

# BE ROBOTICS AND AUTOMATION

## SEMESTER - 1

### 19R101 CALCULUS AND ITS APPLICATIONS

3 1 0 4

**DIFFERENTIAL CALCULUS:** Functions of two variables, limit, continuity, partial derivatives, differentiability, total differential, extreme values and saddle points, constrained maxima and minima, Lagrange multipliers with single constraint, Taylor's formula for two variables. (9 +3)

**MULTIPLE INTEGRALS I:** Basic concepts, double integrals over rectangles, double integrals as volumes, Fubini's theorem, double integrals over general regions, area by double integration, reversing the order of integration. (9 +3)

**MULTIPLE INTEGRALS II:** Double integrals in polar form, triple integrals in rectangular coordinates, spherical and cylindrical coordinates. (9 +3)

**SECOND ORDER LINEAR ORDINARY DIFFERENTIAL EQUATIONS:** Homogeneous linear ODEs of second order, linearity principle, general solution, homogeneous linear ODEs with constant coefficients, Euler–Cauchy equations, solution by variation of parameters, modeling of electric circuits. (9 +3)

**VECTOR CALCULUS:** Gradient of a scalar field, directional derivative, divergence of a vector field, curl of a vector field. Integration in vector field – line integrals, Green's, Gauss divergence and Stokes's theorems. (9 +3)

**Total L: 45 +T: 15 =60**

#### TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D. Weir "Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015.

#### REFERENCES:

1. J.E.Marsden, A.J.Tromba, A. Weinstein "Basic Multivariable Calculus", Springer Verlag., New York, 2019.
2. Howard Anton, Irl Bivens, Stephen Davis "Calculus", John Wiley & Sons, INC., USA, 2016.
3. Wylie C R and Barrett L C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019.
4. James Stewart "Multivariable Calculus", Brooks Cole., USA, 2012.

### 19R102 PHYSICS

3 0 0 3

**MECHANICS:** Review of Vector quantities Inertial mass, Newton's third law and Free Body diagrams. Rigid body dynamics: Centre of mass. Moment of inertia. Torque, angular momentum and angular acceleration. Work, power and energy. Conservation of momentum. Conservation of energy. Elastic and inelastic collisions. Kinetic energy considerations. Circular motion: Radial and tangential forces. Centripetal acceleration and centripetal force. (10)

**OSCILLATORY MOTION:** Simple harmonic motion. Velocity damping. Damping coefficient. Differential equation of SHM. Velocity and acceleration. Restoring force. Vibration of a spring and mass system. Frequency response, phase response and resonance. Analogy with LCR circuits. Energy and energy loss. Vibration and vibration isolation. (8)

**WAVE MOTION:** Definition of a plane progressive wave. Attenuation of waves. Representation of waves using complex numbers. Differential equation of a plane progressive wave. Phase velocity. Phase and phase difference. Solution of the differential equation of a plane progressive wave. Differential equation of 2-dimensional wave motion. Introduction to numerical methods for solution of wave equation. (8)

**OPTICS:** Image formation using lenses and mirrors. Spherical and chromatic aberration. Methods of reducing aberrations. Aspherical components, aperture control, multiple elements. Adaptive optics. Definition of depth of field. Fresnel mirrors. Fresnel mirrors for solar energy. Tracking of Fresnel mirrors. Illumination. Principles of photometry and definition of fundamental photometric quantities. Interference and diffraction. Single and double slits. Interpretation of the energy distribution equation in single and double slit patterns (no derivations). Principle of Fabry - Perot interferometer. Principle of Michelson's interferometer. Applications. Spectral distribution: emission and absorption spectra. Examples. (9)

**ELECTROMAGNETISM:** Magnetic effects of electric current. Magnetic fields. Definition of fundamental terms. Permeability. Forces due to currents. Uniform and non-uniform magnetic fields. Static and time-varying magnetic fields. Electromagnetic induction. Expression for induced emf. Electric fields; definition of fundamental terms. Dielectric polarization. Dielectric

constant. Permittivity. Gauss theorem. Electromagnetic waves. Propagation of electromagnetic waves through isotropic media. Maxwell's equations and interpretation of Maxwell's equations. (10)

**Total L: 45**

**TEXT BOOKS:**

1. Richard Wolfson "Essential University Physics", 3<sup>rd</sup> Edition, Pearson Education., Singapore, 2016.
2. Ghatak "Optics", 6<sup>th</sup> Edition, Tata McGraw-Hill., 2017.

