codes. Analyze encoder and efficient decoder algorithms for convolution codes. Explore efficient design methods and the powerful soft iterative decoding techniques for high capacity codes like LDPC codes and Turbo codes.

**Unit 1: Finite Field Arithmetic**

Introduction, Groups- Rings- Fields- Arithmetic of Galois Field- Integer Ring- Polynomial Rings- Polynomials and Euclidean algorithm, primitive elements, Construction and basic properties of Finite Fields- Computations using Galois Field arithmetic- sub fields- Minimal polynomial and conjugates- Vector space- Vector Subspace- Linear independence.

**Unit 2 : Linear Block Codes**

Linear Block codes- Properties- Minimum Distance- Error detection and correction- Standard Array and Syndrome decoding- Hamming codes- Perfect and Quasi-perfect codes- Extended codes- Hadamard codes.

**Unit 3: Cyclic Codes**

Basic theory of Cyclic codes- Generator and Parity check matrices - Cyclic encoders- Error detection & correction- decoding of cyclic codes- Cyclic Hamming codes- Binary Golay codes- BCH codes- Decoding of BCH codes-The Berlekamp- Massey decoding algorithm. Reed Solomon codes- Generalized Reed Solomon codes- MDS codes.

**Unit 4: Convolutional Codes**

Generator matrices and encoding- state, tree and trellis diagram- Transfer function -- Maximum Likelihood decoding Hard versus Soft decision decoding- The Viterbi Algorithm- Free distance- Catastrophic encoders.

**Unit 5:Soft Decision and Iterative Decoding**

Soft decision Viterbi algorithm- Two way APP decoding- Low density parity check codes- Turbo codes- Turbo decoding

**Outcomes:**

- Design and implement channel encoder and decoder in hardware/ software to meet the required error performance in present day communication applications. Analyze the performance of the developed codes considering constraints on resources and provide innovative solutions.

**Text Books:**


1. Shu Lin and Daniel. J. Costello Jr., "Error Control Coding: Fundamentals and applications", Second Edition Prentice Hall Inc, 2004.
2. R.E. Blahut, "Theory and Practice of Error Control Coding", MGH 1983.
3. W.C. Huffman and Vera Pless, "Fundamentals of Error correcting codes", Cambridge University Press, 2003.
4. Ron M. Roth "Introduction to Coding Theory" Cambridge University Press, 2006
5. Elwyn R. Berlekamp, "Algebraic Coding Theory",McGawHill Book Company, 1984


**Any electives can be added at any time with approval of HOD (has to approved by Senate)**

**GLOBAL ELECTIVES**

**EC351 APPLIED ELECTRONICS (3-0-0) 3**

**Objective:**

1. To make the students understand the fundamentals of various electronic devices.
2. To train them to apply these devices in mostly used and important applications.

**Topics Covered:**

**Unit-1: Amplifier Circuits**
Introduction- R.C coupled, Transformer coupled, Direct coupled amplifiers, Differential amplifiers, Concept of negative feedback, Feedback amplifiers.
**Unit-2: Operational Amplifiers**
Applications of operational amplifiers-Inverting and non-inverting amplifiers, Differentiator, Integrator, V to I and I to V converters, Comparator, Oscillator types.
**Unit-3: Digital Circuits**
Intoduction-Multiplexers, Demiltiplexers, Decoder and encoder, D/A and A/D converter types, sample and hold circuit.
**Unit-4: Microprocessor**
8085 Architecture, Interfacing, System design, Overview of MEMS and Microsystems, Materials, Fabrication Processes and Micro system Packaging.
**Unit-5: Power Semiconductor Devices**
Power diodes, Power transistors, SCR-TRIAC- GTO- IGBT-Principles of operation and characteristics, Introduction to choppers, Inverters, Phase controlled rectifiers and cyclo converters.

**Course Outcomes:**

1. Analyze the characteristics of various electronic devices.
2. Classify and analyze the various amplifier circuits.
3. Able to construct and design the digital circuit.
4. Illustrate and qualitative knowledge of power electronic devices.

**Text Books:**


1. Sedra, A.S. and Smith, K.C., Micro Electronic Circuits, Oxford University Press, 2004.
2. Millman and Halkias, Integrated Electronics, Tata McGraw -Hill, 1998.
3. Ramesh Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, 5th Edition
4. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
5. Rashid, M.H. ,'Power Electronics - circuits, devices and applications', Prentice Hall India, New Delhi, 2006.


**Reference Books:**


1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw- Hill, 2002.
2. M.D.singh and K.B.Khanchandani, "Power Electronics", Tata Mc Graw Hills Publishing Company Limited, New Delhi 2006.

