ACADEMIC CURRICULA
2023-2024

B.Tech in Electronics Engineering
VLSI Design and Technology

Course Structure and Detailed Syllabi
For students admitted in
2023-24
Academic Session

Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956
Bhubaneswar, Odisha, India

Proposed Curriculum
B. Tech in Electronics Engineering (VLSI Design and Technology)
School of Electronics Engineering

SCHEME I
FIRST SEMESTER

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	PH10001	Physics	3	0	0	3	3
2	MA11001	Differential Equations and Linear Algebra	3	1	0	4	4
3		Science Elective	2	0	0	2	2
4		Engineering Elective	2	0	0	2	2
5	LS10001	Science of Living Systems	2	0	0	2	2
6	CH10003	Environmental Science	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	PH19001	Physics Lab	0	0	2	2	1
2	CS13001	Programming Lab	0	2	4	6	4
Sessional							
1	CE18001	Engineering Drawing & Graphics	0	0	2	2	1
Total Credit (Practical & Sessional subject)						**10**	**6**
Total Credit (Semester)						**25**	**21**

SCHEME I
SECOND SEMESTER (Computer Science and Electronics)

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10001	Chemistry	3	0	0	3	3
2	MA11002	Transform Calculus and Numerical Analysis	3	1	0	4	4
3	HS10001	English	2	0	0	2	2
4	EC10001	Basic Electronics	2	0	0	2	2
5	EE10002	Basic Electrical Engineering	2	0	0	2	2
6		HASS Elective I	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	CH19001	Chemistry Lab	0	0	2	2	1
2	EX19001	Engineering Lab	0	0	2	2	1
Sessional							
1	ME18001	Workshop	0	0	2	2	1
2	YG18001	Yoga	0	0	2	2	1
3	HS18001	Communication Lab	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**10**	**5**
Total Credit (Semester)						**25**	**20**

SCHEME I
SECOND SEMESTER (Civil, Mechanical and Electrical)

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10001	Chemistry	3	0	0	3	3
2	MA11002	Transform Calculus and Numerical Analysis	3	1	0	4	4
3	HS10001	English	2	0	0	2	2
4	EC10001	Basic Electronics	2	0	0	2	2
5	ME10001	Engineering Mechanics	2	0	0	2	2
6		HASS Elective I	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	CH19001	Chemistry Lab	0	0	2	2	1
2	EX19001	Engineering Lab	0	0	2	2	1
Sessional							
1	ME18001	Workshop	0	0	2	2	1
2	YG18001	Yoga	0	0	2	2	1
3	HS18001	Communication Lab	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**10**	**5**
Total Credit (Semester)						**25**	**20**

SCHEME II
FIRST SEMESTER

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10001	Chemistry	3	0	0	3	3
2	MA11001	Differential Equations and Linear Algebra	3	1	0	4	4
3	HS10001	English	2	0	0	2	2
4	EC10001	Basic Electronics	2	0	0	2	2
5	EE10002	Basic Electrical Engineering	2	0	0	2	2
6		HASS Elective I	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	CH19001	Chemistry Lab	0	0	2	2	1
2	EX19001	Engineering Lab	0	0	2	2	1
Sessional							
1	YG18001	Yoga	0	0	2	2	1
2	ME18001	Workshop	0	0	2	2	1
3	HS18001	Communication Lab	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**10**	**5**
Total Credit (Semester)						**25**	**20**

SCHEME II
SECOND SEMESTER

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	PH10001	Physics	3	0	0	3	3
2	MA11002	Transform Calculus and Numerical Analysis	3	1	0	4	4
3		Science Elective	2	0	0	2	2
4		Engineering Elective	2	0	0	2	2
5	LS10001	Science of Living Systems	2	0	0	2	2
6	CH10003	Environmental Science	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	PH19001	Physics Lab	0	0	2	2	1
2	CS13001	Programming Lab	0	2	4	6	4
Sessional							
1	CE18001	Engineering Drawing & Graphics	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**10**	**6**
Total Credit (Semester)						**25**	**21**

LIST OF ELECTIVES

Engineering Elective							
Sl. No.	Course Code	Subjects	**L**	**T**	**P**	**Total**	**Credit**
1	CE10001	Basic Civil Engineering	2	0	0	2	2
2	ME10003	Basic Mechanical Engineering#	2	0	0	2	2
3	EE10001	Elements of Machine Learning*	2	0	0	2	2
4	EC10003	Biomedical Engineering	2	0	0	2	2
5	EE10003	Basic Instrumentation	2	0	0	2	2

Not for students of Mechanical Engineering
* Not for students of Computer Engineering

Science Elective							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10005	Nanoscience	2	0	0	2	2
2	PH10003	Smart Materials	2	0	0	2	2
3	LS10003	Molecular Diagnostics	2	0	0	2	2
4	PE10002	Science of Public Health	2	0	0	2	2
5	MA10003	Optimization Techniques	2	0	0	2	2

HASS Elective I							
Sl. No.	**CourseCode**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	HS10013	Society, Science, and Technology	2	0	0	2	2
2	HS10202	Essential of Management	2	0	0	2	2
3	HS10121	Shades of Economics	2	0	0	2	2
4	HS10123	Indian Economy Post Liberalisation	2	0	0	2	2
5	SO10043	Socio-Political Environment	2	0	0	2	2
6	PS10043	Thinking Perspectives	2	0	0	2	2
7	PS10045	Creativity, Innovation and Entrepreneurship	2	0	0	2	2
8	EX17001	Community/Environment-based Project	0	0	4	2	2

1ST YEAR DETAIL SYLLABUS

PHYSICS

Course Code: **PH10001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This subject is designed to enrich the basic knowledge of engineering students in the field of physics and to support the engineering and research programs. The subject will also help the students to develop mathematical models to understand the behavior of physical systems and phenomena.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the basic concepts of oscillation, waves, wave function and fields,
CO 2: Understand the principles of wave phenomena in light and matter, and the quantum mechanics,
CO 3: Apply the principles of oscillation, superposition of waves, electromagnetic theory, and quantum mechanics in different fields,
CO 4: Analyze different types of particle motion in different media,
CO 5: Evaluate the problem-solving skills for the topics learnt, and
CO 6: Develop critical thinking ability supported by the learned concepts of Physics.

COURSE DETAILS

Oscillation
Damped Harmonic Oscillation (underdamped, overdamped and critically damped), Energy decay, Relaxation time, Quality factor, Forced oscillation, Resonance, Coupled oscillations, Applications.

Waves and Interference
Wave equation, Superposition of waves, Interference of light, Types of interference: Division of wavefront and division of amplitude.

Interference in thin films
Wedge shaped thin film, Newton's rings and their applications, Michelson interferometer, Applications.

Diffraction

Diffraction and its applications, Types of diffraction, Fraunhofer diffraction by a single slit, Plane diffraction grating (condition of maxima, minima), Maximum order of observable spectra, Absent spectra, and Dispersive power, Applications.

Quantum Mechanics
Dual nature of radiation and matter, de Broglie hypothesis for matter waves, Phase velocity and Group velocity, Heisenberg's uncertainty principle and applications, Wave function and its interpretation, Concepts of operators, Schrodinger's time-dependent and time-independent equations, Postulates of Quantum mechanics, Particle in one-dimensional box and applications, Quantum tunnelling and applications.

Electromagnetic Theory
Vector calculus: scalar and vector field, Gradient, divergence and curl, Line, surface and volume integrals, Gauss divergence and Stoke's theorem, Maxwell's equations in differential and integral form with necessary derivations. Electromagnetic wave equations, Transverse nature of electromagnetic waves.

Laser and Fiber Optics
LASER: Properties and applications, Spontaneous and stimulated emission, Meta-stable state, Population inversion, Pumping, Three and four-level Laser, Ruby Laser.

Optical fiber
Principle, Construction, Types of optical fiber, Acceptance angle, Numerical aperture, Applications.

Textbook

1. B. K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publication, New Delhi, 2nd Edition 2022, ISBN-13: 978-81-953536-7-5.

Reference books

1. D J Griffiths, Introduction to Electrodynamics, Pearson Education, 4th Edition, 2015.
2. L. I. Schiff and J. Bandhyopadhyay, Quantum Mechanics, Tata McGraw-Hill Publications, 4th Edition, 2014, ISBN-9781259062865.
3. A K Ghatak, Optics, Tata McGraw-Hill Publications, 4th Edition, 2008, ISBN: 9780070262157.
4. A. Beiser, Concepts of Modern Physics ,Tata McGraw-Hill Publications, 6th Edition, 2002, ISBN 10: 0071234608.
5. R K Gaur and S. L. Gupta, Engineering Physics, Dhanpat Rai Publications, New Delhi, 2nd Edition, 2012, ISBN-10: 8189928228.

CHEMISTRY

Course Code: **CH10001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enrich the students with the basic concepts in Chemistry and to strengthen their fundamentals which will support them to pursue education and research in engineering. The course will help the students to conceptualize alternative sources of energy by electrochemical means and use the instrumental techniques to explore chemical products.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Rationalize bulk properties and processes using thermodynamic consideration and apply the knowledge to decide the feasibility of a given process,
CO 2: Analyze the kinetics of multistep reactions as well as the theories of reaction rates,
CO 3: Understand the importance of catalysis and their mechanism of action and applications,
CO 4: Apply the principles of electrochemistry to evaluate properties, such as pH, solubility Product, etc. and understand the working principle of modern batteries,
CO 5: Apply different spectroscopic techniques, such as UV-Vis, IR and NMR, for structural Elucidation, and
CO 6: Differentiate between smart and intelligent materials.

COURSE DETAILS

Chemical Equilibrium and Thermodynamics
Introduction, Internal energy, Enthalpy, Entropy and free energy, Dependence of free energy on temperature and pressure, Gibbs-Helmholtz equation, Free energy change and equilibrium constants, Van't Hoff isotherm and isochore, Clapeyron-Clausius equation, Partial molar properties, Chemical potential, and Gibbs-Duhem equation.

Chemical Kinetics
Rate of reaction and rate laws of multiple reactions (steady-state approximation), and of parallel, opposing and consecutive reactions; Theories of reaction rate: Collision theory, Lindemann modification, Absolute reaction rate; Catalysis: Types, theories, and kinetics of enzyme catalysis (Michaelis-Menten mechanism).

Spectroscopy
UV-Vis spectroscopy: Beer-Lamberts law, Types of transition, Concept of auxochrome and chromophores, Factors affecting λ_{max} and, Woodward-Fieser rules for calculation of λ_{max} in diene systems; IR spectroscopy: Types of vibration, Hooks law, detection of functional groups like C=C, -OH, $-NH_2$ and -C=O;

NMR Spectroscopy
Basics of NMR Spectroscopy: Theory, Chemical shift, Shilding-deshilding effect, Structural elucidation of simple compounds.

Electrochemical Energy Systems
Types of electrodes, electrode/cell potential; Nernst equation and application to: find electrode and cell potential, equilibrium constant, solubility product and pH; Modern batteries: Fuel cells (AFCs, PEMFs, SOFCs, MCFCs), Zn-air battery, Li-ion battery, Na-ion battery, Ni-MH battery.

Smart and Intelligent Materials
Introduction to smart materials, Properties and types of smart materials, Structures, System intelligence- components and classification of smart structures, Common smart materials and associated stimulus-response, Application areas of smart systems.

Textbook

1. S Chawala, Engineering Chemistry, Dhanpat Rai and Co, 4th Edition, ISBN: 9788177001938.

Reference books

1. S Agarwal, Engineering Chemistry: Fundamentals and Applications, Cambridge University Press, ISBN: 9781107476417.
2. S. Chakroborty, S. Sen, and S. Mittal, Engineering Chemistry, Cengage Learning India Pvt. Ltd., ISBN: 9386668645.
3. B.R. Puri, L.R Sharma, and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 47th Edition, ISBN: 978-9382956013.
4. R M. Silverstein, Fransis X, Webster, D J Kiemle, Spectrometric Identification of Organic compounds, -Jhon Wiley& Sons, INC, 7th Edition.
5. S Glasstone, Elements of Physical chemistry-, Macmillan publishers, 2nd Edition ISBN: 978-0333038437.
6. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007, 1st Edition ISBN: 978-0471684770.

ENVIRONMENTAL SCIENCE

Course Code: **CH10003**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to create awareness in the students on monitoring, assessment, and management of environmental pollutants. The subject will also make the students aware of more benign chemistry, i.e.,green chemistry, and help them to understand the implementation of Environmental Impact Assessment (EIA).

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the components and composition of the environment along with the radiation balance model,
CO 2: Rationalize the different types of pollutants, their sources, effects, and control measures,
CO 3: Develop the idea of water purification strategies,
CO 4: Identify toxic wastes and conceptualize the principles of solid waste management,
CO 5: Conceptualize the principles of green chemistry and implement them in the synthesis of advanced material, to reduce pollution, and
CO 6: Provide for Environmental Impact Assessment (EIA) requirements before planning a project.

COURSE DETAILS

Overview of the Environment
Overview of the environment, terminologies, Components of Earth: Lithosphere, atmosphere, hydrosphere and biosphere, Concept of black body radiation and albedo, eZro-dimensional energy balance model.

Air Pollution and Control
Primary and secondary air pollutants, CFC, Smog (oxidizing and reducing), Important environmental issues: Depletion of the ozone layer, Acid Rain, Greenhouse effect and global warming, Control measures: Baghouse filter, Cyclone separator, Electrostatic precipitator, Catalytic converter, and Scrubber.

Water Pollution and Control
Types and sources of water pollutants, wastewater treatment techniques: Ultrafiltration, aerobic and anaerobic treatment, Reverse osmosis, Electrodialysis, Ddisinfection by chlorination, Ozonization, Modern water purification system, Water quality parameters like hardness, Water softening process (permutit), WHO guidelines for drinking water.

Soil Pollution and Solid Waste Management
Soil pollution: Sources of pollutants and mitigation measures. Types of solid wastes: Heavy metal, bio-medical and radioactive wastes, Toxic and biochemical effects of solid wastes, Solid waste management (landfilling, incineration, and composting).

Green Chemistry and EIA
Basic principles of green chemistry with examples, Matrices to explain greenness, R^4M^4 model, life cycle analysis. Importance, scope and principles of EIA with a case study.

Textbook

1. A. K. De, Environmental Chemistry, New Age International Publishers, 9th Edition.

Reference books

1. S. Chakroborty, D. Dave, and S. S. Katewa, Environmental Chemistry-, Cengage Learning India Pvt. Ltd., 1st Edition.
2. Aloka Debi, Environment Science and Engineering, Universities Press,2nd Edition.
3. Erach Bharucha, Textbook of Environment studies for undergraduate courses, Universities Press, 2nd Edition.
4. D. De and D. De, Fundamentals of Environment and Ecology, S. Chand &Co, 2013.
5. Jain and Jain, Engineering Chemistry, Dhanpat Rai,Publishing Company.
6. S.C. Santra, Environmental Science,New Central Book Agency, ISBN: 9788173814044.

PHYSICS LABORATORY

Course Code: **PH19001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This lab course covers different measurement techniques of various parameters using the instruments i.e. interferometer, spectrometer, spherometer, screw gauge, vernier calliper, microscope, and telescope. It includes the application of photoelectric effect and photovoltaic effect in photo cell and solar cell respectively. Evaluation of the mechanical strength of materials by calculating elastic constants such as Young's modulus, rigidity modulus and Poisson's ratio are also included. This course provides hands on training for the usage of electrical, optical and mechanical systems for various measurements with precision and analysis of the experimental data by graphical interpretation and error calculation.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the wave nature of light through experiments based on interference and diffraction Phenomena,
CO 2: Apply the laws of quantum physics to understand the photoelectric emission using the particle nature of light,
CO 3: Characterize photovoltaic cells to find out efficiency in terms of power output,
CO 4: Evaluate mechanical properties of materials using their elastic properties,
CO 5: Apply the principles of optics such as refraction, total internal reflection to calculate refractive index and related parameters, and
CO 6: Use the principles of oscillation to understand phenomena such as damping, resonance and to determine the factors (such as gravity, elasticity etc) affecting the time period of various oscillators.

Topics

Measurement by vernier callipers, screw gauge, spherometer: A review

- Determination of wavelength (λ) of a monochromatic light by Newton's ring experiment.
- Determination of wavelength (λ) and difference (dλ) between wavelengths of sodium D-lines by Michelson's interferometer.
- Determination of grating element (e+d) of a plane diffraction grating.
- Determination of Planck's constant using photocell.
- Study of the characteristics of a photo cell.
- Study of the characteristics of a solar cell.
- Determination of Young's modulus (Y) of a material by bending of beam method.
- Determination of Poisson's ratio (σ) of rubber.
- Determination of rigidity modulus (η) of a material by dynamic method.
- Determination of refractive index (μ) of a transparent liquid by Boy's method.
- Determination of numerical aperture of optical fibre.
- Determination of acceleration due to gravity (g) by bar pendulum.
- Determination of damping coefficient, relaxation time and quality factor of damped harmonic oscillation by simple pendulum.
- Measurement of velocity of sound in air using resonance column method.
- Studies on dielectric/multi-ferroic materials (Open ended)
- Diffraction studies using Laser sources (Open ended)

Reference books

1. Physics laboratory instruction manual, School of Applied Sciences, Department of Physics, KIIT Deemed to be University, Bhubaneswar.
2. S. L. Gupta and V. Kumar, 2018, Practical Physics, Pragati Prakashan, 33rd Edition, ISBN: 978-93-87151-58-1.

CHEMISTRY LABORATORY

Course Code: CH19001
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

This lab course covers different types of chemical experiments ranging from volumetric analysis to spectroscopic techniques. This course provides the students with hands-on training in many of the advanced spectroscopic and analytical techniques in chemistry. The experiments in the course span over diverse applications in chemistry. It contains experiments dealing with environmental chemistry, volumetric analysis, organic and inorganic synthesis, electrochemistry, and spectroscopy.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Handle different chemicals with proper safety protocols in an advanced Chemistry laboratory,
CO 2: Learn and apply basic techniques used in Chemistry laboratory for preparation, purification and identification,
CO 3: Analyze the kinetics of 1st order reactions and estimate the rate constant,
CO 4: Use different instrumental techniques such as Conductometry, pH-metry, Potentiometry and Colorimetry,
CO 5: Analyse basic water quality parameters like hardness, dissolved oxygen, alkalinity, chloride, ferrous iron contents etc,and
CO 6: Rationalize and learn the spectroscopic and synthesis techniques in chemistry.

Topics

- Estimation of total hardness in a given water sample in terms of calcium and magnesium hardness by EDTA method.
- Estimation of the amount of NaOH and Na_2CO_3 present in a given mixture solution
- (a) Determination of the strength of $KMnO_4$ solution by using standard sodium oxalate solution. (b) Determination of the amount of Ferrous (Fe^{2+}) ions present in the Mohr's salt solution by using standard $KMnO_4$ solution.
- Determination of the amount of dissolved oxygen present in a given water sample by Winkler's method.
- Finding the strength of Fe^{2+} present in the supplied Mohr's salt solution by potentiometric titration.
- Determination of the rate constant of acid-catalyzed hydrolysis of ethyl acetate.
- Determination of the chloride ion (Cl^-) present in a given water sample by the argentometric method.
- Finding the strength of supplied acid by pH-metric titration against a standard alkali.
- Finding the strength of a given hydrochloric acid solution by titrating it against standard sodium hydroxide solution conducto-metrically.
- Verification of Beer Lambert's Law and application of this law to determine the unknown concentration of a given solution.
- Determination of the concentration of ferric ions (Fe^{3+}) in a given water sample by a spectrometric method using KCNS as color developing agent.
- Determination of the Isoelectric point (pI) of glycine amino acid.
- Synthesis of transition metal complexes and characterization by using IR and ^{1}H-NMR. (Open ended)
- Determination of the concentration of different ions (cations and anions) in a given water sample by colorimetry. (Open ended).
- Application of potentiometric titrations (Open ended).

Reference books

1. Chemistry laboratory Instruction manual, School of Applied Sciences, KIIT Deemed to be University
2. Vogel's Quantitative Chemical Analysis, J. Mendham, R.C. Denney J. D. Barnes, M.J.K. Thomas, 6th Edition, Longman
3. Standard methods for examination of water and wastewater, 23rd Edition, APHA.

DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA

Course Code: **MA11001**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to familiarize the prospective engineers with techniques in ordinary differential equations and linear algebra. It aims to equip the students to tackle advanced level of mathematics and applications that they would find useful in their disciplines.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the concept of modelling and formulation of Differential equation of physical problems,
CO 2: Apply different methods to solve ODE problems involving growth-decay, cooling effects and electrical circuits etc,
CO 3: Develop an ability to solve 2nd and higher order ODEs,
CO 4: Apply the knowledge of special function in engineering problems,
CO 5: Use the essential tool of matrices and linear algebra in a comprehensive manner, and
CO 6: Apply the knowledge of Eigen value and Eigen vector in the field of engineering and also get the concept of complex matrices.

COURSE DETAILS

Ordinary Differential Equations of First Order
Introduction and formation of differential equations, Overview: Variable separable, homogeneous, equations reducible to homogeneous form.Exact differential equations, equations reducible to exact form, linear differential equations, equations reducible to linear form (Bernoulli's equation). Applications of differential equations: Growth-Decay Problem, Newton's Law of Cooling, Mixing problem, Orthogonal trajectories.

Linear Differential Equations of second order
Second order linear homogeneous equations with constant coefficients; differential operators; solutions of homogeneous equations; Euler-Cauchy equation; linear dependence and independence; Wronskian; Solutions of non-homogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients. Applications of 2nd order differential equations in Electric circuit.

Special Functions
Improper Integrals for one variable, some test for convergence of improper integrals, Gamma function, Properties, Beta function, Relation between Gamma and Beta functions. Radius of convergence of power series, Legendre equation. Legendre polynomial. Recurrence relations and Orthogonality property of Legendre polynomial. Bessel's equation, Bessel's function, Recurrence relation.

System of Linear Equations and Vector Space

Linear system of equations; rank of matrix; consistency of linear systems; Solution of system of linear equations: Gauss elimination, inverse of a matrix by Gauss Jordan method, Vector Space, Sub-space, Basis and dimension, linear dependence and independence, Linear transformation.

Matrix-Eigen value problems

Eigen values, Eigen vectors, Eigen basis, quadratic form; Hermitian, Skew-Hermitian forms; similar matrices; Diagonalization of matrices.

Text book

1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley INC, 10th Edition,2011.

Reference books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition.
2. H.K. Das, Introduction to Engineering Mathematics, S.Chand & Co Ltd, 11th Edition.
3. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publications 2007.
4. J. Sinha Roy and S. Padhy, A course on ordinary & partial differential Equation, Kalyani Publication, 3rd Edition.

TRANSFORM CALCULUS AND NUMERICAL ANALYSIS

Course Code: **MA11002**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to familiarize the students with the methods of Laplace and Fourier transformation and various numerical techniques to solve engineering problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply Laplace Transform to problems in the field of science and engineering,
CO 2: Use Fourier series and Transform as a tool to solve differential equations,
CO 3: Estimate the error in the results obtained in the numerical methods,
CO 4: Solve nonlinear equations that arise in engineering problems and interpolation,
CO 5: Know various numerical methods of differentiation and integration, and
CO 6: Apply numerical solution of differential equations and systems of linear equations.

COURSE DETAILS

Laplace Transforms

Laplace Transform, Inverse Laplace Transform, Linearity, Transform of derivatives and integrals, Unit Step function, Dirac delta function, Second shifting theorem, Differentiation and integration of transforms, Convolution, Solution of ODEs and integral equation by Laplace transform.

Fourier Series and Transform: Fourier series, Arbitrary periods, Even and odd functions, Half range expansions, Fourier integral, Cosine and sine transforms, Fourier Transform, Inverse Fourier Transform, Linearity, Fourier Transform of derivative, Convolution.

Approximations & Errors
Approximation of numbers by truncation and rounding-off, Types of errors.
Numerical solution of Nonlinear equations: Solutions by Bisection Method, Fixed Point Iteration Method, Newton-Raphson Method, Regula-Falsi and Secant Method, Rate of Convergence of Secant & Newton-Raphson Method.

Interpolation & Approximation Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.

Numerical Differentiation & Integration: Numerical differentiation of first- and second-order equations using difference table. Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules, Gauss-Legendre's two-point and three -point formulae. Error in Numerical Integration.

Numerical Solution to ODE
Taylor's (OK?) series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, Reduction of second-order ODE to system of first-order ODEs and its solution by R-K method of order four.

Solution of System of Linear Equations, Solutions by Gauss-Seidel and Gauss-Jacobi methods.

Textbooks

1. E Kreyszig, Advanced Engineering Mathematics by Wiley, INC, 10^{th} Edition.
2. Jain, Iyenger and Jain, Numerical Methods for Scientific and Engineering Computation, New age International (P) Ltd., 6^{th} Edition.

Reference books

1. B.S. Grewal, Khanna ,Higher Engineering Mathematics, Publishers, 44^{th} Edition.
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publications, 2007.
3. A, Thangapandi and Somasundaram, Numerical Methods, Scitech Publishers, 2^{nd} Edition.

SCIENCE OF LIVING SYSTEMS

Course Code: LS10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of the course is to enrich the basic knowledge of students in the field of biology and use that knowledge to support the engineering and research programs. Besides, the course also helps to learn methodology to establish models for various biological phenomena and apply the aforementioned models to predict/analyse the functionality of various systems.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Learn the typical characteristics that distinguish life forms and analyze life process at cellular level,
CO 2: Apply concepts on structure and function of simple biomolecules in life processes
CO 3: Understand different process involved in life and analyse their effects,
CO 4: Analyse different biological phenomena and relate them to engineering applications,
CO 5: Comprehend different physiological functions and relate them to computer-based techniques, and
CO 6: Implement concepts of biology and their relevance to engineering and technology.

COURSE DETAILS

Cellular Organization of a Living Organism

Biology in engineering, The Living World: Biodiversity of living world, Microorganisms, Cell as the basic unit of life, Cell theory, Structure and function of Prokaryotic and Eukaryotic cells, Cell growth and reproduction, Homeostasis, Concept of gene, Basic structure and function of chromosomes.

Molecular and Biochemical Basis of an Organism
Chemical Context of Life: Water, Carbon, Structure and Function, Types of bonding, Bio- macromolecules (Carbohydrates, Proteins, Amino acids, Lipids and Nucleic acids), Protein synthesis, Cell differentiation, Stem cells and their applications.

Enzymes, Photosynthesis, Metabolism and Bioenergetics
Enzymes: Introduction, structure, properties, Classification, Mechanism of enzyme actions, Factors affecting enzyme action, Strategies utilized by enzymes to affect catalysis. Photosynthesis: Introduction, pigments, process of photosynthesis, Mechanism of photosynthesis (light reaction and dark reaction). Metabolism and Bioenergetics: Anabolism and catabolism.

Nervous system, Immune system and Cell Signaling
Nervous system: Introduction, History of neuroscience, Types of glial cells, Nerve cells - Neurons, Organization of the nervous system, Action potential, Diseases of the nervous system, Computer-based Neural Networks. Immune system: Introduction, Innate Immunity, Adaptive or acquired immunity, Diseases of the immune system, Immune engineering. Cell signaling: General principles of cell signaling.

Molecular Machines, Biosensor and Bioremediation
Molecular Machines: Introduction, Molecular motors and Machines, F0F1-ATP synthase motors, Cytoskeleton associated motors. Biosensors: Concept of biosensor, Working principle, Types of biosensors, Glucose biosensors, Bio-detectors: DNA detection biosensor, Detection of pollutants, Biosensor in food industry. Bioremediation: Introduction, Role of microorganisms, Factors determining bioremediation, Types – *in situ/ex situ*, Advantages and disadvantages, Biofuel.

Textbook

1. S. Thyagarajan, N. Selvamurugan, M.P Rajesh, R.A Nazeer, Richard W. Thilagarajan, S. Bharathi and M.K. Jaganathan, Biology for Engineers, McGraw Hill Education (India),7th Edition, 2022.

Reference books

1. P. H. Raven and G.B. Johnson. Biology (Indian Edition), Tata McGraw Hill Education Publication,13th Edition, 2023.
2. E D. Enger, Feederick C, Ross and David B. Bailey. Concepts of Biology,Tata McGraw-Hill Publication, 14th Edition, 2011.
3. Neil A. Campbell and Jane B. Recee, Biology, Pearson Education, 8th Edition , December 2007.
4. Cecie Starr, Biology Concepts and Application, Thomson Books, 6th Edition, January 2006.

ENGLISH

Course Code: HS10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of the course is to develop and improve, in the students, the skills of active listening, speaking, reading, and writing in English, through lecture classes and practice sessions, and improve their professional communication abilities. The course will help the students to enhance their critical thinking and situational communicative skills through the study of contemporary social issues depicted in literature.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply verbal and non-verbal modes of communication effectively in practical Situations,
CO 2: Retain a grammatically correct and logical flow while drafting reports and other technical pieces of writing,
CO 3: Develop competence in reading and comprehension,
CO 4: Implement active listening responses in professional practice,
CO 5: Utilize neutral accent in English pronunciation successfully, and

CO 6: Understand situational and conversational English used for different purposes and contents.

COURSE DETAILS

Professional Communication
Process of Communication: Definition, Explanation & Diagram, Difference Between General and Technical Communication; Methods of Communication (Verbal & Non-Verbal); Non-Verbal Communication (Kinesics, Proxemics, Chronemics, Oculesics, Olfactics, Gustorics, Haptics, and Iconics); Paralanguage; Flow of Communication (Formal & Informal); Levels of Communication; and Barriers of Communication (Intrapersonal, Interpersonal, and Organizational).

Basics of Grammar and Writing Skills
Error Detection in Sentences: Articles, Prepositions, Tense, Subject-Verb Agreement, Active and Passive Voice; Use of Punctuation: Full Stop, Comma, Colon, Semi-colon, Single & Double Inverted Commas, Exclamation & Interrogation Marks, Hyphens and Dashes, and Ampersand;
Paragraph Writing – Components; Writing Bias-free English; Business Letters: Enquiry, Claim/Complaint, and Order; Technical Reports: Formats, Style & Referencing; and Reading Techniques: Skimming, Scanning, Intensive & Extensive Reading.

Basic Sounds of English
Hearing & Listening: Types of Listening – Appreciative, Empathetic, Critical, Comprehensive, Superficial, Differences between Listening & Hearing; Introduction to Basic Sounds of IPA: Symbols of IPA, Types of Vowels & Consonants; and Problem Sounds & Mother Tongue Influence: Concept of MTI with Examples.

English Literature
Short Story – O. Henry: 'Gift of the Magi;'Short Story – Ismat Chughtai: 'Sacred Duty;'; Poem – Robert Frost: 'Stopping by Woods on a Snowy Evening;'Poem – Tennessee Williams: 'We Have Not Long to Love;' and Drama: William Shakespeare: Merchant of Venice.

Textbook
1. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill Education Publication, 2005.

Reference books

1. Sidney Greenbaum. The Oxford Grammar (English). Oxford University Press, 1st Edition. 2005.
2. S Verma,Technical Communication for Engineers, Vikas Publishing House,2015.
3. R Dove,The Penguin Anthology of 20th Century American Poetry,Penguin Books. 2013.
4. The Merchant of Venice (The New Cambridge Shakespeare). Mahood & Lockwood eds. CUP. 2018.

COMMUNICATION LABORATORY

Course Code: HS18001
Credit: 1
L-T-P: 0-0-2
Prerequisite: NIL

COURSE OBJECTIVE

This subject is designed to enrich the basic knowledge of engineering students in the field of communication and to support the engineering and research programs.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Use English grammar correctly and unambiguously in technical writing,
CO 2: Apply verbal and non-verbal modes of communication effectively in practical situations,
CO 3: Have a basic understanding of the communication process and to know the practical implementations in the workplace,
CO 4: Retain a logical flow while drafting reports and other technical pieces of writing,

CO 5: Develop competence in reading and comprehension, and

CO 6: Be familiar with English pronunciation and use neutral accent successfully.

COURSE DETAILS

Reading Comprehension
Understanding meaning and sequence of ideas in written language
Activity based on matching, multiple choice questions, open close, appropriate headings.

Time & Tense + Subject-Verb Agreement
Applying correct grammar in everyday writings.

Vocabulary Building (Mind Mapping/Phrasal Verbs)
Developing vocabulary through associating key ideas, and learning idioms and phrases.

Listening Comprehension
Interpreting meaning and syntax in spoken language.

E-mail Writing
Formulating appropriate e-mails with relevant salutation, language &conclusion

Resume Writing/ Video Resume
Creating suitable, job-orientedresume

Thematic Speaking
Practising and implementing theme-based individual speaking skills.

PowerPoint Presentation
Developing skills to design and deliver engaging, informative and impactful presentations

Class Participation.

BASIC ELECTRONICS

Course Code: EC10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The subject is designed to familiarize students of all branches to the all-pervasive field of Electronics, enable them to carry out research in interdisciplinary fields involving semiconductor devices, and utilize the knowledge in solving practical problems in real life in today's age of electronics.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the properties of semiconductor and current conduction mechanism,
CO 2: Comprehend the working of P-N junction diodes; identify different diode circuits and analyze them,
CO 3: Understand the working of different types of transistors,
CO 4: Know about OP-AMP and its applications,
CO 5: Analyze the working of op-amp using either inverting or non-inverting configurations, timing circuit, regulated power supply ICs, and their applications, and
CO 6: Realize the importance of various analog and digital electronic systems and electronic devices.

COURSE DETAILS

Semiconductors, Diodes and Transistors

Properties of semiconductor materials, Applications of semiconductors as p-n junction diode, Diode characteristics and breakdown mechanisms, Half-wave and full-wave rectifiers with filters, Zener diode, Transistor constructions, operations and their characteristics. Transistor biasing, amplifiers, and load line analysis, Concepts of JFET and MOSFET.

Operational Amplifier (Op-amp) and applications
Introduction to Op-amp and its Characteristics. Application of Op-Amp as Inverting amplifier, Non-inverting Amplifier, Summing, Difference amplifier and comparator

Introduction to Digital Electronics
Different number systems and its conversions, Logic gates and truth tables of OR, AND, NAND, EX-OR. Combinational circuit and Sequential circuit.

Miscellaneous Electronic Devices
SCR, Opto-electronic devices and fiber techniques, Introduction and description of sensor performance, Fundamentals of analog communication techniques (AM and FM).

Textbook

1. J Millman, Christos C. Halkias & C D. Parikh, Integrated Electronics: Analog and digital circuits and Systems , 9th Edition, 2021.

Reference books

1. R. L. Boylestad & L. Nashelsky, Electronic Devices & Circuits,PHI,7th Edition,2021
2. D. A. Bell. Electronic Devices and Circuits.(Oxford)5th Edition,2021.
3. D. Chattopadhyay and P. C. Rakshit. Fundamentals & Applications ,New Age International, 15th Edition 2021.

BASIC ELECTRICAL ENGINEERING

Course Code: EE10002
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to provide to the students a comprehensive overview of the basics of the electrical engineering discipline. In particular, the course includes fundamental aspects of DC, AC and magnetic circuit analysis, working principles and applications of machines, and safety measures used in various electrical apparatus and appliances.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the concept of DC circuit,
CO 2: Understand the concepts of AC circuits,
CO 3: Analyze the three phase circuit,
CO 4: Interpret the behavior of magnetic circuits,
CO 5: Remember the principles and operation of electrical machines, and
CO 6: Know the concepts of electrical safety and protection systems.

COURSE DETAILS

D. C. Circuits
Kirchhoff's law, Source transformation, Star-delta transformation and equivalent resistance of the circuits, Mesh and Nodal analysis, Superposition theorem.

A.C. Circuits
Peak, average, R.M.S. values of sinusoidal quantities, Peak factor, Form factor, Phase difference, Phasor representation, AC through R, L, C, AC Series Circuit (RL, RC, RLC), Three-phase AC circuits: Voltage, current and power in star and delta connections.

Electromagnetic Circuits
Magnetizing Force, Reluctance, Permeance, Magnetic field, Magnetic permeability, Analogy between Electric Circuits and Magnetic Circuits. Series magnetic circuit, BH curve.

Scope and Safety Measures
Electrical Energy Scenario in India, Application of Transformer, Three-phase and single-phase induction Motors, Power ratings of air conditioners, PCs, laptops, printers, refrigerator, washing machine, different lamps, electricity tariff, calculation of electricity bill for domestic consumer.

Personal Safety Measures
Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

Equipment Safety Measures
Working principles of fuse and miniature circuit breaker (MCB), Residual Current Circuit Breaker (RCCB).

Text books

1. V K Mehta, Rohit Mehta, Principles of Electrical Engineering and Electronics S Chand and Company, New Delhi ,Revised Edition 2013.
2. D.C. Kulshreshtha, Basic Electrical Engineering Tata Mcgraw publication, 1st Edition 2011.
3. T.K. Nagasarkar and M.S. Sukhija Basic Electrical Engineering, , Oxford University press, 3rd Edition 2017.

Reference book

1. Sanjeev Sharma, Basics Electrical Engineering I.K.International, New Delhi ,Third Reprint 2010.

ENGINEERING MECHANICS

Course Code: ME10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Engineering Mechanics is a specialized need-based extension of Applied Physics and uses the principles of Statics and Dynamics. The objective of this course is to build the foundational knowledge of the students which is required for the design of mechanical systems. In particular, the course will cover aspects of analysis of rigid body, frame and machine under the action of force system, and analysis of free body diagram of a system whether at rest or in motion.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Draw complete and correct free-body diagrams and write the appropriate equations from the free-body diagram,
CO 2: Use scalar analytical techniques for analyzing forces and moments in mechanical systems,
CO 3: Analyze forces in statically determinate structures such as trusses, frames and problems related to friction,
CO 4: Determine the centroid and second moment of area,
CO 5: Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple and practical problems, and
CO 6: Solve real life problems by using mathematics, physical laws and theorems.

COURSE DETAILS

Concurrent Forces in a Plane
Introduction to Engineering Mechanics, Free-body diagrams, Composition and resolution of forces, Methods of moments. Friction: Concept of friction, Wedge friction.

Force Analysis of Plane Trusses

Methods of joints, Method of Sections, Centroid: Parallel forces in a plane, Centroid of plane figures, Theorem of Pappus, and Centroid of composite plane figures.

Moment of Inertia
Moment of Inertia of plane figures, Parallel axis theorem, Perpendicular axis theorem, and Moment of Intertia of composite figures.

Principle of Virtual Work
Equilibrium of Ideal Systems, Virtual work.

Dynamics of Particles
Differential equations of rectilinear motion, Free vibration, D'Alembert's Principle, Momentum and Impulse, Work & Energy, Conservation of energy, Impact.

Curvilinear Motion
Normal and tangential acceleration, Motion of a projectile, Work and Energy in curvilinear motion.

Rotation of a Rigid Body
Kinematics of rotation, Rotation under the action of a constant moment.

Textbook
1. S Timoshenko, D. H Young & J.V. Rao, Engineering Mechanics, Tata McGraw-Hill Publication 5th Edition, 2017.

Reference books

1. I H Shames, Engineering Mechanics (Statics and Dynamics) , Prentice Hall, 4th Edition, 2005.
2. S.S. Bhavikatti, Engineering Mechanics –New Age International,8th Edition, 2021.
3. S. Rajasekaran and G. Sankarasubramanian Engineering Mechanics (Statics and Dynamics),Vikas publishing House, 3rd Edition, 2017.

WORKSHOP

Course Code: ME18001
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

This workshop practice is designed to impart students the basic knowledge on manufacturing or developing a given object irrespective of their branch of engineering. While furnishing the given object, students will familiar with various mechanical operations and the respective tools or machines. This course involves four different sections namely Fitting, Welding, Turning and Sheet metal which cover both conventional and advanced tools to provide students the updated manufacturing experience. Students are also advised with various safety precautions to be followed during a specific manufacturing practice. At the end, students will also gain knowledge on different advanced machines such as CNC machine tools and 3D printing.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Practice different operations related to fitting shop,
CO 2: Use different welding tools to prepare a given type of joint,
CO 3: Demonstrate various turning operations including taper turning and knurling using a conventional lathe machine,
CO 4: Design a tray and prepare it using sheet metal equipment involving soldering,
CO 5: Appraise different operations using a CNC machines,and
CO 6: Interpret different advanced machines such as 3D printing/additive manufacturing.

Topics
- Turning operations
- Sheet metal operations

- Fitting
- Welding

ENGINEERING DRAWING & GRAPHICS

Course Code: **CE18001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to provide students with knowledge and abilities to design a 3D object on 2D paper by hand sketching method and by means of computer aided drafting software.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Use common drafting tools properly,
CO 2: Select, construct and interpret appropriate drawing scale as per the situation,
CO 3: Draw orthographic projections of points, lines and planes,
CO 4: Draw orthographic projection of solids like cylinders, cones, prisms and pyramids,
CO 5: Develop the section of solids for practical situations, and
CO 6: Communicate ideas effectively using Computer Aided Drafting.

Topics

- Introduction to Engineering graphics
- Lettering
- Projection of points & lines
- Line inclined to both the planes
- Projection of planes
- Introduction to Computer Aided Drafting
- Projection of solids
- Section of solids
- Development of surface

Textbook

1. K. Venugopal,Engineering Drawing + AutoCAD New Age Publishers, 1st Edition, 2011.

Reference book

1. S. N. Lal Engineering Drawing with an Introduction to AutoCAD, Cengage India Private Limited, 1st Edition, 2017.

PROGRAMMING LABORATORY

Course Code: **CS13001**
Credit: **4**
L-T-P: **0-2-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course aims to provide exposure to problem-solving through programming. It aims to train the student to the basic concepts of the C-programming language. This course involves lab component which is designed to give the student hands-on experience with the concepts.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Have fundamental knowledge of computers hardware and number systems with commands in Linux,
CO 2: Write, compile and debug programs in C language.
CO 3: Design programs involving decision structures, loops, and functions.
CO 4: Construct arrays to store, manipulate, search and display data.
CO 5: Apply the dynamics of memory by the use of pointers.
CO 6: Use different data structures and create/update basic data files.

Topics

- Basic linux commands
- Operators and Expressions
- Branching statements (if-else, switch).
- Control statements (looping - for, while, do-while).
- Arrays
- Character Arrays (strings).
- Functions.
- Pointers and Dynamic Memory Allocation.
- Structures and Unions
- File Handling

SCIENCE ELECTIVE

NANOSCIENCE

Course Code: CH10005
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to educate, inspire, and motivate young students about nanoscience, nanotechnology, and their applications. The course provides information on the latest innovations in this field to get insights into the nanomaterials synthesis/fabrication and applications that can be achieved at a nanoscale.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn fundamental aspects of nanoscience,
CO 2: Classify different types of nanomaterials based on their dimension and composition
CO 3: Understand different synthesis techniques to grow nanomaterials,
CO 4: Analyse nanomaterials using different characterisation techniques,
CO 5: Apply the acquired knowledge to design new materials, and
CO 6: Evaluate the importance of nanoscience in engineering applications.

COURSE DETAILS

Introduction
Concept and Classifications based on dimensions and compositions, Significance of nanosize: Surface area to volume changes; Properties changing with size (reactivity, melting point, catalytic,
electrical, optical), Nanoscience in nature, and Quantum dots as data storage.

Synthesis of nanomaterials

Top-down synthesis (Mechanical method-ball milling, Photolithography, Laser ablation, sputtering), Bottom up (pyrolysis, sol-gel, CVD, self-assembly), Green synthesis (metallic nanoparticles, metal oxides), Biosynthesis.

Characterization
XRD-X-ray generation, Working principle (Bragg's law), Peak broadening in nanomaterials (Scherrer formula), Electron microscopy (SEM, TEM)—high energy electron generation, electron optics, Scanning Electron Microscopy (SEM)—secondary, back scattered, EDX, Transmission Electron Microscopy (TEM)—bright field imaging, dark field imaging, and Selected area diffraction pattern.

Applications
Cosmetics—ZnO, SiO_2, TiO_2 Nanoparticles in cosmetics, SiO_2 TiO_2 in toothpaste, silver, gold, copper nanoparticles in skin care product; *Medical Fields*—MRI, CT scan contrast enhancement agent, Drug and gene delivery system, Magnetic hyperthermia treatment; *Agriculture*—Nano-pesticides, herbicides, and fungicides, Food packaging; *Aerospace and Aviation Industries*—Carbon nanotubes (CNT)nanocomposites, Metal Nanoparticle-Polymer composites, SiC Nanoparticle reinforced alumina (high temperature strength, creep resistance); and *Nanomaterials for Environmental Remediation*—Degradation/removal of pollutants.

Textbook
1. B S Murty, P Shankar, Baldev Raj, B B Rath and James Murday,Textbook of Nanoscience and Nanotechnology, 1st Edition, 2012, ISBN-13: 978-8173717383.

Reference books
1. Luisa Filipponi and Duncan Sutherland.,Nanotechnologies: Principles, Applications, Implications and Hands-on Activities, Edited by the European Commission Directorate-General for Research and Innovation Industrial technologies (NMP) program, 2012, ISBN: 978-92-79-21437-0.
2. Charles P. Poole Jr., Frank J. Owens., Introduction to Nanoscience and Nanotechnology, An Indian Adaptation, 3rd Edition, 2020, ISBN-13: 978-9354240201.
3. P. I. Varghese, T. Pradeep. A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education, 2017, ISBN: 9781259007323.

SMART MATERIALS

Course Code: PH10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed with the objective of enabling engineering students to get a flavour of advances in materials science. The knowledge of smart materials learnt by the students in the course will let them to realize the usefulness of various new-age materials for technological advances and allow them to explore further in their higher semesters. This course will help them bridge the gap between traditional text book science put into physics, chemistry, etc. and the state-of-the-art science of materials.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1 : Learn about smart materials, their properties and applications,
CO2 : Understand types of smart material based on their electrical and magnetic properties,
CO3 : Characterize piezoelectric, ferroelectric and multiferroic materials,
CO4 : Identify novel functions of smart materials,
CO5 : Apply the acquired knowledge of smart materials in different applications, and
CO6 : Evaluate the importance of smart materials in day-to-day life.

Introduction to Smart Materials
common smart materials and associated stimulus-response, Classification: active and passive, Piezoelectric, Shape-memory alloys, Photo-responsive polymers, Electroactive polymers, Magnetostriction and Electro-strictriction, Thermo-responsive polymers, Dielectric elastomers, Halochromic, Thermoelectric materials; Application areas of smart materials: Space, health care and biomedical sectors.

Piezoelectric Materials: Piezoelectric Effect

Direct and Converse, Piezoelectric coefficients, Piezoceramics, Piezopolymers, Piezoelectric Materials as Sensors, Actuators etc.

Shape-memory Alloys
Shape memory alloys (SMAs) and properties, Phase change in SMAs, Shape memory effect: One-way and two-way, binary, and ternary alloy systems, Applications.

Chromic Materials
Photochromic, Thermochromic, Electrochromic, Magneto-chromic and Piezo-chromic Materials.

Multiferroic Materials
Multiferroics definitions, Ferroic phases, Magnetoelectric coupling; Type-I and Type-II multiferroics, Mechanism: Charge ordering, lone pair, geometric effect, and spin driven mechanism; Multiferroic materials, Applications.

Textbook

1. B. K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publication, New Delhi, 2nd Edition 2022, ISBN-13: 978-81-953536-7-5.

Reference books
1. Mohsen Shahinpoor, Fundamentals of Smart Materials, 2020, Royal Society of Chemistry, ISBN: 9781782626459.
2. M. Schwartz, Smart Materials, 1st Edition, 2008, CRC Press, ISBN 9781420043723.

MOLECULAR DIAGNOSTICS

Course Code: LS10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of the course is to understand methods and techniques that are used to study biological processes in living beings. They include experimental and methodological approaches, protocols and tools for biological research.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Learn the basics of Genes, Chromosomes, DNA, RNA and proteins along with their Aberrations,
CO 2: Understand the principles and working mechanisms of various instruments used in the study of biological processes in living things,
CO 3: Apply the knowledge of different diagnostics methods for quantitative estimation of xenobiotics (drugs and their metabolites) and biotics (proteins, DNA, metabolites) in biological systems,
CO 4: Analyze the recent developed techniques which are required for gene editing and their Applications,
CO 5: Evaluate the role of various bio-analytical techniques in environmental studies, biomedical sciences, life sciences, molecular biology, and biotechnological research, and
CO 6: Implement the knowledge of diagnostics in designing point-of-care instruments for different diseases.