**REFERENCES:**

1. Avadhanulu, M.N "Engineering Physics", S. Chand & Co., 2010.
2. Purcell, E.M "Electricity and Magnetism – Berkeley Physics Course", Tata McGraw-Hill., 2017.
3. F.S.Crawford "Waves", Berkeley Physics Course, 2008.
4. Paul A Tipler and Gene Mosca "Physics for Scientists and Engineers", 6<sup>th</sup> Edition, W.H.Freeman and Company., New York, 2007.

### 19R103 APPLIED CHEMISTRY

**3 0 0 3**

**METALS AND ALLOYS:** Phase rule-influence of alloying on properties-Pb/Ag and Cu/Ni systems-applications, Fe- C system. Applications of aluminium and titanium alloys. Modification of metallic surfaces-electroplating of copper, nickel and chromium, electroless plating of nickel and copper, electropolishing and electrochemical machining (9)

**POLYMERS:** Polymers -classification, degree of polymerisation, mechanisms- chain and condensation polymerization, average molecular weights, polydispersity. Properties - amorphous and crystalline states – structural features influencing crystallinity, thermal properties - glass transition temperature (T<sub>g</sub>) – factors affecting T<sub>g</sub>, mechanical properties, electrical properties. Polymer composites – matrix materials, fibres - carbon, glass, aramid, properties and applications. Conducting polymers-mechanism of charge transport, applications in LED's, photovoltaics. (9)

**CORROSION AND PROTECTIVE COATINGS:** Chemistry of corrosion – Electrochemical cells– electrode potential, Nernst equation, emf and galvanic series. Forms of corrosion - galvanic, differential aeration, stress corrosion cracking, erosion, fretting, corrosion fatigue, tribocorrosion. Corrosion rate - factors influencing corrosion. Protective coatings- conversion coatings- anodizing, phosphating, chromating, organic coatings-paints-types and applications, superhydrophobic and self-healing coatings. (9)

**ELECTROCHEMICAL POWER SOURCES:** Batteries- characteristics-construction and working of lechlanche, lead- acid, nickel-cadmium and lithium ion batteries. Advanced batteries and supercapacitors. Fuel cells- working principle and applications of proton exchange membrane, direct methanol and solid oxide fuel cells. Hydrogen as a fuel-production and storage. (9)

**MISCELLANEOUS MATERIALS:** Water- quality parameters, methods of determination of hardness, TDS, conductivity, purification-ion exchange, membrane filtration, sensors for water quality monitoring- pH, flame photometry, photo colorimeter, ICP-MS. Lubricants-classification, properties, mechanism of lubrication- additives and improvers. High temperature materials: refractories-types, uses, ceramics-electro ceramics and uses. Adhesives and sealants. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Shashi Chawla "A Text Book of Engineering Chemistry", Dhanpat Rai & Co., New Delhi, 2005.
2. SS Dara, SS Umare "A Textbook of Engineering Chemistry", 20<sup>th</sup> Edition, S Chand & Co., New Delhi, 2010.

**REFERENCES:**

1. Sharma B. K "Engineering Chemistry", Krishna Prakashan Media (P) Ltd., Meerut, India, 2005.
2. Mary Jane Shultz "Engineering Chemistry", Cengage learning, USA, 2009.
3. Jain P C, Jain M "Engineering Chemistry", Dhanpat Rai Publishing Company., New Delhi, 2005.