**EC352 COMMUNICATION SYSTEMS**

**Course Objectives**

The objective of this course is

1. To introduce different methods of analog communication and their significance
2. To introduce Digital Communication methods for high bit rate transmission
3. To introduce the concepts of source and line coding techniques for enhancing rating of transmission of minimizing the errors in transmission.
4. To introduce various media for digital communication

**Topics Covered:**

**Unit -1: Analog Modulation**

Principles of Amplitude Modulation, single and double side band - suppressed carrier system and frequency modulation - varactor diode and reactance modulator - AM detectors - FM discriminators - AM and FM transmitters and receivers.

**Unit - 2: Digital communication**

Sampling theorem - pulse modulation techniques - PAM, PWM and PPM concepts - PCM encoder and decoder - Data transmission using analog carriers (FSK, PSK, QPSK, MSK and QAM).

**Unit -3: Synchronous and Asynchronous transmission:**

Transmission - error control techniques - data communication protocols link oriented protocols - asynchronous protocols – computer communication networks.

**Unit - 4: Modern Communication Systems:**

Microwaves and optical communication system, Satellite communication system, Mobile communication system.

**Unit - 5: Principles of television engineering:**

Requirements and standards - need for scanning - types of camera tubes and picture tubes - B/W and colour systems - PAL - CCTV -Cable TV – Introduction to analog television engineering – Digital television – fundamentals – HDTV .

**Course Outcomes**

The students will be able

1. To have an overview of various analog modulation schemes.
2. Understand the principle operation of various modulator and demodulator circuits.
3. Illustrate the different types of digital modulation techniques.
4. To have an overview of various communication systems.
5. Explain the basic operation of B/W and colour TV systems.
6. Understand the various data communication protocols.

**Text Books**


1. Kennedy.G, “Electronic Communication System”, Tata McGraw Hill, 1987.
2. Roddy.D and Coolen.J, “Electronic Communications”, Prentice Hall of India, 4th Edition.
3. Simon Haykins, “Electronic Communications”, John Wiley, 3rd Edition, 1995.


**Reference Books**


1. Taub and Schiling “Principles of communication systems” Tata McGraw Hill 2007.
2. Das.J, “Principles of Digital Communication”, New Age International, 2011.
3. Theodore S. Rappaport, “Wireless Communications - Principles and Practice”, Pearson, 2nd Edition, 2010
4. Bernard Sklar, “Digital communication fundamentals and applications”, Pearson Education, 2nd edition, 2009.

**EC353 ELECTRONIC DEVICES (3-0-0) 3**

**Objective:**

1. To make the students understand the fundamentals of various electronic devices.
2. To train them to apply these devices in mostly used and important applications.

**Topics Covered:**

**Unit-1: Semiconductor Diodes**
PN junction diode –operation and VI characteristics, diode current equation, diffusion and transient capacitance, Zener diode characteristics, Zener diode as regulator.
**Unit-2: Bipolar Junction Transistors**
Introduction- PNP and NPN transistor, Operation and characteristics, Analysis of CB, CE and CC configuration, Transistor as switch.
**Unit-3: Field effect Transistors**
Operation and characteristics of JFET and MOSFET, MOSFET as switch and amplifier, Introduction to CMOS circuits.
**Unit-4: Special Semiconductor Devices**
Metal semiconductor junction-MESFET, Schottky barrier diode, Varactor diode, LED, Laser diode, PIN diode and Photodiodes.
**Unit-5: Power Semiconductor devices**
Power diodes, Power transistors, Operation and characteristics of SCR, DIAC, TRIAC, GTO and IGBT.

**Course Outcomes:**

1. Analyze the characteristics of various electronic devices.
2. Classify and analyze the various circuit configurations of transistors.
3. Illustrate and qualitative knowledge of power electronic devices.

**Text Books**


1. Sedra, A.S. and Smith, K.C., Micro Electronic Circuits, Oxford University Press, 2004.
2. Millman and Halkias, Integrated Electronics, Tata McGraw -Hill, 1998.
3. Rashid, M.H. ,'Power Electronics - circuits, devices and applications', Prentice Hall India, New Delhi, 2006.


**Reference Books:**


1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw- Hill, 2002.
2. M.D.singh and K.B.Khanchandani, "Power Electronics", Tata Mc Graw Hills Publishing Company Limited, New Delhi 2006.

**EC354 CMOS VLSI DESIGN (3 - 0 - 0) 3**

**Pre-Requisite:** Knowledge of Digital Electronics circuits

**Objectives:**

4. To introduce various aspects of Digital VLSI circuits
5. To teach the layout issues for CMOS Digital circuits.
6. To make them understand the testing issues.