COURSE DETAILS

Biomolecules
Overview of DNA, RNA, and Proteins, Chromosomal structure & mutations, DNA polymorphisms; and Gene and Genetic errors.

Molecular Basis of Diseases
Infectious, non-infectious; Diagnosis- traditional, modern tools, Concepts of molecular diagnostics.

Molecular Diagnosis and Techniques

DNA fingerprinting, Auto-antibody fingerprinting, Southern blotting, PCR, Real-time PCR and variations; Nucleic acid sequencing: New generations of automated sequencers, CRISPR technology and its use in diagnostics and gene editing.

Protein Diagnostics Techniques
Antigen-antibody reactions, ELISA, variations of ELISA; Western blotting.

Point-of-Care Devices
Biosensors and nano-biosensors for disease and metabollites detection.

Textbook

1. M K. Campbell, S O. Farrell, O M. McDougal, AE Biochemistry, Cengage Publisher,9th Edition 2017, ISBN-13: 9789814846448.

Reference books

1. N Rifai, Andrea Rita Horvath and Carl T. Wittwer, Principles and Applications of Molecular Diagnostics,2018, Elsevier Publisher, 1st Edition, 2018.
2. K G Ramawat & Shaily Goyal, Molecular Biology and Biotechnology, ISBN9788121935128 Publisher S Chand & Co., 2nd Edition, 2010.
3. H Lodish, Arnold Ber, Molecular Cell Biology, WH Freeman Publisher, 8th Edition, 2016, ISBN-10 9781464187445.

SCIENCE OF PUBLIC HEALTH

Course Code: PE10002
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is to orient the students to core scientific disciplines in public health practice.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand and enlist the scientific approaches in public health,
CO 2: Understand and apply the epidemiologic and biostatistical science in evidence synthesis,
CO 3: Understand and apply the environmental health science in public health practice,
CO 4: Understand and apply the social and behavioral science in public health practice,
CO 5: Understand and apply the health economic and health management principles in setting priority for resource allocation, and
CO 6: Understand and apply the health economic and health management principles in health system optimization.

COURSE DETAILS

Scientific Approaches to Public Health
Health and public health concepts, Science and practice of applied public health: Scientific disciplines as part of interdisciplinary public health, Examples of use of behavioral model in changing the community perception of public health interventions

Social and Behavioral Sciences in Public Health
Social and behavioral determinants of health and disease, WHO and CDC models of social determinants of health, Disease and social status, Disease and poverty, Social interventions for good health.

Health behavior change models for public health interventions, Health Belief Model, Transtheoretical Model. The theory of planned behavior, Health communication to improve the outcome of public health interventions

Environment Health Sciences in Public Health

Environment & climate change, Ecosystem, Lifestyle and dietary effects on health, food safety and sanitation, Environmental pollution, waste disposal and treatment.

Epidemiology and Data Science in Public Health

Epidemiology and achievements in public health, Measurements in Epidemiology—Incidence and prevalence, Causation and association, and Measures of association.

Outline of study designs (including cross-sectional study design, case-control study design, cohort study design and randomized control trials); Introduction to confounding and bias; Screening tests- validity and reliability methods.

Management and Economic Sciences in Public Health

Systems approach (input, process and outcome) in public health. Health management information system, Horizontal and vertical integration of public health interventions, Public-Private mix.

Understanding community, Community health related needs assessment, Community orientation and Community mobilization, Introduction to digital health.

Textbooks

1. R Detal, Oxford Textbook of Global Public Health, Oxford, 7th Edition, 2021.
2. K Parks, Textbook of Preventive and Social Medicine, M/S Banarsidas Bhanot Publishers, . 26th Edition, 2021.

Reference books

1. Robert H. Friis,. Essentials of Environmental Health, Jones & Bartlett Publishers, 2018
2. Warrier S,. Information and Communication Technologies in Public Health ASociological Study,CBS Publishers, 2020.
3. Baker JJ. Baker RW, Dworkin NR, Health Care Finance: Basic Tools for Non-financial Managers., Jones and Bartlett Publishers, Inc, 5th edition. 2017.
4. Ross TK, Practical Budgeting For Health Care: A Concise Guide, Jones andBartlett Publishers, Inc, 2020.

OPTIMIZATION TECHNIQUES

Course Code: MA10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To familiarise the students with a few rudimentary and popular optimization techniques to enable them to solve resource-constrained real world problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the concept of Linear programming problem (LPP) and will able to formulate linear programming problem,
CO 2: Understand the basic terminology and concepts of solving LPP,
CO 3: Solve LPP by simplex method,
CO 4: Know the concept of duality in Optimization technique,
CO 5: Apply optimization technique to solve transportation problem, and
CO 6: Solve assignment problem.

COURSE DETAILS

Linear Programming

Mathematical foundations and basic definitions, Linear optimization: Formulation and graphical solution of linear programming problems, Simplex method, Duality.

Transportation
General structure of a transportation problem, Finding initial basic feasible solution by North-West corner rule, Least-Cost method and Vogel's Approximation Method, and Testing for optimality.

Assignment Problem
Hungarian assignment method, Unbalanced assignment problems, Restrictions in assignment, Travelling Salesman model.

Textbook

1. H.A. Taha, Operation Research, An Introduction, Pearson Education, 10th Edition.

Reference books

1. K. Gupta, Kanti Swarup, and Man Mohan .,Operations Research, P., S.Chand &Co, 2004.
2. N. S. Kambo, Mathematical Programming Techniques.,East West Press, 1997.
3. R. Fletcher., Practical Methods of Optimization, 2nd Ed., John Wiley, 1987.
4. Hanif D, Sherali, M. S. Bazarra. & J.J. Jarvis, Linear Programming and Network Flows, Wiley Publication. 2nd Edition.

ENGINERING ELECTIVE

BASIC CIVIL ENGINEERING

Course Code: CE10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to provide an overview of different aspects of civil engineering profession , namely, surveying, materials, structural, and geotechnical engineering, hydraulics and water resources, environmental engineering, and transportation engineering and their roles in the societal development.
COURSE OUTCOME**S**

After successfully completing the course, the students will be able to

CO 1: Understand the importance and practical applications of different types of surveying,
CO 2: Learn about the different construction materials and understand the philosophy of structural analysis and design,
CO 3: Understand engineering behaviour of soil and types of foundations,
CO 4: Understand different hydraulics, hydrological and water resources engineering applications,
CO 5: Learn about the management strategies of wastewater and solid waste, and
CO 6: Understand the basics of different types of highways, railways, ports and harbours.

COURSE DETAILS

Introduction
Role of civil engineers in designing, building, and maintaining infrastructure and improving quality of life,Specializations in the civil engineering and their specific roles.

Surveying
Plans, maps, scales, divisions of surveying, classification of surveying, leveling, and advanced methods of surveying.

Construction Materials & Structural Engineering
Different construction materials and their uses, **structural analysis and design philosophy.**

Geotechnical Engineering

Overview on origin of soil, engineering properties and their classification; Soil exploration; Foundations: Their importance and purpose; Factors to consider in foundation design and stability of slopes; and Improving site soils for foundation use.

Hydraulics & Water Resources Engineering
Overview of fluid properties, open channel flow, surface and groundwater hydrology, and irrigation infrastructures.

Environmental Engineering
Types of waste water, Principles of wastewater management, Types of solid waste, and Principles of solid waste management.

Transportation Engineering

Classification of highways, Typical construction methods of roads, traffic surveys and their applications in traffic planning, Railways, Ports and Harbours.

Textbook

1. Er. Shrikrishna A. Dhale and Er. Kiran M. Tajne, Basics of Civil Engineering, S. Chand & Co., 1st Edition, 2014.

Reference books

1. S. S. Bhavikati, "Basic Civil Engineering" by New Age International Publisher, 1st Edition, 2021.
2. M. S. Palanichamy "Basic Civil Engineering", Tata McGraw-Hill Publication.

BASIC MECHANICAL ENGINEERING

Course Code: ME10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to give an overview of the fundamental aspects of mechanical engineering so that a student pursuing any branch of engineering will realize the possibilities that the branch of mechanical engineering offers.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the basic principles of thermodynamics,
CO 2: Develop an understanding of fluid machines like turbine and pump,
CO 3: Determine stress and strains in a component subject to a load,
CO 4: Understand the working and design aspect of power drives,
CO 5: Recognize appropriate material for a particular engineering application, and
CO 6: Understand the fundamentals of manufacturing processes.

COURSE DETAILS

Concepts of Thermodynamics
Systems, properties, state, and cycle, Thermodynamic equilibrium and quasi-static process, First law of thermodynamics for closed system, First law of thermodynamics for open/flow systems, Second law of thermodynamics, Kelvin Plank statement, Clausius statement, and Basic concept of entropy

Fluid Mechanics and Hydraulic Machines
Introduction to fluids, Properties of fluids, Pressure variation with depth, Bernoulli's equation and its applications, and Introduction to hydraulic turbines and pumps.

Mechanics of Materials
Stress, Strain, Stress-Strain diagrams for ductile and brittle materials, Elastic constants, Hooks Law, Factor of Safety, One-dDimensional loading of members of varying vross sections.

Power Transmission
Gear, , Belt, and Chain Drives, Shaft under varying loading conditions, Introduction to robots, Applications of robotics, Basic robot motions, Sensors and Actuators.

Manufacturing Processes
Introduction to engineering materials, Types and classification of materials, Properties of materials, Introduction to casting, forming, forging, rolling, extrusion and welding, Introduction to machine tools, NC, CNC, and 3-D Printing.

Textbook

1. P Kumar, Basic mechanical Engineering, Pearson Education, 2nd Edition, 2018

Reference books

1. J K Kittur and G D Gokak, Elements of Mechanical Engineering Willey, 1st Edition, 2015.
2. B Agrawal, C M Agrawal ,Basic Mechanical Engineering, Willey, 1st Edition, 2011.

ELEMENTS OF MACHINE LEARNING

Course Code: EE10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Today, we have access to massive data which get generated through information and computer technology in our connected world. Most of these data lie unused and often overwhelm us due to their size and variety. The objective of this course is to introduce to the students to the field of learning from data, discovering data patterns, converting them into knowledge, and applying it to solve real-world problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Demonstrate fundamentals of machine learning,
CO 2: Identify data types, apply suitable processing and visualize using suitable methods,
CO 3: Describe Unsupervised Learning and apply clustering techniques,
CO 4: Describe Supervised Learning and apply classification techniques,
CO 5: Demonstrate perceptron and Multi-layer Perceptron models, and
CO 6: Apply machine learning techniques for real world requirement.

COURSE DETAILS

Introduction
Importance and Applications of Machine Learning, Supervised, Unsupervised, Reinforcement Learning and Evolutionary Learning.

Data Analysis
Measurement Scales and Data Types; Visualization, Pre-processing and Transformation of Data; Dimensionality Reduction; and Data (Dis)Similarity.

Unsupervised Learning
K-means and Density-based,Clustering Methods.

Supervised Learning

K-Nearest Neighbour, Decision Tree by Qualitative and Quantitative(information Gain method); Evaluation by Confusion Matrix of Supervised Learning Methods.
`

Learning with Neural Networks
Perceptron, Multi-layer Perceptron and, Error Backpropagation Learning.

Textbooks

1. Gopal, M., Applied Machine Learning, McGraw Hill Education, 2018
2. Pradhan, M. and U. D. Kumar,Machine Learning Using Python,Wiley India Pvt.Ltd, 2019.

Reference books

1. Alpaydin, E., Introduction to Machine Learning, 3rd Edition, The MIT Press, 2014.
2. Bishop. C M, Pattern Recognition and Machine Learning, Springer, 2006.
3. Jain, V. K., Big Data Science Analytics and Machine Learning, Khanna Publishers, 2021
4. Mitchell, T. M.,Machine Learning, McGraw Hill, 1997.
5. Müller, A. C.,Introduction to Machine Learning with Python, O'Reilly Media, Inc, 2016
6. Raschka, S. and V. Mirjalili, Python Machine Learning, 3rd Edition, Packt Publishing, 2019.
7. Shalev-Shwartz, S. and S. Ben-David ,Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.

BIOMEDICAL ENGINEERING

Course Code: EC10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Biomedical Engineering is a multidisciplinary field that combines knowledge available in a wide range of disciplines such as engineering, medicine, and societal science. The course focuses on innovating newer equipment and technologies to improve human health and enhance health care facilities in a holistic manner.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply knowledge of basic engineering and biology to solve the problems,
CO 2: Knowledge of human body about cell, potential and organs of body,
CO 3: Develop a thorough understanding on principles of bio-instrumentation,
CO 4: Explain the role of bio-potential electrodes, and design of sensors,
CO 5: Differentiate and analyse the biomedical signal sources, and
CO 6: Knowledge about imaging techniques used in hospital.

COURSE DETAILS

Introduction and Overview
Introduction to biomedical engineering, Applications of biomedical engineering.

The Human Body
cCll-structure and function, Tissue & organs, Bio-potentials, Action potential, Major human systems (musculoskeletal, circulatory, nervous, and respiratory system)

Bio-instrumentation
Instruments in medical practice, Man-instrumentation system, Basic components, Linear network analysis, Bioelectric amplifier (OpAmp, isolation amplifier, instrumentation amplifier), Bio-instrumentation design, and Intelligent medical instrumentation.

Biomedical Electrodes and Sensors

Ssignal acquisition, Bio-potential measurements, Active and passive sensors, and Electrodes for biophysical sensing (Ag-AgCl, surface electrodes, microelectrodes), transducers, sensors.

Biomedical Signals, Imaging and Informatics
Bioelectric phenomena, Sources of biomedical signals, Origin of biopotentials, Basics of bio-signal processing, noise, Interference, Electrical safety issues, Principle of medical imaging techniques, such as X-ray, US, MRI, CT scan, and nuclear imaging, and Fundamentals of bio-informatics.

Textbook

1. John D. Enderle & Joseph D. Bronzino Introduction to Biomedical Engineering, Academic press, 3rd Edition, 2012.

Reference books

1. Joseph D. Bronzino, Donald R. Peterson,The Biomedical Engineering Handbook, CRC press, 4th Edition 2015.
2. G.S. Sawhney, Fundamentals of Biomedical Engineering, New Age International (P) Ltd, 2011.

BASIC INSTRUMENTATION

Course Code: EE10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to impart, to the students, the principles of analog and digital measuring instruments which include the working mechanisms of sensors and transducers and their applications in industrial and biomedical systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the basics of measuring instruments,
CO 2: Measure different electrical quantities,
CO 3: Understand the working principles of optical and electrical transducers and sensors,
CO 4: Understand the working of electrical transducers and sensors,
CO 5: Apply the transducers in industrial applications, and
CO 6: Use instruments in biomedical applications.

COURSE DETAILS

Analog and Digital Instruments
Basics of measuring instruments, Types of analog instruments, Measurement of voltage, current, power and energy in single and three phase circuits; Digital Instruments: Digital voltmeter, Digital multimeter, Timer/counter, and Time, phase and frequency measurements in oscilloscope.

Sensors and Transducers
Optical sources and detectors: LED, photo-diode, light dependent resistor; Basics of fiber optic sensing, IR Sensors. Resistive, capacitive, inductive, piezoelectric, and Hall effect sensors, Temperature transducers: Thermocouple, RTD , and thermistor.

Transducers in Industrial Applications
Measurement of displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure, flow, liquid level, pH, conductivity and viscosity.

Instruments in biomedical applications
ECG, Blood Pressure measurement, CT Scan, and Sonography

Textbook

1. R. K. Rajput ,Electrical and Electronic Measurements and Instruments,S Chand Publication, 4th Edition, 2015,William David Cooper,Electronic Instrumentation and Measurement Techniques, by PHI, 2010.

Reference books

1. Er. R.K. Jain, Mechanical and Industrial Measurements (Process Instrumentation and Control), Khanna Publishers, 1995.
2. A.K Sawhney, A course in Electrical and Electronics Measurements and Instrumentation Dhanpat Rai Publication, 10th Edition, 2012.
3. D Patranabis, Sensors And Tranducers, PHI Publication, 2ndEedition, 2017.

HASS ELECTIVE I

SOCIETY, SCIENCE AND TECHNOLOGY

Course Code: HS10013
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

There is a circular relationship between society, science, and technology. Society creates a need and an ambience to develop science and technology, and science and technology create means to meet societal needs and new opportunities to make human life better. Studying this relationship is the objective of this subject. The subject will expose, before the students, the past developments of science and technology and the social forces that played a dominant role in making these developments possible and the way these were used in the society. The subject will also present the ethical principles that underlie the development and use of science and technology in the society.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the forces that shape the development of science and technology,
CO 2: Understand the major milestones of scientific discoveries have impacted human thought processes,
CO 3: Understand the effect of technological developments in societal transformation,
CO 4: Analyse the contribution of Science and Technology in solving societal and Environmental problems,
CO 5: Evaluate the ethical issues related to abuse of science and technology, and
CO 6: Apply the skills learned to suggest solutions to global problems linked to science and Technology.

COURSE DETAILS

Introduction
Human Curiosity to Know the Truth of Nature, Need to Improve Quality of Life, Emergence of Science and Technology, Characteristics of Society, Science, and Technology, and Impact of Science and Technology on the Society.

Scientific Discoveries
Milestone Scientific Discoveries of the Past and the Ways They Impacted Human Thought Process and Culture; Scientific Method, Developing a Theory, and Making of a Discovery; Discoveries in the Physical, Biological, and Mathematical Sciences; Normal Science, Paradigms, Anomalies, Crisis and Emergence of Scientific Theories, and Scientific Revolutions.

Technological Developments
Milestone Developments of Technologies and the Ways They Transformed the Society. Stories of Technological Developments such as Steam Engines, Electricity, Semiconductors, and IoT.

Science and Technology in the Service of the Society
Contributions of Science and Technology to Solving Societal, Environmental, and Global Problems.
Successes and Limitations, and Abuses and Control of Science and Technology; Ethical Considerations.

Textbook

1. Bucchi, M., Science In Society: An Introduction to Social Studies of Science, Routledge Publication, 1st Edition,2004.

Reference books

1. Collins, H. and T. Pinch, The Golem: What You Should Know about Science, 2nd Edition, New York: Cambridge University Press,1998.
2. Collins, H. and T. Pinch,The Golem: What You Should Know about Technology, 2nd Edition. New York: Cambridge University Press, 2014.
3. Kuhn, T. S.,The Structure of Scientific Revolutions, 4th Edition, Chicago University Press, 2012.
4. Hatton, J. and P. B. Plouffe, Eds., Science and Its Ways of Knowing, New Jersey: Prentice Hall,1997.
5. Moskovites, M., Ed., Science and Society, Ontario: House of Anansi Press Limited,1997
6. Sismondo, S. An Introduction to Science and Technology Studies, 2nd Edition. Maldon, MA: Blackwell Publishing, 2009.
7. Sarukkai, S. What Is Science?, New Delhi: National Book Trust, India, 2012.
8. USSR Academy of Sciences Science and Society, Moscow: Nauka Publishers, 1989.

SOCIO-POLITICAL ENVIRONMENT

Course Code: SO10043
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is providing basic knowledge on socio-political environment of India and to equip the students with an understanding of their roles, duties and responsibilities in a democratic set up.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand contemporary Indian social problems,
CO 2: Understand the roles and functions of the three political institutions in our democratic up,
CO 3: Familiarize the students with the Rights and Duties enlisted in the Indian Constitution,
CO 4: Grasp the interrelationships among political, social and economic issue,
CO 5: Visualize contemporary changes in Political Institutions, and
CO 6: Realize the importance of equity, equality, and dignity in a democratic system.

COURSE DETAILS

Social Problem in India
Meaning and Definition of Social Problems, Characteristics, Causes and Consequences, Problems of Poverty, Unemployment, Population growth, Problems ofWomen and Aged, Corruption and Nepotism, Illiteracy, Substance Abuse, and Terrorism.

Social Stratification
Equity and Equality, Caste, Religion, Class, Gender Discrimination, UrbanSlums.
Political Institutions
Meaning and Basic Concepts of PoliticalInstitutions: Legislative, Executive and Judiciary Systems of the Indian Constitution.

Fundamental Rights and Duties
Fundamental Rights and Duties in Indian Constitution, Directive Principles of State Policy.

Contemporary Changes in Political Institutions

Changing Role of the Government in Contemporary India, Role of Government in the Formation of National and International Policies and Their Impact on Business and Trade.

Textbooks

1. C. N. Shankar Rao, S. Chand., Indian Social Problems,by S.cahand Publication,2017
2. M. Laxmikanth., Constitution of India,Cengage Learning,2020.
3. Himanshu Roy & M.P Singh Indian Political System, Pearson publisher,4th Edition,2018.
4. Ram Ahuja ,Social Problems in India, Rawat publisher,4th Edition,2014.

Reference books

1. Our Parliament, Subhash C Kashyap, NBT, 2021.
2. Social Stratification, Dipankar Gupta (Ed), Oxford India Publication, 1997.
3. Modernisation of Indian Tradition, Yogendra Singh, Rawat Publication, 1986.

THINKING PERSPECTIVES

Course Code: PS10043
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Cognition plays a significant role in **accumulation and processing of information.** This subject provides an in-depth understanding of some of the cognitive processes in terms of current theories, models and applications. It helps learners to understand the importance of these cognitive processes and the rationale behind cognition, problem solving, critical thinking, and scientific thinking. It facilitates students to identify and analyze the key conceptual and theoretical frameworks underpinning cognitive process.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the definition and scope of cognition, problem solving, and creativity,
CO 2: Understand the theories related to cognition, decision making, and critical thinking,
CO 3: Understand the classic and current experimental research in cognitive processes,
CO 4: Develop skills essential in designing and conducting experiments in cognition, reasoning, and problem solving,
CO 5: Understand various aspects of critical thinking, scientific thinking, and design thinking process, and
CO 6: Apply the knowledge of cognitive processes to one's own personal life and to real life issues.

COURSE DETAILS

Basics of Cognition

A Brief History, Emergence of Modern Cognitive Approach, Thinking, Basic Elements of Thought: Forming Concepts, Propositions, Images.

Reasoning, some Basics sources of error, Information-processing approach, connectionist approach, evolutionary approach, ecological approach.

Memory Processes and Critical Thinking

Organization of Long Term Memory, Forgetting, Retrieval and Metamemory; Proactive and Retroactive inference; Amnesia and Retrieval, Flashbulb Memory, Eyewitness Memory, Traumatic Memory, False Memories.

Phases of Critical Thinking

Intellectualization, Suggestion, Hypothesis, Reasoning, and Testing, Critical Thinking Abilities: Thinking, Observational, and Questioning and Dispositions, Critical Thinking Skills: Analysis, Communication, Creativity, Problem-solving Skills, and Open-mindedness.

Systems Thinking and Scientific Thinking
System Definition and Characteristics, Approaches to System Modelling, Causal-Loop Diagramming, System Archetypes, Micro world and Learning Laboratory, The Learning Organization and the Fifth Discipline, Systems Thinking Study, Examples.

Characteristics of Science
Systematic observation and experimentation, Inductive and deductive reasoning, Lessons from Scientific Thinking: Empirical Evidence, Logical Reasoning.

Creativity and Designing Thinking
Creative Thinking, Stages in Creative Thinking, Nature of Creative Thinking, Features of Creativity—Novelty, Originality and Usefulness, Guilford's Measure of Creativity—Fluency, Flexibility, and Originality, Barriers to Creativity, Enhancing Individual and Organizational Creativity.

Designing Thinking as a Process of Problem Solving: Defining Problems, Challenging Assumptions, Developing Concepts, identifying Alternative Strategies and Solutions, Prototyping, and Experimenting Problem Solving through Innovative Solutions, Stages of Design Thinking—Empathize, Define, Ideate, Prototype and Test.

.

Textbooks

1. Solso, R. L.,Cognitive Psychology, Pearson Education, 6th Edition. 2004.
2. Baron, R. A. Psychology,Pearson Education, 5th Edition, 2002
3. Rathus, S.A. Introductory Psychology Wadsworth Cengage,5th Edition, 2016.
4. Ciccarelli, S. & White, N.J, Psychology 5th Edition, Pearson Education.2017
5. The Fifth Discipline: The Art & Practice of the Learning Organization, Cengage Publication,2nd Edition, 2006.
6. Cross, N., Design Thinking: Understanding How Designers Think and Work, Berg Publishers.

Reference books

1. Baddley, A.,Human memory: Theory and practice. New York Psychology Press,1997.
2. Treror, A.,The psychology of language: From data to theory. Taylor Francis,2002
3. Smith, E.E. &Kosslyn, Cognitive psychology: Mind and brain. Prentice Hall,2007.
4. Tripathi, A.N. &Babu, Nandita (2008). Cognitive processes. In Misra, G. Psychology in India: Advances in Research, Vol. 1,Pearson Education.
5. Vaid, J., & Gupta, Ashum,Exploring word recognition in a semi-alphabetic script: the case of Devanagari. Brain and Language, 81, 679-690.

CREATIVITY, INNOVATION AND ENTREPRENEURSHIP

Course Code: PS10045
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed for students who want to enhance their creative and innovative skills and apply them to prepare business plans to form entrepreneurial enterprises. More specifically, the course is designed to help students to stimulate creativity in themselves and learn the impact of innovation on growth creation and design thinking in real-world business situations. In this course, the concepts of entrepreneurship and the environment in which the entrepreneurs act will be developed along with business plans and business models for start-ups.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the key elements of creativity and innovation,
CO 2: Visualize the impact of innovation on growth creation,
CO 3: Apply creative and design thinking to real-world business situations,
CO 4: Create a foundation of entrepreneurship development and its theories,
CO 5: Develop business plans and business models to start entrepreneurial enterprises, and
CO 6: Analyze the business plan and implement it in real field.

COURSE DETAILS

Introduction
Definitions, Importance, and Relationships among Creativity, Innovation, and Entrepreneurship; Examples.

Creativity
Definitions, Importance, and Relationships among Creativity, Innovation, and Entrepreneurship; Examples, Creative Thinking and Stages of Creative Thinking, Barriers to Creativity, Enhancing Individual Creativity, Guilford's Usual Unusual Test, Psychometric Approaches to Tests of Creativity, Structured tools of Creativity (Developing Creative Focus, Exercising Mind, Setting Directions, Suspending Rules, Thinking Differently, Establishing Formatted Work Space, Stimulating Mechanisms, Utilizing Experiences.

Innovation
Innovation, Benefits, Keys to Successful Innovations, Types of Innovation, Barriers to Innovation, Methods of Generating Ideas, Design Thinking. Creative Problem Solving, and Measures of Innovation.

Entrepreneurship
Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur, Social Entrepreneur, Case Study on the Entrepreneurial Excellence of N. R. Narayan Murthy, Introduction to Agricultural, Rural, Tourism, Social and Digital Entrepreneurship, Entrepreneurial Motivational Behavior (Creativity, Self-Efficacy, Locus of Control, Risk Taking, Leadership, Communication),

Converting Ideas into Products/Services with Differentiating Features, Niche Market, Design of the Products/Services, Bootstrap Marketing, Formulation of Business Plan, Business Model, Financial Planning, and Sources of Finance.

Practical classes will be devoted to organizing practicing sessions on creativity, case study discussion sessions and market analysis sessions on generating novel ideas, and developing and presenting business plans. Students, in groups, will design a new product/service, do a bootstrap market study, develop a business plan, and make an elevator pitch.

Textbooks

1. Khanka, S. S. Creativity, Innovation, and Entrepreneurship, S.Chand .
2. Praveen Gupta, Business Innovation, S. Chand , 2007

Reference books

1. Barringer B. R. and R. Duane,Entrepreneurship: Successfully Launching New Ventures: Pearson Prentice Hall, Ireland, 3rd Edition 2009.
2. Duening, T. N., R. D. Hisrich, and M. A. Lechter , Technology Entrepreneurship: Taking Innovation to the Marketplace, Elsevier, Amsterdam, 2nd Edition 2015.
3. Harrington, H. J., Creativity, Innovation, and Entrepreneurship: The Only Way to Renew Your Organization, Routledge, 2019.

ESSENTIALS OF MANAGEMENT

Course Code: HS10202
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course explores the basic concepts and processes of management. Students will learn the importance of management in their professional life from the stories on the evolution and practices of management. Students will examine the fundamental roles and processes of planning, organizing, staffing, directing and controlling that comprise the managers' role. This course also examines the fundamentals of marketing and financial management for the success of the organization. This course will make an attempt to introduce students to the business environment and strategic management process to understand the nuances of business. Students will develop skills related to the manager's function as required in today's competitive environment.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Learn different approaches, theories and stories of various practitioners of management and know how such knowledge could be applied to achieve goals of Organizations within the changing environment,
CO 2: Understand the core functions of management in order to facilitate efficient effective decision making both at individual and organizational level,
CO 3: Identify the human resource requirement of the organization for achieving its objective effectively,
CO 4: Synthesize various marketing and financial skills and techniques in order to be successful in corporate world,
CO 5: Assess the business environment and understand the importance of various types of business environment for better decision making, and
CO 6: Acquire the lesson learnt in strategic management process for strategic decision making by leveraging the core competencies of the organization.

COURSE DETAILS

Evolution of Management Thoughts
Concept, Scope and Significance of Management; Classical Approach; Scientific, Bureaucratic & Administrative theory of Management; Neo-classical and Modern Approach; Contribution of Management Practitioners

Functions of Management (Part I)
Nature, scope and significance of Planning; Types of Planning; Process of Planning; Barriers to effective planning; Decision making: concept, types and process; Organizing: concept and significance; Delegation of authority; Authority vs.Responsibility; Structure of Organization: departmentalization, Centralization vs. Decentralization

Functions of Management (Part II)
Concept of Staffing, Manpower planning and Job design; Recruitment and selection; Training and development; Performance Appraisal; Directing: Concept, Direction and Supervision; Controlling: Concept, Importance and levels; Process and types of controlling

Marketing and Financial Management
Marketing Mix (Product, place, price, Promotion); Market Segmentation; Introduction, scope, importance and functions of Financial management; Introduction to Financial statements: Profit and loss account; balance sheet

Business Environment and Strategic Management
Business environment: concept, importance, elements; Types of business environment; Strategic Management: Concept, Importance and levels of strategy; Process of Strategic Management

Textbooks

1. S.A. Sherlekar & V.S. Sherlekar, Modern Business Organization & Management (Systems Approach) by Himalya Publishing House, 2018.

2. Harold Koontz and Heinz Weihrich ,Essentials of Management: an International Perspective by, McGraw Hills, 2020

Reference books

1. K. Ashwathappa, Essentials of Business Environment, Himalaya Publishing House, 2017.
2. Joseph L. Massie, Essentials of Management Pearson Education India, Fourth edition, 2015.
3. Azhar Kazmi & Adela Kazmi, Strategic Management, McGrawHill, 5th edition 2020.

SHADES OF ECONOMICS

Course Code: HS10121
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course will provide technical students with knowledge in concepts of environmental economics, resource economics, and circular economy, allowing prosperity for present and future generations. The course will equip future engineers with skill to handle resources efficiently and effectively. Acquaint them with the contemporary trends in business settings and thereby innovate novel solutions to existing problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the economic drivers that shape the future of India,
CO 2: Understand sustainability issues related to usage of factor endowment,
CO 3: Ability to create linkage between Economics, Science and Technology,
CO 4: Apply knowledge, reasons and the need for regulating circular economy,
CO 5: Assess and analyses scope for global market opportunities, and
CO 6: Explore yet to be unearthed employment opportunities.

COURSE DETAILS

Purple Economy: Economics of *Glocalization*
Introduction to colours and world of economics (including White, Blue, Black, Green, Purple, Grey, Red, Pink, Silver); Concept and definition of purple economy; Cultural footprint; Local and global cultural economy; Culture and well being; Rethinking employment and training in the purple economy; Vocal for Local; Make in India.

Grey Economy: Economics of Informal Sector
Concept and definition of grey economy; Introduction to formal and informal Sector; Formal and informal sector linkage; Labour absorption and dualism in economy; Theoretical and policy issues; Migration in informal sector.

Green Economy: Economics of Reduce, Reuse, and Recycle
Concept and definition of green economy; Green investment and green bond; Green technology and renewable resources; Carbon footprint; Waste management.

Blue Economy: Economics of Ocean Resources
Concept and definition of blue economy; The marine environment; Fisheries and aquaculture; Tourism; Ocean-based renewable sources of energy; Transportation and the blue economy; ; Pollution of water resources; Water resource management.

Black Economy: Economics of Unsanctioned Sector
Concept and definition of black money; Causes and consequences of black economy; Global black income generation; Extent of black money in India. Government measures to curb black money.

Textbook

1. S.K Mishra and V. K. Puri, Indian Economy. Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6

Reference books

1. Uma Kapila. Indian Economy:Economic Development and Policy. Academic Foundation ISBN-10 : 9332705550 and ISBN-13 : 978-9332705555,2022.
2. Taneja and Myer :Economics of development and Planning, Vishal Publishing Co. ISBN-13 : 978-9382956068.
3. Datt Gaurav & Mahajan Ashwani , Indian Economy, S Chand & Company Limited. 2017.
4. Adrian C. Newton, Elena Cantarello, An Introduction to the Green Economy. Science, Systems and Sustainability,2014 Circular Economy- (Re) Emerging Movement. (2020). Shalini Goyal Bhalla.
5. Shalini Goyal Bhalla. Circular Economy- (Re) Emerging Movement.,2020.

6. Somnath Hazra & Anindya Bhukta,The Blue Economy. An Asian Perspective. The Informal Economy: an Employer's Approach. The Informal Economy: an Employer's Approach. 2021.
7. The Purple Economy: An Objective, An Opportunity, 2013.
8. Tom Tietenberg, Lynne Lewis, Environmental and Natural Resource Economics. 2018.

INDIAN ECONOMY POST LIBERALISATION

Course Code: HS10123
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Study of this course provides an extensive understanding of changing structure of Indian economy over time. This course targets to put emphasis on inclusive growth, reducing poverty, inequality and creating decent employment in the economy. This course will give an understanding about the issues faced by an economy in achieving sustainable development.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Interpret the changing structure of Indian economy,
CO 2: Perceive the issues and challenges faced by Indian economy,
CO 3: Evaluate the policies and programmes required to achieve inclusive growth,
CO 4: Realise the importance of human capital in triggering economic development,
CO 5: Comprehend the state and role of external sector in strengthening Indian economy,and
CO 6: Help in achieving sustainable development for the economy.

COURSE DETAILS

Introduction and features
Changing structure of the Indian economy Changing paradigms of Development Strategies and Economic Reforms.

Poverty, Inequality and Employment
Various concepts and estimates of poverty; Income inequality; Problem of unemployment; Interface among growth, poverty and employment; Inclusive growth and Human Development; Sustainable Development Goals—Targets for reduction in Poverty, Inequality and Decent Employment.

Demographic Issues
Demographic trends, size and structure of population; Health and Education; Skill challenges and demographic dividends; Sustainable Development Goals—Targets forGreater Wellbeing and Better Human Capital.

Perspectives in Agriculture, Industry and Services
Agricultural growth performance and food security; Growth, trends and changing pattern of Indian industries, industrial reforms and policies; Services in India's growth process; Sustainable Development Goals—Targets for Inclusive and Sustainable Growth.

External Sector and Issues in Indian Public Finance
Foreign trade and trade policy; fiscal devolution, Indian Union Budget and Tax System

Textbook
1. Uma Kapila, Indian Economy Perfomance and Policies,academic foundation, 2020,ISBN:978-933270545

Reference books

1. S.K. Mishra, and V. K. Puri, Indian Economy, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6
2. Gaurav Datt and Ashwani Mahajan,Indian Economy, GENERIC. Classic Edition,2022 ISBN-10 : 9352531299 ISBN-13 : 978-9352531295

COMMUNITY / ENVIRONMENT-BASED PROJECT

Course Code: **EX17001**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is offered to give the students an opportunity to connect with the community and the environment, learn and prioritize their problems, and define the problems in ways that make them amenable to scientific analysis and pragmatic solution. Appreciating the community problems, visualizing and experiencing them in person, self-learning, applying to realities, searching for and finding implementable solutions are the primary benefits of this project-based subject.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify need of the community,
CO 2: Formulate objective of a project,
CO 3: Communicate orally and through formal technical write-ups,
CO 4: Analyze and interpret data wherever essential,
CO 5: Provide an implementable solution to the problem, and
CO 6: Work in team following ethical manners.

The projects will be applied to problems uppermost in the minds of the community regarding the problems that they confront regularly. The problems may range from social inequality and social justice to lack of common services such as health, education, water, power, banking, and from lack of access to government subsidies and policies to deforestation and environmental problems.

B. Tech. Honors/ Research Degree
in
Electronics Engineering (VLSI Design and Technology)

B.Tech in Electronics Engineering (VLSI Design and Technology) Program Educational Objectives (PEOs):

1. Lead a successful career in industries or undertake entrepreneurial endeavors and provide solutions in the areas of designing and developing VLSI circuits and systems, utilizing industry-standard tools and methodologies.
2. Utilize their knowledge, skills and resources to design, invent and find creative and innovative solutions to engineering problems in a multidisciplinary work environment following appropriate ethical practices.
3. Develop attitude in lifelong learning, apply and adapt new ideas as the technology evolves.

Program Outcomes (POs):

The program outcomes are:

a) **Engineering knowledge:** Ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b) **Problem analysis:** Ability to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) **Design/Development of solutions:** Ability to design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d) **Conduct investigations on complex problems:** Ability to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e) **Modern tool usage:** Ability to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

f) **The engineer and society:** Ability to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g) **Environment and sustainability:** Ability to understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h) **Ethics:** Ability to apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i) **Individual and team:** Ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j) **Communication:** Ability to communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receiveclear instructions.

k) **Project management and finance:** Ability to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) **Life-long learning:** Ability to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

The program specific outcomes are:

a) Proficiency to design, simulate, and analyze VLSI circuits and systems using industry-standard tools and techniques, demonstrating a deep understanding of VLSI design principles, methodologies, and emerging technologies.

b) Ability to carry out research in the fields of SoC Design, microfabrication and related technologies.

c) Ability to design and develop complex products using suitable tools for societal and engineering needs with skills to communicate effectively in groups.

CURRICULUM

The total minimum credits required for completing the B.Tech in Electronics Engineering (VLSI Design and Technology)Program is 160

PROFESSIONAL ELECTIVE COURSES

Professional elective-I, II, III are offered during semester five and six. Professional elective IV and V are offered during semester seven and eight. List of electives to be offered during an academic year is announced at the beginning of respective semesters. An elective will be offered only if ten or more students are interested in it. Not that all the electives will be offered in every academic year. Some electives may have seat limitations and will be offered in first cum first serve basis. In order to accommodate more aspiring students, electives having high demand may be offered twice, that is during autumn as elective-I or II and again as elective-III during spring semester.

Students can select electives based on their interest in a domain. Areas of specialization or domain are optional, however electives can be grouped to provide learning around a functional area. Students may qualify for a maximum of one area of Specialization. Completion of the specialization will not be reflecting on transcripts or degree certificate.

THIRD SEMESTER

Theory							
Sl No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	EV21001	Analog and Digital Electronic Circuit	3	1	0	4	4
2	EC20001	Signals and Systems	3	0	0	3	3
3	EV20001	Microfabrication	3	0	0	3	3
4	CS20001	Concepts of Data Structures and Algorithms	3	0	0	3	3
5	MA21001	Probability and Statistics	3	1	0	4	4
6	EX20003	Scientific and Technical writing	2	0	0	2	2
Total Credit (Theory subjects)						**19**	**19**
Practical							
1	EC29001	Electronic Circuits Lab	0	0	4	4	2
2	CS29001	Data Structures Lab	0	0	2	2	1
Sessional							

1		Vocational Elective	0	0	2	2	1
Total Credit (Practical & Sessional subject)						**8**	**4**
Total Credit (Semester)						**27**	**23**

FOURTH SEMESTER

Theory							
Sl No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA21006	Vectors, Differential Equations and Complex Analysis	3	1	0	4	4
2	EV20002	Digital VLSI Circuits	3	0	0	3	3
3	EV20004	Digital Logic Design with Verilog	3	0	0	3	3
4	EV20006	Embedded Design and Computer Architecture	3	0	0	3	3
5	EX20001	Industry 4.0 Technologies	2	0	0	2	2
6		HASS Elective-II	3	0	0	3	3
Total Credit (Theory subjects)						**18**	**18**
Practical							
1	EV29002	Digital VLSI Lab	0	0	2	2	1
2	EV29004	Verilog Lab	0	0	2	2	1
3	EV29006	Embedded Lab	0	0	2	2	1
Sessional							
1							
Total Credit (Practical & Sessional subject)						**6**	**3**
Total Credit (Semester)						**24**	**21**

FIFTH SEMESTER

Theory							
Sl No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	EC20008	Communication Engineering	3	0	0	3	3
2	EV30001	Mixed Signal IC Design	3	0	0	3	3
3		Professional Elective-I	3	0	0	3	3
4		Professional Elective-II	3	0	0	3	3
5		HASS Elective-III	3	0	0	3	3
6	HS30101	Engineering Economics	3	0	0	3	3
Total Credit (Theory subjects)						**18**	**18**
Practical							
1	EV39001	Analog IC Design Lab	0	0	2	2	1
2	EV39003	Scripting Language and Python Lab	0	0	2	2	1
Sessional							

1		K-Explore Open Elective-I	0	0	2	2	1
2	EC38001	Electronics Product Development	0	0	2	2	1
Total Credit (Practical & Sessional subject)						**8**	**4**
Total Credit (Semester)						**26**	**22**

SIXTH SEMESTER

Theory							
Sl No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	EV30002	VLSI for Signal Processing	3	0	0	3	3
2	EV30004	SoC Design	3	0	0	3	3
3	EV30006	VLSI Verification and Testing	3	0	0	3	3
4	HS30401	Universal Human Values	3	0	0	3	3
5		Professional Elective-III	3	0	0	3	3
6		Open Elective-II	3	0	0	3	3
Total Credit (Theory subjects)						**18**	**18**
Practical							
1	EV39002	SoC Design Lab	0	0	2	2	1
2	EV39004	VLSI Testing and Verification Lab	0	0	2	2	1
	EV39006	VLSI Signal Processing Lab	0	0	2	2	1
Sessional							
1		Minor Project	0	0	2	2	2
Total Credit (Practical & Sessional subject)						**8**	**5**
Total Credit (Semester)						**26**	**23**

SEVENTH SEMESTER

Theory							
Sl No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	EX40003	Engineering Professional Practice	2	0	0	2	2
2		Professional Elective-IV	3	0	0	3	3
3		Open Elective-III	3	0	0	3	3
4							
5							
6							
Total Credit (Theory subjects)							**8**
Practical							
1							
2							

Sessional							
1	EV47001	Project-I					5
		Internship/Training					2
Total Credit (Practical & Sessional subject)							7
Total Credit (Semester)							**15**

EIGHTH SEMESTER

Theory							
Sl No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1		Professional Elective-V	3	0	0	3	3
2		Open Elective-IV	3	0	0	3	3
3							
4							
5							
6							
Total Credit (Theory subjects)							**6**
Practical							
1							
2							
Sessional							
1	EV47002	Project-II					9
Total Credit (Practical & Sessional subject)							**9**
Total Credit (Semester)							**15**

PROFESSIONAL ELECTIVES – I/II/III

Sl. No	Course Code	Course Title	L	T	P	Total	Credits
1.	CS20002	Operating Systems	3	0	0	3	3
2.	CS20006	Database Management Systems	3	0	0	3	3
3.	CS30010	Cloud Computing	3	0	0	3	3
4.	CS30011	Computational Intelligence	3	0	0	3	3
5.	CS30019	Web Technology and Applications	3	0	0	3	3
6.	CS30029	Computer Vision and Pattern Recognition	3	0	0	3	3
7.	EC30007	ARM and Advanced Processors	3	0	0	3	3
8.	EC30008	Wireless Sensor Networks	3	0	0	3	3
9.	EC30009	Compound Semiconductor Basics	3	0	0	3	3
10..	EC30010	Mobile Ad Hoc Network	3	0	0	3	3
11.	EC30012	Nanoelectronics	3	0	0	3	3
12.	EC30013	Optical and Satellite Communication	3	0	0	3	3
13.	EC30015	Hardware and Software Co-Design of Embedded System	3	0	0	3	3
14.	EC30017	Audio and Speech Processing	3	0	0	3	3
15.	EC30019	Information Theory and Coding	3	0	0	3	3

16.	EC30021	Industrial IoT	3	0	0	3	3
17.	EE30012	Sensors & Actuators	3	0	0	3	3
18.	EE30022	Special Machines & Control	3	0	0	3	3
19.	EE30038	Introduction to Electrical Machines	3	0	0	3	3
20.	EE30047	Power Electronics Circuits	3	0	0	3	3
21.	EL30001	Industrial Automation	3	0	0	3	3
22.	EM30007	Machine Learning based Signal Processing	3	0	0	3	3
23.	EM30008	Deep Learning: Algorithms and Implementation	3	0	0	3	3
24.	EM30009	Data Analytics	3	0	0	3	3
25.	EM30011	Data Mining	3	0	0	3	3
26.	EV30003	Semiconductor Optoelectronics	3	0	0	3	3
27.	EV30005	Semiconductor Material Synthesis and Characterization	3	0	0	3	3
PROFESSIONAL ELECTIVE –IV/ V							
1.	CS30023	Software Defined Networking	3	0	0	3	3
2.	CS40010	Augmented and Virtual Reality	3	0	0	3	3
3.	CS40015	Cryptography and Network Security	3	0	0	3	3
4.	EC40001	Optimization Techniques in Engineering	3	0	0	3	3
5.	EC40002	Millimetre Waves and Terahertz Technology	3	0	0	3	3
6.	EC40003	Cognitive Radio and Cooperative Communication	3	0	0	3	3
7.	EC40004	Quantum Communication	3	0	0	3	3
8.	EC40006	Advanced VLSI and SoC	3	0	0	3	3
9.	EC40007	Low Power VLSI Design	3	0	0	3	3
10.	EC40008	Advanced Computer Architecture and RISC-V Processor Design	3	0	0	3	3
11.	EC40009	Biomedical Signal Processing	3	0	0	3	3
12.	EE30024	Electric Drives and Control	3	0	0	3	3
13.	EE40010	Electric Vehicles Technology	3	0	0	3	3
14.	EL40001	Process Control & Robotics	3	0	0	3	3
15.	EL40003	Advanced Control System	3	0	0	3	3
16.	EM40001	ML for Language Processing	3	0	0	3	3
17.	EM40006	Cybersecurity	3	0	0	3	3
18.	EM40008	Bioinformatics	3	0	0	3	3
19.	EM40010	Optimization Methods in Machine Learning	3	0	0	3	3
20.	EV40001	High Speed Interface Design	3	0	0	3	3

Elective Baskets (Specialization)

PE I	PE II	PE III	PE IV	PE V	Specialization
CS20002	CS20006 / CS30019	EM30009 / EM30011 / CS30010	CS30023 / CS40015	EM40006 / CS40010	**Computer Engineering**
EC30019	EC30013	EC30010 / EC30008	EC40003 / CS40015	EC40004 / EC40002	**Communication & Networking**
EC30009 / EC30007	EV30003 / EV30005	EC30015	EC40007 / EV40001	EC40006 / EC40008	**VLSI & Embedded Design**
CS30011 / EM30007	CS30029 / EC30017	EM30008 / EM30009 / EM30011	EC40009 / EM40010	EM40001 / EM40008	**Machine Learning and Applications**
EE30038 / EC30021	EE30047 / EE30012	EE30022 / EL30001	EE30024 / EL40003	EL40001 / EE40010	**Automation**

LIST OF HASS ELECTIVES

HASS Elective-II

Sl. No	Course Code	Subjects	L	T	P	Total	Credit
1.	HS20120	Economics of Development	3	0	0	3	3
2.	HS20122	International Economic Cooperation	3	0	0	3	3
3.	HS20220	Organizational Behaviour	3	0	0	3	3
4	HS20222	Human Resource Management	3	0	0	3	3

HASS Elective-III

Sl. No	Course Code	Subjects	L	T	P	Total	Credit
1.	HS30125	Market Structure and Pricing Policies	3	0	0	3	3
2.	HS30127	Pragmatic Inquiry	3	0	0	3	3
3.	HS30129	Economic Analysis of Decision Rules	3	0	0	3	3
4.	HS30131	Economics of Health and Education	3	0	0	3	3
5.	HS30223	Business Ethics and Corporate Governance	3	0	0	3	3
6.	HS30225	Leadership and Team Effectiveness	3	0	0	3	3
7.	HS30421	Gender Studies	3	0	0	3	3
8.	HS30423	Tribal Resource Management	3	0	0	3	3
9.	HS30425	Indian Knowledge System	3	0	0	3	3

RESEARCH ELECTIVE - I (OFFERED BY SCHOOL OF ELECTRONICS ENGINEERING)

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1.	EC30009	Compound Semiconductor Basics	3	0	0	3	3
2.	EC40007	Low Power VLSI Design	3	0	0	3	3
3.	CS30023	Software Defined Networking	3	0	0	3	3
4.	EC40015	5G Supportive Technologies	3	0	0	3	3
5.	EC40017	Planner Antenna	3	0	0	3	3
6.	EC40019	Solar Cell Device and Material Technology	3	0	0	3	3

RESEARCH ELECTIVE – II (OFFERED BY SCHOOL OF ELECTRONICS ENGINEERING)

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1.	EC40003	Cognitive Radio and Cooperative Communication	3	0	0	3	3
2.	EC40006	Advanced VLSI and SoC	3	0	0	3	3
3.	EC40010	Massive MIMO Technology	3	0	0	3	3
4.	EC40014	RF CMOS VLSI	3	0	0	3	3
5.	EC40016	VLSI Signal Processing	3	0	0	3	3
6.	EC40018	Smart Antennas	3	0	0	3	3

VOCATIONAL ELECTIVES

Vocational courses offered by School of Civil Engineering

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1.	CE28001	Building Drawing, Estimation & Costing (for Civil Engineering Students)	0	0	2	1	1

2.	CE28003	GIS & GPS Applications (For other branch students)	0	0	2	1	1

Vocational courses offered by School of Computer Science Engineering

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1.	CS28001	Web Design	0	0	2	1	1

Vocational courses offered by School of Electrical Engineering

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1.	EE28011	Industrial wiring and control panel design	0	0	2	1	1
2.	EE28013	Installation, operation and maintenance of solar power system	0	0	2	1	1
3.	EE28015	Domestic wiring and home automation	0	0	2	1	1
4.	EE28017	Cyber physics application in industrial IOT	0	0	2	1	1
5.	EE28019	Industrial Control and Remote Monitoring	0	0	2	1	1

Vocational courses offered by School of Electronics Engineering

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1.	EC28001	Computational Photography	0	0	2	1	1
2.	EC28003	Sound Engineering	0	0	2	1	1
3.	EC28005	Sensors for Automation	0	0	2	1	1
4.	EC28007	PCB Design	0	0	2	1	1

Vocational courses offered by School of Mechanical Engineering

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1	ME28011	Additive Manufacturing(3-D Printing)	0	0	2	1	1
2	ME28013	Die development by CNC milling	0	0	2	1	1
3	ME28015	Concept Car Manufacturing	0	0	2	1	1
4	ME28017	Development of Autonomous Wheeled	0	0	2	1	1
5	ME28019	Modelling of Micro-Wind turbine by 3D	0	0	2	1	1

K-EXPLORE OPEN ELECTIVE - I

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1.	SA38001	Robotics	0	0	2	2	1

2.	SA38003	Web Designing	0	0	2	2	1
3.	SA38005	Civil-Tech	0	0	2	2	1
4.	SA38007	Circuit Design & Control	0	0	2	2	1
5.	SA38009	Indian Classical, Folk & Bollywood Dance	0	0	2	2	1
6.	SA38011	Indian Classical & Western Music	0	0	2	2	1
7.	SA38013	Graphic Designing & Editing	0	0	2	2	1
8.	SA38015	Art & Craft	0	0	2	2	1
9.	SA38017	Theatre & Street Play	0	0	2	2	1
10.	SA38019	Film Making	0	0	2	2	1
11.	SA38021	Debating,Public Speaking& Anchoring	0	0	2	2	1
12.	SA38023	Creative Writing	0	0	2	2	1
13.	SA38025	Photography & Videography	0	0	2	2	1
14.	SA 38027	Fashion Styling	0	0	2	2	1
15.	SA 38029	Culinary Arts	0	0	2	2	1
16.	SA 38031	Quiz Activity	0	0	2	2	1
17.	SA 38033	Social Outreach	0	0	2	2	1
18.	SA 38035	Health & Emergency Care	0	0	2	2	1

SIGNALS AND SYSTEMS

Course Code: **EC20001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

This course will begin with an introduction to analog and digital signal processing, then elaborates on various transformation techniques to signals, and finally presents an idea about actual implementations of these methods in today's hardware and software systems. The course includes analog-time, discrete-time signals and, systems. The syllabus revisits the continuous time transform methods like Fourier and Laplace. This will be followed by discrete time transform methods like the Z transform, DFT, and its properties and system theoretic implications. Later, the concepts and foundations of digital filter design and its realization are built up for FIR and IIR filters.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze continuous and discrete signals, apply sampling process, determine related characteristics.
CO 2: Distinguish and classify various types of systems and analyze system characteristics in time domain.
CO 3: Apply appropriate continuous time transformation technique for signal analysis.