### 19R104 INTRODUCTION TO MECHANICAL SYSTEMS

**3 0 0 3**

**STATICS OF PARTICLES:** Introduction – Units and Dimensions – Laws of Mechanics – Force- Characteristics - System of forces - Lami's theorem, Parallelogram and triangular Law of forces, Statics of rigid bodies in two dimensions, force couple system. (7)

**EQUILIBRIUM OF RIGID BODIES:** Free body diagram – Types of supports –Action and reaction forces - Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions. (8)

**PROPERTIES OF SURFACES AND SOLIDS:** Centroids and centre of mass – Area moments of inertia of plane areas – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia- Mass moment of inertia – Comparison of Mass moment of Inertia and Area Moment of Inertia. (11)

**RIGID BODY DYNAMICS:** Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion- Newton's laws of motion – Work Energy Equation. Friction force – Laws of sliding friction –equilibrium analysis of simple systems with sliding friction. (11)

**INTRODUCTION TO ROBOTS:**Robotics - Law of robotics – Anatomy – Configuration of robots – free body diagram of robot configuration and force analysis. (8)

**Total L:45**

**TEXT BOOKS:**

1. Beer F.P, Johnston Jr.E.R "Vector Mechanics for Engineers Statics and Dynamics", 11<sup>th</sup> Edition, McGraw Hill Education, 2017.
2. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta "Industrial Robotics (SIE): Technology, Programming and Applications", McGraw Hill Education India., 2012

**REFERENCES:**

1. Hibbeler R.C, Ashok Gupta "Engineering Mechanics Statics and Dynamics", 11<sup>th</sup> Edition, Pearson Education., 2009.
2. Bhavikatti S.S "Engineering Mechanics", 7<sup>th</sup> Edition, New Age International (P) Limited Publishers, 2019.
3. Young D H, Timashenko S "Engineering Mechanics", Tata McGraw-Hill., 2006
4. S K Saha "Introduction to Robotics", 2<sup>nd</sup> Edition, McGraw Hill Education India, 2014.

## 19G105 ENGLISH LANGUAGE PROFICIENCY

**2 1 0 3**

**LEARNING LANGUAGE THROUGH STANDARD LITERARY AND GENERAL TEXTS:** Integrated tasks focusing on language skills; Training based on Text based vocabulary, tone, register and Syntax features. (12 + 0)

**GRAMMAR IN CONTEXT:** Word Order; Subject Verb Concord; Style features - Tenses, Conditionals, Prepositions, Active and Passive Voice, Modals, Cloze and Spotting Error exercises. (10 + 0)

**GUIDELINES FOR WRITTEN COMMUNICATION:** Principles of clear writing, Paragraph writing, Essay writing, Emphasis Techniques, Summarizing and Paraphrasing, Analytical writing. (8 + 0)

**FOCUS ON SPOKEN ENGLISH :** Task – based activities: Graded levels of difficulty and with focus on language functions - Level 1: Self – expression – Greetings in Conversation, Hobbies, Special interests, Daily routine - Level 2: General Awareness – Expression of Concepts, Opinions, Social Issues, Description of a process / picture/chart, news presentation / review - Level 3: Advanced Skills – Making Short Speeches and Participating in Role Plays. (0 + 10)

**LISTENING ACTIVITY:** Task based activities using Language Laboratory. (0 + 5)

**Total L: 30 +T: 15 =45**

**TEXT BOOK:**

1. Faculty In-charge "Course Material on "English Language Proficiency", PSG College of Technology., Coimbatore, 2019

**REFERENCES:**

1. Jill Singleton "Writers at Work: The Paragraph", Cambridge University Press., New York, 2012.
2. Simon Haines, Mark Nettle and Martin Hewings "Advanced Grammar in Use", Cambridge University Press, New Delhi, 2008.
3. Anne Laws "Writing Skills", Orient Black Swan, Hyderabad, 2011.
4. Sinha DK "Specimens of English Prose", Orient Black Swan, Hyderabad, 2012.

## 19R110 ENGINEERING GRAPHICS

**0 0 4 2**

**INTRODUCTION:**

- 1) Introduction to Engineering Drawing, BIS, Principles of dimensioning

- 2) Geometric constructions
- 3) Curves —Conic section, Cycloids and Involutés. (10)

**ORTHOGRAPHIC PROJECTION:**

- 1) Principles of orthographic projection-projection of points
- 2) projection of straight lines
- 3) projection of planes and solids
- 4) Orthographic projection of simple engineering components. (15)

**SECTION AND DEVELOPMENT OF SOLIDS:**

- 1) Introduction to Sections of solids – Prisms, pyramids, cylinder and cone
- 2) Introduction to development of Surfaces - Prisms, pyramids, cylinder and cone. (10)

**PICTORIAL PROJECTIONS:**

- 1) Principles of pictorial views, isometric view of simple mechanical and robotic engineering components.
- 2) Orthographic views from given pictorial views
- 3) Isometric views from given two or three views. (10)

**COMPUTER AIDED DRAFTING:**

- 1) Introduction to engineering graphics CAD tools
- 2) Drawing Orthographic views from Isometric views using CAD tools (15)

**Total P: 60**

**REFERENCES:**

1. Venugopal K, Prabhu Raja V "Engineering Graphics", New Age International Publishers, 2017.
2. Department of Robotics and Automation Engineering "Engineering Graphics Manual", 2019.