**Topics Covered:**

**Unit -1: Introduction**
Introduction of Digital circuits, logic gates, basics of combinational logic, sequential logic, finite state machine
**Unit -2: Design Methodology**
VLSI design methodology, VLSI technology- NMOS, CMOS fabrication. Layout design rules. Stick diagram. Latch up, Non-idealities of MOSFET.
**Unit -3: Combinational circuits**
Characteristics of MOS and CMOS switches. Implementation of logic circuits using MOS and CMOS technology, multiplexers and memory, MOS transistors, threshold voltage, MOS device design equations. CMOS inverters, propagation delay of inverters, Pseudo NMOS, Dynamic CMOS logic circuits, power dissipation.
**Unit -4: Memory System**
Memory cell: Layout of SRAM, DRAM.ROM Implementation, Delay, Implementation of PLD, EPROM, EEPROM, An overview of the features of advanced FPGAs, LUTs, Comparison of ASICs, FPGAs, PDSPs and CBICs . Fault tolerant VLSI architectures
**Unit -5: Testing**
VLSI testing -need for testing, Fault Modelling, Single and Multiple stuck at fault, manufacturing test principles, design strategies for test, chip level and system level test techniques.

**Course Outcomes:**

1. Able to design CMOS Digital Circuits.
2. Able to Layout CMOS Circuits.
3. Understand the timing issues related to combinational and sequential circuits.

**Text Books:**

1. N.H.E. Weste et al, CMOS VLSI design, (3/e), Pearson , 2005.
2. J. Smith, Application Specific Integrated Circuits, Pearson, 1997.

**Reference Books:**

1. Pucknell & Eshraghian, Basic VLSI Design, PHI, (3/e).
2. Uyemura, Introduction to VLSI Circuits and Systems, Wiley, 2002

**EC 355 DIGITAL ELECTRONICS (3 - 0 - 0) 3**

**Objectives:**

Modern electronics is based on digital logic design, in this course basics of digital logic designing are covered which includes Boolean algebra, propositions, truth tables, minimization of combinational circuits. Karnaugh maps and tabulation procedure, implementation of sum of product and product of sum in hardware.

**Topics Covered:**

**Unit-1: Boolean algebra**
Number systems- conversions, error detection and error correction. Review of Boolean algebra-theorems, sum of product and product of sum simplification, Simplification of Boolean expressions- Implementation of Boolean expressions using universal gates.

**Unit-2: Combinational logic circuits**
Memories – ROM- Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs. Adders, subtractors, parity generator, decoders, encoders, multiplexers, demultiplexers, Realisation of boolean expressions- using decoders-using multiplexers.

**Unit-3: Sequential circuits**
Latches, flip flops, edge triggering, asynchronous inputs. Shift registers, Universal shift register, applications. Binary counters – Synchronous and asynchronous up/down counters, mod-N counter, Counters for random sequence.

**Unit-4: Synchronous circuit analysis and design:**
Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams

**Unit-5: Logic families:**
Introduction to TTL and ECL logic families: Basic working of a TTL NAND gate-characteristics of a TTL NAND gate- important specifications – Basic working of ECL gate- – DTL- RTL.

**Course Outcomes:**

The expected outcome after learning this course are that a student must be able to design a digital circuit, understand the differences between combinational and sequential circuits and will be able to implement the circuit.

**Text Books:**


1. Wakerly J F, Digital Design: Principles and Practices, Prentice-Hall, 4thEd.
2. R P Jain, Modern Digital Electronics 4th Edition, Tata Mcgraw Hill Education Private Limited
3. D. D. Givone, Digital Principles and Design, Tata Mc-Graw Hill, New Delhi, 2008.

**EC356 DIGITAL IMAGE PROCESSING (3 - 0 - 0) 3**

**Objective:**

3. This course develops an overview of the field of image processing and help to understand the fundamental algorithms and how to implement them.
4. Provide an experience in applying image processing algorithms to real problems.