CO 4: Analyze the signal and its properties in its frequency domain using discrete time transformation techniques.
CO 5: Apply Fourier transform techniques in real time applications.
CO 6: Apply the knowledge of analog filters to digital filters, design and realization of digital filter.

COURSE DETAILS

Introduction to Signals and System
Representation of continuous and discrete time signals, Basic operations, Sampling Theorem, Linear convolution, Correlation.

Revision of Fourier and Laplace Analysis
Significance of Fourier series in LTI system, Continuous time Fourier series formula. Dirichlet conditions & properties, S-plane mapping, ROC properties and examples, Relationship between Fourier and Laplace Transform, Pole-zero Plot.

Discrete Time Fourier Transforms
Discrete Time Fourier Transform, Conditions and properties of DTFT, Discrete Fourier Transform, Properties of DFT, Inverse Discrete Fourier Transform, Circular Convolution, Properties of Circular Convolution, Sectioned convolution, Fast Fourier Transform.

Z-Transform
Z transform, ROC, Properties, Applications

Digital Filters
Introduction to Digital FIR Filter, Design of FIR Filter: Rectangular, Digital IIR filters: Introduction to Digital IIR Filter, Conversion to digital IIR Filter using impulse invariance technique, Bilinear Transformation, Realization of Digital Filters, Direct form – I realization Direct form – II.

Introduction to Adaptive Filter and applications.

Textbooks

1. Proakis J.G. and Manolakes D. G. *Digital Signal Processing* (4th Edition). Pearson.
2. Oppeinhem A. V. and Willsky A. S. (2015). *Signals & Systems* (2nd Edition), Pearson.

Reference books

1. Lathi B. P. *Principle of Signal Processing and Linear System* (1st Edition). Oxford University Press.
2. Babu P. R. *Digital Signal Processing* (2nd Edition). Scitech.

Mitra S. K. *Digital Signal Processing - Computer Based Approach* (4th Edition). MGH.

COMMUNICATION ENGINEERING

Course Code: **EC20008**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of the course is to learn the concepts of various analog and digital communication systems. Students will also be able to analyze and develop the problem solving abilities related to communication Engineering.

COURSE OUTCOMES

CO 1: Analyze signal attributes and apply the concept of Fourier transform and series to observe signal in frequency and time domain, and explore the concepts of stochastic processes.

CO 2: Select appropriate analog modulation techniques for specified broadcasting requirements and design corresponding transmission and reception systems with their spectral representations.

CO 3: Apply the concept of sampling theorem to develop and analyze different Pulse Modulation based communication systems including PCM and their integration with TDM system for signal transmission and reception.

CO 4: Apply problem solving skills to recommend appropriate digital communication techniques considering the principle of operation of ASK,FSK,PSK,QPSK and QAM.

CO 5: Analyze the significance of various terminologies associated with Wireless and Satellite Communication and evaluate the performance

CO 6: Analyze the significance of signal communication with Optical Communication technology and various and various applications.

COURSE DETAILS

Introduction
Basic communication system , Signals in time and frequency domain, Fourier transform and Series, properties of FT and FS, Various Signal functions, Brief Idea of Probability, Cumulative Distributive Function, Probability Density Function, Gaussian and Rayleigh PDF.Concept of Signal to Noise Ratio.

Amplitude Modulation Techniques
Need of Modulation, Frequency Translation, Principle of AM, side bands, Power Relationship, Assignable Frequency spectrum, Side band Transmission, DSB, SSB, VSB, AM modulators and demodulators, AM Radio Receiver,Super hetero-dyne Principle.

Frequency Modulation Techniques
Principle of FM, Frequency Deviation, Spectrum of FM wave, Power in Modulated wave, Narrow band FM, Pre-emphasis and De-emphasis, Block Diagram of FM Transmitter,FM Detector,Block Diagram of FM Receiver,

Pulse Modulation Techniques
Analog vs Digital modulation, Sampling Process, Pulse Amplitude Modulation, Pulse Width Modulation,Pulse Position Modulation,Time Division Multiplexing, Frequency Division Multiplexing, The Quantization Process, Pulse Code Modulation, Bandwidth vs SNR trade-off in PCM.

Digital Modulation
Data Form, Principles involved in ASK, PSK (BPSK, QPSK, $\pi/4$ QPSK), FSK.

Different Communication Systems
Introduction to Modems, Brief concept of satellite communication, Fiber optic communication and Mobile communication.

Textbooks:

1. B.P. Lathi, Modern Digital and Analog Communications Systems, Oxford Univ Press, 4th Edition.
2. Simon Haykin, Introduction to Analog & Digital Communication System, .Wiley Student edition 2011

Reference book:

1. H. Taub, and D.L.Schilling, Principles of Communication System, McGraw Hill, 3rd Edition

COMPUTATIONAL PHOTOGRAPHY

Course Code: **EC28001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE
Computational photography (CP) is the fusion of computer graphics, computer vision, optics and imaging. The role of CP is to overcome the limitations of traditional cameras by combining imaging and computing to enable new and improved ways to capture, represent and interact with the physical world. The course provides and overview of elements photography, which includes digital image capturing mechanisms, lighting controls, effect of focal length and aperture and various lossy and lossless image storage mechanisms. Objective is to briefly explain computational methods used to enhance photographs.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate concept of photography, and digital camera technology
CO 2: Understand types of cameras and their mechanisms
CO 3: Demonstrate computational image processing
CO 4: Apply computational photography methods for photo composition and panoramic
CO 5: Apply computational image processing for photography quality enhancement
CO 6: Comprehend various image filtering techniques

COURSE DETAILS

Introduction to Computational Photography
History of Photography and Computational Photography, Digital Representation of Images, Cameras, Difference between Full frame, APSC and Medium format sensors, scaling, crop sensor advantages/disadvantages

Digital photography
Principle of Operation of DSLR camera, Aperture, ISO, Shutterspeed and Angle Control, Camera Calibration and Tethering, Computational Cameras, Image Storage formats: Compressed vs uncompressed formats, Basics of Lenses: Wide angle, Telephoto, Prime lenses, Macro lenses. Difference in angle, Depth of field control

Computational Techniques
Concept of Color, color models , noise, its types, image histogram, Image Processing software: Licensed and Open Source

Training on Computational Photography
Shooting with wide angle lenses, Shooting with Telephoto lens, zooming, changes in angle , Shooting with Prime lenses and constant aperture lenses, Shooting with Macro lenses, microscopic photography

Training on Digital Imaging-I
Photography Genres, Scene Composition, Dynamic Range improvement, Portraits, Photographing scenes, crowd and people, Shooting Portraits, group photos and events

Training on Digital Imaging-II
Long exposure, Brenizer's Method, Sports High Shutter speed, Burst, fisheye, architecture photography, Macro, Basics of Long exposures, using polarizing filters Shooting panorama, Brenizer's method and other photographing techniques Shooting sports, high shutter speed

Training on Digital Imaging-III
Use of lights, soft box and flashes, guide number etc. , product photography, computational photography,E-commerce photography, Use of Lights, Flash, wireless flash, Basics of product photography, photography for e-commerce and computational photography

Training on Post Processing-I
RAW image processing, Basic adjustments and correction, Lens Distortion and color correction using Adobe Photoshop, Monochrome image processing, color image processing batch processing using Light-room

Training on Post Processing-II
Image enhancement operations, noise removal, Artistic filtering, cosmetic filtering, and other post processing methods. Post Processing III: Background removal, artificial coloring.

Training on Post Processing-III
Open Source and free software for image post processing and computational photography, their usage and capabilities.

Photography Ethics
Photography ethics: empathy, consent, integrity, ethical decision making, privacy

Textbook
1. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd ed

Reference books
1. Ayush Bansai, Achuta Kadambi, and Ramesh Raskar, Computational Imaging Book
2. Richard Hartley and Andrew Zisserman., Multiple View Geometry in Computer Vision
3. David Forsyth and Jean Ponce., Computer Vision: A Modern Approach

4. Steven Gortler., Foundations of 3D Computer Graphics
5. Rafael Gonzalez and Richard Woods., Digital Image Processing
6. Barbara London and John Upton, Photography

SOUND ENGINEERING

Course Code: **EC28003**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE
It elaborately covers in various aspects of sound(physical and mechanical behavior), equipment used for recording/ reproducing and basic idea for the preparation of final sound track in film or television production.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Recognize, define, and explain the principles of sound engineering related to signal flow, microphones, recording, mixing, production, and mastering.
CO 2: Demonstrate practical, imaginative understanding and fluency on sound engineering technologies and procedures .
CO 3: Solve problems independently, imaginatively, and creatively in the field of sound engineering will be demonstrated by students.
CO 4: Learn how to conduct research and have a critical comprehension of sound engineering and its related fields.
CO 5: Understand the basic techniques of sound recording.
CO 6: Understand the working of different types microphone and louspeakers and their applications in industry.

COURSE DETAILS

- Introduction to technology of sound
- Analysis of prerecorded speech, music and effects
- Observation of the installation of PA System in a large auditorium
- Study and analysis of different microphones
- Study the feature of 2 channel digital sound recorder
- Study about the effect of loudness in relation with the distance from source to the listener
- Sound recording and reproduction practice by using recorder in PA system chain
- Study of sound in different environmental situation
- Study and analysis on Modulated Radio wave AM and FM in Live streaming radio stations
- Study the effect of Bass and Treble (Concept of Equalization)

Textbook
1. Glyn Alkin, Sound Recording and Reproduction

Reference book
1. Michael Talbot Smith, Sound Assistance

SENSORS FOR AUTOMATION

Course Code: **EC28005**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE
Sensors and automation are revolutionizing the technology in the areas like consumer electronics, automotive industry, healthcare, and in other settings. The course will provide an opportunity for students to learn different sensors and its application in real world problems. It will empower the students to develop their knowledge regarding operation, application and integration of sensors to enable the design and realization a complete systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about the microcontroller, its hardware interfacing and programming
CO 2: Understand the working principle and characteristics of different types of sensor
CO 3: Interface various sensor interfacing with microcontroller and display devices
CO 4: Understand the basic principles of analog to digital conversion and its application with different sensors
CO 5: Gain knowledge about various types of automation system
CO 6: Develop and implement sensor for final products in real time applications

COURSE DETAILS

1. Introduction to microcontroller, platform of operations with basic programming techniques
2. Interfacing of serial and parallel device with microcontroller
3. Interfacing of microcontroller with display devices
4. Use of ADC to interface various analog sensors with microcontroller
5. Introduction to sensor, measurement of physical parameters like temperature and humidity
6. Application of ultrasonic and proximity sensor
7. Application of gas and pressure sensor
8. Application of IR sensor and RFID
9. Interfacing actuators to drive DC motor (application of touch switch as actuators)
10. Implement sensor in final products for real time solution

Textbook

1. T. Karvinen, and K. Karvinen, Getting started with sensors, Shroff Publishers, Kindle , Edition, 2014.

Reference books

1. J. S. Katre, Sensors in Automation, Tech Knowledge Publications, 1st Edition, 2023
2. D. Patranabis, Sensors and Transducers, PHI Learning, 2nd Edition, 2003.

PCB DESIGN

Course Code: **EC28007**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

Over the years, printed circuit board manufacturing has continued to grow in order to keep up with the increasing demands of newer, faster, and more complex electronic circuitry. This course will familiarize students to design, simulate electronics circuit and fabricate PCB for prototyping using CAD tool. This program is designed to provide a balanced foundation of theoretical knowledge and practical skills in printed circuit board design.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand and evaluate different electronics components.
CO 2: Create schematic and simulate the circuit using OrCAD or any other CAD tools.
CO 3: Understand single- and double-layer PCB.
CO 4: Create and fabricate PCB and analyze the PCB using screen printing method.
CO 5: Understand assembly of electronics component by soldering.
CO 6: Analyze and test the circuit for any error.

COURSE DETAILS

Description of different Electronics Component and their Identification

Passive and active components, component identification, Color code for resistor and disc capacitors, Inductor and their types, simple air core and iron core inductor design.

Circuit Design and Simulation using CAD tool (OrCAD)

Design of a simple electronics circuit using data sheet and circuit schematic and simulation.

Schematic to PCB transfer and routing

Schematic to PCB transfer (assigning foot prints to various components, transfer to PCB), routing, DRC, ERC, EMC

Screen Printing Procedure
Preparation of screen, mask transfer

PCB preparation and Checking of Routing
transfer of layout to PCB using screen printing methods, etching, cleaning, error checking of routing, component mounting, soldering

Testing and Verification
Testing the circuit with the help of multi-meter and CRO

Textbooks

1. Chris Robertson, Printed Circuit Board, PHI, 2003
2. Elaine Rhodes, Developing Printed Circuit Assemblies: From Specifications to Mass Production, 2008, ISBN: 978-1435718760.

Reference books

1. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, PHI, 2003.
2. Kraig Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor, Newnes, 2009
3. Open source EDA Tool KiCad Tutorial : http://kicad-pcb.org/help/tutorials/

ELECTRONIC CIRCUITS LAB

Course Code: **EC29001**
Credit: **2**
L-T-P: **0-0-4**
Prerequisites: **Nil**

COURSE OBJECTIVE
Students will be able to gain knowledge and implement as well as simulate basic analog and digital electronic circuits (amplifier, oscillator, voltage regulator, decoder, multiplexer, counter) using discrete components and ICs. Students will have the ability to analyse, and resolve engineering problems associated with component selection, assembly and testing and get familiarization to PCB designing

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Design and simulate amplifier circuit using BJT/FET and ICs .
CO 2: Design and simulate oscillator circuit using BJT/FET and ICs .
CO 3: Design and simulate filter circuit using discrete components/ICs .
CO 4: Design and simulate voltage regulator circuit using discrete components/ICs .
CO 5: Simulate and design combinational logic circuits like adders, decoders and multiplexers in Xilinx ISE and logic gate ICs.
CO 6: Simulate and design sequential logic circuits like Synchronous type counters and Asynchronous type counters in Xilinx ISE and Flip-flop ICs.

ARM AND ADVANCED PROCESSORS

Course Code: **EC30007**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
The objective of this course is to teach the higher-level concepts of Advanced Microprocessors and ARM to the students. The students learn about Multitasking, Virtual memory, Memory management, Paging, TLB, RISC features, Pipelining and Branch Prediction like concepts. They develop skills for writing programs on ARM to solve simple problems as well as

some real time applications.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Appraise the concepts implemented in higher level Processors like Multitasking, Virtual Memory, Memory Management etc.
CO 2: Examine the mode of Operation of 80286, Concept of program invisible registers, Segment Descriptors etc.
CO 3: Analyze Segment Descriptors, Privilege level and Protection, Virtual '86 Mode and Paging in 80386, enhanced features incorporated in 80486
CO 4: Analyze the RISC features implemented in the design of Pentium Processors, Parallel processing through U & V Pipelines / Superscalar Execution and Branch Prediction Techniques
CO 5: Acquire the knowledge of a 32-bit ARM Processor, its RISC features, Registers, Pipelining and Interrupts
CO 6: Evaluate the 32-bit ARM instruction set, 16-bit Thumb instructions and Interfacing

COURSE DETAILS

Introduction
Overview of Intel higher level Processors, Concept of Multitasking, Virtual memory & Memory management.

Intel 80286 & 80386
Brief outline of Processor Architecture, Mode of operation, Segment descriptor, Privilege level & protection and Task switching in 80286, Virtual 86 mode, Paging and TLB in 80386

Pentium Processor
Features of RISC processors & Implementation of RISC features in Pentium, Pipelining, Superscalar execution & Branch prediction Technique

ARM & Interfacing
ARM design, ARM Processor fundamentals: Registers, CPSR, Memory map, Pipelines, Exceptions, Interrupt Vector Table, Introduction to ARM Instruction set and Thumb instructions, Interfacing – LCD, ADC, DAC, Stepper motor, UART

Textbooks
1. K. Ray and K. M. Bhurchandi - Advanced Microprocessor and Peripherals - Architecture, Programming and Interfacing, McGraw Hill Eduction Pvt Ltd - 3rd Edition
2. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Shujen Chen - ARM Assembly Language Programming & Architecture - Micro Digital Ed, ISBN: 9780997925906 - 2nd Edition.

Reference books
1. B. B. Brey - The Intel Microprocessors 8086/8088, 80186/80188, 80386, 80486, Pentium and Pentium Pro - Processor - PHI - 8th Edition
2. D. V. Hall - Microprocessors & Interfacing, Programming & Hardware - TMH - 3rd Edition.
3. William Hohl, Chirstopher Hinds - ARM Assembly Language: Fundamentals and Techniques - Taylor & Francis - 2nd Edition.
4. M A Mazidi & others, ARM System Developers Guide Design & Optimizing System Software – Andrew N. Sloss & others - Elsevier.

WIRELESS SENSOR NETWORK

Course Code: EC30008
Credit: 3

L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE
This course describes the functioning of a wireless sensor network, the layered architecture and auxiliary units viz., time synchronization and localization.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Identify the different elements of Wireless Sensor Network (WSN), network designing factors including the characteristics, and constraints.
CO 2: Make use of different techniques in physical and MAC layer in WSN.
CO 3: Apply different routing mechanisms in WSN.
CO 4: Analyze Transport layer, Application layer protocols and cross layer effects and solutions for WSN.
CO 5: Estimate the position of sensor nodes using different ranging techniques and ranging based protocols for WSN.
CO 6: Elaborate the time synchronization challenges and discuss some approaches that have been designed to address these challenges.

COURSE DETAILS
Introduction
Basic concepts, Platforms, Standardization, Architecture and protocols, Applications in military, Environment, Healthcare, Industry and Energy, Factors influencing WSN Design.

Physical & MAC Layer
PHY layer standard (IEEE 802.15.4), MAC challenges, MAC protocols for Sensor Network, Contention based MAC (S-MAC, B-MAC, CC-MAC), Reservation based MAC (TRAMA) & Hybrid MAC (Zebra MAC).

Network & Transport layer
Routing challenges, Data centric and flat architecture protocol (SPIN), Hierarchical protocol (LEACH), Geographical routing protocol (MECN), QoS based Protocol (SAR), Challenges of Transport layer, Transport layer protocols (PSFQ & CODA).

Application Layer
Source Coding, Query Processing, Network Management

Cross Layer Solutions
Interlayer Effects, Cross layer Interactions (MAC-Network, MAC-Application, Network and PHY, Transport – PHY), Cross layer module.

Localization
Challenges in localization, Ranging techniques, Range based localization protocols, Range free localization protocol.

Time Synchronization
Challenges for time synchronization, Timing Sync Protocol for Sensor Network (TPSN), Time Diffusion Synchronization Protocol (TDP), Rate based Diffusion Protocol (RDP).

Textbook
1.Ian F. Akyildiz and Mehmet Can Vuran, Wireless Sensor Networks, John Wiley and Sons Ltd, Publication, 2010.
Reference books
1. Jun Zhny and Abbos Jamalipour, Wireless Sensor Network - a networking perspective, Wiley, 2009.
2. C. Raghavendram, K Sivalingam and T. Znati, Wireless Sensor Network, Springer, 2005.

COMPOUND SEMICONDUCTORS BASICS

Course Code: **EC30009**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
This course is an introduction to properties of Compound Semiconductors highlighting the theoretical and practical aspects of their device physics and suitability for high speed devices. Beginning with an introduction to the basics of semiconductor devices and characteristics, it presents an overview compound semiconductor materials, as well as a detailed look at the electrical and optical properties of compound semiconductor hetero-structures.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Analyze the basic concepts of Semiconductor Devices and characteristics.
CO 2: Assess the requirements of Compound Semiconductors.
CO 3: Evaluate of the Performance measure of high speed devices
CO 4: Analyze principle of operation and the unique features of HBT, HEMT, TFET.
CO 5: Evaluate the issues and targeted performances of Compound Semiconductor Devices.
CO 6: Develop critical thinking ability supported by the learned concepts of Compound Semiconductors: Device Properties & Applications.

COURSE DETAILS

Introduction
Fundamentals of Semiconductor Devices, P-N Junction Diode and MOSFET, Introduction of Compound Semiconductors, Crystal structure, Properties of Compound semiconductors, Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon based devices, Band Diagrams, Pinch off voltage and threshold voltage, D.C. Characteristics and Analysis of Drain Current. Sub threshold Characteristics, Short Channel Effects.

Important parameters governing for the high speed and high power device performance
Transit time of charge carriers, junction capacitances, ON-resistances, the device geometry and size, carrier mobility, doping concentration and temperature break down voltage.

Hetero junction Bipolar Transistors (HBTs)
Principle of operation and the benefits of hetero junction BJT for high speed applications. GaAs and InP based HBT device structure, SiGe HBTs and the concept of strained layer devices.

High Electron Mobility Transistors (HEMT)
Hetero-junction devices. The generic Modulation Doped FET(MODFET) structure for high electron mobility realization. Principle of operation and the unique features of HEMT, InGaAs/InP HEMT structures. Tunneling devices: Principle of operation and the unique features of TFET, Resonant-tunneling hot electron transistors

Textbooks
1. S.M. Sze, High Speed Semiconductor Devices, Wiley (1990) ISBN 0-471-62307-5
2. G.A. Armstrong, C.K. Maiti, TCAD for Si, SiGe and GaAs Integrated Circuits, The Institution of Engineering and Technology, London, United Kingdom, 2007, ISBN 978-0-86341-743-6.

Reference books
1. Ralph E. Williams, Modern GaAs Processing Methods, Artech (1990), ISBN 0-89006-343-5,
2. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press (1991), ISBN 0-12-691740-X.

MOBILE AD HOC NETWORKS

Course Code: EC30010
Credits: **3**

L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

Wireless networks play an increasingly important role in the world of communications.This course provides an introduction to operation and developing standards for mobile networks, such as Vehicular Networks, Unmanned Air Vehicles, and Small Satellites, and students will learn to analyze the performance of these cutting-edge networks. Related protocols and their performance are studied using formal analytical tools and realistic simulations.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze and evaluate characteristics, Architecture, features, factors and challenges related to Mobile Ad Hoc Networks (MANET).
CO 2: Compare different Medium Access Control (MAC) protocols in the context of MANET and choose apt MAC protocol based on application requirements and network design specifications.
CO 3: Compare different Routing protocols in the context of MANET and choose apt Routing protocol based on network scenario.
CO 4: Assess issues and challenges for providing Quality of Service (QoS) in Ad Hoc wireless Networks and plan required QoS solutions in MAC and Network layers.
CO 5: Evaluate various Energy Management schemes in Ad Hoc Wireless Networks and would be able to judge the best scheme based on network specifications.
CO 6: Perceive various Ad Hoc Nomadic Mobile Applications to acquire skills required for designing and creating scenario specific Ad Hoc Mobile Applications.

COURSE DETAILS

Introduction

Origin Of Ad Hoc :Packet Radio Networks - Technical Challenges - Architecture of PRNETs - Components of Packet Radios - Introduction to Ad Hoc networks - Definition, characteristics features - Issues in Mobile Ad Hoc networks- Types of Ad Hoc Mobile Communications - Types of Mobile Host Movements - Ad Hoc wireless Internet. Characteristics of Wireless channel Mobility models - Indoor and Outdoor.

Medium Access Protocols

MAC protocols: design issues, goals and classification. Contention based protocols - With reservation, scheduling algorithms, protocols using direction antennas - Distributed packet reservation - Multiple access protocol, collision avoidance time allocation protocol. IEEE standards: 802.11 a, 802.11 b, 802.11g.

Routing Protocols and Multicast Routing in Ad Hoc Networks

Introduction - Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks - Classifications of Routing Protocols Table Driven routing protocols: Destination Sequenced Distance Vector Routing Protocol - Cluster head Gateway switched routing protocol. On Demand routing protocol: Dynamic source routing protocol, AODV routing protocol, temporarily ordered routing algorithm. Hybrid routing protocols: Zone routing protocol, Zone based Hierarchical link state routing protocol. Architecture Model for Multicast Routing Protocols - Classifications of Multicast Routing Protocols - Tree Based Multicast Routing Protocols - Mesh-Based Multicast Routing Protocols - Energy-Efficient Multicasting - Comparisons of Multicast Routing Protocols.

QOS and Energy Management

Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks - Classifications of QoS Solutions - MAC Layer Solutions - Network Layer Solutions. Need for Energy Management in Ad Hoc Wireless Networks - Classification of Energy Management Schemes - Battery Management Schemes - Transmission Power Management Schemes - System Power Management Schemes.

Ad Hoc Nomadic Mobile Applications

In the Office, While Traveling, Arriving Home, In the Car, Shopping Malls, The Modern battlefield, Car-to-Car Mobile Communications, Mobile Collaborative Applications - Location/context based mobile services - Introduction to wireless mesh networks and vehicular Ad Hoc networks.

Textbook

1. C.Sivaram Murthy and B.S Manoj, Ad Hoc Wireless Networks, Pearson Education, Second Edition India, 2001.

Reference books

1. K Toh, Ad Hoc mobile wireless networks, Protocols and Systems, Pearson Education, 2nd Edition, 2009.
2. Stefano Basagni, Mobile Ad hoc Networking, Wiley Inter science, IEEE Press, 2004.
3. George Aggelou, Mobile Ad Hoc Networks, McGrawHill, 2004.

Thomas Krag and Sebastin Buettrich, Wireless Mesh Networking, OõReilly Publishers, 2nd Edition, 2007.

NANOELECTRONICS

Course Code: **EC30012**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

In this course the students will be introduced to the basic concepts of Nanoelectronics, Nanodevices, Spintronic and also able to learn the quantum mechanics that governs the operation of Nanoelectronics devices.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the basic and advanced concepts of Nano electronics.
CO 2: Apply and evaluate the use of fundamental science of quantum mechanics in Nano electronics.
CO 3: Identify Nanoelectronics materials and will be able to distinguish from other materials.
CO 4: Analyze the different fabrication and characterization techniques of nanostructure materials.
CO 5: Apply the concepts of few Nano electronics devices.
CO 6: Analyze and evaluate the idea of single electron transistors and its further applications

COURSE DETAILS

Particles and Waves

Introduction to Particles and waves, Wave Particle duality, Schrodinger Wave equation, Wave Mechanics of particle with suitable examples, Atoms and atomic orbitals
Density of states, quantum transport and tunneling effect.

Tunnel Junction and Applications of Tunneling

Tunneling Through a Potential Barrier, Metal-Semiconductor, and Metal-Insulator-Metal Junctions, Tunnel Junctions, Tunnel Junction Excited by a Current Source. Spintronics and Foundations of nano-photonics.

Field Emission, Gate—Oxide Tunneling and Hot Electron Effects in nano MOSFETs, Growth, Fabrication, and Measurement Techniques for Nanostructures: Introduction, Bulk crystal and heterostructure growth, Nanolithography, etching, and other means for fabrication of nanostructures and nano-devices, Techniques for characterization of nanostructures (FESEM, STM).

Nanostructure Devices

Quantum dots and nanoparticles, Carbon nanotubes and nanowires, Nano pillars, Nano sensors and Nano medicines, MEMS, Single Electron Transistor, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs. Applications of Nano electronic devices,12

Textbooks

1. Vladimir V. Mitin , Viatcheslav A. Kochelap and Michael A. Stroscio, Introduction to Nano electronics (Science, Nanotechnology, Engineering, and Applications); Cambridge University Press, 2008
2. T Pradeep, NANO: The Essentials Understanding Nanoscience and Nanotechnology, McGraw Hill, 2018

Reference books

1. George W Hanson, Fundamentals of Nan electronics, Pearson 2008
2. WR Fahrner, Nanotechnology and Nano electronics – Materials, Devices and Measurement Techniques Springer, 2005
3. Stephen D. Sentaria, Microsystem Design, Springer, 2001
4. Marc Madou, Fundamentals of Microfabrication & Nanofabrication, 3rd Edition, CRC Press, 2011.

OPTICAL & SATELLITE COMMUNICATION

Course Code: **EC30013**
Credits: **3**
L-T-Pl: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The course intend to make the students to learn the Optical Communication and Networking Concept, primarily signal propagation through optical fiber, Modulation for optical Communication, Losses, Dispersion, Link Budget and Networking. The knowledge of Satellite Communication and Systems are also very important for a communication Engineering student. The aim of the course is to develop the industry identified competencies within the students like Maintenance of optical communication systems and Satellite communication systems through various teaching and learning processes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the significance of terminology associated with optical communication, analyze the principle of light propagation through optical fiber with concept of modes and solve problems on this concept.
CO 2: Analyze various types of losses and dispersion in optical fiber and solve related problems associated with the concept.
CO 3: Analyze the structure, principle of operation and the characteristics of optical sources and detectors.
CO 4: Identify the optical communication system link elements, preparation of link budget and estimate basic entities of optical Networking.
CO 5: Identify the Satellite communication elements and analyze the principles.
CO 6: Analyse the Satellite Communication Systems and design the satellite Link budget.

COURSE DETAILS

Principles of Optical Communication and Wave Propagation in Optical Fiber

Optical frequencies used in optical fibers, Principle of light propagation in optical fibers, Advantages of optical fiber communication. Relation, Basic structure of optical fibers and ray diagram of optical path in an optical fiber, Acceptance angle, Numerical aperture. Concept of modes, Different types of modes in optical fibers, Relation between modes and rays, Cut-off condition for guided modes, Boundary conditions, single mode / multi-mode fibers, Concept of V number and its importance.

Losses in Fiber and Dispersion

Intrinsic / Extrinsic losses, Material or impurity losses, Rayleigh scattering loss, Absorption loss, Bending loss. Loss versus wavelength plot, Concept of dispersion, Intermodal dispersion, Intramodal dispersion, Wave guide and material dispersion, minimization of dispersion.

Optical Sources, Detectors, and Fiber Optic Links

Characteristics of optical sources, Principle of operation of LED and LASER diode,Intensity modulation circuits for LED and Laser diode. Principle of operation of PIN diode and APD, Basic structures, Current characteristics, SNR calculation and Noise equivalent power, Bit error rate, fiber optic links - power budget, rise-time budget.

Single-wavelength networks

SONET/SDH, FDDI, WDM networks - Broadcast- and-select WDM LAN, Wavelength-routed metro and wide-area networks, passive optical networks for access segment.

Principle and elements of Satellite Communication
Introduction, Frequency spectrum for satellite communication, Types of orbits, Kepler's Laws of planetary motion, Orbital perturbations, Geostationary orbit, Satellite launching, General satellite communication, Block diagram uplink, Downlink frequencies, Types of modulation techniques used

Losses, Attenuation and Satellite Link Budget
Signal loss on transmission through earth's atmosphere, Atmospheric losses, Ionosphere effects, Rain attenuation. Satellite link budget : Transmission losses, Interference, System noise temperature, Link power budget

Satellite sub-systems
Antenna sub-systems, Attitude and orbit control sub-system, Power sub-system, Communication sub-system, TTC&M sub-systems.

Textbooks
1. J. C. Palais, Optical Fiber Communication, Pearson Education, 2022 reprint
2. Pratt, Bostien, Allnut, Satellite Communication, John Willey Publications, 2nd edition, 2013

Reference books
1. G. Kaiser, Optical Fiber Communication, McGraw Hill, - 5th edition, 2013
2. Denish Roddy, Satellite Communication, McGraw Hill, 3rd edition, 2001

HARDWARE AND SOFTWARE CO-DESIGN FOR EMBEDDED SYSTEM

Course Code: **EC30015**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
This course will make the student understand the concept of an embedded system, to get the clarity of various design metrics for a system, and learn the concept of improving productivity by presenting a unified view of software & hardware. Futher they will be exposed to general purpose processors, standard single purpose processors and to grasp the advanced techniques for embedded system modelling using the RTOS and task scheduling algorithms.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Interpret the HW /SW co design issues and challenges
CO 2: Apply different embedded system modelling techniques.
CO 3: Analyse different methods of software design for embedded system
CO 4: Apply knowledge to create different architecture for es
CO 5: Create prototyping of an embedded system
CO 6: Apply knowledge to optimize the performance of embedded system

COURSE DETAILS

Introduction to Embedded System & Co-Design
Embedded System & Future trend, Problem description, goals of co-design, co-design steps, existing co-design approaches, and present challenges.

System Modelling and Specification
Models of computation (Signal flow graphs, Data flow model, Task graphs, Finite State Machines, hierarchical models), Petri net, UML.

Software Design
Embedded System Software, ES Software Consideration, Dealing with Data Que and Interrupt, Computation and communication model of software, consideration ES with OS, Memory and shared memory issues.

Architectures for Embedded Systems & Synthesis
Single processor – coprocessor architecture, mixed-signal architectures, multiprocessor architectures, reconfigurable architectures, Systems on Chip, I/O System, Peripherals and buses, Partitioning and Architecture Selection, Software

Synthesis, cost Estimation Hardware Synthesis.

Prototyping and Verification of ES
prototyping phases- simulation & emulation, prototyping with development boards, rapid prototyping, Testing- Goals and scope of testing, testing approaches, design for testability, Verification- functional, timing and formal verification, debugging.

Textbook
1. Bashir I. Morshed, Embedded Systems – A Hardware-Software Co-Design Approach Springer, 2021.

Reference books

1. Felice Balarin, Massimiliano Chiodo, Paolo Giusto, Harry Hsieh, Attila Jurecska, Luciano Lavagno, Claudio Passerone, Alberto Sangiovanni-Vincentelli, Ellen Sentovich, Kei Suzuki, Bassam Tabbara, Hardware-Software Co-Design of Embedded Systems, Springer, 1997
2. D. Gajski, F. Vahid, S. Narayan, and J. Gong, Specification and Design of Embedded Systems, Prentice Hall, 1994.
3. Wayne Wolf, Jorgen Staunstrup, "Hardware / Software Co- Design Principles and Practice", , Springer.2009
4. Giovanni De Micheli, Mariagiovanna Sami, "Hardware / Software Co- Design", Kluwer Academic Publishers, 2002.

AUDIO AND SPEECH PROCESSING

Course Code: **EC30017**
Credits: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
This course will be able to provide the basic concepts and methodologies for the analysis, modeling, synthesis and coding of speech and music. Also the the students will get a foundation for developing applications and for future study in this field. Further it introduces software tools for the analysis and manipulation of speech and music and to gain practical experience in the design and implementation of speech and music processing algorithms.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Explain the fundamental concepts of speech production, perception, and auditory psychoacoustics.
CO 2: Analyse and extract features from speech signals using various digital models and linear prediction techniques.
CO 3: Design and implement speech coding and synthesis algorithms for various applications.
CO 4: Apply speech transformations, such as time scale modification and voice morphing.
CO 5: Implement and evaluate automatic speech recognition systems using various models and techniques, including speaker recognition systems.
CO 6: Apply speech enhancement techniques to real-world applications, such as digital hearing aids.

COURSE DETAILS

Introduction
Mechanism of speech production and perception, acoustic and articulatory phonetics,

Digital models for the sampled speech signal
Acoustic Theory, lossless tube models – digital models.

Linear prediction of speech
Time domain processing of speech signals: short-time energy, magnitude, zero-crossing rate, auto correlation - formulation of LPC equation - solution of LPC equations - Levinson Durbin algorithm - Levinson recursion - Schur algorithm - lattice formulations and solutions – PARCOR coefficients

Spectral analysis of speech
Short Time Fourier analysis - filter bank design.

Auditory Perception

Psychoacoustics- Frequency Analysis and Critical Bands - Masking properties of human ear.

Speech coding
Sub band coding of speech - transform coding - channel vocoder - formant vocoder - cepstral vocoder -vector quantizer coder- Linear predictive Coder.

Speech synthesis
Pitch extraction algorithms - Gold Rabiner pitch trackers - auto correlation pitch trackers - voice/unvoiced detection - homomorphic speech processing – homomorphic systems for convolution - short-time cepsturm and complex cepsturm - pitch extraction using homomorphic speech processing.

Speech Transformations
Time Scale Modification - Voice Morphing. Automatic speech recognition systems – isolated word recognition - connected word recognition -large vocabulary word recognition systems - pattern classification – Dynamic Time Warping – Hidden Markov Modeling - speaker recognition systems - speaker verification systems – speaker identification. Speech Enhancement Techniques — Approaches and Challenges in the design of Digital Hearing Aids.

Textbooks

1. L.R. Rabiner and R.W. Schafer, Digital Processing of Speech Signals Pearson Education, Delhi, India, 2004
2. D. O'Shaughnessy, Speech Communications: Human and Machine, Second Edition, University Press, 2005.

Reference books

1. Thomas F. Quatieri, Discrete-time Speech Signal Processing: Principles and Practice, Prentice Hall, Signal Processing Series, 2002
2. Philipos C. Loizou, Speech Enhancement – Theory and Practice, CRC Press, 2013
3. John N. Holmes, Wendy J. Holmes, Speech Synthesis and Recognition, Taylor and Francis, 2nd Edition, 2003.
4. J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis Discrete-Time Processing of Speech Signals, Wiley-IEEE Press, NY, USA, 1999.

INFORMATION THEORY & CODING

Course Code: **EC30019**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The course will help in forming a strong foundation for the broad areas of information theory, coding and cryptography. It emphasizes on the basic concepts, lays stress on the fundamental principles and motivates their application to practical problems. This course starts with the basics of information theory and source coding. The theory of linear block codes (including cyclic codes, BCH codes, RS codes), convolution codes are explained. Basics of secure communications including cryptography and physical layer security are covered.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the mathematical definitions of information, using conditional and unconditional probability theorem
CO 2: Analyze and differentiate several sources of information and coding techniques
CO 3: Explain and analyze channel coding schemes and Shannon's information theory
CO 4: Distinguish between various error decoding schemes
CO 5: Design and simplify different codes such as cyclic codes, CRC codes (cyclic Redundancy Codes) and BCH codes, generate Convolution codes
CO 6: Discuss practical applications of coding for secure communication

COURSE DETAILS

Introduction
Introduction to Information Theory, Entropy, Mutual Information, Conditional and Joint Entropy, Measures for Continuous Random Variable, Relative Entropy

Source Coding
Variable Length Codes, Prefix Codes, Source Coding Theorem, Various source coding techniques: Huffman, Arithmetic, Lempel Ziv, Run Length, Rate Distortion Functions, Entropy rate of Stochastic Proces. Introduction to Image Compression, JPEG Standards.

Channel Capacity & Coding
Channel models, Channel Capacity, Shannon Limit, Channel capacity of MIMO systems,

Error control coding
Linear Block Codes, Hamming Codes, parity chech coding, Cyclic code for burst error correction, BCH Codes and convolutional Codes, Trellies Coded Modulation

Coding for Secure Communication
Introduction to Cryptography, Overview of Encryption Techniques, Symmetric (Secret Key) Cryptography, Data Encryption Standard (DES), Hashing techniques, quantum cryptography, Biometric Cryptography

Textbooks
1. Ranjan Bose, Information Theory, Coding and Cryptography, McGraw Hill, 2nd edition, 2011
2. J. Das, P. K. Chatterjee & S. K. Mullick, Principle of Digital CommunicationNew age Internationals, 2008

Reference books
1. T. M. Cover & J. A. Thomas, Elements of Information Theory, Wiley-Interscience-2nd edition 2010.
2. J. G. Proakis, Digital Communication, McGraw Hill Education, 4th edition

INDUSTRIAL INTERNET OF THINGS

Course Code: **EC30021**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
The course is intended to introduce the students, the basics of Industrial Internet of Things, its architecture, protocols, design requirements, and key technologies. The learner will be able to understand the key concepts of industrial data transmission and acquisition. Application of data analytics and machine learning methods provides insights into IIoT data science. Some case studies will help the reader to understand the application of IIoT in various industrial sectors.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the basic concepts of IIoT and Industry 4.0
CO 2: Explain key technologies for IIoT and Industry 4.0
CO 3: Apply the sensors and actuators in industrial applications
CO 4: Develop industrial data transmission and acquisitions systems
CO 5: Develop machine learning and data science methods for IIoTs.
CO 6: Analyze case studies on IIoT use cases in Industries and develop allied methods and applications.

COURSE DETAILS

Introduction
Overview of IoT, architecture, application-based IOT protocols, cloud computing, Big Data IIoT and Industry 4.0, Industry 4.0 Basics, Design requirements, Sustainability, Cybersecurity and Impacts of Industry 4.0, IIoT Basics, Industrial Internet systems, Industrial Sensing, Processes. Business models of IIoT, Reference architecture of IIoT

Industrial Process and Devices: Technical requirements, The industrial process, The CIM pyramid, The I-IoT data flow

Industrial Data Flow and Devices
Technical requirements, The I-IoT data flow in the factory, Controllers. Sensors: Introduction, Characteristics, Categories. Actuators: Introduction, Thermal, Hydraulic, Pneumatic, and Electromechanical Actuators.

Industrial data transmission
Foundation Fieldbus, Profibus, HART, Interbus, Bitbus, CC-Link, Modubus, Batinbus, DigitalSTORM, CAN, DeviceNet, LonWorks, ISA 100.11, LoRa. Acquisition: Distributed control system, PLC, SCADA. Inventory management and quality control

Case Studies
Manufacturing, Automotive, and Mining Industry

Industrial IoT Security
Cyber security vs cyber physical IoT security, Divergence in IT and OT security fundamentals, Industrial threats, Vulnerabilities, and Risk factors. Evolution of cyber-physical attacks. Securing Connectivity and Communications, Distinguishing features of IIoT, Connectivity, Security Assessment of IIoT Connectivity and Protocols.

Textbooks

1. Sudip Misra, Chandana Roy, Anandrup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0 published , CRC Press, First Edition 2021
2. Giacomo Veneri and Antonio Capasso, Hands-On Industrial Internet of Things, Packet Publishing Ltd.

Reference books

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things published, Apress 2016
2. Sravani Bhattacharjee, Practical Industrial Internet of Things Security: Packt Publishing 2018
3. D. Pyo, , J. Hwang, , and Y. Yoon, Tech Trends of the 4th Industrial Revolution, Mercury Learning & Information

ELECTRONICS PRODUCT DEVELOPMENT

Course Code: **EC38001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisites: **Nil**

COURSE OBJECTIVE
This course provides an overview of the process and considerations involved in the development of electronics products. It covers the key stages of product development planning, including ideation, concept design, prototyping, testing, manufacturing, and commercialization. Students will gain hands-on experience with tools, techniques, and methodologies used in electronics product development through practical projects and case studies.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Appreciate the product development lifecycle and the role of electronics in product design.
CO 2: Gain knowledge of design principles, requirements, and constraints for electronics products.
CO 3: Develop skills in prototyping, testing, and refining electronics product designs.
CO 4: Learn about manufacturing processes, quality control, and regulatory compliance in electronics product development.
CO 5: Explore strategies for commercialization, market analysis, and intellectual property protection.
CO 6: Apply knowledge and skills acquired to successfully complete a product development project.

COURSE DETAILS

Overview of the product development lifecycle
Role of electronics in product design, Market analysis and identifying customer needs, Design Principles for Electronics Products

Product design considerations
form factor, user interface, power requirements, Component selection, sourcing, and supply chain management, Design for manufacturability and assembly, Circuit Design and Simulation

Circuit design techniques and best practices
Simulation tools for electronics design and analysis, PCB layout and routing considerations

Prototyping and Testing

Rapid prototyping techniques
Breadboarding, soldering, 3D printing, Test and measurement tools for electronics verification
Design verification and iteration process, Manufacturing and Quality Control

Manufacturing processes for electronics products
Assembly, soldering, and surface mount technology, Quality control, testing, and inspection methodologies, Regulatory Compliance and Certification

Standards and regulations for electronics products (FCC, CE)
Product safety, electromagnetic compatibility (EMC), and environmental considerations
Certification processes and documentation requirements, Intellectual Property and Commercialization

Intellectual property rights and protection
Market analysis and competitive landscape, Business models, pricing strategies, and market entry considerations, Project Development and Presentation

Team-based product development project
Project management techniques and tools, Final presentation and documentation of the product development project.