**Topics Covered:**

**Unit-1: Digital Image Processing**
Examples of Digital Image Processing - Components of image processing -Elements of Visual perception - Image sensing and acquisition using single sensor - sensor strips and sensor arrays - Image sampling and quantization: Basic concepts of sampling and quantization - Spatial and Gray level representation - Aliasing and Moire Patterns
**Unit-2: Image Enhancement**
Spatial Domain: Grey level transformation - Image negatives - Log transformations - Power law transformations - Piecewise linear transformation - Histogram Processing - Enhancement using Arithmetic and Logic operation - Smoothing Spatial Filter - Linear filter, Order Statistics filter - Sharpening Spatial Filters. Frequency Domain: Introduction to the Fourier Transform and the Frequency Domain - Smoothing Frequency Domain Filters - Sharpening Frequency Domain Filters - Homomorphic Filtering
**Unit-3: Color image processing and image Restoration:**
Noise Models - Restoration in the Presence of Noise Only - Spatial Filtering - Mean Filters, Order-Statistics Filters - Adaptive Filters - Periodic Noise Reduction by Frequency Domain Filtering Linear - Position Invariant Degradations - Estimating the Degradation Function. Color Image Processing: Color Fundamentals - Color Models, Pseudo-color Image Processing - Intensity Slicing - Gray Level to Color Transformations - Basics of Full- Color Image Processing - Color Transformations - Smoothing and Sharpening - Color Segmentation
**Unit-4: Wavelets and Multi-resolution Processing**
Image Pyramids - Sub-band Coding –The Haar Transform - Multi-resolution Expansions -Wavelet Transforms in One Dimension - Wavelet Transforms in Two Dimension
**Unit-5: Image Compression, Segmentation and Morphological Image Processing**
Compression: Redundancy - Image Compression Models - Elements of Information Theory - Error-Free Compression -Lossy Compression - Image Compression Standards. Segmentation: Detection of Discontinuities - Edge Linking and Boundary Detection Thresholding - Region-Based Segmentation - Segmentation by Morphological Watersheds. Morphological Image Processing: Basic Concepts from Set Theory - Logic Operations Involving Binary Images - Dilation and Erosion - Opening and Closing, Hit-or-Miss Transformation - Basic Morphological Algorithms -Gray-Scale Morphology

**Outcomes:**

1. Students learn about image processing tools
2. Apply the image processing for practical applications

**Text Books:**


1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, (3/e), Prentice Hall
2. R. C. Gonzalez, R. E. Woods, and S. L. Eddins, Digital Image Processing with MATLAB, Prentice Hall
3. Maria Petrou, Costas Petrou, Image Processing: The Fundamentals (2/e), Wiley Publisher
4. A. K. Jain, Fundamentals on Digital Image Processing, PHI

**EC357 DIGITAL SIGNAL PROCESSING (3 - 0 - 0) 3**

**Objective:**

The subject aims to introduce the mathematical approach to manipulate discrete time signals, which are useful to learn digital tele-communication.

**Topics Covered:**

**Unit-1: Signals and Systems**
Review of LSI system theory- DTFT-Frequency response of discrete time systems-All pass inverse and minimum phase systems.
**Unit-2: Discrete Fourier Transform**
Relationship of DFT to other transforms- FFT- DIT and DIF FFT algorithm-Linear filtering using DFT and FFT.
**Unit-3: Finite Impulse Response Filters**
Frequency response-FIR filter types- Design of FIR filters- Mapping formulas-Frequency transformations-Direct form realization of FIR systems-Lattice structure for FIR systems.
**Unit-4: Infinite Impulse Response Filters**
IIR filter types-IIR filter design- Bilinear transformation- impulse invariance transformation-Structures of IIR filters-Finite word length effects- Limit cycle oscillations
**Unit-5: Applications and Multi-rate signal processing**
Sampling rate conversion byan integer and rational factor-Polyphase FIR structures for sampling rate conversion-interpolation- decimation-Homomorphic filtering

**Course Outcomes:**

Students will be able to

1. Analyze discrete-time systems in both time & transform domain and also through pole-zero placement.
2. Analyze discrete-time signals and systems using DFT and FFT.
3. Design and implement digital finite impulse response (FIR) filters.
4. Design and implement digital infinite impulse response (IIR) filters.
5. Understand and develop multirate digital signal processing systems.

**Text Books:**

1. J.G. Proakisetal, Digital Signal Processing, (4/e) Pearson, 2007.
2. A.V. Oppenheim & R.W. Schafer, "Discrete Time Signal processing", (2/e),Pearson Education, 2003.

**EC358 EMBEDDED SYSTEMS (3 -0 - 0) 3**

**Objectives**:

This course concerns with Embedded systems basic knowledge, embedded architectures, Architectures and programming of microcontrollers, embedded system applications.

**Topics Covered**

**Unit I: Introduction to Embedded Systems**
Definition of Embedded System. Embedded Systems Vs General Computing Systems. History of Embedded Systems. Classification, Major Application Areas. Purpose of Embedded systems, Characteristics and Quality Attributes of Embedded Systems Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM. RAM. Memory according to the type of Interface. Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators. Communication Interface: Onboard and External Communication Interfaces.

**Unit II: Programming Embedded Systems in C**
Introduction, Definition of embedded system, Choice of Processor, programming language, operating system, development of embedded software.
Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real lime Clock, Watchdog Timer. Embedded firmware Design Approaches and Development Languages.