Textbooks

1. R.G. Kaduskar, and V.B. Baru, Electronic Product Design, 2ed, Wiley India Pvt. Limited.
2. V.S.Bagad, Electronic Product Design - A Conceptual Approach, Technical Publication, ISBN: 9789350993620

Reference books

1. Kim R. Fowler , Electronic Instrument Design, Architecting for the Life Cycle, Oxford University Press, ISBN: 9780195083712
2. Karl T. Ulrich, Steven D. Eppinger, Maria C. Yang, Product Design and Development| 7th Edition ,Mc Graw Hill Education, ISBN13: 9781260043655
3. S D Mehta , Electronic Product Design, S.Chand Publication

COMPOUND SEMICONDUCTORS BASICS

Course Code: **EC30009**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
This course is an introduction to properties of Compound Semiconductors highlighting the theoretical and practical aspects of their device physics and suitability for high speed devices. Beginning with an introduction to the basics of semiconductor devices and characteristics, it presents an overview compound semiconductor materials, as well as a detailed look at the electrical and optical properties of compound semiconductor hetero-structures.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Analyze the basic concepts of Semiconductor Devices and characteristics.
CO 2: Assess the requirements of Compound Semiconductors.
CO 3: Evaluate of the Performance measure of high speed devices
CO 4: Analyze principle of operation and the unique features of HBT, HEMT, TFET.
CO 5: Evaluate the issues and targeted performances of Compound Semiconductor Devices.
CO 6: Develop critical thinking ability supported by the learned concepts of Compound Semiconductors: Device Properties & Applications.

COURSE DETAILS

Introduction
Fundamentals of Semiconductor Devices, P-N Junction Diode and MOSFET, Introduction of Compound Semiconductors, Crystal structure, Properties of Compound semiconductors, Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon based devices, Band Diagrams, Pinch off voltage and threshold voltage, D.C. Characteristics and Analysis of Drain Current. Sub threshold Characteristics, Short Channel Effects.

Important parameters governing for the high speed and high power device performance
Transit time of charge carriers, junction capacitances, ON-resistances, the device geometry and size, carrier mobility, doping concentration and temperature break down voltage.

Hetero junction Bipolar Transistors (HBTs)
Principle of operation and the benefits of hetero junction BJT for high speed applications. GaAs and InP based HBT device structure, SiGe HBTs and the concept of strained layer devices.

High Electron Mobility Transistors (HEMT)
Hetero-junction devices. The generic Modulation Doped FET(MODFET) structure for high electron mobility realization. Principle of operation and the unique features of HEMT, InGaAs/InP HEMT structures. Tunneling devices: Principle of operation and the unique features of TFET, Resonant-tunneling hot electron transistors

Textbooks

1. S.M. Sze, High Speed Semiconductor Devices, Wiley (1990) ISBN 0-471-62307-5
2. G.A. Armstrong, C.K. Maiti, TCAD for Si, SiGe and GaAs Integrated Circuits, The Institution of Engineering and Technology, London, United Kingdom, 2007, ISBN 978-0-86341-743-6.

Reference books

1. Ralph E. Williams, Modern GaAs Processing Methods, Artech (1990), ISBN 0-89006-343-5,
2. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press (1991), ISBN 0-12-691740-X.

OPTIMIZATION TECHNIQUES IN ENGINEERING

Course Code: **EC40001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
Students will gain expertise in designing algorithms based on conventional techniques and be able to deal with intractable problems and implement algorithms given the description. At the end of this course, students will be able to comprehend and apply various optimization techniques for numerical analysis of different engineering and design related problems. Course modules include various methods to obtain the extremum (minimum or maximum) of a non-dynamic system and the use of these methods in various engineering applications.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Analyze the need for optimization, the concepts of design variables and constraints.
CO 2: Apply various unconstrained optimization techniques and develop corresponding Python/MATLAB codes.
CO 3: Apply various multi-variable optimization techniques and develop corresponding Python/MATLAB codes.
CO 4: Analyze various constrained optimization techniques and utilize them for evaluating engineering problem statements.
CO 5: Investigate various complex problems using dynamic programming algorithms.
CO 6: Analyze various advanced metaheuristic techniques and develop Python/MATLAB codes for analysis.

COURSE DETAILS

Introduction

Design variables, constraints, variable bounds, local and global optimization, classification of optimization techniques.

Unconstrained Optimization Techniques

Single-variable optimization techniques - Concepts of Bracketing (Exhaustive Search) and Region Elimination (Interval Halving), Programming in Python/MATLAB.Gradient Based techniques - Newton-Raphson method and its application, Programming in Python/MATLAB.Multi-variable optimization techniques - Concepts of Direct Search (Hooke-Jeeves pattern search method) and Gradient based search (Cauchy's method, Newton's method).

Constrained Optimization Techniques

L1 and L2 norm based optimization, Kuhn-Tucker (KT) necessity and sufficiency theorems, Penalty function method, Method of multiplier.

Dynamic Programming

Dynamic programming algorithms, shortest path problems, time optimal control.

Metaheuristics

Genetic Algorithm, Particle Swarm Optimization, Simulated Annealing, Differential Evolution - Grey Wolf Optimization, Programming in Python/MATLAB.

Textbook

1. Deb, Kalyanmoy, Optimization for engineering design: Algorithms and examples. PHI Learning Pvt. Ltd., 2012.

Reference books

1. Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.
2. Deb, Kalyanmoy, Multi-objective optimization using evolutionary algorithms: an introduction. Springer London, 2011.
3. Rao, S. S.,Engineering optimization: theory and practice. John Wiley & Sons,2019.
4. Bellman, R. E. and Dreyfus, S. E., Applied dynamic programming (Vol. 2050). Princeton university press, 2015.

MILLIMETER-WAVES AND TERAHERTZ TECHNOLOGY

Course Code: **EC40002**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

This course deals with the fundamental theory of millimeter wave multiple access techniques and the fundamentals of Terahertz technology. The course will comprehensively discuss the channel modelling for mm Waves and multiple access techniques.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the various communication technologies, difference between sub-6GHz 5G and mm-Wave 5G, characteristics of mm-Wave and standards
CO 2: Apply the channel models for mm-Wave systems and design them.
CO 3: Analyze the different modulation schemes and multiple access technologies for mm-Wave systems.
CO 4: Analyze the beam forming concept and apply water filling algorithm for channel capacity improvement in mm-Waves.
CO 5: Explain the sources of THz and the means of detecting it
CO 6: Explain the application of THz for future wireless communication systems.

COURSE DETAILS

Introduction to Millimeter Wave (mm-Wave) Technology
Overview of communication technologies (1G to 5G), 5G requirements, sub-6GHz 5G, mm-Wave 5G, mm-Wave characteristics, mm-Wave standards, mm-Wave MIMO systems.

Channel Modelling for mm-Wave Technology
Channel modelling challenges, mm-Wave propagation loss due to atmospheric Oxygen, and water vapor (especially, at 60GHz), path loss models, Channel models for mm-Wave MIMO systems.

Modulation and Multiple-Access Techniques

Modulation techniques: Orthogonal frequency division multiplexing (OFDM), filter bank multi-carriers (FBMC), generalized frequency, division multiplexing (GFDM), and universal filtered multi-carrier (UFMC)

Orthogonal Frequency Division

Multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).

MIMO and Beam Steering Technology
mm-Wave transmission and reception, antennas for mm-Wave beam-steering concept, MIMO requirements, noise in MIMO mm-Wave, spatial diversity.

Overview of Terahertz (THz) Technology
Introduction to THz radiation, Overview of THz generation and detection: THz pulses, and continuous THz wave generation, Overview of THz components (waveguides, filters, and modulations)

THz Communications
Ultra fast THz communication, Short distance THz communications, 6G communications with THz, Space communication with THz

Textbooks

1. Theodore S.Rappaport, Robert W. Heath Jr., Robert C. Daniels and James N. Murdock, Millimeter Wave Wireless Communication, Prentice Hall, 2014.
2. Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

Reference books

1. Kao- Cheng Huang and Zhoacheng Wang, Millimeter Wave Communication Systems, Wiley IEEE Press, 2011.
2. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, New Directions in Wireless Communication Systems from Mobile to 5G, CRC Press,2017
3. Erik Bründermann, et al., Terahertz Techniques, Springe, 2012.
4. R. A. Lewis, Terahertz Physics, Cambridge University Press, 2012

COGNITIVE RADIO AND COOPERATIVE COMMUNICATIONS

Course Code: **EC40003**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
Cognitive radio is an exciting emerging technology that has the potential of dealing with the stringent requirement and scarcity of the radio spectrum. Aim of this course is to familiarize students with the technology that allows the agile and efficient utilization of the radio spectrum by offering distributed terminals or radio cells the ability of radio sensing, self-adaptation, and dynamic spectrum sharing.

COURSE OUTCOMES

After successfully completing the course, the students will be able to:

CO 1: Analyze Cooperative Communication Concepts and Cooperation protocols.
CO 2: Differentiate between Distributed space–time coding (DSTC) - Distributed space–frequency coding (DSFC) and analyze Differential modulation for DF and AF cooperative communication.
CO 3: Analyze the features of cooperative Networking like energy efficiency, distributed routing, source channel coding etc.
CO 4: Analyze the concept of Software Defined Radio and Cognitive Radio.
CO 5: Model various cognitive Radio tasks.
CO 6: Explain the recent trends and challenges in Cognitive Radio.

COURSE DETAILS

Introduction

Cooperative Communication, Cooperation protocols - Hierarchical cooperation, Cooperative communications with single relay, Multi-node cooperative communications.

Distributed Space–Time Coding (Dstc) - Distributed Space–Frequency Coding (Dsfc)

Distributed space–time coding (DSTC) - Distributed space–frequency coding (DSFC); Relay selection- Differential modulations for DF cooperative communications - Differential modulation for AF cooperative communications.

Cooperative Networking

Energy efficiency in cooperative sensor networks, Cognitive multiple access via cooperation, Content-aware cooperative multiple access, Distributed cooperative routing, Source–channel coding with cooperation.

Introduction to Software Defined Radio and Cognitive Radio

Characteristics and Benefits of Software Radio; Dynamic Spectrum Access; Digital dividend; Types of Cognitive Radio; Spectrum policies and Regulations; Information theoretic perspective on Cognitive Radio networks.

Cognitive Radio Tasks

Spectrum sensing and its methods; Cooperative Spectrum sensing; Spectrum sharing; spectrum mobility; spectrum management; spectrum trading.

Recent Trends and Challenges in Cognitive Radio

OFDM based Cognitive Radio; Security issues in cognitive radio; Game theory in Cognitive radio; applications of cognitive radio; IEEE 802.22 WRAN standard.

Textbook

1. Rayliu K J, Sadek A K, Weifeng Su and Andres Kwasinski, Cooperative Communications and Networking, Cambridge University Press, 2009.

Reference books

1. 1.Jeffrey H Reed, Software Radio: A Modern Approach to Radio Engineering, PEA Publication, 2002.
2. Bruce A Fette, Cognitive Radio Technology, Elsevier Publication, Burlington, 2009.
3. Joseph Mitola III, Cognitive Radio Architecture: The Engineering Foundations of Radio XML, Wiley Interscience Publication, NEW JERSEY, 2006.
4. Kwang-Cheng Chen and Ramjee Prasad, Cognitive Radio Networks, John Wiley & Sons, 2009.

QUANTUM COMMUNICATION

Course Code: **EC40004**
Credit: **3**

L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
This course introduces students to basic laws of quantum mechanics and provides an introduction to the revolutionary quantum technologies.This course is about the potential for quantum technologies, a field that promises to revolutionize the way we compute by using the dynamics of quantum mechanics. The boundary between classical and quantum physics, quantization of EM field and its consequences, quantum electromagnetic and atomic physics and their applications in quantum communication, quantum computations and quantum sensing are discussed. The course aims to develop conceptual understanding of quantum phenomena and identifies engineering challenges of various quantum technologies.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Identify fundamental differences between quantum and classical technologies
CO 2: Analyze mathematically simple quantum phenomena
CO 3: Explain quantum signatures in experimental data
CO 4: Discuss quantum errors and error correction methods
CO 5: Analyze engineering challenges of quantum technologies
CO 6: Discuss methods of fault-tolerant quantum computation

COURSE DETAILS

Overview of Quantum Technologies
Quantum Engineering, Motivation: Quantum Computing, Quantum Communication, Motivation: Quantum sensing, Fundamentals of Quantum Mechanics

Essential Concepts in Quantum Mechanics
The Birth of quantum mechanics, Postulates of quantum mechanics, Hamiltonian and Schrodinger Equation, Dirac notation, Density operator

Quantum Resources
EM waves: Quantum EM fields, Polarization of optical fields, EM resonators, Single photon detection, E-field detection, Quantum light.
Atoms: Two-level atom, Introduction to light-atom interactions, Trapping and cooling atoms, Three-level atoms, Rydberg atoms, Trapped ions
Superconducting Devices: Fundamentals of superconductors, Superconducting two-level systems, Superconducting qubits, Superconducting qubits and challenges

Quantum Sensing and Communication
Light interferometry-LIGO, Particle interferometry- Ramsey measurement, Sensing via defects in diamond, Quantum cryptography, Quantum teleportation, Quantum Memory, Entanglement distribution

Quantum Computing
Introduction to classical computing, Introduction to quantum computing, Experimental implementation of quantum computation, Deterministic two-qubit logic gates, Single and two-qubit photonic gates, Superconducting gates, Quantum logic operation using trapped ions, Quantum logic operation using Rydberg atoms, Linear optics quantum computing, Engineering Quantum Systems

Textbook
1. Nielsen, M., & Chuang, I., Quantum Computation and Quantum Information: 10th Anniversary Edition. Cambridge: Cambridge University Press,2010, doi:10.1017/CBO9780511976667;

Reference books
1. David A. B. Miller, Quantum Mechanics for Scientists and Engineers Illustrated Edition, Advanced Quantum Communications: An Engineering Approach Sandor Imre, Laszlo Gyongyosi, ISBN: 978-1-118-00236-0, December 2012 Wiley-IEEE Press
2. A.M. Zagoskin, Quantum Engineering: Theory and Design of Quantum Coherent Structures, Cambridge, Cambridge University Press, 2011, ISBN 978-0-521-11369-4.

ADVANCED VLSI AND SoC

Course Code: **EC40006**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

This course focuses on data path interconnects aware design methodologies, SoC design flow, bus architecture, hardware security and IP protection.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the basic arithmetic building blocks used in VLSI Circuits.
CO 2: Apply knowledge to implement arithmetic blocks for data path design
CO 3: Analyze the partitioning technique for component placement.
CO 4: Solve the VLSI interconnects and clock routing issues.
CO 5: Discuss the SoC design method and soft- and hard-core processors.
CO 6: Evaluate and analyze the method of SoC Verification and IP protection methods.

COURSE DETAILS

Design of arithmetic building blocks

Introduction to processor design and digital arithmetic, Carry select adder, Manchester carry-chain, Carry bypass adder, carry-save adder, Array multiplier, carry save multiplier, Wallace tree multiplier, Booth's multiplier, Delay optimization of adders and multipliers, Area-time trade-off, power consumption issues,
Optimization for speed, Low-power design and high-speed logic.

Design automation tools and partitioning

Constructive and iterative partitioning, Kernighan-Lin algorithm, ratio-cut algorithm, Placement, floor planning and pin assignments
Global routing, Lee's algorithm, Channel routing, clock and power routing algorithms.

Clocking and interconnect issues

Clocking and Crosstalk, system noise, complexity management, Signal integrity issues, high speed interconnects, Clock, clock skew, clock distribution and routing, Clock buffering, gated clock and clock tree, Design of buffers and I/O pad and memory design interconnect issues.

Introduction to SoC

Soc Design Flow, Overview of SoC Design methodologies, SoC Components- Processor and Memory, On chip interconnect- AMBA Bus, soft and hard core development process.

SoC Verification & SoC Security

Overview of verification techniques, Verification flow, HW/SW Multi-Level Security, Overview of hardware security, IP protection, Encryption

Textbooks

1. Weste and Eshranghian "Principles of CMOS VLSI Design", Second Edition,Pearson Education, 2001
2. Farzad Nekoogar, Faranak Nekoogar, "From ASICs to SOCs: A Practical Approach", PHI, 2003

Reference books

1. Neil H.E. Weste, David F. Harris, "CMOS VLSI Design ", Pearson Education, 2010
2. Jan M. Rabaey, Anant Chandrakasan, and Borivoje Nikoli, "Digital Integrated Circuits", Prentice Hall (India), 2016

LOW POWER VLSI DESIGN

Course Code: **EC40007**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
This course focuses on Optimization of VLSI design prototype in architecture, gate and in cell level of abstraction.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain various power dissipation mechanisms in a CMOS logic
CO 2: Estimate and analyse the various components power dissipation in VLSI circuits.
CO 3: Apply and analyse various low power optimization techniques in architecture level
CO 4: Apply and analyse various low power optimization techniques in gate level
CO 5: Analyse various low power optimization techniques in cell level
CO 6: Analyse various low power optimization techniques in layout level

COURSE DETAILS

Basic MOS inverters, MOS combinational circuits
Sources of power dissipation in CMOS circuits: static power dissipation - diode leakage power, subthreshold leakage power, gate and other tunnel currents; dynamic power dissipation - short circuit power, switching power, gliching power; degrees of freedom, energy delay product, power delay product.

Supply voltage scaling approaches
Technology Level - feature size scaling, threshold voltage scaling; logic level - gate sizing for voltage scaling; architecture level - parallelism and pipelining; algorithm level - transformations to exploit concurrency; dynamic voltage scaling. Switched capacitance minimization approaches: system level - power down, system partitioning;

Algorithm level
Concurrency, locality, regularity, data representation; architecture level - concurrency, signal correlation; logic level - gate sizing, logic styles; layout level - layout optimization; technology level - advanced packaging, SOI.

Leakage power minimization techniques:
Threshold voltage scaling: MTCMOS, VTCMOS and Multiple-Vt CMOS circuits.

Textbook
1. Ajit Pal, Low-Power VLSI Circuits and Systems‖, Springer, 2015

Reference books
1. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers,2002.
2. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-India,2011.

ADVANCED COMPUTER ARCHITECTURE AND RISC-V PROCESSOR DESIGN

Course Code: **EC40008**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
This course focuses on instruction pipeline and their hazards, branching, pipeline scheduling mechanisms, cache memory organization and mapping techniques and also teaches about RISC-V Architecture and instruction formats and Brief overview to ARM.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Interpret the performance of a processor based on metrics such as execution time, cycles per instruction (CPI), Instruction count etc
CO 2: Explain instruction pipeline and pipeline hazards
CO 3: Analyze pipeline scheduling and different scheduling mechanisms.
CO 4: Apply the concept of memory hierarchy for efficient memory design
CO 5: Discuss the RISC V instruction sets and addressing modes used in RISC -V processors.
CO 6: Evaluate RISC -V processor instructions and their usage.

COURSE DETAILS

Introduction
Review of basic computer architecture, RISC vs CISC, Performance evaluation methods, Introduction RISC pipeline, Instruction pipeline and performance.

Instruction Pipeline Principles
Pipeline hazards, Pipeline hazard control and branching, MIPS pipeline for multi-cycle operation.

Pipeline scheduling mechanism
Compiler technique, dynamic scheduling, static and dynamic scheduling.

Cache memory and its organization
Cache memory basics, Cache memory mapping replacement algorithms, cache memory optimization.

RISC-V Processor
Introduction to RISC-V Processor, RISC -V instruction format and RIC-V Instruction sets, RISC-V Addressing Modes and Synchronization, Overview of a basic RISC Processor- ARM.

Textbooks
1. J.L.Hennessy, D.A.Patterson, Computer Architecture: a quantitative approach, Morgan Kaufmann, 5th edition, 2011, ISBN: 978-1558605961.
2. David A. Patterson & John L. Hennessy, Computer Organization and Design RISC-V Edition, Elsevier, 2nd Edition, 2020

Reference books
1. Bernard Goossens, Guide to Computer Processor Architecture, springer, 1st edition, 2023
2. Sivarama P. Dandamudi, Guide to RISC Processors for Programmers and Engineers, 1st Edition, 2005
3. Sarah L. Harris & David Harris, Digital Design and Computer Architecture- RISC-V Edition, Morgan Kaufmann, 2012, ISBN: 9780123978165
3. Daniel Page, A Practical Introduction to Computer Architecture, Springer London, 1st edition 2009
4. William Stallings, Computer Organization and Architecture, Prentice Hall, 10th edition, 2015, ISBN-10: 013293633X, ISBN-13: 978-0132936330

BIOMEDICAL SIGNAL PROCESSING

Course Code: **EC40009**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
Biomedical signals are acquired from a medical or biological source which can be at the cell level, molecular level, or organ level. Several biomedical signals are generally employed in the research laboratory, and hospitals. The aim this course covers the application of signal processing and stochastic methods to detect or diagnosis of disease or physiological states in the human body.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appraise various techniques for acquiring bio-medical signals.
CO 2: Investigate and interpret bio-medical signal characteristics.
CO 3: Apply signal processing techniques for noise reduction and artefact removal.
CO 4: Demonstrate skills in analyzing bio-medical signals using time-frequency analysis.
CO 5: Implement appropriate signal processing algorithms for disease diagnosis.
CO 6: Evaluate feature extraction and feature selection techniques to identify abnormal patterns.

COURSE DETAILS

Introduction to Biomedical Signals

Generation of Bio-signals, Sources of bio-signals, Bio electric potential/ action potential, Types of bio-signals (ECG, EEG, EMG, EOG), Study of diagnostically significant bio-signal parameters, Acquisition of bio-signals (signal conditioning).

Filtering Techniques

Classification of signals and noise, Digital filtering, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications. Biomedical signal processing by Fourier analysis, wavelet (time-frequency) analysis.

Analysis of Bio-signals

Cardiological signal processing: Basic Electrocardiography, ECG data acquisition, Power spectrum of the ECG, filtering techniques, Template matching, QRS detection algorithm, Estimation of R-R Interval, Real-time ECG processing**.**

Neurological signal processing: The brain and its potentials, origin of brain waves, EEG signal and its characteristics (EEG rhythms, waves, and transients), Detection of EEG rhythms, spike and wave detection. Analysis of EMG signal and PCG Signal. Deep learning for bio-signal analysis**.**

Applications of BSP

Analysis of chaotic signals Application areas of BSP: Multi-resolution analysis (MRA) and wavelets, Principal component analysis (PCA), Independent component analysis (ICA), Adaptive segmentation of ECG and PCG signals, Time varying analysis of heart rate variability, Detection of Coronary Artery Disease , Analysis of Ectopic ECG beats. Pattern classification on biomedical signal analysis.

Textbooks

1. Rangaraj M. Rangayyan, Biomedical Signal Analysis, IEEE Press, 2001.Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019.
2. W. J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall, 1993.

Reference books

1. Eugene N Bruce, Biomedical Signal Processing and Signal Modeling, John Wiley & Son's publication, 2001.
2. Myer Kutz, Biomedical Engineering and Design Handbook, Volume I, McGraw Hill, 2009.
3. D C Reddy, Biomedical Signal Processing, McGraw Hill, 2005.
4. A V Oppenheim & R W Schafer, Discrete-time Digital Signal Processing, 2009, 3rd edition, Prentice-Hall

MASSIVE MIMO TECHNOLOGY

Course Code: **EC40010**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The course is intended to make the research students understand the massive MIMO system, Principle and working of massive MIMO system, means and modes of communication. They will able to analyze the Principle and working of different massive MIMO network scenarios and application to Millimeter wave communication. Also they will able to comprehend and analyze the power control in massive MIMO system and its applications for small cells and device to device communications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Compare and contrast the concepts of MIMO and massive MIMO techniques.

CO 2: Analyze and optimize the performance of massive MIMO for capacity and SNR improvement of various Network Scenarios.
CO 3: Apply and analyze the Massive MIMO Aided millimeter communication Technology
CO 4: Analayze the power control in massive MIMO system.
CO 5: Discuss case studies on massive MIMO applications.
CO 6: Apply MIMO and Massive MIMO techniques for real world scenarios and applications.

Introduction

Evolution of cellular systems from 1G to 4G and the principles underlying different generations, Engineering requirements and application scenarios for 5G, Role of massive MIMO as a key 5G solution, Characteristics and benefits of massive MIMO systems, signal and channel models, Difference between traditional MIMO and Massive MIMO.

Massive MIMO Technology

Main Application Scenarios: Homogeneous Network Scenarios, Heterogeneous Network Scenarios,Physical Layer Technology, Recorders and detectors in multi cell environments, Networking Technology, Scheduling

Massive MIMO Aided millimeter communication Technology

Back ground, deployment of Millimeter Wave Communication, Physical Layer Challenges and solutions, CSI acquisition and beam forming schemes.MAC and Networking Design

Power control in massive MIMO systems

Single cell, multiple cells, max-min fairness; Propagation channels: Conditions for favorable propagation, independent Rayleigh fading, uniformly random line-of-sight channels;

Case studies

Examples of single and multiple cell deployment; Recent research results: Pilot Decontamination, Effects of hardware impairments, Massive MIMO with FDD operation, Cell-free Massive MIMO;

Other potential 5G technologies such as device to device communications and applicability of massive MIMO to small cells.

Textbooks

1. T. L. Marzetta, E. G. Larsson, H. Yang, and H. Q. Ngo, *Fundamentals of Massive MIMO*, Cambridge University Press, 2016
2. Long Zhao, Hui Zhao, Kan Zheng, Wei Xiang ,Massive MIMO in 5G Networks: Selected Applications, Springer,2018

References books

1. R. S. Kshetrimayum, *Fundamentals of MIMO Wireless Communications*, Cambridge University Press, 2017.
2. W. Xiang, K. Zheng, and X. Xuemin, *5G Mobile communications*, Springer, 2017
3. J. Rodriguez, *Fundamentals of 5G Mobile Networks*, John Wiley & Sons, 2015
4. H. Yang and T. S. Quek, *Massive MIMO meets Small Cell: Backhaul and Cooperation*, Springer, 2016.

RF CMOS VLSI

Course Code: **EC40014**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course introduces the design parameters of integrated radio front-end circuits for given specifications. The course imparts knowledge on RF modulation,RF CMOS circuit design and testing.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Evaluate the performance parameters of RF and wireless systems
CO 2: Analyze performance issues and trade-offs based on a knowledge of different passive and active devices.
CO 3: Select appropriate modulation technique for a specified RF circuit implementation.
CO 4: Investigate and select device topology for specified RF circuit implementation.
CO 5: Examine the operation and parameters of basic functional blocks of RF systems.
CO 6: Analyze different designs of PLLs for RF circuit applications.

COURSE DETAILS

Introduction to RF & Wireless Technology

Complexity, design and applications. Choice of Technology. Basic concepts in RF Design: Nonlinearly and Time Variance, intersymbol Interference, random processes and Noise. Definitions of sensitivity and dynamic range, conversion Gains and Distortion.

Passive and Active Devices

Passive devices: monolithic capacitors, resistors, inductors, RLC networks, transmission lines, lumped and distributed resonators, impedance matching networks, transformers, and baluns. Active devices: MOSFET operations (in both long channel and deep submicron regimes), practical limitations, and other various silicon transistors and technologies (Si/SiGe Bipolar, SOI, etc.).

Analog & Digital Modulation for RF Circuits

Comparison of various techniques for power efficiency. Coherent and Non coherent defection. Mobile RF Communication systems and basics of Multiple Access techniques. Receiver and Transmitter Architectures and Testing Heterodyne, Homodyne, Image-reject, Direct-IF and sub-sampled receivers. Direct Conversion and two steps transmitters

RF Device Modeling

BJT and MOSFET behavior at RF frequencies. Modeling of the transistors and SPICE models. Noise performance and limitation of devices. Integrated Parasitic elements at high frequencies and their monolithic implementation.

Basic Blocks in RF Systems

Low Noise Amplifiers design in various technologies, Design of Mixers at GHz frequency range. Various Mixers, their working and implementations, Oscillators: Basic topologies VCO and definition of phase noise. Noise-Power trade-off. Resonator less VCO design.

VLSI Implementations of RF Systems

Quadrature and single-sideband generators, Radio Frequency Synthesizes: PLLS, Various RF synthesizer architectures and frequency dividers, Power Amplifiers design. Linearisation techniques, Design issues in integrated RF filters.

Textbook

1. B.Razavi, RF Microelectronics, 2nd edition,Prentice-Hall PTR,
2. T.H.Lee, The Design of CMOS Radio-Frequency Integrated Circuits, Cambridge University Press,2nd Edition,2003

Reference books

1. Frank Gustrau, RF and Microwave Engineering: Fundamentals of Wireless Communications,Wiley
2. Reinhold Ludwig, RF Circuit Design Theory And Application,2nd Edition, Pearson Education,2000
3. Valeria Teppati,Andrea Ferrero, Mohamed Sayed, Modern RF and Microwave Measurement Techniques, Cambridge Univ. Press,2013

5G SUPPORTIVE TECHNOLOGIES

Course Code: **EC40015**
Credit: **3**
L-T-P : **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVES

This course provides the comprehensive overview of the of the 5G supportive Technologies. The key supportive technologies like D2D, mm-wave communications, massive MIMO, wireless network coding, interference management and spectrum utilization issues are emphasized. Various 5G application domains such as automotive, building, energy and manufacturing economic sectors are addressed. The relationship between IoT, machine type communications, and cyber-physical systems under 5G standard are include. Glimps for future e6G communication is also provided with it's base technologies.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend and Analyze the 5G Concept and Architecture.
CO 2: Comprehend and analyze the concept behind Machine to Machine and Device to Device based Communication.
CO 3: Comprehend and analyze various 5G radio access technologies for wireless communication.
CO 4: Comprehend and analyze the concept of Massive MIMO technology in the context of 5G Communication.
CO 5: Comprehend and analyze the concept of Interference Management , Mobility Management and Dynamic network reconfiguration in 5G systems.
CO 6: Comprehend and analyze concept of Spectrum ,standard and technologies for 5G and future 6G communication.

COURSE DETAILS

Introduction

Background History, Mobile Communication generations from 1G to 4G, IOT: relation to 5G,5G capacity and Volume, Global Initiatives, Standardization activities

5G System concept and Architecture

5G use cases and requirements, Basic concepts of 5G system, Basics of RAN architecture, High level requirements for 5G architecture, Functional architecture and 5G flexibility, Physical architecture and 5G deployments.

Machine Type Communications (MTC) and Device to Device(D2D) Communication

MTC categorization and requirements, Fundamental Technologies for MTC, Massive MTC, Ultra reliable and Low Latency MTC, Device to Device communication from 4G to 5G,4G LTE D2D, 5G D2D, Radio resource management for Mobile Broad band D2D.

5G Radio Access Technologies

Access design principles for Multi User Communications: Orthogonal Multiple Access Systems, Spread Spectrum Multiple access Systems,Capacity Limits for multiple access systems, Multi carrier with filtering:Filter bank based Multi carrier,Universal Filtered OFDM,Non-Orthogonal Schemes for efficient Multiple Access: Non-Orthogonal Multiple Access(NOMA), Sparse Code Multiple Access (SCMA)

Massive Multiple Input Multiple Output(MIMO) Systems

MIMO in LTE,Single user MIMO,Multi-User MIMO,Capacity of Massive MIMO, Resource allocation and Transceiver Algorithms for Massive MIMO, Fundamentals of base band and RF Implementations in Massive MIMO.

Interference Management and Mobility Management and Dynamic reconfiguration in 5G

Network Deployment Types, Interference Management in 5G, Mobility Management in 5G,Dynamic network reconfiguration in 5G.

Spectrum for 5G

Spectrum for 4G, Spectrum Challenges for 5G,Bandwidth requirements, Spectrum access nodes and sharing scenarios,5G spectrum Technologies, Spectrum ,standard and technologies for future 6G communication.

Textbook:

1. Afif Qsseiran, Jose F Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016

Reference books

1. Jonathan Rodriguez,Fundamentals of 5G mobile networks, WILEY,2015
2. 5G NR the next generation Wireless Access Technology, Academic Press, Second Edition,2020

VLSI SIGNAL PROCESSING

Course Code: **EC40016**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
This subject is designed to represent DSP systems and covers some of the important techniques for designing efficient VLSI architectures for its applications. The subject will also help students to develop high throughput system for real time applications, with an intention to reduce power consumption and chip area.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Interpret DSP Architectures and Algorithms.
CO 2: Apply pipelining and parallel processing to FIR filters for Low Power application
CO 3: Compare different technique of retiming, folding and unfolding of DSP architecture to reduce critical path delay.
CO 4: Appraise systolic array design of DSP architecture.
CO 5: Apply Fast convolution technique for Filtering Application.
CO 6: Analyze different arithmetic architecture for addition, subtraction and multiplications technique applicable to DSP.

COURSE DETAILS

Introduction
Graphical representation of DSP algorithms, Block Diagram, signal flow graph (SFG), data flow graph (DFG) and dependence graph (DG), critical path, loop bound and iteration bound.

Pipelining and Parallel Processing
Introduction, Pipelining and parallel processing of FIR digital filters, Pipelining and Parallel Processing for Low Power.

Retiming, Unfolding and Folding
Retiming techniques; algorithm for unfolding, Folding transformation

Systolic architecture design
Systolic array design methodology, FIR Systolic Arrays, Selection of Scheduling Vectors, 2D Matrix Multiplication Systolic Array Design.

Fast Convolution
Cook-Toom algorithm, modified Cook-Toom algorithm, Winograd algorithm, iterated convolution

Bit level Arithmetic Architectures
Parallel Multipliers- Parallel Multiplication with sign extension (Parallel Carry Ripple Array and Parallel Carry Save Multipliers), Bit Serial Multipliers.

Textbook
1. Keshab K. Parhi, VLSI Digital Signal Processing Systems, Design and Implementation, John Wiley, Indian Reprint, 2007.

Reference books
1. Magdy A. Bayoumi, VLSI Design Methodologies for Digital Signal Processing Architectures , Springer/BSP Books, 2005.
2. S.Y. Kuang, H.J. White house, T. Kailath,VLSI and Modern Signal Processing, Prentice Hall, 1995.
3. U. Meyer, Baese, Digital Signal Processing with Field Programmable Gate Arrays, Springer, Second Edition, 2004.

PLANAR ANTENNAS

Course Code: **EC40017**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of the course is to understand the theory and the design principles of planar antennas for the applications to small devices. The subject focuses to learn the design methods of microstrip antenna, planar monopole antenna, planar antenna arrays, slot antenna, millimeter wave and TeraHertz antennas for the applications to miniaturized devices.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the antenna basics for the design of small planar antennas.
CO 2: Analyze the characteristics and design principles of microstrip antennas for small and low gain antenna applications.
CO 3: Construct the circularly polarized patch antennas and microstrip antenna arrays for small and high gain antenna applications.
CO 4: Design planar slot antennas and planar monopole antennas for the applications to small and omnidirectional antennas.
CO 5: Evaluate the characteristics and design aspects of electrically small antennas.
CO 6: Make use of planar antennas for special applications to wireless access.

COURSE DETAILS

Introduction to Antennas and Planar Antennas

Radiation, Antenna parameters, Basics of antenna array, Different types of planar antennas, Brief description of fabrication process of planar antennas.

Microstrip Patch Antennas-I

Characteristics of microstrip patch antennas, radiation from microstrip antenna, field configurations, different types of feeding techniques. Design equations for rectangular and circular microstrip patches, analysis of microstrip antennas using transmission line model and cavity method. Broadband techniques using stacked patch antennas, proximity-coupled and aperture-coupled microstrip antennas, slot-loaded and slit-loaded microstrip antennas, microstrip antennas with shorted pin, effect of finite ground plane on the performance of microstrip antennas, principle of planar fractal antennas.

Microstrip Patch Antennas-II

Methods of generating circular polarization in microstrip antennas using single feed and double feed, methods of generating multiple frequencies using microstrip antennas, miniaturization techniques for microstrip antennas. Design techniques of microstrip antenna arrays with feed network, effect of mutual coupling, microstrip phased array antenna design.

Planar Slot Antennas

Geometry and design of microstrip slot antenna, radiation pattern, CPW-fed slot antennas, design of folded slot antenna, annular slot antenna.

Planar Monopole Antennas

Feeding methods and characteristics of planar triangle monopole, Sierpinski monopole, planar bi-conical monopole antenna and roll monopole antenna.

Electrically Small Antennas

Electrically small antennas and their limitations, planar inverted F antenna (PIFA), PIFA for wireless potable sets, ground-plane effects on PIFA performance, different types of PIFA, multi-frequency PIFA, Printed notch antennas, small fractal antennas, dielectric resonator antennas, small TeraHertz antennas.

Planar Antennas for Special Applications

Planar mobile handset antennas, planar laptop computer antennas, planar antennas for USB modem, planar antennas for WLAN and UWB communication.

Textbooks

1. R. Garg, P. Bhartia, I. Bahl and A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, 1st Ed., 2001.
2. Z. N. Chen & M. Y. W. Chia, Broadband Planar Antennas-Design & Applications, John Wiley & Sons, 1st Ed., 2006.

Reference book

1. K-L. Wong, Compact and Broadband Microstrip Antennas, John Wiley & Sons, 1st Ed., 2002.

SMART ANTENNAS

Course Code: **EC40018**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course focuses on advanced topics in design of smart antennas systems, including antenna array principles and smart antenna algorithms such as angle of arrival estimation and antenna beam forming. The course provides the student with the basic principles of smart antenna systems, which is an adaptive antenna array consisting of multiple antennas. Objective is to use intelligent algorithms to calculate the optimal antenna combination to make optimal use of beam forming and antenna array technologies, thereby reaping better benefits.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze linear and circular antenna arrays.
CO 2: Classify adaptive processing for smart antenna using different methods.
CO 3: Solve design problems on smart antenna in presence of mutual coupling between the antennas.
CO 4: Minimize mutual coupling in presence of jammers.
CO 5: Solve design problems on smart antenna by estimating direction of arrival (DOA) of signal.
CO 6. Investigate different types of DOA estimation methods..

COURSE DETAILS

Introduction

Analysis of linear and circular antenna arrays, phased array antenna, Array synthesis methods, Adaptive antennas and smart antennas, adaptive processing using minimum variance distortion less technique.

Direct Data Domain Least Square Approaches to Adaptive Processing

Direct data domain least square procedures, eigenvalue method, forward method, backward method, forward-backward method, main beam construction for prevention of signal cancellation.

Mutual Coupling in Adaptive Smart Antennas

Mutual coupling among an array of dipoles (qualitative), compensation using open-circuit voltages and minimum norm formulation, effect of mutual coupling for constant jammers and constant signals, compensation for mutual coupling for constant jammers and constant signals.

Direction of Arrival (DOA) Estimation and Adaptive Signal Processing for Smart Antennas

Problem formulation, transformation matrix to compensate undesired electromagnetic effects, DOA estimation for a semicircular array, adaptive processing using a single snapshot from a non-uniformly spaced array in presence of mutual coupling and near-field scatterers, DOA estimation using a phased array on a conformal hemispherical surface, DOA estimation using cyclostationarity, Optimization of base station location for indoor wireless communication.

Textbook

1. T. K. Sarkar, M. C. Wicks, M. Salazar-Palma and R. J. Bonneau, Smart Antennas, Wiley-Interscience, 1st Ed., 2003

Reference books

1. Ahmed El-Zooghby, Smart Antenna Engineering, Artech House, 1st Ed., 2005.
2. F. Gross, Smart Antennas for Wireless Communication: With MATLAB, McGraw Hill, 1st Ed., 2005.

SOLAR CELL DEVICE AND MATERIALS TECHNOLOGY

Course Code: **EC40019**

Credits: 3
L-T-P: 3-0-0
Pre-requisites: Nil

COURSE OBJECTIVE
This course is an introductory course on solar photovoltaic materials and devices covering fundamentals of operation of solar cells, physics of semiconducting materials, P-N junction device characteristics in dark and light. We will also discuss various solar photovoltaic technologies and their status with a brief discussion of the fabrication and characterization aspects of the devices. The course will also discuss the simulation aspects of designing and the PV module design basics.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Interpret the basics of Semiconductor Properties and working principle of solar cell.
CO 2: Explain the basic operation of a photovoltaic cell; explain the optical and electrical mechanisms that limit efficiency and methods for improving these limits
CO 3: Design, analyze and simulate basic homojunction and heterojunction photovoltaic cells.
CO 4: Design and analyze different types of photovoltaic solar cells.
CO 5: Apply different fabrication and characterization process involved in thin film solar cell.
CO 6: Estimate the performance metrics of PV modules.

COURSE DETAILS

The Physics of Solar Cell
Review of Semiconductor Physics, Electrons and holes; density of states; drift and diffusion; conductivity; carrier generation and recombination; optical phenomena in solids; carrier generation by photon absorption.

Solar Spectrum and Air Mass Concepts, Semiconductors as basic solar cell material, materials and properties, P – N junction , I-V curves in dark and under illumination and solar cell. Sources of Losses and prevention.

Principles of solar energy conversions, open circuit voltage; short circuit current, maximum power, fill factor, conversion efficiency.

Photovoltaic Technology

a) Silicon Solar cell technologies
Mono- crystalline and poly – crystalline cells, wafer production, Si–wafers, commercial Si solar cells, process flow of commercial Si cell technology, Metal contacts. Monocrystalline materials and design issues;

b) Thin Film Solar Cells
Substrate and Super-state configuration, Thin film module manufacturing, Amorphous Si Solar cell technology.

Principles of homojunction and heterojunction solar cells. Cadmium Telluride Cell Technology, CIGS, CZTS based thin film solar cell. 2D materials for solar cell fabrication.
Strategies for improving solar cell efficiency, light trapping, bandgap engineering, multi-junction concepts.

New Generation Solar Cells
Dye-sensitized solar cells (DSSC), Perovskite solar cells (PSC), Organic photovoltaics (OPV), Nano Materials for Solar Cell

Fabrication and Simulation Methodology
Thin Film Solar Cells, Advantage of thin film, Thin film deposition techniques: Evaporation, Sputtering, Atomic Layer Deposition (ALD), Spin Coating, Doctor Blade, Spray pyrolysis.
Open source software for solar cell modeling: SCAPS-1D, TCAD, WXAMPS

Introduction To PV Module Design
PV Modules: Series Resistance and shunt resistances, optimization, module design basics, interconnection schemes, PV arrays, associated system electronics components.
Life cycle analysis, impact on air, water and soil pollution.

Textbook:
1. Chetan Singh Solanki, Solar Photovoltaics, Fundamentals, Technologies and Applications
Third Eds, PHI, 2015

Reference books
1. U. P. Singh and N. B. Chaure, Recent Advances in Thin Film PV Eds., Springer, 2022
2. A. Luque and S. Hegedus, eds., Handbook of Photovoltaic Science and Engineering, 2nd Edition, John Wiley & Sons, Inc., 2011, ISBN: 978-0-470-72169-8.
3. Gavin J. Conibeer and Arthur Willoughby, eds., Solar Cell Materials: Developing Technologies, John Wiley & Sons, Inc., 2014, ISBN: 978-0-470-06551-8
4. J. Poortmans and V. Arkhipov, eds., Thin Film Solar Cells: Fabrication, Characterization, and Applications, John Wiley & Sons, Ltd., 2006,

INDUSTRIAL AUTOMATION

COURSE CODE: **EL30001**
Credit: **3**
L-T-P : **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
Understand automation technologies and identify advantages, limitations and applications of the same. Selection of proper sensor and its working. Design of controller using different controlling methods. Develop ability to recognize, articulate and solve industrial problems using automation technologies.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand the need of automation in real world and Industry 4.0 challenges
CO 2: Analyze the need of transducer and working of different transducers and actuators
CO 3: Determine the effects of different controllers and design of controllers using analog and digital platform
CO 4: Analyze the different advanced control schemes applied to different industrial processes.
CO 5: Analyze the Architecture of PLC, and design different process control applications through ladder logic.
CO 6: Understand DCS, SCADA hardware and software and its merits/demerits in industrial automation.

COURSE DETAILS

Introduction to Industry 4.0
History of industrial revolutions, Concept of IR4.0, Typical architecture of IR4.0, Design principles and major role players in IR4.0, Advantages and Challenges.

Sensors, Actuators and Signal conditioning
Displacement sensors, Force sensors, Ultrasonic sensors, Temperature sensors, Pressure sensors, Dc motors, Servo motors, Stepper motors, Piezo electric actuators, Pneumatic actuators etc. Estimation of errors and calibration, Filtering, Amplification, Isolation, ADC, DAC, Sensor protection circuits, Signal transmission and noise suppression,

Controller tuning
Need of controller, Effects P, I, D, PI, PD and PID controller, Design of controller parameters using Ziegler-Nichols tuning method, Cohen coon tuning method, Implementation of Analog and Digital PID controller.

Advanced control techniques
Feed forward control, Ratio control, Cascade control, Adaptive control, Duplex or split range control, Override control, Model predictive Control.

Programmable Logic Controller (PLC)
An overview of PLC, Introduction, definitions and history of PLC, Architecture of PLC system,input and output modules, Ladder logic, PLC Programming, Application Examples.

Introduction to Distributed Control System, SCADA
DCS architecture, Functional requirements of Distributed control systems, Communication Protocol, Introduction to SCADA, SCADA system components, architecture and communication, Application examples

Textbooks

1. Krishna Kant, Computer-Based Industrial Control, 2nd edition Prentice Hall of India Ltd.
2. John R. Hackworth, Fredrick D. Hackworth Jr., Programmable Logic Controllers: Programming Methods and Applications, Pearson.

Reference books

1. Surekha Bhanot, Process Control Principles & Applications, OXFORD, 1st Edition
2. Ogata, Modern Control Engineering, 4th edition, Prentice Hall of India
3. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGrawHill, 2009

PROCESS CONTROL AND ROBOTICS

Course Code: **EL40001**
Credits: **3**
L-T-P: **3-0-0**
Prerequisities : **Nil**

COURSE OBJECTIVE
To introduce the fundamental concepts of robotic system and its control that provides opportunity to learn mathematical modeling of kinematics and dynamics of robots and practice controller design for different robotic applications.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Learn and describe brief history, basic elements, different types and applications of robots
CO 2: Understand and explain the kinematics and dynamics associated mathematics of robots
CO 3: Employ and demonstrate basic techniques for computed torque control of robots
CO 4: Analyze stability of control systems employed for robotic applications
CO 5: Apply advanced and intelligent control techniques to formulate suitable control systems for robotics
CO 6: Evaluate and interpret the performance robotics and and associated control systems

COURSE DETAIL

Fundamentals Concepts in Robotics
Basic Elements and Anatomy of Robots, Classification of Commercial Robots, History of Robotics, Design and Control Issues, Applications of Robotics

Kinematics of Robotic System
Basic manipulator Geometries, Robot Kinematics, Homogeneous Transformation, Forward Kinematics, Inverse Kinematics, Manipulator Jacobians

Dynamics of Robotic System
Lagrange-Euler Dynamics, Structure and Properties of the Robot Equation, State-Variable Representations and Feedback Linearization, Cartesian and Other Dynamics, Actuator Dynamics

Basic Control of Robotic System
Basic Control Theory: Linear and Nonlinear State-Variable Systems, Nonlinear Systems and Equilibrium Points, Stability Theory and Lyapunov Theorems, Linear Controller Design

Computed Torque Control, Digital Robot control, Optimal Outer-Loop Design, Cartesian Control

Advanced Control Techniques for Robots
Robust Control: Feedback - Linearization Controllers, Nonlinear Controller, Dynamics Redesigns

Adaptive Control: Adaptive Control by a Computed-Torque Approach, Adaptive Control by an Inertia-Related Approach, Composite Adaptive Controller

Intelligent Control for Robots
Fundamentals of Fuzzy Logic and Neural Networks, Fuzzy Logic Control, Tracking Control Using Static Neural Networks, Tuning Algorithms for Linear-in-the-Parameters NN, Tuning Algorithms for Nonlinear-in-the-Parameters NN

Textbooks

1. Lewis, Frank L., Darren M. Dawson, and Chaouki T. Abdallah, Robot Manipulator Control: Theory and Practice by 2nd Ed., CRC Press, 2003.
2. K. R. Guruprasad, Robotics: Mechanics and Control, PHI Learning Pvt. Ltd. 2019.

Reference books

1. John Craig, Introduction to Robotics: Mechanics and Control, 4th Ed. Pearson, 2017
2. R. K. Mittal and I. J. Nagrath, Robotics and Control, 1st Ed. McGraw Hill Education, 2003

ADVANCED CONTROL SYSTEM

Course Code: **EL40003**
Credits: **3**
L-T-P: **3-0-0**
Pre-requisites: **Nil**

COURSE OBJECTIVE
This course introduces students to developed and advanced techniques for solving complex control problems. The course presents theory and methodology for analysis and modelling of systems and signals, and methods for design and synthesis of feedback controllers. The emphasis of this course will be on robust control and optimal control of dynamical systems.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: Comprehend state variable representation of continuous and discrete time LTI systems.
CO2: Analyze state models for linear continuous time and discrete time systems.
CO3: Apply vector and matrix algebra to find the solution of state equations
CO4: Evaluate controllability and observability conditions of a given system.
CO5: Design control systems using state feedback and pole placement techniques.
CO6: Develop Lyapunov function for the stability analysis of nonlinear systems.

COURSE DETAIL

State Variable Analysis and Design
Introduction, Concept of State, State Variables and State Model, State Models for Linear Continuous – Time Systems,

State Variable Analysis and Design
Diagonalization, Solution of State Equations, Concepts of Controllability and Observability.

Pole Placement Design and State Observers
Introduction, Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design, Design of State Observer.

Non-linear systems Analysis
Introduction, Common Nonlinear System Behaviours, Common Nonlinearities in Control Systems, Fundamentals, Describing Functions of Common Nonlinearities, , Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane.

Non-linear systems Analysis
Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems.

Textbooks
1. I.J. Nagarath and M.Gopal, Control Systems Engineering, New Age 5th Edition, 2007
2. M.Gopal, Digital Control and State Variable Methods: Conventional and Intelligent Control Systems, McGraw Hill 3rd Edition, 2008

Reference books
1. K. Ogata, Discrete Time Control System, 2nd Edition Pearson Education
2. Hasan Khalil, Non linear systems, 3rd Edition PHI

MACHINE LEARNING BASED SIGNAL PROCESSING

Course Code: **EM30007**
Credits: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
Traditionally, signal characterization is performed with mathematically driven transforms and statistical tools. On the other hand, machine learning aims to design algorithms that learn from data. This course discusses the use of machine learning techniques to process and understand signals. This course focuses on, firstly to acquaint students with the representation and characterization of speech, images, and other important signals. Thereafter, designing of ML models for classifying and retrieving information from signals is engrossed. Content delivery will be conceptual oriented and not cover mathematical or optimization methods in detail.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Conceptualize the difference between deterministic and stochastic processes
CO 2: Appreciate various spectral analysis methods
CO 3: Comprehend the methods and underlying challenges in extracting hidden information from various signals
CO 4: Explain clustering methods, fuzzy set, rough set and neural network topology.
CO 5: Explain Neural Network topology and learning algorithms.
CO 6: Apply ML methods for speech, seismic, image analysis and other similar applications.

COURSE DETAILS

Introduction to Various Signals
Audio and Speech Signal, Image Acquisition and Storage, Radar, Sonar & Seismic signals, Signal decomposition using Fourier & Wavelet transforms,

Estimation and Detection
Introduction, Bayesian Hypothesis Testing, Maximum Likelihood Hypothesis, Maximum likelihood estimator, Least Square Estimator, Parametric estimation, Wiener Filter, Kalman Filter, Non-paremetric estimation, Filter Bank Methods.

Spectral Analysis Stochastic Processes

Adaptive Spectral Analysis, Multivariate Signal Processing, Independent Component Analysis, Principal Component Analysis, Markov Process, Gaussian Mixture Model, Linear Prediction Analysis.

Machine Learning

Unsupervised Learning: Clustering Principles, K-Means, Expectation Maximization, GMM Clustering
Basics of Fuzzy Logic and Rough Sets,Fuzzy Clustering, Fuzzy Probabilities
Supervised Neural Network and Ensemble Methods: Perceptron, Multi Layer Perceptron, Stochastic Gradient Descent and Backpropagation algorithm, Deep learning, Linear sequential model using Keras, Transfer learning,

Applications

Selected applications of Machine Learning techniques for speech, image and manifold learning of radar and seismic signals.

Textbooks

1. Francesco Camastra, Alessandro Vinciarelli, Machine Learning for Audio, Image and Video Analysis Theory and Applications, 2nd Edition, 2015, Springer
2. Deepika Ghai, Suman Lata Tripathi, Sobhit Saxena, Manash Chanda, Mamoun Alazab, Machine Learning Algorithms for Signal and Image Processing, 2022, Wiley Online, ISBN:9781119861829.

Reference books

1. Max A. Little, Machine Learning for Signal Processing: Data Science, Algorithms, and Computational Statistics, Oxford University Press
2. Valliappa Lakshmanan, Martin Görner, Ryan Gillard, Practical Machine Learning for Computer Vision, Released July 2021, Publisher(s): O'Reilly Media, Inc., ISBN: 9781098102364

DEEP LEARNING: ALGORITHMS AND IMPLEMENTATION

Course Code: **EM30008**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

In this course, students will learn the fundamental principles, underlying mathematics, and implementation details of deep learning. This includes the concepts and methods used to optimize these highly parameterized models (gradient descent and backpropagation, and more generally computation graphs), the modules that make them up (linear, convolution, and pooling layers, activation functions, etc.), and common neural network architectures (CNN, RNN, etc.). Applications ranging from computer vision to natural language processing and generative models will be demonstrated. Through in-depth programming assignments, students will learn how to implement these fundamental building blocks as well as how to put them together using popular deep learning libraries, Keras & PyTorch.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the functional roles of DNN sequential blocks.

CO 2: Demonstrate skills in selecting deep learning architecture for computer vision tasks.

CO3: Develop critical thinking skills to evaluate and analyze generative models for computer vision applications

CO 4: Appraise and apply transfer learning and the concepts of fine-tuning

CO 5: Implement deep learning techniques on sequential data

CO 6: Design deep learning techniques to perform efficient analysis for real-world applications

COURSE DETAILS

Foundations of Deep Learning
Overview of ANN, Feed forward, MLP, Gradient descent, back propagation algorithm, evolution of DL, Regularization

Convolution Neural Networks
CNN Architectures: Convolution, Pooling Layers, Transfer Learning, GAN, Popular CNN Model Architectures (Imagenet, LeNet architecture, AlexNet, VGGNet, GoogLeNet, ResNet architecture

Recurrent Neural Network
RNN architecture, LSTM, GRU, Encoder Decoder architecture

Applications of Deep Learning
Applications of Deep Learning to Computer Vision: Image segmentation, Object detection, Image Captioning, Medical imaging, Image Classification using Transfer Learning, Applications of Deep Learning to NLP.

Advance Models
Auto-encoders, Generative Adversarial Network

Implementation
Tensor Flow, PyTorch, Comparing TensorFlow & PyTorch, Configuring and Running Jupyter notebooks on an AWS EC2 GPU Instance.

Textbooks
1. Ian J. Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.
2. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019.

Reference books
1. Phil Kim, Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence, Apress, 2017.
2. Ragav Venkatesan, Baoxin Li, Convolutional Neural Networks in Visual Computing, CRC Press, 2018.
3. Navin Kumar Manaswi, Deep Learning with Applications Using Python, Apress, 2018.
4. Francois Chollet, Deep Learning with Python, Manning Publications, 2018

DATA ANALYTICS

Course Code: EM30009
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE
Objective of this course is to familiarize students with the concepts of data science, gain knowledge on Big data technologies and tools, become familiar with statistical concepts and apply data analytics techniques.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Make use of data science concepts to handle big data.
CO 2: Examine the statistical concepts for finding relationships among variables and estimate data samplings.
CO 3: Select the data analytics techniques&models for both data prediction and performance analysis.
CO 4: Develop rules using frequent item sets and association mining.
CO 5: Solve real-time problems using classification and clustering techniques.
CO 6: Apply the mining techniques for data streams.

COURSE DETAILS

Introduction to Data Science
Introduction to data, Data science, Challenges of traditional systems, Evolution of analytic ccalability, Types of computing (Distributed, Parallel, Grid), Data analytics life-cycle, Introduction to Big Data (Characteristics) and Hadoop (Hadoop Ecosystem, MapReduce, Hbase, Pig, Hive, Sqoop, NOSQL), Visualizations

Statistical Concepts
Data exploration: Distribution of a single variable, Basic concepts (populations and samples, Data sets, variables, and observations, types of data), Descriptive measures for categorical variables, Descriptive measures for numerical variables, Outliers and missing values. Finding relationships among variables: Categorical variables, Numerical variables, Sampling and distributions: Terminology, Estimation, Confidence interval estimation, Sampling distributions, Confidence interval, Hypothesis testing, Chi-square test for independence

Data Analytic
Introduction, Types of data analytic, Importance of data analytics, Data analytics applications, Regression modelling techniques: Linear regression, Multi-variable regression, Non linear regression, Logistic regression, Time series analysis, Performance analysis (RMSE, MAPE).

Frequent Item-sets and Association
Introduction to frequent itemsets, Market-basket model, Algorithm for finding frequent, Itemsets, Association rule mining, Apriori algorithm and correlations.

Classification & Clustering
Introduction to classification and clustering, Distance-based algorithms: K-Nearest Neighbour (KNN), Decision Tree-based algorithms: Decision Tree (ID3 Algorithm), Linear Support Vector Machines, Naves Bayes. Overview of clustering techniques, Hierarchical clustering, Partitioning methods, K- means algorithm.

Data Streams
Introduction to mining data streams, Data stream management systems, Data stream mining, Examples of data stream applications, Stream queries, Issues in data stream query, Processing, Sampling in data streams, Filtering streams, Counting distinct elements in a stream, Estimating moments.

Textbook

1. Radha Shankarmani, M.Vijayalaxmi, Data Analytics, Wiley India Private Limited, ISBN: 9788126560639.

Reference books

1. S. Christian Albright and Wayne L. Winston, Business Analytics: Data Analysis & Decision Making . 6th Edition, Cengage Learning. (ISBN: 9781305947542)
2. Jiawei Han, Micheline Kamber, and Jian Pei, Data Mining: Concepts and Techniques 3rd Edition. Morgan Kaufmann. (ISBN: 9780123814791)
3. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (Editor), Wiley, 2014
4. DT Editorial Services, Big Data, Black Book, Dreamtech Press, 2015

DATA MINING

Course Code: **EM30011**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **NIL**

COURSE OBJECTIVE
This course is an introductory course on data mining. It introduces the basic concepts, principles,methods, implementation techniques, and applications of data mining, with a focus on two major data mining functions: (1) pattern discovery and (2) cluster analysis.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Articulate the role of data mining in decision-making
CO 2: Perform data processing and analysis.
CO 3: Recall important pattern discovery concepts, methods, and applications, such as frequent pattern, and association rules
CO 4: Recall basic concepts, methods, and applications of cluster analysis.
CO 5: Evaluate the output of data mining for decisions and practical application
CO 6: Demonstrate the benefits of data mining from business perspective.

COURSE DETAILS

Introduction
What is data mining? Why data mining? Data mining process, Introduction to data mining tasks (Classification, Clustering, Association Analysis,Anomaly Detection).

Data Pre-processing
Understanding of data, Types of attributes, Properties of attribute values, Types of data, Data quality, Sampling, Data normalization, Data cleaning, Similarity measures, Feature selection/Instance selection, Importance of feature selection/ instance selection in various big data scenarios

Classification
Decision-Tree based approach (e.g. C4.5), Rule-based approach (e.g. Ripper), Instance-based classifiers (e.g. k-Nearest Neighbor). Support Vector Machines (SVMs), Ensemble learning, Classification model Selection and evaluation, Applications: B2B customer buying stage prediction, Recommender systems

Clustering
Partition and hierarchical clustering methods, Graph-based method, Density-based methods, Cluster validation applications: Customer profiling, Market segmentation.

Association Analysis
Apriori algorithm and its extensions, Association pattern evaluation, Sequential patterns and frequent sub-graph mining, Applications: B2B customer buying path analysis, Medical informatics, Telecommunication alarm diagnosis.

Anomaly Detection
Statistical-based and density-based methods, Ethics of data mining, Privacy in data mining

Case Studies
Big data analytics in mobile environments, Fraud detection and prevention with data mining techniques, Big data analytics in business environments

Textbook
1. Han, J., Kamber, M., & Pei, J., Data mining: Concepts and techniques, 3rd ed., Waltham: Morgan Kaufmann

Reference books
1. Foster Provost and Tom Fawcett, O'REILLY, Data Science for Business, ISBN: 978-1-449-36132-7, 2013
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Addison Wesley, ISBN: 0-321-32136-7

ML FOR LANGUAGE PROCESSING

Course Code: EM40001
Credit : 3
L-T-P: 3-0-0
Prerequisites : EM30007

COURSE OBJECTIVE
- To understand the steps involved in Natural language processing
- To learn about the lexical, syntactic and semantic analysis of natural language processing

- To explore the various parsing techniques for natural languages
- To understand the statistical models for Natural language processing
- To learn about the various applications involved in Natural language processing

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Evaluate different computing architectures for natural language processing for various parameters
CO 2: Justify the various steps necessary for processing natural language
CO 3: Suggest appropriate lexical and parsing techniques for a given natural language
CO 4: Apply appropriate statistical models for a given natural language application
CO 5: Modify existing algorithms to suit any natural language for processing
CO 6: Suggest appropriate pre-processing steps essential for the various applications involving natural languageprocessing

COURSE DETAIL

Lexical Analysis
Lexical Analysis, Regular expression and Automata for string matching, Words and Word Forms, Morphology fundamentals, Morphological Diversity of Indian Languages, Morphology Paradigms, Finite State Machine, Transducers Based Morphology, Automatic Morphology Learning, Parts of Speech, N-gram Models, Hidden Markov Models.

Speech Processing
Biology of Speech Processing, Place and Manner of Articulation, Word Boundary Detection, Argmax based computations, HMM and Speech Recognition, Text to Speech Synthesis, Rule based, Concatenative based approach.

Parsing
Theories of Parsing, Parsing Algorithms, Earley Parser, CYK Parser, Probabilistic Parsing, CYK, Resolving attachment and structural ambiguity, Shallow Parsing, Dependency Parsing, Named Entity Recognition, Maximum Entropy Models, Conditional Random Fields.

Lexical Knowledge Networks
Meaning: Lexical Knowledge Networks, Wordnet Theory, Indian Language Wordnets and Multilingual Dictionaries, Semantic Roles, Word Sense Disambiguation, WSD and Multilinguality, Metaphors, Coreference and Anaphora Resolution.

Applications
Applications: Sentiment Analysis, Text Entailment, Machine Translation, Question Answering System, Information Retrieval, Information Extraction Cross Lingual Information Retrieval (CLIR).

Textbook
1. Christopher Manning, Schutze Heinrich, Foundations of Statistical Natural Language Processing, MITPress, 1999.

Reference book
1. Allen James, Natural Language Understanding, Second Edition, Benjamin Cumming, 1995.

CYBERSECURITY

Course Code: **EM40006**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
This course aims to provide a comprehensive introduction and effective defence to distinct challenges like; securing the infrastructure, securing devices, and securing local networks.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand what cybercrime is and appreciate the importance of legal perspective on cybercrime and organizational implications
CO 2: Explain types of cyberattacks, role of cybercafes and what is cyberstalking
CO 3: Understand the security challenges in mobile devices, removable medias, and organizational measures needed to protect information systems.
CO 4: Describe tools ans methods used in cybercrime
CO 5: Learn about phishing-pharming-phoraging and different types of ID thefts
CO 6: Understand global and Indian IT Act in cybercrime perspective

COURSE DETAILS

Introduction of Cybersecurity
Cybercrime, Classifications, Legal perspectives, Ethics of Hacking and Cracking

Cyber offenses
Active and Passive Attacks, Cyberstalking, Botnets, Benefits of Cloud Computing

Vulnerbility
Autthentication Security and Attacks on Mobile Devices, Email Attacks and Browser based vulnerabilities, Server Vulnerability,TCP/IP Vulnerability, Incident handling, Organizational Security Policy

Tools and Methods Used in Cybercrime
Proxy Servers, Phishing, Spoofing, Encryption & Password Cracking, Session Hijacking, Hacking Network Devices, Trojan Horses, Malware in Action

Prevention and Mitigation
Buffer overflow detection and Prevention, Organizational Security Policies, Digital Forensic tools, , Incident Handling

Social, Political, Ethical and Physiological Dimensions
Intellectual property in Cyberspace, Ethical Dimensions, Legal Perspective, Information Technology Act

Textbook
1. Nina Godbole, Sunit Belapure, Kamlesh Bajaj, Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives Paperback – January 1, 2011, Wiley India

2. Alfred Basta, Cyber Security And Cyber Laws, Cengage Learning India Pvt Ltd

Reference books
1. Yuri Diogenes and Dr. Erdal Ozkaya, Cybersecurity – Attack and Defense Strategies: Counter modern threats and employ state-of-the-art tools and techniques to protect your organization against cybercriminals.

2. Ashish Mishra, Modern Cybersecurity Strategies for Enterprises: Protect and Secure Your Enterprise Networks, Digital Business Assets, and Endpoint Security with Tested and Proven Methods

BIOINFORMATICS

Course Code: **EM40008**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
Bioinformatics is a rapidly evolving interdisciplinary field in which computational resources are necessary to investigate and interpret complex biological data. The students will gain the basic knowledge of sources of sequences and protein

structure data, an understanding of the relevance and importance of this data, and some exposure to basic algorithms used for processing this data.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand fundamental concepts and application of Bioinformatics
CO 2: Have an overview of the most important methods and tools that are used
CO 3: Understand how some of the basic methods for biological sequence analysis works
CO 4: Understand the need for methods to be accurate and efficient
CO 5: Implement some of the algorithms
CO 6: Using existing tools to perform simple sequence analyses

COURSE DETAILS

Introduction to Bioinformatics
Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles

Sequence Alignment and Database Searching
Introduction, Evolutionary Basis of Sequence Alignment, Optimal alignment method, Statistical Significance of Alignment. Database searching Artifacts; Database similarity searching: FASTA, BLAST, Various basic and advance version, Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts).

Introduction to Genes and Proteins
Genome Sequences, ORFs, Genes, Introns, Exons, Splice Variants, DNA/RNA Secondary Structure Triplet Coding, Protein Sequences, Protein Structure: Secondary, Tertiary, Quaternary, The notion of Homology. Scoring matrices: Basic concept of a scoring matrix, Similarity and distance matrix, Predictive Method using Nucleotide Sequence: Introduction, Marking repetitive DNA, Database search, Codon bias detection, detecting functional site in DNA.

Phylogenetics
Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis.

Machine learning for Bioinformatics
Unsupervised learning, K-means clustering, Hierarchical clustering, Heatmap representations. Dimensionality reduction, Principal Component Analysis (PCA). Hands-on session with unsupervised learning analysis of cancer cells further highlighting practical considerations and best practices for the analysis and visualization of high dimensional datasets.

Textbooks
1. A. M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2022

Reference books
1. T. K. Attwood & D. J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Ltd, Low Price Edition, 2001.
2. D.W. Mount, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, 2001.
3. D. Baxevanis and F. Oulette, Bioinformatics : A practical guide to the analysis of genes and proteins, Wiley Indian Edition, 2002.
4. M.D.B. Bergeron, Bioinformatics Computing, Prentice Hall India (Economy Edition), 2003.

OPTIMIZATION METHODS IN MACHINE LEARNING

Course Code: **EM40010**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course introduces students to the fundamental concepts, techniques, and algorithms in optimization for machine learning. Students will learn how optimization plays a crucial role in the design and analysis of machine learning models. The course will cover a broad range of optimization methods, with a focus on understanding their theoretical properties and practical implementation.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the foundational concepts of optimization and their importance in the context of machine learning, including the role of loss functions, performance metrics, and optimization problems.

CO 2: Analyze and implement a variety of optimization techniques, including gradient descent and its variants, adaptive learning rate methods, second-order optimization methods, and metaheuristic optimization algorithms.

CO 3: Apply regularization techniques to prevent over fitting and improve the generalization performance of machine learning models.

CO 4: Design and implement optimization algorithms for deep learning models, including proper initialization, back propagation, and fine-tuning strategies.

CO 5: Employ model selection and hyperparameters optimization techniques to enhance the performance of machine learning models on real-world tasks.

CO 6: Utilize distributed and parallel optimization algorithms to scale up optimization processes for large-scale machine learning applications.

COURSE DETAILS

Introduction to Optimization and Machine Learning/Deep Learning

Introduction to optimization, Machine learning basics, The role of optimization in machine learning, Loss functions and performance metrics, Deep learning basics, Back propagation algorithm, Initialization techniques, Transfer learning and fine-tuning

Convex and Non Convex Optimization Techniques

Convex sets and functions, Convex optimization problems, First-order and second-order optimality conditions, Introduction to gradient descent ,Batch gradient descent, Stochastic gradient descent (SGD), Mini-batch gradient descent, Momentum and Nesterov accelerated gradient (NAG) , Adagrad, RMSprop, Adam and its variants, Learning rate scheduling, Early stopping, Dropout, Cross-validation techniques, Grid search, Random search, Bayesian optimization

Second-Order Optimization Methods

Newton's method, Quasi-Newton methods (BFGS, L-BFGS), Conjugate gradient method,

Non -Convex Optimization Techniques

Local and global minima, Saddle points and plateaus, Strategies for escaping saddle points,

Constrained Optimization

L1 and L2 regularization, Elastic net regularization, Equality and inequality constraints, Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions Sequential quadratic programming (SQP)

Metaheuristic Optimization Algorithms

Genetic algorithms, Simulated annealing, Particle swarm optimization, Ant colony optimization

Multi-objective Optimization

Pareto optimality, Scalarization methods, Evolutionary multi-objective optimization algorithms (NSGA-II, MOEA/D)

Distributed and Parallel Optimization

Data and model parallelism, Synchronous and asynchronous updates, Distributed optimization algorithms (ADMM, Federated Learning)

Textbooks

1. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press. (Link: https://www.deeplearningbook.org/)
2. Deb, Kalyanmoy. Optimization for engineering design: Algorithms and examples. PHI Learning Pvt. Ltd., 2012.

Reference books

1. Boyd, S., & Vandenberghe, L. Convex Optimization. Cambridge University Press. (Link: https://web.stanford.edu/~boyd/cvxbook/)
2. K. Deb.- Multi-Objective Optimization Using Evolutionary Algorithms— (Chichester, U.K.: Wiley, 2001
3. Ruder, S. , An Overview of Gradient Descent Optimization Algorithms. arXiv preprint arXiv:1609.04747. (Link: https://arxiv.org/abs/1609.04747)
4. Sra, S., Nowozin, S., & Wright, S. J. (Eds.). Optimization for Machine Learning. MIT Press.

5. Nocedal, J., & Wright, S., Numerical Optimization. Springer Science & Business Media.

MICROFABRICATION

Course Code: **EV20001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE:
The basic objective of the course is to enable the students to get a fair idea of VLSI fabrication steps and latest happenings around different unit processes like clean room environment, crystal growth, oxidation and its types, diffusion and its shortcoming that leads to ion implantation, deposition techniques, etching process and VLSI interconnect via realization using metallization step.

COURSE OUTCOMES:
After successfully completing the course, the students will be able to

CO1: to be aware about the trends in semiconductor technology in clean room environment
CO2: to understand the process of Silicon crystal growth and wafer preparation
CO3: to grasp the idea of different oxidation and lithography process
CO4: to understand basic diffusion and ion implantation techniques
CO5: to understand the various steps involved during process of deposition and etching during IC manufacturing
CO6: to comprehend etching and metalization process for chip fabrication

COURSE DETAILS

Introduction
Brief History of Semiconductor technology, Scaling Trends and Scaling Methodologies, Scaling Challenges, ITRS Roadmap. Electronic Materials: Crystal Structures, Defects in Crystals, Si Crystal Growth, Czochralski and Float Zone crystal growth, GaAs growth Clean room and Wafer Cleaning: Definition, Need of Clean Room, types of cleaning , standard RCA cleaning of Si.

Oxidation and Photo lithography
Silicon oxidation methods and properties: dry and wet, Kinetics of Oxidation, Oxidation Rate Constants, Dopant Redistribution, Oxide Charges, Photo-lithography: pattern transfer techniques, Radiation Sources, Masks, photoresist, Introduction to Advanced Lithography: E-beam Lithography, X-ray Lithography, Ion Beam Lithography.

Diffusion and Ion implantation
Types of diffusion, Pre-Deposition and Drive-in Diffusion Modeling, Dose, 2-Step Diffusions, Successive Diffusion, Lateral Diffusion, stopping mechanisms, Junction Depth, Irvin's Curves, Diffusion System. Ion Implantation: Problems in Thermal Diffusion, Advantages of Ion Implantation, Ion Implantation System, Mask, Energy Loss Mechanisms, Depth Profile, Range & Straggle, Lateral Straggle, Dose,, Ion Implantation Damage and Annealing

Deposition,Etching and Metalization
Deposition requirements and techniques :Physical Vapor Deposition: Thermal evaporation,Electron beam evaporation, Sputtering Chemical Vapor Deposition,Different types of CVD techniques: APCVD, LPCVD, Metalorganic CVD (MOCVD), Plasma Enhanced CVD,Anisotropy, Selectivity, Wet Etching, Plasma Etching, Reactive Ion Etching,Metallization: Overview of Copper and Aluminum interconnects,Contacts, Metal gate/Poly Gate, Electromigration,Metal Silicides, Multi-Level Metallization

Text Book:
1. Gary. S. May and S. M. Sze, "Fundamentals of semiconductor fabrication", Wiley India,2004 Edition.

Reference Books:

1. Silicon VLSI Technology, Plummer, Deal and Griffin ,1st Edition, Pearson Education,2009
2. Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology – Volume II", CRC Press, Third Edition, 2011.

DIGITAL VLSI CIRCUITS

Course Code: EV20002
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE:

In this course on Digital VLSI Circuits, students will delve into the intricate realm of Very Large Scale Integration with a focus on digital design. The primary objective is to equip participants with the knowledge and skills necessary to understand, design, and implement complex digital systems on integrated circuits. Through a combination of theoretical lectures and demonstration through simulation, students will gain a comprehensive understanding of CMOS logic families, transistor-level design, layout methodologies, CMOS combinational and sequential circuits, high performance CMOS logic, semiconductor memories used in modern VLSI design.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Recall the key concepts and principles of digital VLSI circuit design, including CMOS logic families, transistor-level design, and layout methodologies,
CO 2: Interpret the behavior and characteristics of MOS transistor by analyzing threshold voltage, current and impact of scaling,
CO 3: Apply knowledge to analyze the different MOS inverter architecture in terms of performance metrics such as speed, power and area,
CO 4: Evaluate the performance of digital VLSI circuits through transistor sizing, parasitic capacitances and delay.
CO 5: Design and implement high performance digital VLSI circuits to meet specified requirements, integrating advanced techniques such as pipelining, area reduction, and power optimization for efficient and reliable operation
CO 6: Critique the trade-offs involved in different design choices for semiconductor memories.

COURSE DETAILS

Introduction to VLSI Design flow

Overview and Introduction to VLSI design, Moore's Law.VLSI Design flow,Y-chart, Design hierarchy, concept of regularity, modularity and locality.VLSI Design style: Full custom and semi-custom design style (standard cell and gate array based design), Field programmable devices: FPGA architecture.

Physics of MOSFET

Two terminal MOS Structure, concept of band diagram of two terminal MOS structure. Qualitative description of accumulation, depletion and inversion condition. Concept of flat band voltage. Threshold voltage and its components. Substrate bias effect.Estimation of drain current, Channel length modulation, MOSFET scaling and overview of short geometry effects.

MOS Inverters:

Introduction to MOS inverter, concept of voltage transfer characteristics (VTC) curve, qualitative analysis of MOS inverters with passive and active load, CMOS inverter: structure and operation, switching threshold voltage of inverter, symmetrical CMOS inverter design.

Transient Analysis of MOS Inverters:

Qualitative description of different components of parasitic load capacitances. Definition of delay times (rise time, fall time, 50% delay time), Power dissipation in CMOS circuits, dynamic, short circuit and leakage power dissipation and its analysis.

Combinational Logic Circuits

CMOS combinational circuits. Properties of CMOS combinational circuits. Basic structure of CMOS logic cells. 2 input NAND circuit. 2 input NOR circuit. Transistor size definition. Drive strength and logic effort. Delay of scaled cell. Estimation of logic effort. Complex CMOS logic design, Layout and design rules overview, stick diagram with examples.

Sequential Logic Circuits
Main structure of RS-latch. Clocked latch. D latch. JK flip-flops (FFs). T FF. T and D FFs built on JK FF. Racing in FFs. Edge clocking. Master-slave (MS) RS latch. MS D latch. CMOS FF.

Dynamic CMOS and Pass Transistor based Logic
Pre-charge evaluate logic, cascading and charge sharing problems and solutions, DOMINO, NORA logic. NMOS and PMOS as pass gate, pass transistor based logic design examples, CMOS transmission gate based logic design.

Semiconductor Memories
Random access memories (RAM). Static memories (SRAM 6T static memory cell),DRAM (1T and 2T) overview of (ROM,EPROM),Flash memory programming.

Text Book:

1. CMOS Digital Integrated Circuits Analysis & Design by Sung-Mo Kang, Yusuf Leblebici, Chul Woo, Kim,4th Edition, McGraw Hill, 2014

2. CMOS VLSI Design: A Circuits and Systems Perspective by Neil Weste, David Harris, 4th edition, Pearson, 2010.

Reference books:

1. Jan M.. Rabaey, Chandrakasan, A. P., & Nikolić, B. (2003). Digital integrated circuits: a design perspective. Pearson Education, Incorporated..

DIGITAL LOGIC DESIGN WITH VERILOG

Course Code: **EV20004**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **EC10001**

COURSE OBJECTIVE:
This course imparts in designing digital circuits and abstracting their behavior using Verilog HDL. It also emphasizes on RTL modeling of digital circuits, verifying these Models and synthesizing RTL models to standard cell libraries and FPGAs. This course aims to provide students with the understanding of the different technologies related to HDLs, construct, compile and execute Verilog HDL programs using provided .

COURSE OUTCOMES:
After successfully completing the course, the students will be able to

CO1: Understand the language constructs and programming fundamentals of Verilog HDL
CO2: Choose the suitable abstraction level for a particular digital design
CO3: Construct Combinational and sequential circuits in different modelling styles using Verilog HDL
CO4: Synthesize the RTL design and analyze the synthesis output
CO5: Analyze and Verify the functionality of digital circuits/systems using test benches
CO6: Design and verify digital system using Verilog HDL

COURSE DETAILS

Introduction to Logic Design with Verilog: Verilog as HDL, Levels of Design Description, Concurrency, Program structure, Top-down and Bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block, Verilog Data types and Operators, system tasks, compiler directives

Data-flow and Gate-Level Modelling: Continuous assignments, Delay specification, expressions, operators, Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in dataflow model, Modelling using basic Verilog gate Primitives, Description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays, Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in Gate-level Modelling.

Behavioral Models of Combinational and Sequential Logic: Behavioral modeling, data types for behavioral modeling, behavioral models of combinational logic, popagation delay and continuous assignments, lathes and level sensitive circuits in verilog, behavioural models of flip flops and latches, functions and Tasks.

Logic Synthesis and Simulation: synthesis of combinational logic, synthesis of sequential logic with latches, synthesis of three state devices and bus interfaces, synthesis of sequential logic with flip flops, synthesis of explicit state machines registered logic, Test Bench – components of testbench, Combinational Circuits Testing, Sequential Circuits Testing.

Text Book:

1. Padmanabhan, Tripura Sundari -Design through Verilog HDL, Wiley, paperback, 2016

Reference books:

1. Stephen Brown and Zvonko Vranesic - Fundamentals of Digital Logic with Verilog, 2nd Edition, TMH, 2008.
2. Samir Palnitkar-Verilog HDL: A Guide to Digital Design and Synthesis, Pearson Education, 2nd Ed., 2009.
3. Z Navabi - Verilog Digital System Design, 2nd Edition, McGraw Hill, 2005.

EMBEDDED DESIGN AND COMPUTER ARCHITECTURE

Course Code: **EV20006**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE:

This course will give an insight into embedded system design and their perspectives, Embedded System modelling. This will teach students about ALP and Embedded C Coding for embedded system design using ARM processor. This course focuses on HW/SW Codesign Methods.

COUSE OUTCOMES:

After completion of the course the students will be able to

CO1: Understand basic computer architectures and its use in embedded systems
CO2: understand the difference between embedded systems and general-purpose systems.
CO3: Analyse and designs hardware using single-purpose processors.
CO4: comprehend different peripheral interfaces to embedded systems.
CO5: Analyse and comprehend the design trade-offs made by different models of embedded systems.
CO6: apply knowledge gained in software-hardware integration in team-based projects.

COURSE DETAILS

Introduction To Computer Architecture:

Introduction, basic architecture, Non-Neumann and Harvard Architecture, Internal processor design: ALU – registers – control unit - clock – on chip memory – processor i/o – interrupts – processor buses – processor performance, logic micro-operations and instruction level parallelism, microprogrammed control.

Introduction: Introduction to embedded systems, Design Standards, Characteristics of embedded Systems

Modelling techniques: Finite State Machines Model, State Charts and Petri-nets, Data driven and control driven concurrency

Hardware/ Software Co-Design: Hardware software portioning and scheduling, hardware and software estimation models, Co-Simulation

Peripherals: parallel and Serial communication protocols (RS232, USB, I2C, SPI,)

Embedded Processors: Brief introduction to MIPS, PowerPC and other RISC Processors, ARM SoC and its programming (using Assembly and Embedded C)

Text Book:

1. Computer as Component: Principle of Embedded Computing System Design by Wayne Wolf, Morgan-Kaufmann, 2012
2. Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid & Tony Givagis, , John Wiley, 2011.

Reference Book:

1. Embedded System Design, Peter Marwedel, Springer, 2009
2. Embedded Systems, Raj Kamal, 2nd Edn., TMH, 2011.

ANALOG AND DIGITAL ELECTRONIC DEVICES AND CIRCUITS

Course Code: **EV21001**
Credit: **4**
L-T-P: **3-1-0**
Prerequisites: **Nil**

COURSE OBJECTIVE:

By the end of this analog electronics course, students will gain a comprehensive understanding of the principles, theories, and applications underlying analog and digital electronic circuits. Through theoretical lessons and tutorial sessions, participants will develop the skills necessary to design, analyze, and troubleshoot analog and digital circuits effectively. Emphasizing fundamental analog and digital circuits such as MOSFET amplifiers, Boolean algebra, number systems, different combinational and sequential logic circuits, this course aims to equip learners with the proficiency to design and implement various electronic systems. Additionally, students will cultivate problem-solving abilities and critical thinking skills essential for addressing real-world challenges in both analog and electronics engineering.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understanding fundamentals of MOSFET and digital electronics,
CO 2: Apply knowledge to solve MOS amplifier using small signal model,
CO3: Simplify and realize Boolean expressions and design various combinational Circuits,
CO 4: Able to design and implement digital circuits using various components such as logic gates, flip-flops, registers, and counters ,
CO 5: Judge the performance of analog to digital and digital to analog converters used in electronic circuits,
CO 6: Develop the ability to model the behavior of digital circuit using state Machines.

COURSE DETAILS

Introduction to MOS Transistor and Amplifiers:

MOSFET structure and operation, voltage-current characteristics, Threshold voltage, enhancement and depletion mode devices. Low and high frequency small signal model of MOSFET, concept of unity-gain cut-off frequency of transistor, analysis of common source and common drain amplifiers, voltage gain and output resistance calculation at low frequency operation.

Introduction to Digital fundamentals
Boolean Algebra axioms and basic theorems; De. Morgan's Theorem, Standard and canonical representations of logic functions, Conversion between SOP and POS; Simplification of logic functions, Karnaugh Map, Don't Care Conditions, Number systems-binary, Signed binary, Octal, hexadecimal number; Binary arithmetic, One's and two's complements arithmetic, BCD arithmetic.

Combinational circuits:
Multiplexer; Demultiplexer / Decoder, BCD to 7-segment decoder driver; Encoder, Priority encoder; Parity generator and checker, Codes, Code converters; Adder, Subtractor, Carry look ahead adder; Magnitude comparator.

Sequential circuits:
Bistable latch, SR, D, JK, T Flip-Flop: level triggered, edge triggered, master – slave, Various representations of flip-flops, flip-flop conversions. Shift register, Universal shift register; Application of shift register: ring counter, Johnson counter. Up and down counter, Ripple (asynchronous) counters, Synchronous counters.Design of synchronous sequential circuit using Mealy model and Moore model: state transition diagram.

Data Converters:
Digital to analog converters: weighted resistor/converter, binary ladder, converter, accuracy and resolution; Analog to digital converter (Flash type, Counter type & Successive approximation type).

Text Book:
1. Millman, J., Halkias, C. & Parikh, C. D. (2017). Integrated Electronics (2nd Edition). McGraw-Hill Publications. ISBN 13: 978-0-07-015142-0.
2. Mano, M. M. (2016). Digital Logic and Computer Design (1st Edition), Pearson Education. ISBN-13:978-93-325-4252-5.

Reference books:
1. Boylestad, R. L.& Nashelsky, L. (2021). Electronics Devices and Circuits (11th Edition). Pearson Education. ISBN 13: 978-0-13-262226-4.
2. Anand Kumar, A. (2016). Fundamentals of Digital Circuits (4th Edition). PHI. ISBN: 9788120352681

DIGITAL VLSI LAB

Course Code: **EV29002**
Credit: **1**
L-T-P: **0-0-2**
Prerequisites: **Nil**

COURSE OBJECTIVE:
The basic objective of the course is to enable the students to get a fair idea of VLSI circuit simulation using dedicated EDA tool.Using these engine tools, spice program provides facility to the use to design & simulate new ideas in circuit design before going to the time consuming & costly process of chip fabrication.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: to be aware about different EDA tool and their functions.
CO2: to design and verify the operations of CMOS logic
CO3: to grasp the idea of design and simulate Transmission Gate based design
CO4: to understand the basic building gates for Flip-flop design
CO5: to design and verify various gates using CMOS
CO6: to accomplish the layout of CMOS inverter

LIST OF EXPERIMENTS:

Experiment 1
Introduction to circuit design tool and its different functionalities.

Experiment 2
Design and simulation of CMOS inverter logic

Experiment 3
Design and simulation of user defined logic using PTL

Experiment 4
Design and simulate a flip-flop.

Experiment 5
Design and simulate of MUX logic using Transmission Gate.

Experiment 6
Design and simulation user defined boolean expression (upto 3i/p) using CMOS logic

Experiment 7
Layout CMOS inverter.

Experiment 8
Automatic layout generation.

Experiment 9
Open ended Experiment 1

Experiment 10
Open ended Experiment 2

VERILOG LAB

Course Code: **EV29004**
Credit: **1**
L-T-P: **0-0-2**
Prerequisites: **Digital Electronics**

COURSE OBJECTIVE
The Verilog HDL lab introduces students to the world of hardware description languages (HDLs) and their powerful role in designing digital circuits. Through hands-on labs, students will gain a solid understanding of Verilog's core syntax, data types, operators, and other essential building blocks. The course equips students with the skills to design, simulate, and implement Verilog HDL circuits. This valuable skillset opens doors to exciting careers in fields like integrated circuit design, FPGA programming, and embedded system development.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Design and simulate the simple Boolean functions using dataflow style Verilog code.
CO 2: Design and simulate the combinational logic circuits using dataflow style Verilog code.
CO 3: Design and simulate the arithmetic circuits using structural style Verilog code.
CO 4: Design and simulate the sequential logic circuits using behavioral style Verilog code.
CO 5: Deploy the combinational and sequential circuits into the FPGA board.
CO 6: Design, test and deploy complex circuits into FPGA board.

LIST OF EXPERIMENTS

1. Write dataflow style and structural style Verilog codes to design the half-adder and full-adder circuits. Write testbenches to simulate the half-adder and full-adder circuits.

2. Write a Verilog code to design a 4-bit ripple-carry adder. Write a testbench to simulate the 4-bit ripple-carry adder.

3. A) Write a dataflow style Verilog code to design a 2x1 multiplexer. Write a testbench to simulate the 2x1 multiplexer.

B) Write a dataflow style Verilog code to design a 4x1 multiplexer. Write a testbench to simulate the 4x1 multiplexer.

C) Write a structural style Verilog code to design an 8x1 multiplexer. Write a testbench to simulate the 8x1 multiplexer.

4. A) Write a behavioral style Verilog code to design a JK flip-flop. Write a testbench to simulate the JK flip-flop.

B) Write Verilog codes to realize a T flip-flop using a JK flip-flop. Write a testbench to simulate the T flip-flop.

C) Write Verilog codes to realize a D flip-flop using a JK flip-flop. Write a testbench to simulate the D flip-flop.

5. Write a behavioral style Verilog code to design a 1K x 8 RAM. Write a testbench to simulate the design.

6. Write a behavioral style Verilog code to design a 4-bit synchronous Up-Down counter. Write a testbench to simulate the synchronous counter.

7. Write a Verilog code to design a Mealy machine for a 4-bit sequence detector. Write a testbench to simulate the sequence detector. The design must be able to detect overlapped sequences.

8. A) Implement and test the combinational logic circuits into FPGA board.

B) Implement and test the sequential logic circuits into FPGA board.

9. Open Ended Experiment 1.

10. Open Ended Experiment 2.

EMBEDDED LAB

Subject Code: EV29006
Credit: 1
L-T-P: 0-0-2
Prerequisites:

COURSE OBJECTIVE:
This course will make students to interface various sensors and peripherals using PIC18F and ARM Cortex Processors using embedded C programming style. It also able make student build their own embedded project alone or in group.

COURSE OUTCOMES:
After completion of the course student will be able to

CO1: Write a program to configure I/O ports and used to drive LEDs using PIC18F microcontroller

CO2: Write program interface 16x2 character LCD using PIC18F microcontroller
CO3: Write program to interface OLED display ARM Cortex processor and display characters of suitable size.
CO4: Write program to stepper motor driving wit/without PWM with ARM Cortex processor.
CO5: Write program to interface ADC/DAC with ARM Cortex processor.
CO6: Make students to work as an individual or in group for designing a Embedded System based project.

TENTATIVE EXPERIMENT LIST:

1. Configuring I/O ports and LED glowing using PIC18F microcontroller
2. 16x2 character LCD interface with PIC18F microcontroller to display a message.
3. Configuring I/O ports and LED glowing using ARM Cortex Processor
4. LED intensity control using PWM with ARM Cortex processor
5. Interfacing I2C OLED display with ARM Cortex Processor to display characters of suitable size.
6. ADC and LCD interface with ARM Cortex Processor
7. Stepper Motor interfacing using ARM Cortex processor with PWM/without PWM.
8. Interfacing UART to send and receive messages with ARM Cortex Processor.
9. Open Ended experiment I*
10. Open Ended experiment II*

**The open ended experiment will be based on interfacing Bluetooth module, RF Module, temperature sensor, generating different waveforms using DAC (Triangular, Square wave with suitable duty cycle, sine wave etc.)*

MIXED SIGNAL IC DESIGN

Course Code: EV30001
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE:
Analog and mixed-signal integrated circuits play an important role in many modern emerging system-on-chip (SoC) design applications. With the expansion in the markets of these applications, the demands of analog/mixed-signal ICs have dramatically increased. Although analog/mixed-signal ICs have gained more importance and demands in modern SoC applications the design complexities have further increased. The analog circuits being prone to noise and electromagnetic interference, ensuring noise immunity without compromising on performance parameters

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Apply a knowledge of the operation of MOSFET transistors and circuits to the analysis and design of small signal model of a circuit
CO 2: Select the most appropriate design configuration for a specified single stage amplifier implementation.
CO 3: Evaluate performance issues and trade-offs based on a knowledge of different current mirror circuits.

CO 4: Choose the most appropriate operational amplifier configuration for a specified analog circuit implementation.

CO 5: Model noiseless analog circuits based on the knowledge of different types of noises and their compensation

CO 6: Analyze different designs based on comparator and opamp

COURSE DETAILS

1. Analog circuits in VLSI, Overview of circuit performance parameters
    a. analog design octagon
    b. Small signal model of MOS
    c. Second order effects
2. Single stage Amplifiers
    a. Basic amplifier topologies and their characteristics,
    b. common-source stage amplifier with different loads
    c. Cascode stage

3. Biasing circuits
    a. Basic and Cascode current mirrors,
    b.Current and Voltage references; bandgap reference,
    c.Folded Cascode current mirror
    d.cascode current mirror for low voltage applications

4. Differential amplifier
    a.advantages of differential signaling,simple differential amplifier
    b. diffrential amplifier with tail current source
    c.qualitative and quantitative analysis
    d.Gilbert cell

5. High frequency response and Noise
    a. Association of poles with nodes,Miller poles
    b. Transfer function of common source,common gate and cascode amplifiers
    c. Pole zero compensation
    d. Types of noise and noise compensation

6. OPAMP
    a. Ideal characteristics of opamp
    b. Single ended and diferential opamp with cascode load
    c. Two stage opamp,gain boosting
    d. Frequency response and pole compensation

7. comparator and oscillator
    a. Simple comparator, Switch-based comparator, Latch-based comparator.
    b. Nyquist rate ADC and DAC design
    c.sigma delta modulator
    d.Ring oscillator, LC oscillator, Voltage control oscillator, PLL

Textbook:

1. Design of Analog CMOS Integrated Circuits; Behad Razavi; 2nd edition, TMH, 2017
2. Analog Integrated Circuit Design (2nd edition)By Tony Chan Carusone, David Johns and Kenneth Martin Publisher: Wiley; 2 edition (December 13, 2011)

VLSI FOR SIGNAL PROCESSING

Course Code: EV30002
Credit: 3
L-T-P: 3-0-0

Prerequisites: EC20001

COURSE OBJECTIVE

This course offers an extensive overview of key techniques essential for crafting efficient VLSI architectures tailored for Digital Signal Processing (DSP). Emphasis will be placed on architectural optimization across multiple levels of the design to create efficient hardware implementations.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply the signal flow graphs and data flow graphs to represent signal processing algorithms.
CO 2: Apply the techniques of pipelining and parallel processing to design VLSI architectures for high-speed and low-power applications.
CO 3: Analyze the critical path using the concepts of re-timing.
CO 4: Analyze the unfolding and folding in signal processing architectures.
CO 5: Design and evaluate architectural transformations used to translate signal processing algorithms into efficient hardware architectures.
CO 6: Design and optimize the performance of the VLSI architectures for signal processing.

COURSE DETAILS

Representation Methods of Signals and System

Graphical representation of signals, Signal flow graph, Data flow graph, Loop bound, Iteration bound, Algorithms for computing iteration bound, iteration bound of multi rate data flow graphs.

Pipelining and Parallel Processing

Pipelining of FIR Digital Filters, Parallel processing, Design of first order IIR filter using pipelining and parallel processing, Pipelining and parallel processing for low power.

Retiming

Definition and Properties, Solving Systems of Inequalities, Retiming Techniques.

Unfolding and Folding

Algorithm for unfolding, Properties of unfolding, critical path, unfolding and retiming, Application of unfolding, Folding transformation, Register minimization techniques, Register Minimization in folded architectures, Folding of Multi-rate Systems.

Systolic Architecture Design

Systolic array design methodology, FIR systolic array, Matrix-Matrix multiplication, 2D systolic array design.

Fast Convolution

Cook-Toom algorithm, Winograd algorithm, Iterated convolution, Cyclic convolution.

Textbooks

3. Parhi, K. K. (2007). *VLSI Digital Signal Processing Systems: Design and Implementation*. John Wiley & Sons.

Reference books

3. Kung, S. Y., Kailath, T., & Whitehouse, H. J. (1984). *VLSI and Modern Signal Processing*. Prentice Hall Professional Technical Reference.
4. Ismail, M., & Fiez, T. (1994). *Analog VLSI: Signal and Information Processing* (Vol. 166). New York: McGraw-Hill.