**Unit III: RTOS Based Embedded System Design:**
Operating System Basics, Types of Operating Systems, Tasks, Process and Threads. Multiprocessing and Multitasking, Task Scheduling. Task Communication: Shared Memory. Message Passing. Remote Procedure Call and Sockets. Task Synchronization: Task Communication / Synchronization Issues. Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

**Unit IV: ARM Architecture ARM Design**
Philosophy, Registers, Program Status Register. Instruction Pipeline Interrupts and Vector Table. Architecture Revision, ARM Processor Families. ARM Programming Model – I: Instruction Set: Data Processing Instructions. Addressing Modes. Branch. Load. Store Instructions, PSR Instructions. Conditional Instructions.

**Unit V: ARM Programming**
Thumb Instruction Set: Register Usage, Other Branch Instructions. Data Processing Instructions. Single-Register and Multi Register Load -Store Instructions. Stack. Software Interrupt Instructions, Simple C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation. Conditional Execution and Loops

**Course Outcomes:**

Students will be able to

1. Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
2. Become aware of interrupts, hyper threading and software optimization.
3. Design real time embedded systems using the concepts of RTOS.

**Text Books:**

1. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
2. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008.
3. ARM Systems Developer's Guides- Designing & Optimizing System Software Andrew N. Sloss. Dominic Symes. Chris Wright, 2008. Elsevier Reference Books

**Reference Books:**

1. Raj Kamal, Embedded Systems Architecture, Programming, and Design. (2/e), Tata McGraw Hill, 2008.
2. K.V. Shibu, Introduction to Embedded Systems, Tata McGraw, 2009.
3. Peter Barry and Patric Crowley, Intel architecture for Embedded system.

**EC359 COMMUNICATION NETWORKS**

**Objectives:**

To get an understanding on the fundamentals of networks and issues involved.
To acquire an understanding on the set of rules and procedures that mediates the exchange of information between communicating devices.

**Topics Covered:**

**Unit 1: Layered architecture**
Overview of circuit and packet switching – message switching –virtual circuits - Comparison of OSI and TCP/IP Internet protocol stacks.
**Unit 2 Data Link Layer**
General issues in networking – Delays – Throughput- Architectural concepts in ISO's OSI layered model- Data link layer - Direct Link Networks- Error detection- Reliable Transmission- MAC Protocols – ALOHA- CSMA - LANs – IEEE 802.3- IEEE 802.5 - IEEE 802.11
**Unit 3 Network layer**
Datagram and Virtual circuit service – Routers – ICMP.- IPV4 and IPV6 - IP addressing- Sub netting- CIDR- DHCP – NAT – ARP - Routing Principles
**Unit 4: Transport layer**
Transport layer services - Connection Management - Transmission Control Protocol (TCP) - User Datagram Protocol (UDP) - Principles of reliable data transfer - Principles of congestion control - Flow control.
**Unit-5: Application layer**
Overview of HTTP, FTP, SMTP, MIME, DNS, Multimedia networking applications, streaming stored video and audio, Internet phone, RTP.

**Course Outcome:**

Compare and examine, OSI and TCP/IP protocol stacks Categorize services offered by all layers in TCP/IP protocol stack Analyze a network under congestion and propose solutions for reliable data transfer,examine the protocols operating at different layers of TCP/IP model.

**Text Books:**

1. J.F.Kurose&K.W.Ross, Computer Networking (3/e) Pearson.
2. W.Stallings, Wireless Communication and Networks, Pearson, 2003

**EC360 INTRODUCTION TO ROBOTICS ( 3- 0- 0 ) 3**

**Objectives:**

1. To study the various parts of robots and fields of robotics.
2. To study the various kinematics and inverse kinematics of robots.
3. To study the Euler, Lagrangian formulation of Robot dynamics.
4. To study the trajectory planning for robot.
5. To study the control of robots for some specific applications.

**Topics Covered**

**Unit - 1: Basic Concepts**

Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov"s laws of robotics – dynamic stabilization of robots.

**Unit - 2: Power Sources and Sensors**

Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.

**Unit - 3: Manipulators, Actuators and Grippers**

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

**Unit - 4: Kinematics and Path Planning**

Solution of inverse kinematics problem – multiple solution Jacobian work envelop – hill Climbing Techniques – robot programming languages

**Unit - 5: Case Studies**

Mutiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.

**Course Outcomes:**

Upon completion of the course, the student should be able to:

1. Explain the basic concepts of working of robot
2. Analyze the function of sensors in the robot
3. Write program to use a robot for a typical application
4. Use Robots in different applications

**Text Books:**


1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", Mc Graw-Hill Singapore, 1996.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.