SEMICONDUCTOR OPTOELECTRONICS

Course Code: EV30003
Credit: 3

L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE:
The Semiconductor Optoelectronics course covers principles, design, and applications of semiconductor devices interacting with light. Students study band theory, carrier dynamics, and photon generation, understanding underlying physics. They analyze LEDs, photodetectors, and lasers, learning operational mechanisms and practical applications. Through design projects, they apply knowledge to create tailored optoelectronic systems, considering performance metrics like efficiency and reliability. Problem-solving exercises bridge theory with real-world scenarios. Critically evaluating research literature enhances analytical skills. By course end, students grasp semiconductor optoelectronics' significance in technology.

COURSE OUTCOMES:
After successfully completing the course, the students will be able to

CO-1 Able to recognize and articulate the fundamental principles underlying semiconductor optoelectronics, including band theory, photon generation, and carrier dynamics
CO-2 Analyze various semiconductor optoelectronic devices such as light-emitting diodes (LEDs), photodetectors, and lasers, evaluating their operating principles, performance characteristics, and applications
CO-3 Design semiconductor optoelectronic systems tailored to specific applications
CO-4 Assess the performance metrics of semiconductor optoelectronic devices and systems, including efficiency, speed, spectral characteristics
CO-5 Apply theoretical concepts of semiconductor physics and quantum mechanics to solve practical problems in optoelectronics
CO-6 Critically analyze research literature in semiconductor optoelectronics, identifying trends, evaluating methodologies, and synthesizing findings to advance their understanding of current developments in the field

COURSE DETAILS

Review of Semiconductor Device Physics
Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level, and quasi-Fermi levels, p-n junctions, Schottky junction, and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures, and Quantum Wells. Interaction of photons with electrons and holes in a semiconductor, Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.

Semiconductor Photon Sources
Electroluminescence. The LED: Device structure, materials and characteristics. The semiconductor Laser: Basic structure, theory, and device characteristics, direct current modulation, Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL), Laser diode arrays, Device packages, and handling.

Semiconductor Optical Amplifiers & Modulators
Semiconductor optical amplifiers (SOA), SOA, characteristics and some applications, quantum-confined Stark Effect and Electro-Absorption Modulators.

Semiconductor Photodetectors
Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection; Photodiodes, PIN diodes, and APDs: structure, materials, characteristics, and device performance. Photo-transistors, solar cells, and CCDs. Optoelectronic integrated circuits - OEICs.

Text book:
1. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
2. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).

Reference book:

1. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2nd Ed. (2007),

SYSTEM-ON-CHIP DESIGN

Course Code: EV30004
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE:

With technological advances that allow us to integrate complete multi-processor systems on a single die, Systems-on-Chip (SoCs) are at the core of most embedded computing and consumer devices, such as cell phones, media players and automotive, aerospace or medical electronics. This course will provide an understanding of the concepts, issues, and process of designing highly integrated SoCs following systematic hardware/software co-design & co-verification principles.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Analyze the functional and nonfunctional performance of the system early in the design process to support design decisions.

CO2: Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.

CO3: Understand hardware, software, and interface synthesis and issues in interface design.

CO4: Use co-simulation to validate system functionality.

CO5: Describe examples of applications and systems developed using a co-design approach.

CO6: Appreciate issues in system-on-chip design associated with co-design, such as intellectual property, reuse, and verification.

1. Introduction to SOC
    a. Architecture of the present-day SoC
    b. - Design issues of SoC- Hardwar-Software Codesign – Core Libraries – EDA Tools
2. DESIGN METHODOLOGY FOR LOGIC CORES
    a. SoC Design Flow – guidelines for design reuse
    b. Design process for soft and firm cores – Design process for hard cores – System Integration
3. DESIGN METHODOLOGY FOR MEMORY AND ANALOG CORES
    a. Embedded memories
    b. – design methodology for embedded memories
    c. Specification of analog circuits – High speed circuits
4. DESIGN VALIDATION
    a.Core-Level validation –
    b.Core Interface verification - SoC design validation
5. STA and CTS
    a. STA-critical path,set up and hold time violations
    b. Clock tree synthesis
6. CORE AND SoC DESIGN EXAMPLES
    a. Microprocessor Cores – Core Integration
    b. On-chip bus – Examples of SoC

Textbook:

1. Rochit Rajsuman, 'System-on-a-Chip: Design and Test', Artech House, 2000

SEMICONDUCTOR MATERIALS SYNTHESIS AND CHARACTERIZATION

Course Code: EV30005
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE:

The Semiconductor Material Synthesis and Characterization course explores methods for creating and analyzing semiconductor materials crucial to modern technology. Students delve into synthesis techniques such as epitaxy, chemical vapor deposition, and molecular beam epitaxy, learning to control material properties for specific applications. Characterization methods including X-ray diffraction, electron microscopy, and spectroscopy are studied to analyze material structure, composition, and electronic properties. Hands-on laboratory sessions enable students to apply theoretical knowledge in practical settings, synthesizing and characterizing semiconductor materials. By course completion, students develop a deep understanding of semiconductor material synthesis and characterization, vital for advancing technology in fields like electronics, photonics, and renewable energy.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1	Understand the silicon extraction and purification process
CO2	Understand Crystallography of Si and various methods of growth
CO3	Understand key methods of physicochemical and morphological techniques
CO4	Apply knowledge to characterize materials using different standard methods
CO5	Analyzing interface instability and convection effect in different growth technique
CO6	Create production grade semiconductor for IC design

COURSE DETAILS

Introduction to characterization methodologies

Principles of extraction, pyrometallurgical processes, material and heat balance of processes,
thermodynamics of processes; introduction to laws, thermodynamic equilibrium, thermochemistry, Ellingham diagram. Process kinetics; introduction to chemical kinetics and rate processes, heterogeneous kinetics, kinetics of liquid-liquid reactions, concepts of reactor design. Structure & properties of molten liquids.

Production of metallurgical grade (MG) Silicon

Carbothermic reduction, principle, operation and practice of sub-merged arc furnace, energy and process calculation, refining & impurities control in molten MG Si. Production of electronic grade (EG) Si: Concept of fluidized bed reactor, Siemens Process.

Crystal Growth technique

Crystal growth processes (Bridgman and its variants, Czochralski), heat and species transfer during non-steady and steady state plane-front growth, interface instability and effect of convection on interface stability

Analysis and Characterization methods

XRD (Bulk and thin film), Microscopy (Optical, SEM, TEM, SPM), UV-Visible spectroscopy, Photoluminescence, Raman spectroscopy

Text Books:

1. Principles of Extractive Metallurgy, Terkel Rosenqvist, McGraw-Hill Book Company, 1973

2. Stoichiometry and Thermodynamics of Metallurgical Processes: Y K Rao, Cambridge University Press, 2009

Reference Books:

1. Handbook of Extractive Metallurgy: Fathi Habashi; Wiley-VCH , 1997
2. Solar-Grade Silicon: Refining and Recycling: L Zhang et al, CRC Press, 2013
3. Scheel and Capper: Crystal Growth Technology: From Fundamentals and Simulation to Large- scale Production, John Wiley & Sons, 2008

VLSI VERIFICATION AND TESTING

Course Code: **EV30006**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Digital Electronics**

COURSE OBJECTIVE

This course offers a thorough understanding of the principles governing the verification process. It equips students with essential skills to build effective Verification code, enabling them to evaluate functional coverage through thorough analysis of verification results. **Additionally, the course explores the foundational principles and challenges of VLSI testing, covering topics like fault models, design for testability, and built-in self-test.**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Distinguish between the VLSI verification process and the VLSI testing process.

CO 2: Formulate properties of the digital design for the purpose of verification.

CO 3: Apply the assertions and temporal logic for verifying digital design.

CO 4: Utilize the concepts of fault modeling and testing for digital VLSI circuits.

CO 5: Apply design-for-testability and built-in self-test techniques to test complex sequential circuits.

CO 6: Develop verification programs and test approaches for verifying and testing complex digital circuits.

COURSE DETAILS

Introduction to Verification
Verification versus validation, Verification versus simulation, Verification process, Basic test bench functionality, Constrained random stimulus, Randomization, Functional coverage, Test bench components, Layered testbench.

Formal Equivalence Checking
Types of equivalence checking (combinational, sequential and transaction-based), RTL to netlist equivalence, Netlist to netlist equivalence, Assertion-based equivalence checking.

Formal Property Checking
Property definition, Invariants, Safety properties, Liveness properties, Semantics of Linear Temporal Logic, SystemVerilog Linear Temporal Logic operators.

Introduction to Fault Models
Different types of faults (stuck-at, stuck-open, stuck-short, bridging, delay faults), Memory fault models, Fault equivalence, Fault dominance.

Design For Testability
Scan cell designs, Scan architectures, Scan design rules, Scan design flow.

Built-In Self-Test (BIST)
BIST design rules, Test pattern generation, Output response analysis, Logic BIST architecture.

Textbooks

4. Kropf, T. (2013). *Introduction to Formal Hardware Verification*. Springer Science & Business Media.
5. Zwolinski, M. (2009). *Digital System Design with SystemVerilog*. Pearson Education.
6. Wang, L. T., Wu, C. W., & Wen, X. (2006). *VLSI Test Principles and Architectures: Design for Testability*. Elsevier.

Reference books

1. Seligman, E., Schubert, T., & Kumar, M. A. K. (2023). *Formal Verification: An Essential Toolkit for Modern VLSI* Design. Elsevier.
2. Jha, N. K., & Gupta, S. (2003). *Testing of Digital Systems*. Cambridge University Press.

ANALOG IC DESIGN LAB

Course Code: EV39001
Credit: 1
L-T-P: 0-0-2
Prerequisites: Nil

COURSE OBJECTIVE:
Analysis, design and applications of modern analog circuits.Gain the understanding of implementing the design based on given specification.To be able to draw trade-offs among analog design performance parameters.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: Analyze VTC characteristics of CMOS Invereter
CO2: Understand biasing requirements for maintaining the region of operation
CO3: Design Single stage amplifier with different types of load
CO4: Design simple and cascode current mirror
CO5: Design differential amplifier with tail current source
CO6: Design OP-AMP with different specifications

LIST OF EXPERIMENTS:
1. Analysis of CMOS Inverter VTC characteristics
2. Design of CS stage amplifier with resistive load and diode connected load
3. Design of CS stage amplifier with current source load
4. Design of CS stage amplifier with source degeneration
5. Design of CG and source follower circuit
6. Desgn of Cascode load amplifier
7. Design of simple and cascode current mirror circuits
8. Design of bandgap references
9. Design of Differential amplifier with tail current source and analysis of common mode and differential mode response
10. Design of single stage,two stage and gain boosted OPAMP design

SOC DESIGN LAB

Course Code: EV39002

Credit: **1**
L-T-P: **0-0-2**
Prerequisites: **Nil**

COURSE OBJECTIVE:
Impart the skill of design and analysis of modern day SOC architecture.RTL and system level integration of SOC cores via appropriate bus architecture.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: Design basic modules using system C
CO2: Design UART based serial interface
CO3: Design dynamic memory allocation scheme
CO4: Design and program IO interface
CO5: Integrate different cores through AHB peripheral
CO6: Design PLL and clock tree for SOC application

LIST OF EXPERIMENTS:
1. Design of leaf module and structural netlist using system C
2. System C abstracted data modeling, Threads and methods
3. Design of glue logic for memory map,
4. Design of event driven UART device
5. RTL design of DMA controller
6. Design of 8-bit GPIO controller
7. Building a System on Chip- Integrating AHB peripherals to ARM using Verilog HDL for Timer, MEMORY and GPIO
8. Synthesis of AHB peripherals on the Spartan FPGA Kits
9. Clock Frequency Multiplier PLL
10. Design of basic inter-core interruptor

SCRIPTING LANGUAGE AND PYTHON LABORATORY

Course Code: **EV39003**
Credit: **1**
L-T-P: **0-0-2**
Prerequisites: **Nil**

COURSE OBJECTIVE
The objective of the Python and TCL Programming Lab for VLSI (Very Large Scale Integration) is to equip participants with essential skills and knowledge required for effective VLSI design automation. This lab aims to provide hands-on experience in utilizing Python and TCL scripting languages for various aspects of VLSI design, including synthesis, simulation, verification, and physical design. Through a combination of theoretical learning and practical exercises, participants will gain proficiency in writing scripts to automate design tasks, analyze circuit behavior, debug errors, and optimize design performance. Furthermore, the lab will emphasize the integration of Python and TCL with industry-standard VLSI design tools, ensuring participants are equipped with practical skills applicable in professional settings. By the end of the lab, participants will have the ability to efficiently leverage Python and TCL programming to streamline VLSI design processes, contributing to enhanced productivity and innovation in the field of semiconductor design and fabrication.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: Memorize the data types, operators and string operation in Python and TCL
CO2: Understand the concept of arrays, list and dictionaries
CO3: Solve complex problems using different operators and loops

CO4: Experiment with file operation in Python and TCL
CO5: Construct Functions, classes and Procedures in Python and TCL
CO6: Create custom script to automate the design flow in specific CAD tools

LIST OF EXPERIMENTS:

1. Introduction to Python: data types and operators, loops, strings
2. Working with Array , list, tuples, set and dictionaries in Python
3. File operation in Python: Read, write, append.
4. Function and classes in Python
5. Basics of TCL: data types, variables, operators, decisions
6. Working with Loops, arrays, strings and dictionaries in TCL
7. Procedures in TCL, File operation: open, read, write and append in TCL
8. FPGA design flow in VIVADO using TCL
9. Open Ended Experiment-I
10. Open Ended Experiment-II

Text book:

1. Martelli, A., Ravenscroft, A., & Ascher, D. (2011). Python Cookbook. O'Reilly Media.
2. Welch, B., Glover, D., & Cohen, M. (1990). Practical Programming in Tcl and Tk. Prentice Hall.

VLSI TESTING AND VERIFICATION LAB

Course Code: **EV39004**
Credit: **1**
L-T-P: **0-0-2**
Prerequisites: **Digital Electronics**

COURSE OBJECTIVE

The primary objective of this lab is to equip students with the knowledge and practical skills to ensure that VLSI designs function as intended before being manufactured. The lab will provide a solid foundation for applying verification and testing methodologies used in real-world VLSI design environments.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Design and verify digital circuits using immediate assertions.
CO 2: Design and verify digital circuits using concurrent assertions.
CO 3: Formulate and verify the properties of the digital circuits using assertion-based property verification.
CO 4: Test the presence of stuck-at faults in the combinational logic circuits.
CO 5: Test the presence of bridging faults in the digital circuits.
CO 6: Design digital circuits for testability.

LIST OF EXPERIMENTS

1. Write a Verilog code to design a full-adder circuit using basic gates only. Write another Verilog code to design a full-adder circuit using two half-adders and an OR gate. Using immediate assertions, verify whether both the designs are equivalent or non-equivalent.

2. Write a Verilog code to design a D flip-flop. Using concurrent assertions, verify the properties of the flip-flop.

3. Using assertion-based verification, verify whether an FSM consisting of 3 states satisfies all the properties or not. (The FSM and the properties will be given during the lab session).

4. Using assertion-based property verification, verify whether a 4-bit up-down counter satisfies all the properties or not. (The properties will be defined by the students during the lab session).

5. Write a Verilog code to design a full-adder circuit using two half-adders and an OR gate. Inject single stuck-at 0 and stuck-at fault 1 into the design and simulate the effects of the faults into the circuit.

6. Generate test patterns and simulate the effects of the single stuck-at faults into a 3-bit ripple carry adder circuit.

7. Generate test patterns to detect bridging faults into a combinational circuit (to be given during the lab session).

8. Using design-for-testability approach, test a 3-bit serial-in, serial-out (SISO) shift register for detecting stuck-at faults in the circuit.

9. Open Ended Experiment 1.

10. Open Ended Experiment 2.

VLSI SIGNAL PROCESSING LAB

Subject Code: **EV39006**
Credit: **1**
L-T-P: **0-0-2**
Prerequisites:

COURSE OBJECTIVE:
This course will enable student to fixed point and floating point operations using FPGA. It also enable students to design different filters architecture using Matlab and their implementation in FPGA.

COURSE OUTCOMES:
After successfully completing the course, the students will be able to

CO1: Implement fixed-point and floating-point operations using MATLAB and HDL.
CO2: Implement DFT and IDFT for signal processing applications in MATLAB and HDL
CO3: Design and implement FIR filter for signal processing application with different frequency in FPGA.
CO4: Design and implement IIR filter for signal processing application with different frequency in FPGA.
CO5: Design and implement LMS adaptive filter for noise cancellation inn FPGA.
CO6: Implement and debug a FIR Filter using hardware-in-loop simulation with FPGA

TENTATIVE EXPERIMENT LIST:

1. Implementation of Fixed-point and floating point arithmetic using Matlab and HDL. (1 class)
2. Design and implementation of 8-poit DFT and IDFT of a sequence using MATLAB and HDL. (2 class)
3. Design and implementation of FIR filter architecture in FPGA. (2 class)
4. Design and implementation of an adaptive filter in FPGA. (2 class)
5. Open ended Experiment (2 class)

HIGH SPEED INTERFACE DESIGN

Course Code: **EV40001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE:
Analysis and design of link architectures and circuits for wireline communication systems. Emphasis on design intuition, link budgeting and power/performance trade-offs in implementation of data links in advanced CMOS process. Topics include channel characterization, noise analysis, equalization, transmitter and receiver circuits, signaling schemes, clocking, synchronization and timing recovery circuits.

COURSE OUTCOMES:
After successfully completing the course, the students will be able to

CO1: Understanding fundamentals of high-speed data link design

CO2: Apply knowledge to model system architecture using modeling tools

CO3: Understanding the challenges of designing high-speed wireline circuits

CO4: Be exposed to several link standards, including USB-Type C, Thunderbolt, PCIe and DDR

CO5: Construct timing recovery and power and clock distribution network

CO6: Create dedicated interfacing circuits for high speed data transmission

COURSE DETAILS

SYLLABUS OUTLINE:

1. Introduction to high-speed links
2. Channel characterization
3. Noise and jitter
4. Equalization
5. Signaling schemes
6. Transmitter circuit design
7. Receiver circuit design
8. Different clocking schemes
9. Timing recovery
10. Power and Clock Distribution

INDUSTRIAL WIRING AND CONTROL PANEL DESIGN

Course Code: **EE28011**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This vocational course will provide an overview of electrical occupations, including the training and the employment options available in electrical industry. It is also designed to provide related training in the electrical trade that will give students the proper coursework in installation and designing of control panel.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Realise the purpose and general principles of control components and circuits, CO 2: Install Industrial wiring circuits according to given specification and plan,
CO 3: Analyze circuit operations on basic motors (3ø induction Motor),
CO 4: Interpret and install circuits according to rules and regulations of the National Electrical Codebook,
CO 5: Connect motor controllers for specific applications with emphasis on safety practices and in accordance with National Electrical Code (NEC) requirements, and
CO 6: Select and size contactors, relays and timing relays and overload relays both physically and schematically and describe their operating principles.

COURSE DETAILS

- Design multiwire circuit for a direct motor starter (DoL) with one operating (forward) direction using QElectrotech software.
- Design multiwire circuit for a direct motor starter (DoL) with two operating (forward & reverse) direction using QElectrotech software.
- Design multiwire circuit for a Star – Delta motor stator with one operating (forward) direction using QElectrotech software.
- Design multiwire circuit for a Star – Delta motor stator with two operating (forward & reverse) direction using QElectrotech software.
- Design & connect for a direct motor starter (DoL) with one operating (forward) direction in modular set up.
- Design & connect for a direct motor starter (DoL) with two operating (forward & reverse) direction in modular setup.
- Design & connect for a Star – Delta motor stator with one operating (forward) direction in modular set up.
- Design & connect for a Star – Delta motor stator with two operating (forward& reverse) direction in modular set up.
- Install & wire for a direct motor starter (DoL) with one operating (forward) direction in Industrial Control Panel.
- Install & wire for a direct motor starter (DoL) with two operating (forward & reverse) direction in Industrial Control Panel.
- Install & wire for a Star – Delta motor stator with one operating (forward) direction in Industrial Control Panel.
- Install & wire for a Star – Delta motor stator with two operating (forward & reverse) direction in Industrial Control Panel.

Reference Books

1. Tarlok Singh, Installation, commissioning and maintenance of electrical equipment.
2. B.P. Patel and M.A. Chaudhari, Industrial Electrical Systems.

INSTALLATION, OPERATION AND MAINTENANCE OF SOLAR POWER SYSTEM

Course Code: **EE28013**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To impart job-oriented training to students and make them well convergent on Installation, operation & maintenance of solar PV system. This vocational course is based on study of solar photovoltaic (PV) cells, modules, and system components; electrical circuits; PV system design and sizing for use on homes, commercial building etc., understanding energy conversion from sunlight to electricity, and working with solar conversion equipment. This Course will give students the book knowledge and hands on experience needed to become entrepreneur / self-employed.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Demonstrate and apply the knowledge of solar electric systems terms and concepts,
CO 2: Size and design a photo voltaic system,
CO 3: Mount, ground, position, install, wire and connect a photo voltaic system,
CO 4: Test voltage generated by photo voltaic system,
CO 5: Learn different types of solar PV modules and batteries used in solar PV plant, and
CO 6: Design of solar PV plant based on estimated loads.

COURSE DETAILS

- To demonstrate the I-V and P-V Characteristics of PV module with varying radiation and temperature level.
- To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
- To show the effect of variation in tilt angle on PV module power.
- To demonstrate the effect of shading on module output power.
- To demonstrate the working of diode as bypass diode and blocking diode.
- To draw the charging and discharging characteristics of battery.
- Observe the output waveform of the inverter in auto mode.
- Workout power flow calculations of standalone PV system of AC load with battery.
- Workout power flow calculations of standalone PV system of DC load with battery.
- Find the MPP manually by varying the resistive load across the PV panel.

Reference Books

1. Chetan Singh Solanki, Solar Photo Voltaic Technology and Systems.
2. B.H. Khan, Non-Conventional Energy Resources.
3. P. Sukhatme, Solar Energy - Principles of Thermal Collection and Storage.
4. G.N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications.

DOMESTIC WIRING AND HOME AUTOMATION

Course Code: **EE28015**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This vocational course will provide an overview of electrical occupations, including the training and the employment options available in electrical consultancy. It is also designed to provide related training in the electrical wing that will give students the proper coursework in installation and designing of domestic wiring and home automation. To develop electrical wiring skills in students through systematic training that would enable the students to construct and test various electrical circuits using appropriate electrician tools, wires, protective devices and wiring accessories as per IS standards.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Use appropriate electrician tools, wires, protective devices and wiring accessories,
CO 2: Rig up wiring diagrams using conduit system of wiring,
CO 3: Apply IS standards for electrical wiring,
CO 4: Prepare different types of wiring joints,
CO 5: Well convergent in drawing electrical wiring circuit, and
CO 6: Enhancement of knowledge regarding specification and application of different electrical devices.

COURSE DETAILS

- Perform the assembly, wiring and implementation of a single switch (SPST Switch) in circuit.
- Perform the assembly, wiring and implementation of a Double switch (SPST Switch) in circuit.
- Perform the assembly, wiring and implementation of a power socket in circuit.
- Perform the assembly, wiring and implementation of a controlled power socket circuit in housing.
- Perform the assembly, wiring and implementation of a two ways switches (SPDT Switch) in circuit.
- Perform the assembly, wiring and implementation of a impulse relay in circuit.
- Perform the assembly, wiring and implementation of a time switch in circuit
- Perform the assembly, the wiring and the implementation of a timer lighting in circuit.
- Perform the assembly, the wiring and the implementation of a twilight switch in circuit in house or in a shop.
- Perform the assembly, wiring and implementation of a controlled lighting in circuit (time switch, timer, twilight switch).
- Perform the assembly, the wiring and the implementation of a water heater in circuit.
- Perform the assembly, wiring and implementation of a central impulse relay in circuit.
- Study and implementation of Light sensitive switch.
- Perform the assembly, wiring and implementation of a fan in circuit.
- Perform the assembly, wiring and implementation of a distribution panel.
- Home automation using KNX technology.
- Application of Load shedding contactor and programmable time switch.

Reference Books

1. Frederic Marsh, Home Automation - A Smart Home Guide: The Beginner's Manual Including Google Home, Echo Dot and Amazon Alexa. Easy Instructions, Directions and Commands ... and Home Automation Guide Series Book 1, Kindle Edition.
2. James Gerhart, Home Automation and Wiring.

CYBER PHYSICS APPLICATION IN INDUSTRIAL IOT

Course Code: **EE28017**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

The students will utilize the principles of Cyber-Physical Systems (CPS) and Internet of Things (IoT) to develop applications, implement IoT applications by selecting appropriate hardware and software platform and also Develop IoT applications using open-source platforms.

COURSE OUTCOMES

After successfully completing the course, the students will be able to CO 1: Basics of cyber physics components,

CO 2: Understanding of sensors and actuators,
CO 3: Layout diagram of open source microcontroller board,
CO 4: Understanding of analog and digital I/O for cyber-physics, CO 5: Understanding of different protocols for IoT connectivity, and CO 6: Basic architecture for IoT enabled Cyber Physics.

COURSE DETAILS

1. **CYBER PHYSICAL SYSTEM (THEORY)**
   - CPS Realworld.
   - Design and Validation of CPS.
   - Smart city application CPS.
   - CPS Hardware Platforms (Process, Sensors and Actuators).

2. **Industry 4.0**
   - IOT Fundamentals and protocols including layers.
   - Sensor and Interfacing.

Hands on Practice

- Architecture and pin diagram of Arduino UNO/MEGA and ESP8266
- IDE installation for open source C++ or Phython
- Analog and Digital voltage sensing and processing through Firmware.
- Analog and Digital voltage based actuator through Firmware
- Display OLED/Seven segment integration through IDE
- PCB Design Concept and implementation with uC.
- Implementation of UI/UX through RestAPI based Thing speak
- DATA logging and Generating CSV through Rest API
- Writing a Firmware for ESP-8266 or NODEMCU (programming based knowledge)
- IoT based transformer / condition monitoring system

Reference Books

1. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things.
2. Asoke K Talukder and Roopa R Yavagal, Mobile Computing, Tata McGraw Hill, 2010.
3. Tanenbaum, Andrew S, Computer Networks, Pearson Education Pte. Ltd., Delhi, 4th Edition
4. Stallings, William, Data and Computer Communications, Pearson Education Pte. Ltd., Delhi, 6th Edition.
5. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing," McGraw Hill, 2009.

INDUSTRIAL CONTROL AND REMOTE MONITORING

Course Code: **EE28019**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To provide hands on experience in developing Industrial Control and remote monitoring by using PLC (Programmable logic Controller), thus by utilizing it in Process control applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know about typical components of a Programmable Logic Controller,
CO 2: Know the concept of Electrical ladder logic and its relationship to PLC instructions, CO 3: Understand the concept of digital electronics and data acquisition,
CO 4: Program PLC logical switching circuits for industrial applications,
CO 5: Choose and utilize Timer, Counter, and other intermediate programming functions, and CO 6: Design and program automated industrial production line.

COURSE DETAILS

1. Programmable logic Controller SYSTEM. (THEORY)

- Introduction to Industrial Automation.
- Introduction to PLC programmable logic controller
- PLCs & related software and its major Components
- Relay logic Hardware Platforms (Switches, Sensors and Actuators).
- Study of Contactors, Timers, Counter and Comparator

2. Human Machine interface

- Introduction to HMI Communication with PLC
- HMI tags and Assignments
- Project on Industrial load sequential feedback control Using PLC HMI

Hands on Practice

- Introduction of PLC SOFTWARE as TIA Portal
- Ladder Programming for Basic gates logics by using SPST Contacts
- Ladder Programming on SPDT
- Latching Concept and related Latching program
- Study of program memory and Programming on Memory Bits
- Study of TIMER BLOCKs and its Programming
- Introduction to COMPARATOR BLOCK and its Programming
- Introduction to COUNTER BLOCK and its Types with Programming
- Project on Industrial Load OFF/ON control Using PLC and HMI
- Introduction to analog Logic in PLC and its Programming

Reference Books

1. Vijay R. Jadhav, Programmable logic Controller, KHANNA PUBLISHERS, 2nd Edition, 2012.
2. R.G Jamkar, Industrial Automation Using PLC, SCADA and DCS, Laxmi Publications Private Limited.
3. PLC and SCADA by Prof Rajesh Mehra and Er. Vikrant Vij Published by University Science Press.
4. John R Hackworth and Frederick D. Hackworth Jr., Programmable logic Controller: Programming methods and Applications, PEARSON Edition: 1st Edition, 2006.

SENSORS AND ACTUATORS

Course Code: **EE30012**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **EE20001**

COURSE OBJECTIVE

This course helps the students to have an exposure to sensors and its importance in the real world. Student will be able to understand basics of sensors, actuators and their operating principle and also have knowledge about simulation and characterization of different sensors.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand components of sensor and selection criteria.
CO 2: select suitable sensor for measuring displacement and velocity.
CO 3: Select suitable sensor for force, weight and pressure measurement.
CO 4: Select suitable sensor to measure temperature, level and flow.
CO 5: Know about different actuators and Electrical actuating systems.
CO 6: Use micro sensor and micro actuators in different applications.

COURSE DETAILS

Introduction

Definitionofsensorandtransducer,classification,characteristics.Selectioncriteriaoftransducers.Smartsensor:Blockdiagram, features.

Displacement and velocity Measurement

Linearandrotarydisplacementsensors:Potentiometer,capacitive,inductive,Positionmeasurement:OpticalEncoder,proximitysensors.

Velocity measurement: Tachometer types, Stroboscope, Encoder.

Measurement of Force, Weight and Pressure

Force and weight measurement :Strain gauge, load cell.Pressure measurement: Manometer types, Strain gauge, diaphragm gauge, capsule, bellows, bourdon tube, piezoelectric sensor.

Temperature measurement
Temperature scales, Mechanical thermometers: Filled insystems, Metallic expansion, Electrical thermometers: RTD, Thermo-couple, Semiconductor temperature sensors.

Level& Flow measurement
Mechanicalmethods:floatanddisplacer.Electricalmethods:Resistance,inductive, capacitance type.Ultrasonic level gauging. Basic principles of flow measurement. Differential pressure devices: orifice, venturi, flow nozzle, pitot tube, annubar.

Actuators
Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria.

Electrical actuating systems
Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator.

Micro Sensors
Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Simulation and characterization of various sensors using COMSOL Multiphysics.
Micro actuators
Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of microactuators: Electrostatic, magnetic, fluidic, inversepiezoeffect.

Textbook
1. S.K.Singh- Industrial instrumentation and control, 3rd Edition,TMH

Reference books

1. Murthy.D.V.S- Transducers and Instrumentation, ,2001,Prentice Hall of India.
2. Patranabis. D- Sensors and transducers, , 2003, PHI.
3. Sergej Fatikow and Ulrich Rembold- Microsystem Technology and Microrobotics, ,1st edition, Springer-Verlag Berlin Heidelberg.
4. Manfred Kohl- Shape memory actuators, first edition, Springer.

SPECIAL MACHINES AND ITS CONTROL

Course Code: **EE30022**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
To understand the working of special machines like stepper motor, switched reluctance motor, BLDC motor & PMSM and Linear induction motor with proper design of controller for smart inverter used to control the above special machine.

COURSE OUTCOMES
After successfully completing the course, the students will be able t:

CO 1: Understand the operation of different special machines.
CO 2: Select different special machines as part of control system components.
CO 3: Analysis of Linear induction motor and its control.
CO 4: Design digital controllers for different machines.
CO 5: Apply the knowledge of axial and radial flux motor into a way of thinking to solve in real time applications.
CO6: Design Smart Inverters and Sizing for Grid Connection and Off Grid.

COURSE DETAILS

Stepper Motors
Introduction, Hybrid stepping motor, Construction, Principles of operation, Energization with two phase at a time, essential

conditions for the satisfactory operation of a 2-phase hybrid steper motor, very slow speed synchronous motor for servo control-different configurations for switching the phase windings-control circuits for stepping motors, an open-loop controller for a 2-phase stepping motor.

Linear Induction Motor
Development of a double-sided LIM from rotary type IM- A schematic of LIM drive for electric traction development of one-sided LIM with back iron-field analysis of a DSLIM fundamental assumptions.

Synchronous Motors
Construction- Principle of operation of Permanent Magnet Synchronous Motors – EMF and torque equations – Starting – Rotor configurations –Dynamic model, Synchronous Reluctance Motors: Constructional features–axial and radial flux motors – operating principle – characteristics.

Control of PMSM, BLDC and Switched Reluctance Motor
Bipolar optical sensor based control of Trapezoidal BLDC Motor, Sensorless control of BLDC motor, Torque ripple control of BLDC motor, Unipolar control for SRM, Torque ripple control of SRM.

Smart Inverters
Selection of power conditioning unit (PCU), Sizing of solar inverter for roof top and grid connected projects, Passive and active protection, IEC/IEEE /Grid Compliance of inverters, Grid-Connected Inverters vs. Stand-Alone Inverters.

Textbooks
1. Miller, T. J. E., Brushless Permanent Magnet and Reluctance Motor Drives, Oxford Science Publications, 1989.
2. Kenjo, T., and Sugawara, A., Stepping Motors and their Microprocessor Controls, Oxford Science Publications, 1984.

Reference books
1. Krishnan, R., Electric Motor Drives: Modeling, Analysis, and Control. Prentice Hall, (2001).
2. Krishnan, R., “Permanent Magnet and BLDC Motor Drives”, CRC Press, 2009.
3. Chang-liang, X., "Permanent Magnet

ELECTRIC DRIVES AND CONTROL

Course Code: **EE30024**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
It aims to familiarize readers with steady-state performance, starting, dynamic and regenerative braking, plugging and reverse direction operation, speed control, sudden and temporary overloads, ambient conditions and mechanical coupling of machines.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1. Learn the need of Electric Drives in the industry.

CO 2. Understand the various braking methods of electrical drives.

CO 3. Know the applications of different electric motors.

CO 4. Analyze the open loop and closed loop control techniques of different drives.

CO 5. Understand different speed control techniques for various industrial drives.

CO 6. Analyze the performance of Permanent Magnet Synchronous and Brushless DC motor drives.

COURSE DETAILS

Introduction
Basic elements of an electric drive, Four quadrant operation of an electric drive, Dynamics of motor load combination, Types of loads, Stable operating condition of various motor load combinations, Fundamental load torque equation, Speed and current limit control, Load curve, load equalization, motor selection and rating calculations.

DC Motor Drives
Review of characteristics of DC motors, Modification of characteristics of DC shunt and series motors, Concept of Electric

Braking, Regenerative, Dynamic and Counter current braking of DC motors.

Control of DC motor drives
Open loop speed control, Closed loop Speed control, Closed loop speed and current control, Closed loop Torque control, Hysteresis controller, PI controller.

Solid State Control of DC drive
Chopper and rectifier based DC Separately excited motor and series motor drive control, four quadrant drive using dual converter.

Induction Motor Drives
Review of characteristics of three phase Induction motors, Modification of speed torque characteristics due to variation of stator voltage, Stator frequency and rotor resistance, Electric Braking of Induction Motors: Regenerative Braking, DC Dynamic braking and Plugging, Slip Power recovery.

Speed Control of Induction Motors
Control of IM by three phase AC-AC Voltage controller, PWM Voltage Source Inverter fed induction motor drives, Current source inverter fed induction motor drives, Comparison of VSI and CSI fed drives, slip compensation schemes, closed loop control (V/f control).

Synchronous and Brushless DC Motor Drives
Synchronous motors, cylindrical rotor, salient pole synchronous motor, permanent magnet synchronous motor, synchronous reluctance motor, Transients due to load disturbances, Braking, Permanent magnet AC motor drives, Sinusoidal PMAC motor drives, Brushless DC motor Drives.

Textbooks

1. G.K. Dubey, Fundamentals of Electric Drives, Second Edition, Narosa Publishers, 2007.
2. S. K. Pillai, A First Course On Electrical Drives, New Age International Publishers, 2nd Edition, 2007.

Reference books

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, Har/Cdr edition (13 September 2006).
2. N. K. De, P. K. Sen: Electric Drives, PHI Learning Pvt. Ltd., 7th Edition, 2004.
3. Bimal. K. Bose, Modern Power Electronics and AC Drives, PHI Publisher, 1st Edition, 2013.
4. S.A. Nasar, Boldea , Electrical Drives, CRC Press, Second Edition, 2006
5. M. A. El-Sharkawi , Fundamentals of Electrical Drives , Thomson Learning, 1st Edition, 2000.
6. R. Krishnan, Electrical Motor Drives, PHI, 2003

INTRODUCTION TO ELECTRICAL MACHINES

Course Code: **EE30038**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course to enable the efficient and effective conversion of one form of energy into another form by using various DC and AC machine.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Know the principle of electromechanical Energy conversion system.
CO2: Understand the principle of operation and characteristics of DC generator.
CO3: Analuze the performace of DC motor through its characteristics
CO4: Analyze the performace of transformer by equivalent circuit
CO5: Know the oprtaion principle, torques and starting of 3 phase induction motor.
CO6: Understand the construction, operating principle and application of Synchronous Machine

COURSE CONTENT

Electromechanical Energy Conversion
Principle, Singly Excited Magnetic System and Doubly Excited Magnetic system, Physical concept of torque production, Electromagnetic torque and Reluctance torque.

DC Machines
DC Generator: EMF equation of dc generator, methods of excitation, armature reaction, interpoles and compensating winding, commutation, characteristics of separately excited and self excited dc generator, losses, condition for maximum efficiency. DC Motor: Working principle, voltage equation, condition for maximum power, characteristics, operating characteristics of dc motor, torque developed, speed control methods.

Transformers
Single Phase Transformer: Working principle, types, EMF equation, Transformer on no load and full load, vector diagram, exact and approximate equivalent circuit, O.C and S.C.test on transformer, Voltage regulation of transformer, losses and efficiency, condition for maximum efficiency, Auto transformer, 3 Phase transformers: connections (Y-Y, Y-Δ, Δ- Δ, Δ-Y).

3 Phase Induction Motor
Types, rotating magnetic field, principle of operation, slip, frequency of rotor current, rotor emf, rotor current, vector diagram and equivalent circuit, expression for torque, conditions for maximum torque, torque slip characteristics, starting torque in squirrel cage and slip ring motors, effect of change in supply voltage on torque, slip and speed , relation between full load torque and maximum torque, Power stages in induction motor, starting methods for 3 phase induction motor.

Synchronous Machine
Alternator: Basic principle, pitch factor, distribution factor, emf equation, alternator on load, voltage regulation: Synchronous impedance method. Synchronous motor: Basic principle.

Textbooks
1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.

Reference Books:
1. Principles of Electrical power systems by J. B. Gupta
2. Text book of Electrical Machine by K R Sidhapura and D B Raval, Vikash, 1st edition, 2013.

POWER ELECTRONIC CIRCUITS

Course Code: **EE30047**
Credits: **3**
L-TP: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE
It aims to familiarize the switching devices, Power converters and Its applications in various systems for power control.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand the working principles of different power electronics devices.
CO 2: Analyze the concepts of single phase and three phase controlled rectifiers.
CO 3: Compare different topologies of DC to DC converters.
CO 4: Realize the control of single phase and three phase Inverters
CO 5: Know the operation of power factor correction circuit and MLI
CO 6: Comprehend the concepts of AC to AC converters

COURSE DETAILS

Introduction to Power Electronics
Comparison of power devices operating in the switch mode to those operating in the active region.

Power Electronic Devices

Thyristor characteristics, Turn ON methods, Dynamic Characteristics of thyristors, Two Transistor Model of thyristor, Characteristics and construction of Power MOSFETS, Characteristics and construction of IGBT, SiC based power devices and applications.

AC to DC Converters
Single Phase Converters – Half Wave with R, RL, RLE load and effect of free Wheeling diode, Single Phase half and full controlled full Wave converters with R and RLE Load, 3 Phase half and fully controlled rectifiers, Power factor correction circuit.

DC to DC Converters:
Step up and Step Down choppers, 4 quadrant choppers for control of DC motor, Basic concepts of bi-directional converter, Forward and Flyback converters.

Inverters
Single Phase Half Bridge and Full Bridge Inverters, 3 Phase Inverters, 180° and 120^0 conduction, Voltage Control of inverters, Concept of multi level inverters, modulation techniques.

AC to AC Converters:
Single phase AC Voltage regulator with R and RL load, Single phase mid-point type cyclo-converter with R-L Load.

Textbooks

1. M. H. Rashid, Power Electronics, Devices, Circuits & Applications Pearson Education, 4th Edition, 2017.
2. Philip T. Krein, Elements of Power Electronics, Oxford University Press, 2nd Edition, 2017.
3. P S Bhimbra, Power Electronics, Khanna Publishers, 7th Edition, 2022.

Reference books

1. N. Mohan, Undeland and Robbins, Power Electronics, Converters, Applications and Design, John Wiley and Sons , 3rd Edition ,2009.
2. P. C Sen, Modern Power Electronics S Chand Publisher, 2013.
3. K.R.Varmah and Chikku Abraham, Power Electronics, Cengage Publications, 2014.
4. M. D. Singh and K.B. Khanchandani, Power Electronics, McGraw - Hill, 2nd edition, 2017.

GIS & GPS APPLICATIONS

Course Code: **CE28003**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of the course is to understand the GIS principles, applications, preparation of study maps, creation of interpolation maps, delineation of watershed, explain the functions of GPS and operation of GPS.

COURSE OUTCOMES

After successfully completing the course, the students will be able to CO 1: Explain the fundamentals of GIS, CO 2: Comprehend the operations of ArcGIS tools and prepare the layout of study area, CO 3: Create interpolation maps,
CO 4: Delineate watershed using ArcGIS,
CO 5: Describe the principles and functions of GPS, and CO 6: Operate GPS in the field for navigation.

COURSE DETAILS

- Overview of Geographic Information System (GIS)
- Familiarization to ArcGIS Interface
- Layout of study area
- Preparation of interpolation map

- Watershed delineation
- Remote sensing satellites
- Basics of Global position system
- Basic operations of GPS Handset
- GPS field surveying and data processing

Reference Books

1. Principles of geographical information systems by P.A. Burrough and R. A. McDonnell, Oxford University Press, UK.
2. Geographic information systems and science by M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, John Wiley & Sons Ltd., England.
3. Global Positioning system: Principles and Applications by Satheesh Gopi, McGraw Hill Education.

CONCEPTS OF DATA STRUCTURES AND ALGORITHMS

Course Code: **CS20001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The objective is to familiarize students with the Time Complexity and Space Complexity of algorithms. In addition, students will be acquainted with various techniques of sorting and searching, and implementing arrays, stacks, queues, and linked lists. This course also includes complex data structures like tree sand graphs related to real-life problems

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply the concepts of data structure and abstract data type (ADT).
CO 2: Synthesize the algorithm for real-life problems with time and space complexity analysis.
CO 3: Implement a linked data structure to solve various problems.
CO 4: Comprehend and apply stacks and Queues for applications such as expression evaluation, etc.
CO 5: Develop and implement Trees data structure.
CO 6: Implement and apply standard algorithms for searching and Sorting.

COURSE DETAILS

Introduction

Notations, Abstract Data Type, Algorithms and Types, Time complexity and Space complexity.

Arrays

Arrays, Sparse matrices, Polynomials.

Linked List

Linked Lists, Doubly linked lists, Circularly linked lists, Applications

Stacks and Queues

Stacks, Queues, Circular Queues, Double ended Queues, Applications in evaluation of expressions.

Trees

Tree representation, Binary Trees, Binary search trees, Tree traversal, Height balanced trees, AVLtrees.

Sorting and Searching
Sorting Techniques: Selection, Bubble, Insertion, Merge, Heap, Quick, Radix sort, Linear search, Binary search, Hash table methods.

Textbooks

1. M.Tenenbaum, Augestien, Data Structures using C, 3rd Edition, Pearson Education, 2007.
2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Addison-Wesley Educational Publishers, 2006.

Reference book

1. Sahni Horowitz,Fundamentals of Data Structure in C, Universities Press, 2nd Ed
2. J.P.Tremblay,P.G.Sorenson, An Introduction to Data Structures with Applications, 2nd Edition,Tata McGrawHill,1981.

OPERATING SYSTEMS

Course Code: CS20002
Credit: 3
L-T-P: 3 0-0
Pre-requisites: Nil

Course Objectives

- To provide knowledge about the services rendered by operating systems
- To explore the various scheduling policies and to provide solutions for critical section and deadlock problems
- To provide a detailed discussion of the various memory management techniques
- To discuss the various file-system design and implementation issues
- To discuss how the protection domains, help to achieve security in a system
- To explore the design and implementation issues of Distributed OS

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Distinguish between different types of modern operating systems, virtual machines
CO 2: Comprehend the techniques used to implement the process manager
CO 3: Comprehend virtual memory abstractions in operating systems
CO 4: Design and develop file system and I/O system
CO 5: Apply various mechanisms in storage management
CO 6: Design and develop OS modules for Distributed Environment

COURSE DETAIL

Introduction
Need for Operating Systems, Computer Systems, OS Operations, Abstract view of OS, Virtualization, Computing Environments, OS Services, OS Structures, System Calls, Building and Booting OS, Process, Threads, Multithreading.

Process Management
Process Scheduling, Process Co-ordination, Synchronization, Semaphores, Monitors, Hardware Synchronization, Deadlocks, Methods for Handling Deadlocks.

Memory Management
Memory Management Strategies, Contiguous and Non-Contiguous allocation, Virtual memory Management, Demand Paging, Page Placement and Replacement Policies.

File Management

File System, Basic concepts, File System design and Implementation, Case Study: Linux File Systems, Mass Storage Structure, Disk Scheduling, Disk Management, I/O Systems, System Protection and Security.

Distributed Systems

Distributed Systems, Distributed operating systems, Distributed file systems, Distributed Synchronization, OS architecture, Case study on LINUX and Windows OS.

Textbook

1. Silberschatz, Galvin, Gagne, "Operating System Concepts", John Wiley and Sons, Tenth Edition, 2018.

Reference books

1. William Stallings, "Operating Systems – Internals and Design Principles", Pearson Publications, Eighth Edition, 2014.
2. Andrew S. Tanenbaum, "Modern Operating Systems", Pearson Publications, Fourth Edition, 2014.
3. Dhananjay M. Dhamdhere, "Operating Systems, A Concept-Based Approach", McGraw Hill Education, Third Edition, 2012.

DATABASE MANAGEMENT SYSTEMS

Course Code: **CS20006**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

- To learn data models, conceptualize and depict a database system using ER diagram
- To understand the internal storage structures in a physical DB design
- To know the fundamental concepts of transaction processing techniques
- To understand the concept of Database Design in Normalization techniques
- To know the manipulation of SQL Queries

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Install, configure, and interact with a relational database management system
CO 2: Conceptualize and depict a database system using ER diagram.
CO 3: Master the basics of SQL and construct queries using SQL
CO 4: Design and develop a large database with optimal query processing
CO 5: Develop efficient storage scheme of saving and retrieving Records and Files
CO 6: Design the database with normalization techniques

COURSE DETAILS

Introduction

Purpose of Database System, Views of data, Data Models, Database Languages, Database System Architecture, Components of DBMS, Entity, Relationship model (E-R model), E-R Diagram notation, EER notations, Examples.

Relational Model

Relational Data Model, Concept of relations, Schema-instance distinction, keys, integrity rules, Relational algebra operators, SQL: Data definition, Data manipulation, Aggregate function, Null Values, Nested sub queries, Joined relations.

Database Design
Dependencies and Normal forms, Dependency theory, Functional dependencies, Armstrong's axioms for FD's, Closure of a set of FD's, minimal covers, Definitions of 1NF, 2NF, 3NF and BCNF, 4NF, 5NF, Decomposition and desirable properties of them.

Transaction Management
ACID properties, Serializability and concurrency control, Lock based concurrency control (2PL), Timestamp ordering protocol, Database recovery management.

Implementation Techniques
Overview of Physical Storage Media, Magnetic Disks, RAID, Tertiary storage, Organization of Records in Files, Indexing and Hashing, Ordered Indices, primary, Secondary index structures.

Textbooks

1. Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Fifth Edition, Tata McGraw Hill,2006.
2. C. J. Date, A. Kannan, S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.