**References:**


1. Deb. S.R.,"Robotics Technology and flexible Automation", John Wiley, USA 1992.
2. Klafter R.D., Chimielewski T.A., Negin M., "Robotic Engineering – An integrated approach", Prentice Hall of India, New Delhi, 1994.
3. Mc. Kerrow P.J. "Introduction to Robotics", Addison Wesley, USA, 1991.
4. Issac Asimov "Robot", Ballantine Books, New York, 1986.
5. Barry Leatham – Jones, "Elements of industrial Robotics" PITMAN Publishing, 1987.

**EC361 SATELLITE COMMUNICATION (3 - 0 - 0) 3**

**Objective:**

To impart knowledge on various aspects in the design of systems for satellite communication.

**Topics Covered:**

**Unit-1: Orbital Mechanics**
Frequency allocation for Satellite services - Elements of orbital mechanics - Equations of motion - Tracking and orbit determination. Orbital correction/control. Satellite launch systems. Multistage rocket launchers and their performance.
**Unit-2 Satellite Subsystems**
Orbital correction/control – Attitude Control - Station keeping - Thermal Control - TT&C Systems – Transponders - Satellite antennas. Reliability considerations
**Unit-3: Elements of communication satellite design.**
Satellite link design: Performance requirements and standards. Design of satellite links – DOMSAT, INSAT, INTELSAT and INMARSAT.
**Unit-4: Multiple access techniques**
FDMA, TDMA, CDMA. Random access techniques - Satellite onboard processing.
**Unit - 5: Earth Station design and tracking antennas**
Earth station design - Configuration. Antenna and tracking systems. Satellite broadcasting.

**Course outcomes**:

Students are able to

1. Able to understand how analog and digital technologies are used for satellite communication networks.
2. Able to understand the radio propagation channel for Earth station to satellite.

**Text Books:**

1. D. Roddy, “Satellite Communication”, 4$^{th}$edition, McGraw- Hill, 2009.
2. T. Pratt & C.W. Bostain, “Satellite Communication”, 2$^{nd}$ edition, Wiley Publishers, 2008.

**Reference Book:**

1. B.N. Agrawal, Design of Geo-synchronous Spacecraft, Prentice- Hall,1986.

**EC362 WIRELESS COMMUNICATION ( 3- 0- 0 ) 3**

**Objective:**

To understand the basics of wireless digital communication used for mobile telephony. To study the basic methodologies of cellular system designing. To understand the various multiplexing mechanisms. To understand the interference measurement and reduction techniques.

**Topics Covered:**

**Unit-1: Cellular concept**
Frequency reuse – co-channel interference - adjacent channel interference - power control for reducing interference - improving capacity in cellular systems - cell splitting - sectoring - hand off strategies - channel assignment strategies - call blocking in cellular networks
**Unit-2: Mobile Radio Propagation**
Reflection, Diffraction, Fading. Diversity techniques for mobile wireless radio systems concept of diversity branch and signal paths - combining methods - selective diversity combining - maximal ratio combining- equal gain combining
**Unit-3: Propagation models**
Path loss prediction over hilly terrain -Practical link budget design using Path loss models - Indoor and outdoor Propagation models
**Unit-4: Multiple access techniques**
FDMA, TDMA, SDMA and CDMA. Spread spectrum. Power control. WCDMA. Capacity of multiple access schemes
**Unit-5: Mobile communication Standards**
Overview of second generation cellular wireless systems: GSM and IS-95 standards, 3G systems: UMTS & CDMA 2000 standards WLAN technology. Ad hoc networks. Bluetooth.

**Course Outcome:**

Describe the cellular concept and analyze capacity improvement Techniques. Mathematically analyze mobile radio propagation mechanisms. Summarize diversity reception techniques. Analyze and examine the multiple access techniques and its application.

**Text Books:**

1. KamiloFeher, 'Wireless Digital Communications', PHI
2. Rapport T.S., 'Wireless Communications, Principles and Practice', Prentice Hall