Reference books

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Fourth Edition, Pearson/Addision Wesley, 2007.
2. Raghu Ramakrishnan, "Database Management Systems", Third Edition, McGraw Hill, 2003.
3. S. K. Singh, "Database Systems Concepts, Design and Applications", First Edition, Pearson Education, 2006.

WEB DESIGN

Course Code: **CS28001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE
Web design and programming is a large field, with different types of technologies implemented by different tools. HTML, CSS, and JavaScript are known to be the three pillars of client-side web programming. After finishing this course, a student should be prepared to write nicely formatted, interactive web pages, with no dependencies on server-side technologies.

COURSE OUTCOMES
After successfully completing the course, the students will be able to
CO1: Understand the basics of web page design,
CO2: Use formatting instructions of HTML,
CO3: Apply the style formats using CSS,
CO4: Write basic scripts using JavaScript,
CO5: Apply DOM in web pages, and
CO6: Create dynamic web pages using HTML and JavaScript.

COURSE DETAILS

HTML Fundamentals
HTML: Structure of a program, various tags and their roles in HTML programs, Lists: ordered, unordered, definition, Table.

More with HTML
Form design, Frames, link and it's types, Images.

CSS Essentials
Style sheets: Inline, Internal, External.

JavaScript Basics
Introduction, characteristics, Variables, Data types, Type casting and conversion Functions. Primitives, operators, Control statements, Array, Function, Function – Parameter Passing and dynamic argument and return statement

More with JavaScript
DOM - browser, window, document, image and form object, Properties and Methods of different objects, Predefined Java Script Object - Array, String and Date Object and their methods, Event handling – Link, Body, Image and events associated with different HTML tags

Textbook
1. MASTERING HTML, CSS & Java Script Web Publishing, Laura Lemay, Rafe Colburn and Jennifer Kyrnin, BPB Publications.

Reference Books
1. HTML, CSS and JavaScript All in One, Sams Teach Yourself, Julie C. Meloni and Jennifer Kyrnin, Pearson Education.
2. HTML 5 Black Book, DT Editorial Services, Dreamtech Press.

DATA STRUCTURES LAB

Course Code: **CS29001**
Credit: **1**
L-T-P **0-0-2**
Pre-requisites: **Nil**

COURSE OBJECTIVE
The fundamental objective of this course is to develop linear and non-linear data structures algorithms for practical application and analyze the algorithm in their time and space complexity.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply and implement the learned algorithm for problem-solving.
CO 2: Develop the program for real-time application of the algorithm.
CO 3: Design, develop, and implement optimal algorithms using appropriate data structures.
CO 4: Implementation of priority queue for optimal algorithms.
CO 5: Implement Binary Tree, Binary Search Tree, and AVL Trees for problem-solving
CO 6: Analyze the different sorting and searching algorithm for real-time applications.

CLOUD COMPUTING

Course Code: CS30010
Credit: 3
L-T-P: 3-0-0
Prerequisites: CS20002

COURSE OBJECTIVE
- To provide an in-depth and comprehensive knowledge of the deployment models in Cloud Computing
- To understand the enabling technologies needed for establishing cloud environment
- To motivate students to do programming and experiment with the various cloud computing environments
- To shed light on the cloud providers and software platforms
- To introduce about different programming models in cloud computing

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
CO 2: Compare the various cloud services and cloud platforms
CO 3: Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, Public cloud, Private cloud, Hybrid cloud
CO 4: Adopt suitable computing mechanisms for establishing a cloud environment
CO 5: Examine various cloud applications and issues.
CO 6: Provide the appropriate cloud computing solutions and recommendations according to the applications used

COURSE DETAILS

Introduction
Evolution: Clustering, Grid computing, Virtualization, Basic concepts, Benefits and Risks, Roles and Boundaries, Characteristics, XaaS based service offerings, Basic Deployment models.

Enabling Technologies
Networks: ISPs, Connection less Packet Switching, Router-based Inter-connectivity, Technical and Business Considerations, Data Center: Standardization and Modularity, Automation, Remote Operation, High Availability, Hardware Virtualization: Hardware Independence, Server Consolidation, Resource Replication, OS and hardware based Virtualization, Web Technology, Multitenant Technology, Service Technology.

Computing Mechanisms
Infrastructure: Logical Network Perimeter, Virtual Server, Storage Device, Usage Monitor, Resource Replication, Specialized: Automated Scaling Listener, Load Balancer, Monitors, Failover System, Hypervisor, Resource Cluster, Multi-Device Broker, State Management Database, Management: Resource, SLA, Billing, Remote Administration, Security.

Cloud Providers & Software Platforms
Globally available public clouds (Microsoft Azure, Amazon Web Services, Google Cloud Platform): Overview and Comparison, Instances, Images, Networking and Security, Storage, Monitoring and Automation, Introduction to Open-source softwares: Eucalyptus, Open Nebula, Open Stack, Apache Cloud Stack.

Programming Models & Advances
Introduction to Map Reduce, Apache Spark, Tensor Flow, Inter cloud: Architecture, Resource Provisioning, Billing, Security, Mobile Cloud Computing: Resource Allocation, Security, Business Aspects, Application, Future Scope, Introduction to Edge and Fog Computing.

Textbook
1. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, "Distributed and Cloud Computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier, 2012.

Reference books
1. Barrie Sosinsky, "Cloud Computing Bible", John Wiley & Sons, 2010.
2. Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'Reilly, 2009.
3. James Turnbull, "The Docker Book: Containerization is the New Virtualization", E-Book, 2015.

COMPUTATIONAL INTELLIGENCE

Course Code: CS30011
Credit: 3
L-T-P: 3-0-0

Prerequisites: Nil

COURSE OBJECTIVE

- To understand the basic concepts and characteristics of soft computing
- To understand and analyse fuzzy rules, fuzzy reasoning and various fuzzy inference systems
- To be able to know derivative free optimization and apply genetic algorithms to optimizationproblems
- To apply neural networks to variousclassification problems.
- To know some hybrid models such as adaptive Neuro-fuzzy inference systems

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Identify the basic concepts and characteristics of soft computing and also its associated methodologies.
CO2: Apply various set theoretic operations in fuzzy sets.
CO3: Analyze fuzzy rules, fuzzy reasoning and various fuzzy inference systems.
CO4: Choose derivative free optimization and apply genetic algorithms to optimization problems.
CO5: Assess concepts of artificial neural networks and apply neural networks to various classification problems.
CO6: Analyze some hybrid models such as adaptive neuro-fuzzy inference systems.

COURSE DETAILS

Introduction

Introduction, Soft Computing constituents and Conventional AI, Neuro-Fuzzy and Soft Computing characteristics

Artificial Neural Networks

Introduction to ANN, Perceptrons and MLP, Adaline and Madaline, Back-propagation Multilayer Perceptrons (BPMLP), Radial Basis Function Networks (RBF), Kohonen Self-Organizing Networks, Learning Vector Quantization, Hebbian Learning, Hopfield networks.

Fuzzy Set Theory

Fuzzy sets, Basic Definition and Terminology, Set-theoretic Operations, Member Function Formulation and Parameterization, More on Union, Intersection and Complement, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Adaptive Neuro-Fuzzy Inference Systems(ANFIS), ANFIS Architecture, Hybrid Learning Algorithm

Particle Swarm Optimization

PSO Model, Global Best, Local Best, Velocity Update Equations, Position Update Equations, Velocity Clamping, Inertia Weight, Constriction Coefficients, Synchronous and Asynchronous Updates, Binary PSO.

Differential Evolution

DE as modified GA, generation of population, operators and their implementation.

Ant Colony Optimization

Basic Concepts, Ant System, Application.

Artificial Bee Colony

Historical Development, Types of Bees and Their Role in the Optimization Process.

Textbooks:

1. Jang, Sun, Mizutani, Neuro-Fuzzy and Soft Computing, Pearson Education

Reference Books:

1. Adam Slowik, Swarm Intelligence Algorithms: A Tutorial, Ed: CRC Press, 2020
2. Simon Haykin, Neural Networks: A Comprehensive Foundation, Pearson Education
3. David E. Goldberg, Genetic Algorithms, Pearson Publication, 2003

WEB TECHNOLOGY AND APPLICATIONS

Course Code: CS30019
Credits: 3
L-T-P: 3-0-0
Pre-requisites: Nil

COURSE OBJECTIVES

- To understand the basics of Web Designing using HTML, DHTML, and CSS
- To learn the basics about Client side scripts and Server side scripts

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Describe and interpret standard web technologies
CO2: Apply the basics of Web Designing using HTML, DHTML, and CSS
CO3: Build real world applications using client side and server side scripting languages
CO4: Design and develop applications using web technologies
CO5: Create the database connectivities
CO6: Suggest appropriate web technologies for any application

COURSE DETAILS

HTML, Introduction, HTML Formatting, Hyper-Links, Lists, Tables, Images, Forms, Frames, Cascading Style sheets, Types, XML, Document type definition, XML Schemas, Document Object model.*

Introduction to Client Side scripting, JavaScript, Control statements, Functions, Arrays, Objects, Events, Dynamic HTML with Java Script, AJAX: Ajax Client Server Architecture, XML Http Request Object, Call BackMethods.

NodeJS and Express, Introduction to AngularJS and Fundamentals of ReactJS, Web servers, IIS (XAMPP, LAMPP) and Tomcat Servers, Server Side Scripting, Java Servlets, Java Server Pages, Java Server Faces, JSFComponents, Session Tracking, Cookies.

PHP, Basic Syntax, Defining variable and constant, PHP Data types, Operator and Expression, Operator Precedence, Decisions and Loop, Functions & Recursion, String Processing and Regular Expressions, Form Processing, Working with file and Directories, Cookies

Database Connectivity with MySQL, Servlets, JSP, PHP, MongoDB, NOSQL Database*, Fundamentals of JQuery and Bootstrap

Textbooks:

1. Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, “Internet & World Wide Web How to Program”, Fifth Edition, Deitel Series, 2012.
2. Jason Gilmore, “Beginning PHP and MySQL from Novice to Professional”, Fourth Edition, Apress Publications, 2010.(Foreign books with available in the publisher site)
3. Brown, Ethan, “Web Development with Node and Express: Leveraging the JavaScript Stack”,Second Edition O'ReillyMedia,.
4. Anthony, Accomazzo, Murray Nathaniel, Lerner Ari, “Fullstack React: The Complete Guide to React JS and Friends”, Fullstack.io, 2017.(Not available in the publisher site)

Reference books:

1. Robert W. Sebesta, “Programming with World Wide Web”, Fourth Edition, Pearson, 2008.
2. David William Barron, “The World of Scripting Languages”, Wiley Publications, 2000.
3. Dayley B., “Node.js, MongoDB, and AngularJS Web Development”, Addison-Wesley Professional, 2014.
4. Vainikka J., “Full-Stack Web Development using Django REST Framework and React”, 2018.

SOFTWARE DEFINED NETWORKING

Course Code: **CS30023**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **CS30003/EC30004**

COURSE OBJECTIVES

- Analyze reduced Complexity of Network Operation
- Describe and understand the concepts of minimize Layer and maximize Network Resources
- Evaluate and understand the Faster Time to Revenue for New Applications
- Memorize Data center and its usage
- Illustrate about Big data

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend Software Defined Networks
CO 2: Analyze reduced Complexity of Network Operation
CO 3: Compare and analyze the advantages of SDN over traditional network
CO 4: Design and implement software defined network
CO 5: Design algorithm for virtualization
CO 6: Design algorithm for big data analytics

COURSE DETAILS

Introduction

Introduction, Control Plane, Data Plane, Distributed Control Planes, IP and MPLS, Creating the IP Underlay, Convergence Time, Load Balancing High Availability, Creating the MPLS Overlay, Replication, Centralized Control Planes, Logical Versus Litera, ATM/LANE, Route Servers, Wire Protocol, FAWG, Config and Extensibility, Architecture, Hybrid Approaches, Ships in the Night, Dual Function Switches.*

Interface

VMWare, Nicira, Mininet, NOX/POX, Trema, Ryu, Big Switch Networks/Floodlight, Layer 3 Centric, L3VPN, Path Computation Element Server, Plexxi Affinity, Cisco OnePK, Management Interface, Network Divide, Modern Programmatic Interfaces, Modern Orchestration.*

Data Center

Multitenant Data Center, Virtualized Multitenant Data Center, SDN Solutions for Data Center Network, VLANs, EVPN, VxLan, NVGRE, Virtualization and Data Plane I/O, Services Engineered Path, Service Locations andChaining, NEV at ETSI, Non-ETSI NEV Work.*

Topology

Network Topology, Traditional Methods, LLDP, BGP-TE/LS, ALTO, I2RS, Build Code First, The Juniper SDN Framework(s), Open Daylight Controller/Framework, Policy.*

Technology:

Bandwidth Scheduling, Manipulation, Calendaring, Bandwidth Calendaring, Big Data and Application Hyper, Virtualization for Instant CSPF, Expanding Technology, Use Cases for Data Center Overlays, Big Data, Network Function Virtualization, Data Center Orchestration, Puppet, Network Function Virtualization, Optimized Big Data, Firewall as Service, Network Access Control Replacement, Virtual Firewall, Feed Back and Optimization, Intrusion Detection/Threat Mitigation.*

*Programming Assignments are mandatory

Textbooks

1. Thomas D. Nandeau, Ken Gray, “Software Defined Networks”, First Edition, O’ Reilly Media Inc., 2013.
2. FEI HU, “Network Innovation through Open Flow and SDN: Principles and Design”, CRC Press, 2014.

Reference Books

1. Azodolmolky, Siamak, “Software Defined Networking with OpenFlow”, Packt Publishing Ltd., 2013.
2. Nadeau, Thomas D., Ken Gray, “SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies”, O'Reilly Media Inc., 2013.
3. Dillinger, Markus, Kambiz Madani, Nancy Alonistioti, “Software Defined Radio: Architectures, Systems and Functions”, John Wiley & Sons, 2005.
4. Goransson, Paul, Chuck Black, Timothy Culver, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, 2016.

COMPUTER VISION AND PATTERN RECOGNITION

Course Code: **CS30029**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The challenge of computer vision is to develop a computer based system with the capabilities of the human eye-brain system. It is therefore primarily concerned with the problem of capturing and making sense of digital images. The field draws heavily on many subjects including digital image processing, artificial intelligence, computer graphics and psychology. The objectives are to develop students’ understanding of the basic principles and techniques of image processing, image understanding, and to develop skillsets in the design and implementation of computer vision techniques.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Explain the image formation and camera technologies
CO2: Perform feature extraction using different image processing techniques.
CO3: Differentiate between image formats
CO4: Perform image transformation based on different types of transformation techniques.
CO5: Design filters to perform image analysis using spatial and frequency domain methods.
CO6: Design systems to detect and track various objects.

COURSE DETAILS

Digital Image Fundamentals

Elements of visual perception, A simple image model, Sampling and Quantization, Relationship between pixels, image geometry: Translation, Rotation.

Image Analysis

Introduction spatial domain methods, Frequency domain method, Enhancement by point processing : Histogram equalization, Spatial filtering : Mean & Median filter, Sharpening filter, High boost filters, Derivative filters, Enhancement in frequency domain, Homomorphic filtering.

Image Transform Review of mathematical preliminaries

Toeplitz and Circulant matrices, Orthogonal and Unitary matrices, Block matrices and Kronecker products, Separable operators, Introduction to image transforms, Two dimensional orthogonal and Unitary transforms,

Properties of unitary transforms, 2-D DFT, Walsh Transforms, Hadamard transform, Discrete Cosine Transform (DCT), Karhunan-Lauve (K-L) Transform, SVD Transform.

Feature Extraction

Edges Canny, Sobel, Line detectors (Hough Transform),Corners -Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, Feature analysis, Feature vectors, Distance/similarity measures.

Object Representation and Tracking

Object detection, Face detection, Pedestrian detection, Face recognition: Eigenfaces, Active appearance and 3D shape models. Object representation, Motion detection and Tracking, Background Subtraction and Modelling, Optical Flow. Point tracking, Kernel tracking, Introduction to Yolo.

Machine Learning for Computer Vision

Neural Architecture, deep learning use cases, Datasets for Machine perception, Training Pipeline, Building sequential model using Keras and CV2, Transfer learning.

Textbooks

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Valliappa Lakshmanan, Martin Görner, Ryan Gillard, Practical Machine Learning for Computer Vision, Released July 2021, Publisher(s): O'Reilly Media, Inc., ISBN: 9781098102364
3. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003.

Reference Books

1. E.R Davis, Computer and Machine Vision Theory, Algorithms, Practicalities, Academic Press,4th Edition
2. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
3. Bradski, G., & Kaehler, A. (2008). Learning Open CV: Computer vision with the OpenCV library. " O'Reilly Media, Inc."
4. Hartley, R., & Zisserman, A. (2003). Multiple view geometry in computer vision. Cambridge university press.

AUGMENTED AND VIRTUAL REALITY

Course Code: CS40010
Credits: 3
L-T-P 3-0-0
Prerequisites: CS30015/CS30029

COURSE OBJECTIVE:

- To know basic concepts of virtual reality
- To understand visual computation in computer graphics
- To understand interaction between system and computer
- To know application of VR in Digital Entertainment
- To know basic concepts of augmented reality

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Discuss the fundamentals and I/O components of the augmented and virtual reality system
CO 2: Evaluate different computing architectures for virtual reality
CO 3: Provide opportunity to explore the research issues in Augmented Reality and Virtual Reality (AR & VR)
CO 4: Apply the different modeling concepts to visual virtualization

CO 5: Explore the role of virtual reality in traditional & emerging applications
CO 6: Develop prototypes using the concepts for virtual reality

COURSE DETAILS

Introduction of Virtual Reality
Fundamental Concept and Components of Virtual Reality, Primary Features and Present Development on Virtual Reality, Multiple Models of Input and Output Interface in Virtual Reality: Input, Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner, Output, Visual /Auditory / Haptic Devices.

Visual Computation in Virtual Reality
Fundamentals of Computer Graphics, Software and Hardware Technology on Stereoscopic Display, Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering.

Interactive Techniques in Virtual Reality
Body Track, Hand Gesture, 3D Manus, Object Grasp.
Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3DStandard; Vega, MultiGen, Virtools.

Application of VR in Digital Entertainment
VR Technology in Film & TV Production, VR Technology in Physical Exercises and Games, Demonstration of Digital Entertainment by VR.

Augmented and Mixed Reality
Taxonomy, Technology and Features of augmented reality, Difference between AR and VR, Challenges with AR, AR systems and Functionality, Augmented reality methods, Visualization techniques for augmented reality, Wireless displays in educational augmented reality applications, Mobile projection interfaces, Marker-less tracking for augmented reality, Enhancing interactivity in AR environments, Evaluating AR systems.

Textbooks

1. Burdea, G. C., P.Coffet., "Virtual Reality Technology", Second Edition, Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann, 2013.

Reference book

1. Alan Craig, William Sherman, Jeffrey Will, "Developing Virtual Reality Applications, Foundations ofEffective Design", Morgan Kaufmann, 2009.

CRYPTOGRPHY AND NETWORK SECURITY

Course Code: **CS40015**
Credit: **3**
L-T-P **3-0-0**
Prerequisites: **EC30004/CS30003**

COURSE OBJECTIVE
The main objective of this course is to cover the cryptography algorithms for network security in communication and to introduce students to the areas of cryptography and crypt-analysis attacks and security goals. This course develops the understanding of the algorithms Symmetric and Asymmetric Algorithms and used to protect users online and to understand some of the design choices behind these algorithms.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Analyze different security threats and attacks with reference to ISO/OSI model security.

CO 2: Differentiate between various cryptography, watermarking, steganography methods.

CO 3: Analyze different Symmetric and Asymmetric cryptographic algorithms

CO 4: Differentiate various key distribution and Digital Signature.

CO 5: Analyze the working of various communication security protocols with respect to OSI layer.

CO 6: Analyze different network security systems implementation in Wireless systems.

COURSE DETAILS

Introduction
Cryptography, Watermarking, Steganography, Escrow and Crypt Analysis, ISO/OSI reference model and Security, Security Goals, Security threatening attacks, Security Services, Security Mechanisms.

Symmetric Key Mono-Alphabetic Cryptography
Symmetric key cipher, Traditional Ciphers, Substitution Cipher, Mono-Alphabetic Ciphers, Additive Cipher/ Shift Cipher/ Caesar Cipher, Multiplicative Cipher,, Affine Cipher (combination of Additive Multiplicative Cipher).

Symmetric Key Poly-Alphabetic Cryptography
Poly-Alphabetic, Auto-key, Play-fair, Vigenere, Hill Cipher, Rotor Cipher- Enigma Machine

Symmetric Key Transposition Cryptography
Introduction to Traditional Transposition, Key-less Transposition, Keyed Transposition, Combined Two Approach, Double Transposition, Stream/ Block.

Asymmetric Key Cryptography
Introduction to asymmetric key cryptography, Keys, General Idea, Plain- text, Cipher-text, Encryption, Decryption.

RSA Cryptosystem
Rivest-Shamir-Adleman (RSA), RSA Procedure, RSA key generation, RSA Encryption and Decryption, Attacks on RAS, Cryptography key distribution system (KDS).

Network Security
Network Security at Application Layer (PGP and S/MIME), Network Security at Transport Layer (SSL and TSL), Security at Network Layer (IPSec).

Textbooks

1. B A Forouzan and D Mukhopadhyay, Cryptography & Network Security Mc-Graw Hill, India, 2ndEdition, 2010.
2. S V. Kartalopoulos, Security of Information and Communication Network Wiley-IEEE Press., 2009.

Reference books

1. Stavroulakis, Peter, Handbook of Information and Communication Security ; Springer, 2010.
2. Adrian Perrig& Doug Tygar, Secure Broadcast communication in Wired and Wireless Communication. Kluwer Publication, 2002.
3. W Mao,Modern Cryptography: Theory and Practice, Pearson, 1st Edition, 2003.

INDUSTRY 4.0 TECHNOLOGIES

Course Code: EX20001
Credits: 2
L-T-P: 2-0-0
Pre-requisites: Nil

COURSE OBJECTIVES
The current manufacturing industries and businesses are moving from the third industrial revolution of the computers and automation to the fourth where the automation becomes even smarter fueled by data analytic and artificial intelligence. This course is designed to offer learners an introduction to use of Internet and Digital technology for better manufacturing and business. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand the key components and enablers of Industry 4.0 Technology
CO 2: Appreciate the smartness in Smart Factories, smart products and smart Services.
CO 3: Outline Smart Factory technologies and their role in an Industry 4.0 world
CO 4: Outline IoT technology and scope of implementing IoT in Industries and businesses.
CO 5: Comprehend distributed cyber-physical and digital manufacturing system
CO 6: Demonstrate the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits

COURSE DETAILS

Introduction
The Fourth Industrial Revolution, Difference between conventional automation and Industry 4.0, Case Studies: Health, Agriculture, Manufacturing

Industry 4.0 and its components
Internet of Things (IoT) & Industrial Internet of Things (IIoT), Internet of Services, Value chains in manufacturing companies, Digital Twins

Digital Manufacturing and Design
Cyber Physical Systems and Next Generation sensors, Collaborative Platform and Product Life-cycle Management, Robotics and Automation

Industrial IoT
Cloud Computing, Big Data Analytic, AI & ML, Virtual and Augmented Reality, Block-chain

Challenges & Opportunities in Industry 4.0
A Digital Strategy alongside Resource Scarcity, Standards and Data security, Financing conditions, availability of skilled workers, Comprehensive broadband infra- structure, Legal framework, Protection of corporate data, liability, Handling personal data.

Textbooks

1. D. Pyo, J. Hwang, and Y. Yoon, *Tech Trends of the 4th Industrial Revolution*, Mercury Learning & Information publisher, 2021.

2. Bruno S. Sergi, Elena G. Popkova, Aleksei V. Bogoviz, and Tatiana N. Litvinova *Understanding Industry 4.0 : AI, the Internet of Things, and the Future of Work*, Pub: Emerald Publishing Limited, 2019

Reference books

1. S. Misra, A. Mukherjee, and A. Roy *Introduction to IoT*. Cambridge University Press, 1st edn. 2021

2. Dac-Nhuong Le, Chung Van Le, Jolanda G. Tromp , Gia Nhu Nguyen, *Emerging Technologies for Health and Medicine: Virtual Reality, Augmented Reality, Artificial Intelligence, Internet of Things, Robotics, Industry 4.0*, John Wiley publisher, 2018

3. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress Berkeley publisher, CA 1st ed 2016.

SCIENTIFIC AND TECHNICAL WRITING

Course Code: **EX20003**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **NIL**

COURSE OBJECTIVE
Technical documents take many forms depending on their purpose and the audience. A technical document can be a project proposal, minutes of a meeting, an advertisement in a newspaper, or even a research paper. A scientific document is a form of technical document where both the author and the audience are experts. The writing styles and the document density of technical documents depend on the nature of the document. The

objective of this subject is to train the students in the art and science of writing a range of scientific and technical documents.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Realize the need to articulate the purpose of the document, identify its audience, and decide the density of information to be included in scientific and technical documents;
CO 2: Internalize the art and science of scientific and technical writing;
CO 3: Make appropriate use of crisp language, illustrations, and symbols.
CO 4: Distinguish between bad and good writing. (Analyze and Evaluate)
CO 5: Prepare a variety of scientific and technical documents, including laboratory and project reports; and
CO 6: Write these documents in an accurate, clear, concise, coherent, appropriate, and readable manner.

COURSE DETAILS

Introduction
Forms and features of creative, technical, scientific, and science writing; Audience types (general and specific experts, technicians, managers, laypersons, and mixed audience); Examples of documents for technical, professional, and scientific communications; Characteristics of effective technical writing: Accuracy, clarity, conciseness, coherence, appropriateness, and readability.

Language Issues
Revisiting English grammar; Punctuation (period, comma, colon, semicolon, question mark, exclamatory mark, apostrophe, quotation marks, hyphen, dash, parentheses, and brackets); Mechanics (capitalization, italics, abbreviations, acronyms); Latin terms used popularly in English texts; Informal and colloquial English; Dangling modifiers, Faulty parallelism, Judicious use of common words and phrases; Active and passive voice; Nominalization; Common English errors; Pitfalls in writing; Adapting texts to issues of gender, race, and ethnicity; and Guarding against Plagiarism.

Paragraphing: Unity of idea, topic sentence, logical and verbal bridges through use of signposts, transitions, and link words; Patterns of development of an idea; and Lists.

Structure of Scientific Documents

Prefatory Materials
Title, Copyright Notice, Declaration and Certificates, Abstract, Keywords, Acknowledgements and Conflict of Interest Statement, Symbols and Abbreviations, and Table of Contents.

Body of Scientific Documents
Introductory Materials—Context, Problem and Current response, Research questions, Hypotheses, and Objectives and Scope; Literature Review—Presentation styles, Citations and Referencing systems, Quoting, paraphrasing, and summarizing; Materials and Methods—Mathematical Materials: Methodology, methods, tools, and techniques; Quantitative, Qualitative, Experimental and Mixed methods; Numbers and Numerals, Engineering and Scientific notations of numbers, Mathematical operators, Equations, Flowcharts, Algorithms, SI units, Significant digits and Order of magnitude, Figures, Tables, and Photographs; Experimental apparatus, Materials, Specifications, Measuring instruments, Procedure, Data analysis; Concluding Materials—Conclusions, Implications, Generalization, Limitations, Scope for further work and Contributions of the work.

End Matters
References, Appendixes, and Supplementary materials.

Structure of Selected Technical Documents
PowerPoint presentation, Abstract of a paper, Laboratory reports, Progress report, Project proposal, Minutes of a meeting, Brochure, and News items.

Textbooks
1. Lecture notes on Scientific and Technical Writing
2. Alred, G. J., C. T. Brusaw, and W. E. Oliu (2008), *Handbook of Technical Writing*, St. Martin's Press, New York, Ninth Edition.
3. Angelika H. Hofmann (2014), Scientific Writing and Communication, Papers, Proposals, and Presentations, Oxford: Oxford University Press.
4. Duke Graduate School Scientific Writing Resource (https://sites.duke.edu/scientificwriting/).

5. Gerald. J. Alred, Charles. T. Brusaw, and Walter. E. Oliu (2008), *Handbook of Technical Writing*, St. Martin's Press, New York, Ninth Edition.
6. OWL, The Purdue Online Writing Laboratory, https://owl.english.purdue.edu/owl/.
7. Perelman, L. C., J. Paradis, and E. Barrett (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing (ed.), Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm, Mayfield Publishing Company, Inc., 1280 Villa Street, Mountain View, CA 94041, 415.960.3222, <http://www.mayfieldpub.com>, <mailto:hypertext@mayfieldpub.com>
8. Rubens, P. (2001), Science and Technical Writing: A Manual of Style, 2nd Edition, Routledge, New York.

ENGINEERING PROFESSIONAL PRACTICE

Subject Code: **EX40003**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
Engineers are expected to perform their tasks responsibly and ethically, following professional standards and guidelines. This subject allows the students to understand the roles and responsibilities of engineers in society, learn professional standards, codes of ethics, issues concerning employment contracts and other legal matters, and skills of working in teams, and to effectively communicate. The subject will be offered jointly by the faculty members of various schools of technology and will be coordinated by the School of Mechanical Engineering.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: Know (a) the features of engineering as a profession, (b) the roles and responsibilities of engineers in society, and (c) the skills for working in teams,
CO2: Realize the use of professional standards, codes of ethics, legal provisions surrounding engineering functions,
CO3: Apply the above-stated standards, codes, legal provisions, and group communication skills in their decision-making situations,
CO4: Break down a complex problem into smaller manageable tasks,
CO5: Compare among alternatives in situations of uncertainty, risk, and ambiguity,and
CO6: Design engineering solutions to industrial environmental and social problems.

COURSE DETAILS

Engineering and Engineer
Engineering as a discipline and a profession; Attributes and functions of a practicing engineer and Engineer as a problem solver, designer, and change agent.

Selected Functions of Engineering
Designing for safety and reliability; Quality and Productivity management; Dealing with problem complexity, Uncertainty, Risk and Ambiguity; Project management and Managerial functions such as planning, Organizing, Motivating and Controlling; Costing and Accounting.

Professional Aspects of Engineering
Accreditation, Certification and Licensing; Ethical issues: Ethics and morality, Ethical dilemmas, Codes of ethics, Professional conduct, Nature and Role of professional societies, Engineering standards; Legal issues—Legal forms of business organizations, Employment contracts, Trademarks, Patents, Copyrights, Trade secrets, Professional liability, Contractual agreements, Environment and Information technology laws and International legal framework such as WTO.

Group Dynamics
Individual cognition; Dynamics of working in teams/groups; Interacting with stakeholders; Dealing with multicultural environments; Team and group communication; and Negotiation and conflict resolution.

Text Book

1. Shrestha, R. K. and Shrestha, S. K. (2020), Text Book of Engineering Professional Practice, 3rd Edition, Heritage Publishers and Distributors Pvt. Ltd.

Reference Books

1. Habash, R. (2019), Professional Practice in Engineering and Computing: Preparing for Future Careers, 1st Edition, Boca Raton: CRC Press.
2. Walesh, S. G. (2012), Engineering Your Future: The Professional Practice of Engineering, 3rd Edition, Wiley.
3. Subramaniam, R. (2017), Professional Ethics, 2nd Edition, Oxford University Press
4. Lectures note on Engineering Professional Practice provide by Concerned faculty members.

ECONOMICS OF DEVELOPMENT

Course Code: **HS20120**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to provide students with the essential tools and concepts of development economics, to prepare them to understand what makes underdevelopment persist and what helps development succeed. Students will explore diverse dimension and measures of development, as well as the application of microeconomic analysis to issues of development in poor countries, including the study of household decisions and the analysis of institutions and norms influencing development.And To enhance students understanding of the SDGs to create a better- informed citizenry, which will lead to a m ore sustainable action by all and for all.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand key factors and issues in the process of economic development,
CO 2: Enhance their ability in applying economic models to study development Problems,
CO 3: Learning the role of the three basic components of ecosystems and environment and underlying causes of their degradation,
CO 4: Understand the policy scenario and the existing environmental conventions/ regulations/ laws,
CO 5: Development of sustainable planning for sustainable development of environment, economy and firms,
CO 6: Select and apply appropriate economic techniques to solve environmental problems and measure the value of environmental goods.

COURSE DETAILS

Economic Growth and Development

Meaning of development and Economic growth, Characteristics of less developed countries. Factors in Economic development, Measuring development and development gap — per capita income, inequality of income and wealth, Gini coefficient, Human Development Index , Physical Quality of Life Index, and other indices of development.

Theories of Economic Growth and Development

Theories of Economic Development: Classical (Smith, Ricardo, Malthus), Marxian – Theory of Social change, immutable laws, Crisis in capitalism, Schumpeter and capitalist development, Rostow's stages of growth. Partial theories of growth and development: Vicious circle of Poverty, Big push, balanced growth, unbalanced growth,

International aspects of Economic Development

International trade as an engine of growth; Static and dynamic gains from trade; Prebisch, Singer and Myrdal theses vs. free trade; Export-led growth; Tariffs and effective protection; WTO and developing countries. External resources; FDI; Aid vs. trade;

Development and Environment

Economy linkage; Environment as a necessity and luxury; Population environment linkage. Allocation problem; Market failure for environmental goods; environment as a public good.

Sustainable Development

Concept and indicators of sustainable development. Common Property Resources, Property right approach to environmental problem-property rights approach, property rights and environmental problems, Externalities and Pigovian tax, Coase theorem, Coase theorem and transaction cost. Prevention, control and abatement of pollution.

Textbooks

1. S.Ghatak, An Introduction to Development Economics, Allen and Unwin, London,2003
2. Kindleberger, C. P. Economic Development, McGraw Hill, New York, 1958
3. Todaro, M. P. Economic Development, Longman, London.

References books

1. Thirwal, A. P. Growth and Development, Macmillan, U. K,2017.
2. Adelman, I. Theories of Economic Growth and Development. Stanford University Press, Stanford, 1966.
2. Chenery, H. and T.N. Srinivasan (Eds) Handbook of Development Economics, Vols 1 & amp; 2 Elsevier, Amsterdam, 2002.
3. Myint, H. Economic Theory and Underdeveloped Countries, Oxford University Press, New York,1971.

INTERNATIONAL ECONOMIC COOPERATION

Course Code: **HS20122**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course's overarching objective is to equip students with knowledge of both the toretical concepts and the actual procedures involved in international trade. The specific purpose is to increase the knowledge of importing and exporting essentials and to offer the with the skills for understanding the international trading process.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn theories of international trade,
CO 2: Understand free trade, protection, and BOP,
CO 3: Analyse the role of international organisations,
CO 4: Understand the working of foreign exchange,
CO 5: Study the EXIM policies,and
CO 6: Analyse secondary data relating to international trade.

COURSE DETAILS

Theories of International Trade

Classical Theories of International Trade- Mercantilism, Absolute Advantage, Comparative advantage Theory, Gains from international trade; Terms of trade; Theory of Reciprocal Demand; Modern Theories of International Trade-Heckscher-Ohlin theory

Free Trade,Protection and Balance of Payment

Free trade and Protection in developing countries; Forms, Methods and Effects of protection; Introduction of BoP; Structure of BoP; Disequilibrium in BoP; Measures to overcome disequilibrium in BoP., Tariff; Trade creation vs Trade diversion.

International Organizations

International Monetary Fund; World Trade Organasation; Regional Trade Agreements; Trade Blocs.

Foreign Exchange

Foreign Exchange Market; Theories of foreign exchange; Factors affecting exchange rate; Fixed and flexible exchange rate; FERA and FEMA.

EXIM Policies

Recent budgetary policies and Programs relating to inequality; Analysis of Economic Survey data.

Textbooks

1. R. R Paul, *Money Banking and International Trade*, Kalyani Publishers; 12th edition,2015, ISBN-10 : 932725774X ISBN-13 : *9327257748-978*

2. Bo Södersten and Geoffrey Reed, Palgrave Macmillan, International Economics. 1994, ISBN-10 : 0333612167 ISBN-13 : *0333612163-978*

Reference books

1. Dominick Salvatore, International Economics: Trade and Finance, Wiley; Eleventh edition,2017, ISBN-10 *: 13-ISBN 8126552344* 978-8126552344

2. Paul R. Krugman, Maurice Obstfeld, Marc Melitz, *International Trade: Theory and Policy*, 2017, ISBN-10 : *IS 9789332585768* BN-13 : *9332585768-978*

ORGANIZATIONAL BEHAVIOUR

Course Code: **HS20220**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **NIL**

COURSE OBJECTIVE

This course shall guide the students to learn the basic concepts of Organizational Behaviour and its applications in contemporary organizations. Further, it help them to describe how people behave under different conditions and understand why people behave as they do. The students would be in a position to synthesize related information and evaluate options for the most logical and optimal solution such that they would be able to predict and control human behaviour and improve results. Lastly, this course would help the students to understand how individual, groups and structure have impacts on the organizational effectiveness and efficiency.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know about organization, organizational behaviour, it's nature, scope and significance,
CO 2: Develop their personality as per industry requirement,
CO 3: Apply motivational techniques to make the employees work with confidence and satisfaction,
CO 4: Develop different leadership styles to adjust themselves in different organizational situations,
CO 5: Improve the knowledge of group behaviour and techniques of group decision making,and
CO 6: Apply the concepts for managing changes in organization as well as the development of an organization's human resources.

COURSE DETAILS

Introduction to Organizational Behaviour

Organizational Behaviour- nature and scope; Need for studying OB; contributing disciplines to OB; evolution of OB; OB approaches and models; OB opportunities and disruptions

Individual Perspective

Introduction to Individual behaviour; Personality- concept, determinants, types and theories/models; Personality and OB; Perception- meaning, perceptual process, factors affecting perception; perception and Its application in OB; Attitude- nature, Components, Formation and Types; Values- concepts, Types and Formation; Attitude, Values and Behaviour

Individual Perspective

Learning- meaning, Determinants, Theories and Principles; Learning and Behaviour; Motivation- nature, importance, process and theories; managerial implication of motivation- job design, quality of work life and employee engagement; organizational citizenship behaviour- meaning, theoretical perspective, determinants and predictors

Group Perspective

Foundation of group behaviour; meaning and characteristics of group; why do people form and join groups; types and groups; stages of group development; group decision making; Team building- meaning and types of team; team building

process; Meaning, sources and types of conflict; conflict management and negotiation strategies; Leadership- meaning and importance; differentiating between leader and manager; leadership styles; leadership theories

Organizational Perspective
Organizational structure- meaning and elements; Organizational culture- meaning, types and functions of culture; creating, sustaining and changing a culture; Organizational change- meaning and need; ; managing resistance to change; Organizational development- meaning, objectives, models and interventions

Textbooks
1. Dr. S..S. Khanka, Organizational behaviour texts and cases Sultan Chand, OB text and cases S.S. Khanka, S chand, 2022
2. Stephen P. Robbins, Timothy A. Judg, Neharika Vohra Organizational Behaviour, Pearson, 18th edition, 2018

Reference books
1. Fiona M. Wilson,Organizational Behaviour and Work Oxford University Press,2014
2. K. Aswathappa ,Organizational Behaviour, , Himalaya Publishing House, 2013

HUMAN RESOURCE MANAGEMENT

Course Code: **HS20222**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **NIL**

COURSE OBJECTIVE
This course aims at providing conceptual knowledge on human resource management that will be useful for a manager of an organization. It also understands employer and employee relationship in order to achieve organizational objectives effectively. It starts with hiring and continues till retention. It also focuses on enabling the students to integrate the understanding of various HR concepts along with the domain concept in order to take correct business decisions.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Learn the various functions of management, personal and professional qualities of a manager in order to manage human resource of an organization effectively,
CO 2: Understand the process of acquiring human resource through effective planning, recruitment and selection process,
CO 3: Apply different training and development methods for organizational effectiveness,
CO 4: Analyse the importance of performance appraisal and equitable pay for the growth of both individual and organization,
CO 5: Inculcate the sense of inter personal relation required in professional front in handling employer-employee relation effectively for achievement of organizational objectives and
CO 6: Know the technique of managing and being managed by the organization.

COURSE DETAILS

Introduction to HRM
Introduction, scope, Objectives; Managerial and Operational functions of Management; HRM as a source of competitive advantage; Qualities and role of HR managers

Planning and Acquiring Manpower
Human resource planning- Introduction, objectives, need, importance; Factors, Process and barriers of HRP; Job analysis- concept, objective and Process; Meaning, process and sources of recruitment; Factors of effective recruitment; Meaning and process of selection; Competency mapping for selection decision; Induction and socialization; recent trends in recruitment and selection

Developing Manpower
Training- nature, need, objectives, importance; areas of training; training process- identifying training need, designing a training program; methods and techniques of training; evaluating training effectiveness; Role specific and competency based training; career planning and development- meaning, objective and process

Managing Performance and Compensation

Performance appraisal- concept, objectives and importance of performance appraisal; Process of performance appraisal; Methods of performance appraisal; Problems in performance appraisal; Potential Appraisal; Components of compensation; objectives and factors affective Wage and salary administration; methods of wage payment; process of wage determination; Pay band compensation system

Maintaining and Retaining Human Resources
Industrial Relation- concept, objective and approaches: Reasons for poor industrial relation; Measures for improving industrial relation; Industrial Dispute- nature, causes, prevention and settlement; meaning, objectives, importance and conditions for successful collective bargaining; Workers Participation in management- concept, objectives, forms and measures; Discipline and Grievance- Statutory provisions concerning discipline; causes and machinery for redressal of grievances

Textbooks
1. P. Jyoti & D. N. Venkatesh ,Human Resource Management, Oxford Publication.
2. Gary Dessler and Biju Varkkey ,Human Resource Management, , Pearson Education, 2020

Reference books
1. S S Khanka Human Resource Management Text and Cases by, S.Chand and company Limited, 2022
2. K. Aswathappa,Human Resource Management. Mc Graw Hill Education, 2013
3. P. Subba Rao Personnel and Human Resource Management., Himalaya Publishing House, 2022

ENGINEERING ECONOMICS

Course Code: **HS30101**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
The objective of Engineering Economics is to aid in decision-making by focusing on the economic implications of technical analysis. It is committed to making operational level decisions and solving problems.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Comprehend the significance of different components of Engineering Economics,
CO 2: Analyze the basic economic concepts required for engineers and managers,
CO 3: Develop the problem solving aptitude in the students through practical and case problems,
CO 4: Decide the feasibility of a particular project by the application of different project evaluation Techniques,
CO 5: Use the economic tools in the decision making process, and
CO 6: Survey the current macroeconomic situations in the economy.

COURSE DETAILS

Introduction to Economics and Engineering Economics
Basic concepts of Engineering Economics: Demand Analysis, Supply Analysis, Market Equilibrium. Revenue Analysis. Demand Forecasting- Quantitative Methods, Consumer's Equilibrium.

Production and Cost Analysis
Short Run and Long Run Production Functions, Producer's Equilibrium condition. Cobb-Douglas Production Function.

Cost Concepts: Short Run and Long Run Cost analyses. Break-Even Analysis.

Market: Concepts and Types;Perfect Competition, Monopoly

Time Value of Money
Interest Formulae and their applications with cash flow diagram. Evaluation of Investment Proposals - Present Worth, Future worth and Annual Equivalent Method of comparison

Economic Appraisal Techniques
Net Present Value (NPV), Internal Rate of Return(IRR) ,Cost Benefit analysis.Depreciation calculation; Meaning and Definition, Methods.

Macroeconomic policies
Functions of commercial banks and central bank, Fundamentals of Business cycle, Macroeconomic policies for stabilization.

Textbooks

1. Dominick Salvatore, Siddartha K. Rastogi, Managerial Economics: Principles and Worldwide Applications, Oxford University Press, ISBN 9780199467068, 9th Edition,2020
2. D N Dwivedi, H L Bhatia, & S N Maheswari,Engineering Economics:, Vikas Publishing House, Noida, ISBN:978-93-5674-625-1, 2nd Edition 2023.
3. James Riggs, David D.Bedworth and Sabah U.Randhawa ,Engineering Economics–, 4th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2016.

Reference book

1. William A. McEachern and Simrit Kaur Micro ECON-A South-Asian Perspective-, Cengage Learning, 2013.
2. Yogesh Maheshwari, Managerial Economics- 3rdEdition, PHI Learning Private Limited,2014.
3. A. Khan, Arshad Noor Siddiquee, Brajesh Kumar,Engineering Economy-Zahid Pearson Publication, 2012.
4. R.Panneerselvam Engineering Economics –, Pub: PHI Learning Private Limited, New Delhi, 9thEdition, 2008.
5. G.S Gupta Managerial Economics, , Tata McGraw Hill Education Private Limited, 2nd Edition, 2011.
6. D.M.Mithani, Managerial Economics – Theory and Applications –Himalaya Publication, New Delhi, 6th Edition, 2009.
7. S.B.Gupta, R7. Monetary Economics-Institutions, Theory and Policy- Publication: S.Chand, 1995.
8. R.D. Gupta R8. Macro – Economics –, Publication: Kalyani Publication, 1994.

MARKET STRUCTURE AND PRICING POLICIES

Course Code: **HS30125**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
Develop the ability for getting conceptual clarity about the various types of markets along with their functions and understand the pricing policy operations in the different markets.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Comprehend the significance of different components of market,
CO 2: Analyze the basic economic concepts required for various types of market and their policies,
CO 3: Develop the problem solving aptitude through practical and case study problems faced by the economy,
CO 4: Able to use the economic tools in the decision making process of fixing prices and quantities in different Market,
CO 5: Differentiate between different markets and the policy measures to regulate it,and
CO 6: Survey and map the impact of the current micro and macro-economic situations in the economy.

COURSE DETAILS

Cost and Revenue Analysis
Concepts of cost (economic cost, production cost, real cost, opportunity cost, private & social cost), Cost function, Output maximisation and Cost minimisation, Derivation of cost function, Traditional and Modern theories of costs.

Concepts of revenue (total, average, marginal revenue), Relationship between TR, AR and MR.

Market Structures and Perfect Competition
Meaning of market, Characteristics of market, and Types of market.

Perfectly competitive market and Features, Equilibrium of the firm and industry under perfect competition (short run and long run).

Monopoly Market

Meaning, concepts and characteristics of monopoly market. Equilibrium price and output determination under monopoly market in short and long run. Monopoly price discrimination. Degree of monopoly power and its measure. Control and regulation of monopoly power.

Duopoly and Oligopoly Market
Non-collusive oligopoly: Cournot's duopoly and Kinked-Demand Model. Collusive oligopoly: Cartel; Cartels aiming at joint profit maximization and market sharing cartels. Price leadership; low-cost price leadership, dominant firm price leadership and barometric price leadership.

Monopolistic Competition
Meaning, price determination of a firm under monopolistic competition; Chamberlin's group equilibrium; theory of excess capacity; selling costs; difference between perfect competition and monopolistic competition; difference between monopoly and monopolistic competition.

Textbooks:

1. Koutsoyiannis, Modern Microeconomics, St. Martin's Press, New York,2nd Edition 1979, ISBN 978-0-333-25349-6
2. G. S. Maddala , Ellen M. Miller ,Microeconomics: Theory and Applications, , McGraw-Hill Inc.,US-Publisher, 1989, 0070394156-ISBN
3. H L Ahuja, Modern Microeconomics: Theory & Applications, S Chand Publishing, 2022, ISBN : 9789355011015,

Reference books:

1. Robert Pindyck, Daniel Rubinfeld, Microeconomics, Eighth Edition, 2017, 9789332585096-ISBN, Pearson Education Publication
2. G. Fransico Stigler, Theory of Price, Prentice Hall of India, New Delhi, 4th Edition 1996.
3. H. Gravelle and R. Rees, Microeconomics, Person Education U.K. 3rd Edition 2007, 2007ISBN: 9788131716557, 8131716554
4. H. R. Varian , Micro Economic Analysis, W W Norton & Company; New York, 3rd edition 2019, ISBN-13 : -978 8130908632

PRAGMATIC INQUIRY

Course Code: **HS30127**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
As a foundation for lifelong inquiry, this course introduces students to research techniques and how they are used in both liberal arts, technical and professional courses.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand the meaning and importance of research in behavioral science,
CO 2: Describe in detail different types of research methodologies,
CO 3: Identify the strengths and weaknesses of the different study designs,
CO 4: Assess whether research studies are using the most appropriate study design,
CO 5: Discuss why various approaches may be appropriate/ inappropriate for their work-based research Question, and
CO 6: Apply the concepts in research related activity.