**Reference Books:**

1. Lee W.C.Y., 'Mobile Cellular Telecommunication', MGH
2. Proakis J.G., 'Digital Communications', MGH

**EC363 OPTICAL COMMUNICATION (3-0-0)3**

**Objective:**

To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

**Topics Covered:**

**Unit-1: Introduction**
Ray theory transmission- Total internal reflection-Acceptance angle –Numerical aperture – Skew rays – Electromagnetic mode theory of optical propagation –EM waves – modes in Planar guide – phase and group velocity – cylindrical fibers –SM fibers.
**Unit-2: Transmission characteristics of optical fibers**
Attenuation – Material absorption losses in silica glass fibers – Linear and Non linear Scattering losses - Fiber Bend losses –Intra and inter Modal Dispersion – Polarization. Optical fiber connectors**,** Fiber alignment and Joint Losses – Fiber Splices– Fiber connectors – Expanded Beam Connectors – Fiber Couplers.
**Unit-3: Sources and Detectors**
Optical sources: Light Emitting Diodes - LED structures - surface and edge emitters, internal - quantum efficiency, injection laser diode structures - comparison of LED and ILD Optical Detectors: PIN Photo detectors, Avalanche photo diodes, construction, characteristics and properties.
**Unit-4: Fiber Optic Receiver and Measurements**
Fundamental receiver operation, Pre amplifiers, Error sources – Receiver Configuration – Probability of Error – Quantum limit. Fiber Attenuation measurements- Dispersion measurements – Fiber Refractive index profile measurements – Fiber cut- off Wave length Measurements – Fiber numerical Aperture Measurements – Fiber diameter measurements.
**Unit-5: Optical Networks**
Basic Networks – SONET / SDH – Broadcast – and –select WDM Networks –Wavelength Routed Networks – Non linear effects on Network performance –Performance of WDM , EDFA system – Solitons – Optical CDMA – Ultra High Capacity Networks.

**Course Outcomes:**

1. Able to understand the propagation of signal through Fiber cable.
2. Able to understand the various modes of propagation and its importance.
3. Able to implement Fiber optics systems.

**Text Books:**


1. G. Keiser, Optical Fiber Communications (4/e), TMH, 2008.
2. Optical Fibre Communication: Principals and Techniques", John M. Senior, PHI New Delhi 3/e,2008


**Reference Books:**


1. MMK. Liu, Principles and Applications of Optical Communications, TMH, 2010.
2. G.P. Agrawal, Fiber Optic Communication Systems, (3/e), Wiley, 2002.
3. J. Gowar, Optical Communication Systems, (2/e), PHI, 2001.

**EC364 MICROPROCESSORS AND ITS APPLICATIONS (3-0-0) 3**

**Objectives**

- To introduce the architecture and programming of 8085 microprocessor.
- To introduce the interfacing of peripheral devices with 8085 microprocessor.
- To introduce the architecture and programming of 8086 microprocessor.
- To introduce the architecture, programming and interfacing of 8086 microprocessor.

**Topics Covered**

**Unit -1: 8085 CPU**
8085 Architecture – Instruction set – Addressing modes – Timing diagrams – Assembly language programming – Counters – Time Delays – Interrupts – Memory interfacing – Interfacing, I/O devices.
**Unit -2: 8086 CPU**
Intel 8086 Internal Architecture – 8086 Addressing modes- Modes of operation -Instruction set- 8086 Assembly language Programming–Interrupts.
**Unit - 3: 80186, 80286, 80386 And 80486 Microprocessors**
80186 Architecture- Enhancements of 80186 - 80286 Architecture real and Virtual Addressing - 80386 Architecture - Special Registers, Memory Management Memory Paging Mechanism – 80486 Architecture – Enhancements – Cache Memory Techniques Exception Handling – Comparison of microprocessors (8086, 80186, 80286, 80386, 80486).
**Unit - 4: Pentium Microprocessors**
Pentium Microprocessor Architecture - Special Pentium Registers - Pentium Memory Management - New Pentium Instructions - Pentium Pro Microprocessor Architecture - Special Features - Pentium II Microprocessor Architecture - Pentium III Microprocessor Architecture - Pentium IV Microprocessor Architecture - Comparison of Pentium Processors.
**Unit - 5: Peripherals Interfacing**
Interfacing Serial I/O (8251)- parallel I/O (8255) –Keyboard and Display controller (8279) – ADC/DAC interfacing – Inter Integrated Circuits interfacing ($I^2C$ Standard)- Bus: RS232C-RS485-GPIB

**Course Outcomes:**

Students will be able to

1. Apply the concept of buses, microprocessor architecture and interrupts.
2. Interface memory and I/O devices with microprocessors
3. Program assembly language programming/ C programming of 8086
4. Design microprocessor based small systems.

**Text Books:**

1. Ramesh S Gaonkar, "Microprocessor Architecture- Programming & Applications with 8085/8080A", 5th Ed., Penram International Publishing (India) Pvt. Ltd.
2. Rodnay Zaks and Austin Lesea, "Microprocessor Interfacing Technique", 1st Indian Edition, BPB Publication (1988)
3. John Uffenbeck, "The 80x86 Family, Design, Programming and Interfacing", Third Edition. Pearson Education, 2002.

**Reference Books**

1. Ram B, "Introduction of Microprocessors & Microcomputers", 4th Ed., Dhanpat Rai Publisher (P) Ltd
2. James L Antonakes, "An introduction to Intel family of Microprocessors", 3rd Ed., Pearson Education.
3. Charles M Gilmore, "Microprocessor; Principles and Applications", 2nd Ed., McGraw Hill
4. A.K. Ray and K.M.Burchandi, "Intel Microprocessors Architecture Programming and Interfacing", McGraw Hill International Edition, 2000

**EC365 INFORMATION THEORY AND CODING ( 3- 0- 0 ) 3**

**Objectives**

To provide basic concepts of Information
To enable the students to propose, design and analyse suitable coding/decoding scheme for a particular digital communication application

**Topics Covered**

**Unit 1**
Information theory- information and entropy-properties of entropy of a binary memory less source- source coding theorem-Shannon fano coding-Huffman coding –Lempel ziv coding-discrete memory less source-binary symmetric channel –mutual information-properties-channel capacity –channel coding theorem
**Unit 2**
Introduction to algebra-groups-fields-binary field arithmetic-construction of Galois field-basic Properties-computations-vector spaces-matrices-BCH codes-description-coding & decoding –Reed Solomon codes-coding & decoding
**Unit 3**
Coding –linear block codes-generator matrices-parity check matrices-encoder-syndrome and error correction-minimum distance-error correction and error detection capabilities-cyclic codes-coding and decoding
**Unit 4**
Coding –convolutional codes-encoder –generator matrix-transform domain Representation-state Diagram-distance properties-maximum likelihood decoding-Viterbi decoding-sequential decoding
**Unit 5**
Burst errors -Interleaved codes-Turbo coding- coding & decoding -Trellis codes- coding & decoding

**Text Books**

1. Simon Haykins,Communication Systems,John Wiley
2. Shi Lin,Costello D.J ., Errpr Control Coding-Fundamentals amd Applications,Prentice Hall Inc. Eaglewood Cliffs

**Reference Books**

1. Das J.Malik A.K., Chatterjee P. K. .,Principles of Digital Communications,New Age International
2. Simon Haykin, Digital Communications,John Wiley
3. Taub& Schilling, Principles of Communication System,TATA MC Graw Hill
4. Tomasi, Electronic Communications,Fundamentals Through Advanced,Pearson education
5. Sklon, Digital Communications Pearson education
6. Couch,Digital and Analog Communication System, Pearson education

**EC367 MACHINE LEARNING AND PATTERN RECOGNITION (3-0-0) 3**
**Prerequisites:**

It is assumed the students have a working knowledge of calculus, linear algebra, and probability theory. It is also assumed the students have some experience programming in a scientific computing environment

**Topics Covered**

**Unit-1**
Introduction to Pattern Recognition, Tree Classifiers, Bayesian Decision Theory, Linear Discriminants
**Unit-2**
Parametric Techniques, Non-Parametric Techniques, Unsupervised Methods- Component Analysis and Dimension Reduction, Clustering
**Unit-3**
Classifier Ensembles, Graphical Models- Introductory ideas and relation back to earlier topics, Bayesian Networks, Sequential Models, (State-Space Models, Hidden Markov Models, Dynamic Bayesian Networks)
**Unit-4**
Algorithm Independent Topics- No Free Lunch Theorem, Ugly Duckling Theorem, Bias-Variance Dilemma, Jacknife and Bootstrap Methods, Syntactic Methods, Neural Networks
**Unit-5:**
Knowledge on Python, Mini project or case studies on one of the following areas

1. Optical character recognition,
2. Speech classification by HMM,
3. Back-propagation artificial neural network for arteriogram segmentation: a supervised approach for medical images
4. Self-adaptive artificial neural network for arteriogram segmentation: an unsupervised approach for medical images
5. Paper Currency Recognition

**Text Book:**

1. Bishop, C. M.Pattern Recognition and Machine Learning. Springer. 2007.
2. Marsland, S.Machine Learning: An Algorithmic Perspective. CRC Press. 2009. (Also uses Python.)

**Reference Books:**

1. Theodoridis, S. and Koutroumbas, K.Pattern Recognition. Edition 4. Academic Press, 2008.
2. Russell, S. and Norvig, N.Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.
3. Bishop, C. M.Neural Networks for Pattern Recognition. Oxford University Press. 1995.
4. Hastie, T., Tibshirani, R. and Friedman, J.The Elements of Statistical Learning. Springer. 2001.
5. Koller, D. and Friedman, N.Probabilistic Graphical Models. MIT Press. 2009.