COURSE DETAILS

Pragmatic Inquiry
Meaning, Characteristics, Need, Type and Approaches.

Research Problem

Meaning, definition, Selection and Framing of problem statement.

Research Design
Meaning, Characteristics, Need, Type, Approaches and Problems of research design.

Sampling Design
Meaning, Characteristics, Need, Type, Approaches and Problems.

Data Collection Method and Analysis
Types of data, Source of data, Methods of data collection, data analysis.

Textbook
1. Deepak Chawla & Neena Sodhi, Research Methodology: Concepts and Cases, Vikas Publishing House,2018, ISBN-10: :13-ISBN ,9325982390 978-9325982390.

Referencebooks
1. C R Kothari and Gaurav Garg, Research Methodology, New Age International Publishers,2019,ISBN-10 9386649225, ISBN-13- 978-9386649225
2. S.K. Mangal, Research Methodology in Behavioural Sciences, Prentice Hall India Learning Private Limited, 2013, ISBN-10 : : 13-ISBN ,9788120348080 8120348080-978
3. Sameer S. Phanse, Research Methodology-Logic, Methods, and Cases,OUP, Sameer S. Phanse,2016 ISBN: 9780199453788

ECONOMIC ANALYSIS OF DECISION RULES

Course Code: **HS30129**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
Analyze and understand investment decisions under the conditions of risk and uncertainty.Particular economic models are not the ends, but the means for illustrating the method of applying mathematical techniques to economic theory in general.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Analyze and understand investment decisions under the conditions of risk and uncertainty,
CO 2: Explain how game theory brings out the strategy used by the oligopoly firms to determine the best possible action to maximize profit-maximizing objective,
CO 3: Understand functional formulation of the problem and application of linear programming,

CO 4: Describes different concepts used in analysing the national income and the different methods applied to measure the national income,
CO 5: Describe and explain the main channels of the monetary transmission mechanism through monetary and fiscal policy,and
CO 6: Describe managerial decisions through the application of some economic concepts, theories and principles.

COURSE DETAILS

Investment Decisions under Risk and Uncertainty
Concepts of Risk and Uncertainty; Investment Decisions under Risk: The Pay-Off Matrix Method, Risk-Adjusted Discount Rate Method, Certainty-Equivalent Approach, Probability Theory Approach, Decision Tree Method, Simulation, Sensitivity Analysis.

Game Theory and Strategic behaviour of Firms
Basics of Game Theory, Prisoners' Dilemma: The Problem of Oligopoly Firms; Application of Game Theory to Oligopolistic Strategy; Nash Equilibrium: Pure and Mixed Strategy

Optimization: Constrained & Extrema

Free and constrained optimization, Extrema of a function of two variables: graphical analysis, Lagrange method. Utility maximization & Cost minimization.

Linear and Non-Linear Programming for Business Decisions

Conditions for Application of Linear Programming; Concept of Feasible Solution; Assumptions of Linear Programming Application of Linear Programming Technique: Profit Maximization Problem, Formulation of Profit Maximization Problem in Linear Programming Mode; Graphical Method of Solving Linear Programming Problems; Simplex Method: Algebraic Solution, Simplex Tableau Method. Introduction to Non-Linear Programming

Input-Output Analysis

Input-output model, its structure and its derivation. The use of input output model in Economics.

Textbook

1. D. N. Dwivedi, H L Bhatia, S N Maheshwari, VIKAS® PUBLISHING HOUSE PRIVATE LIMITED, 2022

Reference books

1. C. Chiang and K. Wainwright, *Fundamental Methods of Mathematical Economics*, McGraw Hill International Edition, 2017
2. K. Sydsaeter and P. J. Hammond:, *Mathematics for Economic Analysis,* Pearson Educational Asia, 2002

ECONOMICS OF HEALTH AND EDUCATION

Course Code: **HS 30131**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The United Nations member states' adoption of the Millennium Development Goals, which include among other objectives achieving universal primary education, reducing child mortality, enhancing maternal health, and combating diseases, reflects the significance of education and health in enhancing wellbeing. This course offers a microeconomic framework to examine, among other things, individual preference in the demand for health and education, governmental involvement, and elements of inequality and discrimination in both sectors. An outline of India's health and education system is also provided.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understanding role of health and education in human development,
CO 2: Analysing microeconomic foundations of health economics,
CO 3: Assessing the growth of health sector in India,
CO 4: Appraising the benefits of investment in human capital,
CO 5: Assessing the growth of education health sector in India,and
CO 6: Examining the underling discrepancies in both sectors.

COURSE DETAILS

Role of Health and Education in Human Development

Importance of health and education outcomes and their relationship with macroeconomic performance.

Health Economics Market

Demand for health; Uncertainty and health insurance market; Alternative insurance mechanisms; market failure and rationale for public intervention; equity and inequality.

Education: Investment in Human Capital

Rate of return to education: Private and Social; Quality of education; Signaling or human capital; Theories of discrimination; Gender and Caste discrimination in India.

Health and Education Sectors in India: An Overview

Health outcomes; health systems; health financing. Cost effectiveness and cost-benefit analysis; burden of disease. Literacy rates, school participation, school quality measures.

Trend in Health and Education Sector in India
Secondary data analysis pertaining to health and education sector. Trend analysis and forecasting using time series data. Simple growth rate calculations.

Textbook

1. S. K. Mishra, and V. K. Puri, *Indian Economy*, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6

Reference books

1. William, Jack, *Principles of Health Economics for Developing Countries*, World Bank Institute Development Studies, 1999.
2. World Development Report, *Investing in Health*, The World Bank, 1993.
3. G.Ronald, Ehrenberg and S.Robert, Smith, *Modern Labor Economics: Theory and Public Policy*, Addison Wesley, 2005.

BUSINESS ETHICS AND CORPORATE GOVERNANCE

Course Code: **HS30223**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **NIL**

COURSE OBJECTIVE
This course focuses upon the fundamental principles and standards that should govern the business organizations. The objective of this paper is to make the students aware about the importance of ethics, corporate governance and role of CSR & sustainable development goals in the business to encourage moral practices and sensitivity towards the ethical dimension of managerial problems.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Familiarize the learners with the concept and relevance of Business Ethics in the modern era,
CO 2: Understand the value of business ethics which will guide them in maintaining firm moral values while taking managerial decision,
CO 3: Apply the ability to make moral judgments in dilemmatic situations across the work domains,
CO 4: Analyse the application of management practices by adhering to corporate law and ethics,
CO 5: Evaluate the scope, opportunity and complexity of Corporate Social responsibility in the global and Indian context,and
CO 6: Create an opportunity to understand the sustainable development goals in maintaining a balance between the economic, environmental and social needs.

COURSE DETAILS

Business Ethics: Concept, Principles & Theories
Meaning, objective and types of Ethics; Business ethics- concept, need, scope, objectives and importance; factors influencing business ethics; Principles of Business ethics; Relationship between ethics and business ethics; theories of business ethics; Ethical dilemma and ethical decision making

Ethics in Practice across the domain
Ethics in marketing- introduction, ethical dilemma in marketing, unethical marketing practices, measures to stop unethical practices in marketing; Ethics in Finance- introduction, code of ethics in finance, unethical practices in finance or frauds, measures to stop unethical practices in finance; Ethics in HRM- introduction, ethical issues in HRM (job discrimination, sexual harassment, employee privacy, whistle blowing, affirmative action); importance of workplace ethics and employee code of conduct

Corporate Governance
Corporate Governance- concept, objective and need. Role of law in corporate governance; important issues in corporate governance; Corporate governance in India-past, present and Future; Importance and principles of Corporate Governance

Introduction to Corporate Social Responsibility
CSR- Concept, evolution and development; Why CSR; Apprehensions against CSR; Forms and dimensions of CSR; making business corporations socially responsible; CSR in India

Sustainable Development
Introduction, meaning, history, features, objectives of sustainable development; The pillars and principles of sustainable development; SDG and its relevance in business

Textbooks

1. Dr. K. Nirmala, Dr. B.A. Karunakara Reddy & N. Aruna Rani, Business Ethics and Corporate Governance, Himalaya Publication House
2. C.S.V. Murthy, Business Ethics and Corporate Governance, Himalaya Publishing, 2022

Reference books

1. Prabhakaran Paleri,Corporate Social Responsibility (concept, cases and trends Cengage Learning India Pvt. Limited, 2020
2. Dr. S.S. Khanka,Business Ethics and Corporate Governance, Sultan Chand, 2019
3. C.U. Saraf, Corporate Social Responsibility (CSR), Corporate Governance, Sustainable Development and Corporate Ethics/Business Ethics Himalaya Publishing House 2017

LEADERSHIP AND TEAM EFFECTIVENESS

Course Code: **HS30225**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **NIL**

COURSE OBJECTIVE
An effective leader understands the team dynamics, stimulates the morale of the followers and always aims at creating a participative workforce by enhancing team work. This course mainly focuses on individual, group and organization factors associated with leadership. There is a strong connection between emotional intelligence and leadership because the technical skills and knowledge will definitely help the students to fulfil the entry level requirements. Similarly, understanding employee empowerment would assist the students in acquiring the desirable professional skills.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Learn the characteristics and need of an effective leader,
CO 2: Understand the effectiveness of different leadership styles in different contexts from an instrumental, political and ethical perspective,
CO 3: Apply leadership theories to the real business scenario,
CO 4: Analyse group dynamics and importance of team work,
CO 5: Evaluate the ways to handle emotions and stress and manage work-life flexibility, and
CO 6: Create organizational environment that is psychologically safe and make the employees feel empowered.

COURSE DETAILS

Leadership: concepts and practices
Meaning, Definition and understanding of leadership; the role and functions of a leader; Differentiation between leadership and management; ; what makes a leader effective; characteristics of an effective leader; leadership in Indian organization

Leadership Perspectives
Trait perspective of leadership (Great man theory and trait theory); Behavioural perspective of leadership (mangerial grid and likert system - four management); Studies on leadership (Hawthorne, IOWA, Michigan and Ohio); Contingency perspective of leadership (fiedler's contency theory, path goal, hersey blanchard situational theory); contemporary perspective to leadership (transformational, transactional, charasmatic, servant and Nurturant-task leadership style)

Team effectiveness and Leadership
Characteristics and types of teams; types and functions of group; Group vs team; understanding an effective team; who is a team leader; tuckman's team development stages; team development and team building; team meetings and leadership; team effectiveness leadership model; high-performance teams and leadership;team cohesiveness; common threats to groups

Emotional Intelligence and Leadership
What are emotions; Meaning, type and source of emotions; Concept and competencies of emotional intelligence; Elements of emotional intelligence; importance of EI; EI at workplace; Emotional intelligence and leadership; Significance of EI for leaders; strategies to enhance EQ in our jobs; EQ vs. IQ; developing EQ; obstacles to the development of EQ

Leadership and empowerment
Employee empowerment- concept, need and importance; approaches to empowerment; advantages and disadvantages of empowerment; empowerment skills of a leader; empowering vs. Dis-empowering; leader as a coach (coaching skill); delegation (advantages and levels of delegation, steps and principles of effective delegation); empowering interpersonal skills

Textbook
1. Ranjana Mittal,Leadership Personal effectiveness and Team Building, Vikas Publishing House Pvt Ltd, 2015

Reference book
1. S. Bhargava and Gourav Bhargava,Team Building and Leadership Neelam Himalaya Publishing House, 2015.

UNIVERSAL HUMAN VALUES

Course Code: **HS30401**
Credits: **3**
L-T-P: **3-0-0**
Pre-requisites: **Nil**

COURSE OBJECTIVE
The objective of the course is to develop a holistic perspective based on self-exploration, understand the harmony in the human being, strengthen self-reflection, and develop commitment and courage to act.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand the concept of value education and its need,
CO 2: Apply their knowledge on value education for apt self-assessment,
CO 3: Comprehend human-human relationship,
CO 4: Build holistic perception of harmony at all levels of existence,
CO 5: Develop the sense of natural acceptance of human values,and
CO 6: Create people friendly and eco-friendly environment.

COURSE DETAILS

Need, Basic Guidelines, Content and Process for Value Education
Purpose and motivation for the course, recapitulation from Universal Human Values-I. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Understanding Harmony in the Human Being - Harmony in Myself!
Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to

me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Understanding Harmony in the Family and Society- Harmony in HumanHuman Relationship
Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship . Understanding the meaning of Trust; Difference between intention and competence . Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence
Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of naturerecyclability and selfregulation in nature. Understanding Existence as Co-existence of mutually interacting units in allpervasive space. Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Implications of the above Holistic Understanding of Harmony on Professional Ethics
Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a) Ability to utilize the professional competence for augmenting universal human order b) Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c) Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations . Sum up. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Textbook

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. A.N. Tripathi, Human ValuesNew Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. Mohandas Karamchand Gandhi ,The Story of My Experiments with Truth -
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)13. Gandhi - Romain Rolland (English)

GENDER STUDIES

Course Code: **HS30421**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
The objective of this course is to make student understand the concepts of masculinity and femininity as analytical categories via analysing the role of communalism, patriarchy, violence as major hurdles to women's rights globally. Further, this course will enhance their understanding over the current health and education status of women to analyze

impact of government health policy on women. Additionally, it will bring greater understanding over the integration of gender concerns and perspectives in policies and programmes for sustenance of environment at international, national, regional levels.

COURSE OUTCOME

After successfully completing the course, the students will be able to

CO 1: Familiarise the students with the concepts of sex, gender and sexuality commonly used in gender studies,
CO 2: Identifying major human rights violations faced by women worldwide,
CO 3: Learn about women's health movements and government health policies,
CO 4: Develop an insight into policy perspective issues, and concerns of girl's education in India,
CO 5: Delineate the characteristics and the issues of environment and the involvement of women in balancing ecosystem,and
CO 6: Understand on sustainable development, millennium development goal, and other global level development initiatives taken for uplifting women status in society.

COURSE DETAILS

Understanding Basic Concepts in Gender Studies

Concepts: Sex, Gender, Sexuality, Femininities, Masculinities and other sexualities, Patriarchy; WID: Women in Development; WAD: Women and Development; GAD: Gender and Development

Gender and Human Rights Discourse

Women's Rights as Human Rights (FGM, FF, Rape, Honour Killing, IVP, Witch Hunting, Virginity Test, Communalism, Trafficking, Immigration); National Commission for Women and other State Commissions, Ministry and Department of Women and Child.

Gender and Health

Sexual and reproductive health (ICPD, B.P.A. Family planning and Abortion); Impact of violence on women's health; Women's health movement: National and International; National health and population policy; National Family Health Survey (NFHS)

Gender and Education

Women's Education in Free India: Gender Disparity in Enrolment; Constraints of Women's Education: Social, Economic, Cultural, Geographical, other Factors; Important Committees and Commissions on Women's Education: Radhakrishnan Commission (1948), Mudaliar commission (1952), Kothari Commission (1964-1966), Ramamurthy Commission (1991).

Gender and Environment

Role of women in environment conservation; Role of Women in Waste Management; Women's Resistance to Environmental Destruction: Joint Forest Management – CHIPKO Movement – Narmada Bachao Aandolan

Reading Materials

1. Gerda Lerner, Creation of Patriarchy, Oxford University Press,1985
2. Menon, Nivedita. ed. 2007. Sexualities. Women Unlimited. New Delhi.
3. Gnew, Sneja, A Reader in Feminist Knowledge, Routledge, New York,1991
4. Marjorie Agosin (ed.), Women, Gender and Human Rights: A Global Perspective, Rawat Publications, 2000
5. Monica Chawla, Gender Justice: women and law in India, Deep and Deep pub., New Delhi, 2006, 2013
6. P D Kaushik, Women's rights; access to justice, Bookwell Publications, New Delhi, 2007
7. Paola Monzini, Sex Traffic, Prostitution, Crime and Exploitation, Zed Pub., 2005
8. Chloe E. Bird, Patricia P. Rieker, Gender and Health, Cambridge University Press, 2008.
9. Jasmine Gideon, Ed., Handbook on Gender and Health (International Handbooks on Gender series), Development Studies, Birkbeck, University of London, UK, 2016.
10. Nelson E, Zimmerman C. Household survey on domestic violence in Cambodia. Ministry of Women's Affairs, Project Against Domestic Violence, Cambodia,1996.
11. Parker B, McFarlane J, Soeken K. Abuse during pregnancy: effects on maternal complications and birth weight in adult and teenage women. Obstetrics and gynaecology, 1994, 84(3):323-328.
12. Madeleine Arnot and Mairtin Mac, An Ghaill, (2006) "Gender and Education" Routledge, New York
13. Aruna Goel, (2004) "Education and Socio-Economic Perspective of Women Development and Empowerment" Deep and Deep Publications, New Delhi
14. Eileen M. Byrne, (1978) "Women and Education" Tevi Stock Publications, Michigan

15. Payal Mago and Isha Gunwal, (2019). Role of Women in Environment Conservation.
16. M.S Swaminathan. (1998). "Gender Dimensions in Biodiversity management". Konark Publisher's Pvt. Ltd, New Delhi.
17. P.K.Rao. (2000). "Sustainable Development – Economics and Policy". Blackwell, New Delhi.
18. Swarup, Hemlata and Rajput, Pam. (2000). "Gender Dimensions of Environmental and Development Debate: The Indian Experience" in Stuart S. Nagel, (ed.) "India's Development and Public Policy". Ashgate, Burlington.

TRIBAL RESOURCE MANAGEMENT

Course Code: **HS30423**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE
The course intends to impart a comprehensive knowledge about the reality, pertaining to economic alleviation of the poor and downtrodden. It is inter-disciplinary and based on utilization of natural resources employing traditional means of approach, conducive for societal growth and development. This shall hone socioeconomic environmental development for uplifting the condition of tribal population for igniting new ideas in the new economy.

COURSE OUTCOME
After successfully completing the course, the students will be able to

CO 1: Identify the concept of sustainable natural resource management,
CO 2: Recognize agribusiness management, its opportunities and risks,
CO 3: Discuss adequate skills to prepare and implement integrated development plan & projects for the optimal use of tribal renewable resources for the sustainable development of the environment,
CO 4: Illustrate the nuances of environmental policies and Laws in India and understand the core competencies required for resource mobilization and policy formulation based on the research insight,
CO 5: Prioritize the role of health and education for the development of tribal community, considering tribal people as resources,and
CO 6: Develop trainees or volunteers as competent change agent in the field of tribal resource management.

COURSE DETAILS

Natural Resource Management
Introduction to Natural Resources and their management: Natural Resource Management (NRM): Concept, Issue and Approaches; Need for developing extension strategies for NRM; Issues in management of NRM; Problems encountered while advocating strategies for NRM; Monitoring and auditing in Natural Resource Management (NRM); Triple Bottom Line (TBL) and concept of Sustainable Natural Resource Management; NRM of Water, land and forests: Water resources and their management, Overview of irrigation management, Integrated Watershed management and rainwater harvesting, River Basin management; Scope of market mechanism in NRM

Agribusiness Management
Agricultural value chains and their relevance; Managerial Insights: Identifying agribusiness opportunities; Assessing feasibility – technical, commercial and financial and thereby identify feasible opportunities for projects; Analyzing influences of external environment factors and associated risks; Discussions on illustrative agribusiness projects; select models and opportunities of agribusiness opportunities and ventures.

Environmental Resource Management of Tribals
Environment and Development-Theories of optimal use of exhaustible and renewable resources; Sustainable Development - The concept of sustainable development; strong and weak sustainability; Mechanism for environment regulation in India; environmental laws and their implementation; Environmental Policy in India-Policy instruments for controlling water and air pollution and forestry policy; Institution for forest Management- The institutions of joint forest management , social foresty-rationale and benefits

Tribal Health and Education Management
Role of Health and Education in Tribal Development: Importance in poverty alleviation; health and education outcomes and their relationship with macroeconomic performance; Tribal Health in India: An Overview Health outcomes; health systems; health; Evaluation of Health Programs for tribals: Costing, cost-effectiveness and cost benefit analysis; burden of disease; Tribal Education in India: An Overview Literacy rates, school participation, school quality measures

Agro forestry Management
Multiplicity of Agroforestry products and services- ecological and economic and cultural considerations- gender equality- preservation of indigenous knowledge. Socioeconomic benefits of agroforestry; Smallholder livelihood and the role of agroforestry- Food and nutritional security Fulfillment of food, fodder, fuelwood and shelter based needs- income generation vs. subsistence production; Adoption of AF- Determinants of adoption: feasibility, profitability, and acceptability; . Self-efficacy in farmer decision-making - policy aspects.

Text Books

1. Madhusudan Bandi ,Tribals and Community Forest Management , Rawat Publication, 2013
2. Jumyir Basar,Indigenous Knowledge and Resource Management Shipra Publications, 2014
3. Laishram Herojit, Rethinking Resource Management: Sustainability and Indigenous Peoples, A.K. Publications, 2012.

Reference Book

1. G.K. Bera, Tribal India's Traditional Wisdom and Indigenous Resource Management by, Abhjeet Publishers.

INDIAN KNOWLEDGE SYSTEM

Course Code: HS30425
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE
The objective of the course is to promote interdisciplinary study on all aspects of the Indian Knowledge System (IKS), preserve and disseminate IKS for further study and societal applications. It will actively help students to engage in spreading the rich heritage of our country and traditional knowledge in the field of Liberal Arts, Literature, Basic Sciences, Engineering and Technology, Economics, mental and physical well being etc.

COURSE OUTCOME
At successfully completing the course, the student will be able to

CO 1: Understand the concept of Indian traditional knowledge and its importance,
CO 2: Know the need and importance of protecting traditional knowledge,
CO 3: Develop an appreciation among the students for ancient scriptures,
CO 4: Contrast and compare characteristics and important kinds of traditional knowledge,
CO 5: Evaluate social change on traditional knowledge and
CO 6: Create innovative ways of bringing forward ancient knowledge to the forefront.

COURSE DETAILS

Meaning of Traditional Knowledge System
Overview of the Vedas, the Upanishads, the Puranas, and the Itihasas. Main Schools of Darshana/ Philosophy: Astika (Vedanta, Nyaya, Vaisheshika, Sankhya, Mimamsa, Yoga) and Nastika (Buddhist, Jainist, Lokayata). Types of Shastra (Vyakarana, Kavya, Alamkara, Shilpa, Vastu, Natya and Sangita). Types of Kavya (Drishya, Shravya, Chitra). Theory of Rasa: Natyashastra by Bharata (Chapter 6). Applied Traditional Knowledge: Myths, Rituals, Taboos and Superstitions, Folktales, Proverbs. Fundamental Concept of Dharma and Its Role in Various Streams of Indian Knowledge System

Yoga and Spiritualism
Definition and Origin of Yoga. Significance of spirituality in Yoga, Historical development of Yoga; Yogic philosophy: The eight limbs of yoga according to Patanjali, Mind, body & spirit connection in yoga; Relevance of Asana, Pranayama & Dhyana in Yoga: Physical posture for physical, mental and spiritual development, Breathing techniques for energy restoration & consciousness, Meditation for inner stillness and mindfulness, Meditation for spiritual growth & self-discovery; Ethics & Moral Values in Yoga: Exploring the ethical principles Yama and Niyama, Application of yogic principles to daily life for spiritual growth; Yoga & Spirituality in modern life.

Fun with mathematics without calculator
Arithmetic- Quick calculation with 11 and 12, Multiplication with 99999 in seconds, multiplication with numbers near the bases, vertical and cross multiplication, Magic squares and square roots, cubes, fractions, divisions, HCF and LMC in

ancient style. Algebra- Factorising quadratic expressions, One variable linear equation, Simultaneous linear equations. Implementation of Vedic mathematics tools during competitive examinations.

Ancient Indian Science and Technology
Technological development in India: Agriculture (Origin and development, ancient crops, Traditional practices), Water management (Overview, Harappan water management, other case studies, Medieval Water structures), Pottery (Overview, Technical aspects), Silpasastra (Architecture and Construction· An introduction to Silpasastra, Construction Technology), Metallurgy (Copper/Bronze/Zinc, Iron and Steel Technology in India).

Trade and Commerce in Ancient India
Internal, External, Trade routes Indo-Roman contacts and Maritime Trade of South India; Silk and Cotton Textiles, the Principal Maritime Trade Commodities of Ancient India; Trade routes in Ancient India: Silk Route and Spice Route.

Reading Materials

1. Dasgupta, Surendranath. A History of Sanskrit Literature, Motilal Banarsidass
2. Banerji, Suresh Chandra. A Companion to Sanskrit Literature, Motilal Banrasidass
3. Chatterjee, Satischandra. An Introduction to Indian Philosophy, Motilal Banarsidass
4. Sharma, Chandradhar. A Critical Survey of Indian Philosophy, Motilal Banarsidass
5. A Text Book on Yoga and Health by Dr. Sajib Kumar Bhowmik, Sports Publication, 2020.
6. Light on the Yoga Sutras of Patanjali, B.K.S Iyengar, Element, 2005.
7. The Complete Book of Yoga: Karma Yoga, Bhakti Yoga, Raja Yoga, Jnana Yoga by Swami Vivekananda, Fingerprint Publishing, 2019.
8. Singhal, Aditi. How to Become A Human Calculator. ISBN : 9789352836543. S Chand Publishing
9. M. Tyra and K Kundan. Magical Book on Quicker Maths . ASIN : 2W93X07B FC. BSC Publishing Co Pvt Ltd.
10. Singh, Balram. Science and Technology in Ancient texts. DK Print World ltd, 2012. ISSN 9788124606322.
11. Chandra Moti, Trade and Trade Routes in Ancient India. New Delhi: Abhinav Publications, 1977
12. Textiles in Ancient India: From Indus Valley Civilization to Maurya Period. Vishwavidyalaya Prakashan, 1994.
13. Duraiswamy, D. Silk and Cotton Textiles, the Principal Maritime Trade Commodities of Ancient India. ACTA VIA SERICA, Vol. 6, No. 2, Dec. 2021: 91-116, 6(2), 91–116.

PROBABILITY AND STATISTICS

Subject Code: MA21001
Credit: 4
L-T-P: 3-1-0
Prerequisite: Intermediate mathematics

COURSE OBJECTIVE
The objective of this course is to familiarize the students with the foundation of probability and statistics and to use it in solving the problems arises in engineering and real life applications.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand basic probability and its applications
CO 2: Study probability distributions and can use it in real life data analysis
CO 3: Have a knowledge on univariate and bivariate distributions and their properties
CO 4: Measure the central tendency and dispersion of a data set to draw conclusion from the data and interpret the data with the appropriate pictorial representation.
CO 5: Have good understanding of the Central Limit Theorem and its applications
CO6: analyze the statistical inference

COURSE DETAILS

Probability and random variables
Basic concepts of sample space, events(with example), Axiom of Probability, Conditional Probability, Bayes' Theorem and its applications. Discrete random variable, probability mass function, cumulative distribution

function and Moment Generating function for discrete random variable, some special distributions like Uniform distribution, Geometric distribution, Binomial distribution, Negative Binomial distribution, Poisson distribution, Hypergeometric distribution, mean and variance. Continuous random variable, density function, cumulative distribution function and Moment Generating function. Uniform distribution, normal distribution, mean, variance, percentile and critical value of normal distribution, normal approximation of the binomial distribution and exponential distribution.

Joint probability and distributions

Joint probability mass function and marginal probability mass function, joint probability density function and marginal probability density function, concept of independent random variable(joint probability), conditional probability mass function and conditional probability density function. Expected value, covariance and correlation for jointly distributed random variable(both continuous and discrete).

Descriptive Statistics

Frequency distribution, pictorial and tabular representation of data, stem and leaf display, dot plots, histogram, box plots and comparative box plots. Basic concepts on mean, median and mode, Skewness, Kurtosis, Correlation, Coefficient of Correlation, rank correlation, Regression Analysis: Least square method.

Inferential statistics

Population, sample, random sample, sampling distribution, distribution of sample mean, central limit theorem, point estimator, point estimation of parameter using method of maximum likelihood estimation, confidence interval, confidence interval for the mean of a normal population with known and unknown variance, confidence interval for the variance of a normal population, hypothesis testing, one sided and two sided alternatives, Tests for mean of the normal distribution with known variance, Tests for mean of the normal distribution with unknown variance, tests for variance of the normal distribution.

Textbooks

1. J. L. Devore, Probability and Statistics for Engineers and Sciences, CENGAGE Learning, 9th Edition.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley, INC, 10th Edition.

Reference Books:

1. S.M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier/AP, 6th Edition.
2. J.S. Milton & J.C. Arnold, Introduction to Probability and Statistics, Mc Graw Hill, 4th Edition.
3. H.J. Larson, Introduction to Probability Theory and Statistical Inference, John Wiley & Sons Inc, 3rd Edition.
4. S.C. Gupta & V. K. Kapoor, Fundamental of Mathematical Statistics, S. Chand, 12th Edition.

VECTORS, DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS

Subject Code: **MA21006**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **MA11001, MA11002**

COURSE OBJECTIVE

The objective of this course is to empower the students to design and solve branch prospective problems by the use of Vector calculus, partial differential equations, Complex variables.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the physical significance of the concepts like divergence, curl and gradient.
CO 2: Apply vector integration theorems like Gauss divergence, Stokes and Greens theorem in different engineering applications like work done by force, evaluation of flux etc.
CO 3: Know the basic analytical techniques for solving the classical wave, heat and Laplace equation
CO 4: Know the concepts of analytic functions, its differentiation and its series representation
CO 5: Understand the fundamental concepts of contour integration to evaluate complicated real integrals via residue calculus

CO 6: Apply multi steps numerical methods to solve initial and boundary value problems

COURSE DETAILS

Vector Calculus
Brief concepts of vectors, gradient of a scalar field, directional derivatives, divergence and curl of a vector field. Vector line integral, surface integral, Green's theorem, Gauss divergence theorem, Stoke's theorem, engineering applications of above integral theorems like work done by force, flux integration, independence of path etc.

Partial Differential Equations (PDE)
Basic concepts of PDE like order, degree, linear, nonlinear, homogeneous and non-homogeneous PDE. Solution of PDE by Variable Separable method. Classification of PDE and their reduction to normal form. One dimensional Wave equation, D'Alembert and Fourier series solution of 1-D wave equation. Solution of 1-D heat equation by Fourier series method. Solution of 2-D Laplace equation and 2-D heat equations. (steady state) with different types of boundary conditions using Fourier series. Laplace equation in polar co-ordinate and its application to find the electrostatic potential/steady state temperature in a disk with appropriate boundary conditions. Solution of PDE by Laplace Transform.

Complex Analysis
Basic concepts of complex number. Complex functions, derivatives, analytic function, Cauchy Riemann equations, harmonic functions, harmonic conjugate, elementary functions like exponential, trigonometric, hyperbolic, logarithmic functions and general powers. Curves in complex plane and their parametric representation. Line integrals, Cauchy integral theorem, Cauchy integral formula, Derivatives of analytic function. Power series, Taylor's series, Maclaurin's series, Laurent's series, singularities, Residues, Residue Integration, Real Integrals and Cauchy's Principal Value integrals.

Numerical Solution of ODEs
Solution of Linear Difference Equations; IVP (Multi Steps Method): (Predictor-Corrector method) Adams-Bashforth Method, Adam-Moulton Method; BVP: Shooting methods.

Textbooks:
1. Erwin Kreyszig, Advanced Engineering Mathematics by Wiley, INC, 10th Edition.
2. Jain, Iyenger and Jain, Numerical Methods for Scientific and Engineering Computation New age International (P) Ltd.,6th Edition.

Reference books:
1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers,36th Edition.
2. B.V. Ramana, Higher Engineering Mathematics TMH, 2017 Edition.
3. H. K. Dass, Advanced Engineering Mathematics S. Chand, 2007 Edition

ADDITIVE MANUFACTURING (3D PRINTING)

Course Code: **ME28011**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE
Additive Manufacturing (AM) is a modern manufacturing technology also known as 3D printing process, will provide a clear understanding about the process, acceptability and usability in various field. AM technologies classified on the basis material types will be focused with its real-life applications with advantages and disadvantages. Different types of errors associated with AM and CAD technology will be discussed with suitable error minimization processes. Various reverse engineering process will be discussed and practically implemented with its real-life applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the concept of additive manufacturing, its benefits and applications in various fields,

CO 2: Know the various liquid, powder and solid material based technologies in Rapid Prototyping and Rapid Tooling process,
CO 3: Know the application of AM process in the field of Bioedical,
CO 4: Design solid models and converting it to 3D printing readable file format required for part fabrication, CO 5: Focus on the various types of errors in the RP parts and errors during CAD file conversion, and
CO 6: Apply reverse engineering process to generate data for fabrication of RP part.

COURSE DETAILS

Introduction to Additive Manufacturing Technologies
Need & Development of AM systems, AM process chain, Impact of AM and Tooling on Product Development, Benefits, Applications, Digital prototyping, Virtual prototyping.
Model Preparation using Solid Modelling Software.

Classification of Additive Manufacturing Technologies
Classification of AM technologies on the basis of Materials types. Discussion on various AM processes based solid, liquid and semi solid type of materials along with its application, advantages and disadvantages.
Hands on practice for model creation and saving on particular file format.

Data Processing for AM Technologies
Process planning for AM, CAD model preparation, data requirements & geometric modelling techniques: Wire frame, surface and solid modelling data formats.
Hands on practice for the fabrication of Single components and Assembly components.

Rapid Tooling
Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting.
Hands on practice for the fabrication of pattern and mould preparation.

Reverse Engineering Processes
Introduction to reverse engineering, Integration of reverse engineering with AM technology.
Hands on practice to generate model data in revere engineering process integrated with AM process

Reference Books

1. Rafiq I Noorani, Rapid Prototyping: Principle and Applications, Wiley & Sons, 2006.
2. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Yes Dee Publishing Pvt. Ltd, Third Edition, 2010.
3. Frank W. Liou, Rapid Prototyping and Engineering Applications, CRC Press, Special Indian Edition, 2007.
4. R.B. Choudhary, Additive manufacturing, Khanna Publication, 2022.

DIE DEVELOPMENT BY CNC MILLING

Course Code: **ME28013**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Workshop (ME18001)**

COURSE OBJECTIVE
The objective of the course is to provide basic knowledge on various tools and precision instruments used during CNC milling operation. It helps in understanding the usage of various machining cycles to reduce the manufacturing lead time. Moreover, it explains the usage of various standards and programming methods to be followed during CNC machining operation. Finally, the students can develop/generate the programs used to produce the geometries with complex contours using CNC milling machine.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand the usage of different tools and precautions to be followed during machining,
CO 2: Know the principle and operation of precision instruments,
CO 3: Understand the technological advancements in NC and aimed to achieve JH pillar,
CO 4: Understanding the programming methods and programming in simulators,
CO 5: Planning for optimized CNC programming by estimating suitable process parameters, and
CO 6: Programming of die contours and executing on CNC milling machine.

COURSE DETAILS

Tools and Safety
List of tools used on Milling Machine to perform various operations. Safety: Introduction to safety equipment and their uses.

Measuring instruments
Vernier caliper, Micrometer, Bevel protractor, Coordinate measuring machine (CMM): Construction, principle graduation and reading, least count.

Introduction to CNC
Introduction to CNC technology, Conventional Vs. CNC machine tool, CNC clamping system. Implementation of JH for CNC.

CNC programming
Introduction to CNC programming, Introduction and demonstration of line programs milling machine using ISO codes into the CNC simulator. Part programming methods, Cutting process parameter selection, Process planning issues and path planning, G & M Codes, Interpolations, Tool compensations.

CNC Programming-Milling
Calculations of parameters like speed feed, depth of cut etc. and set a references for the various operations. Prepare & set CNC Milling operations and dry run on the machine. Execute program and inspect simple geometrical forms
/ standard parts.

Reference Books

1. Yoram Koren, Computer Control of Manufacturing Systems, Mc Graw Hill Publication.
2. Mikell P. Groover, CAD/CAM.
3. P.C. Sharma, A textbook of Manufacturing Technology-II.
4. R.K. Jain, Engineering Metrology, Khanna Publishers.

CONCEPT CAR MANUFACTURING

Course Code: **ME28015**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE
Objective of the course is to give the students hands on experience on building a racing car. Students find it very interesting to develop important parts of a racing car and then assemble and take part in various national and international events. In this process they meet the requirement set by the authorities. Therefore the students learn here how to propose a new car body and prove the feasibility by computational analysis of the body and other important parts.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Remember the fundamentals of concept car characteristics,

CO 2: Understand the aerodynamic requirements in racing vehicles,
CO 3: Use the concepts of chassis behaviour of concept car,
CO 4: Illustrate the suspension characteristics of the concept car,
CO 5: Understand the problems faced in drives and braking systems in motor sports, and
CO 6: Build a concept car body.

COURSE DETAILS

Car Development
Constraints And Specifications – Performance, Handling, Structure; Driver Accommodation and Safety.

Tyres
Adjustable Features, Preliminary Design and Analysis; Driver-Vehicle Relationship. Desirable Vehicle Characteristics, Fundamentals of Track and Lap.

Racing Car Aerodynamics
Aerodynamic Force and Moment, Race Car Drag; Spoilers, Dams, Wings - Effectiveness Of Wings In Steady State Cornering.

Chassis Design
Conditions For Traversing a 90° Corner, Effects Of High Speed Braking, Cornering, Combined Braking Cornering; Steady State Cornering, Throttle Behaviour, Steering Wheel Force And Kick Back; Moving CG Position, Roll Centre Position Changing.

Suspension System
Front Suspension- General Design Issues, Camber Effects; SLA Suspension, McPherson Struts; Independent Rear Suspension- Trailing Arm Types, Instant Axis Concept; Suspension Springs- Torsion Springs, Coil Springs.

Textbook
1. Advanced Race Car Chassis Technology HP1562: Winning Chassis Design and Setup for Circle Track and Road Race Cars Bob Bolles, HP Books; Revised, Updated Edition, 2010.

Reference Books
1. William F. Milliken and Douglas L. Milliken, Race car vehicle dynamics, 11th Edition, SAE, 1995.
2. Peter Wright, Formula 1Technology, Sae Intl; 1st Edition, 2001.

DEVELOPMENT OF AUTONOMOUS WHEELED ROBOTS

Course Code: **ME28017**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Basic Electronics (EC10001)**

COURSE OBJECTIVE
Nowadays, robotics is playing a vital role in industry 4.0, and autonomous wheeled robots are being applied to minimize human efforts and to improve the production rate. This course gives fundamental knowledge about wheeled robotics and its different hardware and software components. Moreover, the course discusses kinematics equations, which will be implemented to control the motion of wheeled robots through the actuators. Further, the present course also describes the integration of various sensors and their programming, which will be used to make an autonomous control system for a robot.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Understand the fundamentals of wheeled robotics and its different components,
CO 2: Apply locomotion constraint features to travel the wheeled robots in different surface conditions,
CO 3: Apply various sensors integration on wheeled robots for autonomous navigation,
CO 4: Analyze the kinematics of wheeled robots,

CO 5: Create a robot programming to make an autonomous sensor-actuator control system, and
CO 6: Design of automation solutions using wheeled robots.

COURSE DETAILS

About Locomotion for Wheeled Robot
Key issues for locomotion, wheeled mobile robot's locomotion, Legged wheeled robots.

Wheeled Robots Kinematics
Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Degree of freedom.

Sensors for Autonomous Wheeled Robots
Various sensors for wheeled robots, Sensor classification, Ultrasonic sensor, Infrared sensor, Vision sensor, Inertial measurement unit (IMU).

Actuators for Autonomous Wheeled Robots
Various actuators for wheeled robots, DC motor, Servo motor, Stepper motor, Motor controller.

Wheeled Robots Programming
Robot programming language features, Computer control and robot software (monitor mode, run mode and editor mode), Arduino microcontroller programming, Raspberry Pi programming, Complete design of an autonomous wheeled robot.

Reference Books

1. R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2011
2. S.G. Tzafestas, Introduction to Mobile Robot Control, Elsevier Science, 2013.
3. G. Dudek, M. Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, 2010.
4. T. Bräunl, Embedded Robotics Mobile Robot Design and Applications with Embedded Systems, Springer Berlin Heidelberg, 2013.
5. U. Nehmzow, Mobile Robotics: A Practical Introduction, Springer, London, 2012.

MODELLING OF MICRO-WIND TURBINE BY 3D CAD DESIGN

Course Code: **ME28019**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Differential Equations and Linear Algebra (MA11001)**

COURSE OBJECTIVE
Introduce computer-based solid, parametric, and assembly modeling as a tool for engineering design; enhance critical thinking and design skills. This course introduces the technology and economics of converting wind energy to electricity and other kinds of energy. Both utility scale horizontal axis wind turbines and small-scale horizontal are addressed, as well as the economical and environmental issues associated with wind energy.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Learn about the basic concepts of wind energy conversion system,
CO 2: Understand the engineering design process and the implementation of different design phases,
CO 3: Create a 3D solid model with high degree of confidence,
CO 4: Develop the ability to extract 2D orthographic views from the 3D model for fabrication,
CO 5: Learn the basics of assembly and associative constraints, and
CO 6: Understand the importance of standalone, grid-connected, and hybrid operation in renewable energy systems.

COURSE DETAILS

Introduction to Wind Energy, Wind Power, State of the art technology
Introduction to renewable sources, Wind energy, Types of wind turbines, State of the art technology in wind energy.

Design and development of small wind turbines
Small wind technology, blade element momentum theory, design of tail fin, Wind turbine tower structure design stiffness and strength consideration, Aerodynamics of wind turbine rotor blade design, angle of attack, profile.

3D modelling of wind turbine using CAD tools (SOLIDOWRKS)
Introduction to 3D modeling, Parametric modeling, feature-based modeling, Design Intent; Solid modeling commands: Sketching, Extrusion, Revolve, fillet, pattern.; Solid Modeling: reference geometry, Sweeps and Lofts;

Assembling of the 3D model of the Wind turbine
Assembly modeling; Top-down and bottom-up, Mates in assembly, exploded view,

Creation of 2D drawings for production/manufacturing processes
Extract 2D orthographic views from the 3D model for fabrication by specifying the proper dimensions, according to industry standards, for parts to be fabricated and to extract section and auxiliary views, Dimensioning standards and conventions. 3D assembly drawing of the wind turbine, exploded view of the tower, 3D drawings of all 3D printed parts.

Simulation of wind turbine using SOLIDWORKS using CAD tools (SOLIDOWRKS and ANSYS)
Engineering analysis with SolidWorks, Stress and deflection of the wind turbine tower, Simulation of wind turbine using SolidWorks

Reference Books

1. James F. Manwell, Jon G. McGowan, and Anthony L. Rogers, Wind Energy Explained: Theory, Design, and Application, Wiley, 2010.
2. Gasch, Robert, Twele, Jochen (Eds.), Wind Power Plants: Fundamentals, Design, Construction and Operation, Springer-Verlag Berlin Heidelberg; 2nd Edition, 2012.
3. Open source SOLIDWORKS Tutorial: https://my.solidworks.com/training/video/40d7a678-3293- 4d7b-ba18-2113ff114b2a.

K-Xplore
(Practice Oriented Open Elective – I)

The B. Tech. curriculum provides for a 1-Credit practice-oriented Open Elective K-Xplore in Semester V to make our undergraduate engineering programme holistic, multidisciplinary, skill-based, and balanced. This course allows the students to explore the opportunity that the KIIT University offers to them to sharpen their skills in areas which excite them the most.

Offered in a self-learning mode, this subject allows the students to hone their skills in areas they are passionate about which they select from a wide spectrum of subjects in art, literature, technology, community engagement and service, health, and environment and sustainability. In addition, the students develop soft skills that are important for them in their professional life. This course, thus, allows students to explore and grow in areas outside of core academics and provides a channel for complementing the lessons learned in the classroom, offering them the opportunity to apply academic skills in a real-world context and providing a truly well-rounded education.

This course is designed on the basis of the guiding philosophy of student-centered learning where the students define problems, evaluate alternatives, design solutions, and self-learn by performing certain assigned activities with limited guidance from faculty facilitators.

Each student selects an area of his (or her) choice from a specified list of areas. All the students with choice in a particular area are assigned to one or more faculty facilitators. Faculty facilitators assign the activities and tasks necessary for the course to the students and decide the desired mode of skills training. They may decide to make small groups of students of varying group sizes to carry out the assigned activities and tasks. They also make the required facilities available to the students to enable them to carry out the assigned activities and tasks.

The timetable will earmark specific hours for the subject. But the students are expected to use their spare time (including holidays and after-lecture hours on working days) to learn the required skills and use these skills to accomplish the assigned activities and tasks. The students, however, have to meet the faculty supervisors on the specified hours every week to appraise them of their progress, clear their doubts, if any, and chart their future plan.

The Head of KIIT Student Activity Centre (KSAC) will coordinate offering of the course.

COURSE OUTCOMES

At successfully completing the course, the student will be able to

CO 1 : Develop the needed technical skills in their chosen fields of interest,
CO 2 : Develop higher levels of self-confidence and soft skills such as communication, writing, discussion and debate, time-management, and leadership skills,
CO 3 : Apply the learned skills to give shape to their passionate ideas,
CO 4 : Develop Innovation and entrepreneurial mindset,
CO 5 : Analyze and judge a problem situation for deploying the learnt knowledge and skills and develop problem solving strategies and
CO 6 : Build new products and services using the learned knowledge and skills.

ROBOTICS

Subject Code: SA38001
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To assist students develop the knowledge of robotics and circuitry, build circuits, bots and robots, and participate in different Robotics events such as Robo Wars.

WEB DESIGNING

Subject Code: SA38003
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To help a student learn and develop front-end and back-end web development skills and create websites.

CIVIL-TECH

Subject Code: SA38005
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To make a student ready to plan and design selected aspects of real life construction projects with relation to environment, transport & connectivity, water resource engineering & soil exploration and gain pre-, present-, and post- construction experience.

CIRCUIT DESIGN & CONTROL

Subject Code: SA38007
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To let the students learn the required skills to design and develop electrical circuits and implement controllers for use in robotics, automation, voice recognition, gesture recognition, etc.

INDIAN CLASSICAL, FOLK & BOLLYWOOD DANCE

Subject Code: SA38009
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To encourage and boost the confidence of the students to choreograph and perform in classical, semi classical / folk and bollywood dance forms.

INDIAN CLASSICAL & WESTERN MUSIC

Subject Code: SA38011
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To give confidence to the students to participate and perform as a vocalist and/or instrumentalist in different forms of Indian classical and western music.

GRAPHIC DESIGNING & EDITING

Subject Code: SA38013
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To nurture the students' skills in creative designing, photo and video editing activities, and digital sketching and painting, using Designing & Editing software such as Photoshop, Illustrator and video editing software.

ART & CRAFT

Subject Code: SA38015
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To endow the students with the skills to do various types of painting such as portrait painting, landscape painting, abstract painting, pencil sketching, and doodling and craft, using various Painting and Sketching tools.

THEATRE & STREET PLAY

Subject Code: SA38017
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To give students the confidence to perform in Theatres, Nukkad, Mono Acts and skits based on written scripts.

FILM MAKING

Subject Code: SA38019
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To impart skills for film making in areas such as cinematography, script writing, audio recording, and editing.

DEBATING, PUBLIC SPEAKING & ANCHORING

Subject Code: SA38021
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To develop the students' skills for performing oratory activities such as extempore speech, debate, poetry reading, open topic speech, public speaking, interviewing, open dialogue, anchoring, and presentation.

CREATIVE WRITING

Subject Code: SA38023
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To develop the students' skills in creative writing, content writing, article writing, and poem composition.

PHOTOGRAPHY & VIDEOGRAPHY

Subject Code: SA38025
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To provide the technical knowledge required to create photos and videos that tell a story or capture a real-world occurrence.

FASHION STYLING

Subject Code: SA38027
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To impart the basic skills of costume design, styling, grooming, and presentation relevant to a specified theme.

CULINARY ARTS

Subject Code: SA38029
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To help the students learn the skills of cooking, knowing ingredients, and preparing cuisines of Pan India and 65 countries

QUIZ ACTIVITY

Subject Code: SA38031
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To give the students the confidence to participate in, and conduct, various forms of quiz, such as Technical Quiz and Business Quiz.

SOCIAL OUTREACH

Subject Code: SA38033
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To sensitize the students on the social issues and giving them an opportunity to connect with the community and the environment through outreach activities, community projects, and volunteering.

HEALTH & EMERGENCY CARE

Subject Code: SA38035
Credit: 1
L_T_P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE
To let the students learn about health issues, basic Life-saving skills and participate in health awareness and sensitization programs.