**19R111 BASIC SCIENCES LABORATORY**

**0 0 4 2**

**PHYSICS LIST OF EXPERIMENTS (ANY EIGHT):**

- 1) Determination of Young's Modulus of a wooden bar—Cantilever method
- 2) Determination of fibre thickness—air wedge method
- 3) Determination of wavelength of mercury spectrum using transmission grating
- 4) Measurement of vibration frequency of electrically maintained tuning fork using Melde's apparatus
- 5) Determination of velocity of sound—Helmholtz resonator
- 6) Determination of Hysteresis loss of a ferromagnetic material
- 7) Determination of Temperature Coefficient of Resistance of metallic wire using post office box
- 8) Determination of thermal conductivity of a metallic material using Wiedemann—Franz law
- 9) Study of reverse bias characteristics of Germanium diode and determination of its band gap
- 10) Thermistor: Measurement of temperature and band gap (30)

**CHEMISTRY (ANY EIGHT EXPERIMENTS):**

- 1) Electroplating of nickel & copper and determination of cathode efficiency
- 2) Anodizing of aluminium and determination of thickness of anodized film
- 3) Determination of molecular weight of polymers by Ostwald / Ubbelohde Viscometer
- 4) Examination of different forms of corrosion using FerroxyI indicator and determination of corrosion rate by current measurement
- 5) Conductometric estimation of acid strength of a pickling bath
- 6) Preparation of chloride ion sensor by anodizing silver and calibration
- 7) Determination of hardness, TDS, pH and conductivity of a water sample
- 8) Potentiometric estimation of ferrous ion in an effluent
- 9) Estimation of ferric ion in a water sample by photocolourimetry
- 10) Determination of kinematic viscosity of lubricating oil using Redwood/ Saybolt viscometer (30)

**Total P: 60**

**REFERENCES:**

1. Department of Chemistry "Chemistry Laboratory Manual", 2019.
2. Department of Physics "Physics Practicals", 2019.
3. Wilson J. D. and Hernandez C. A. "Physics Laboratory Experiments", 7<sup>th</sup> Edition, Houghton Mifflin Company., New York, 2009.

## 19R112 C PROGRAMMING LABORATORY

0 0 4 2

- 1) Working with RAPTOR Tool – Flowchart Interpreter
- 2) Simple programs to understand Operators and expressions.
- 3) Decision making Statements: simple if, if..else, nested if .. else,elseifladder, switch case
- 4) Loops: while, do..while, for
- 5) Implementation of one-dimensional array
- 6) Implementation of two-dimensional array
- 7) Working with Strings
- 8) Functions
- 9) Recursive functions
- 10) Structures: Arrays and Structures, Nested Structures
- 11) Structures and functions
- 12) Implementation of pointer and pointer arithmetic
- 13) Types of pointer:const pointer, pointer to a constant, void pointer, null pointer

(60)

**Total P: 60**

### REFERENCES:

1. Deitel H. M. and Deitel P. J "C: How To Program", Prentice Hall of India., New Delhi, 2015
2. Ajay Mittal "Programming in C-APractical approach", Pearson., New Delhi, 2010
3. Gottfried B "Programming with C", McGraw Hill Education., New Delhi, 2018
4. Herbert Schildt "C:The Complete Reference", McGraw Hill., New Delhi, 2017

## 19IP15 INDUCTION PROGRAMME

0 0 0 0

As per AICTE guidelines

### SEMESTER - 2

## 19R201 COMPLEX VARIABLES AND TRANSFORMS

3 1 0 4

**COMPLEX DIFFERENTIATION:** Complex differentiation - analytic function, Cauchy-Riemann equations, harmonic functions, linear fractional transformations. (9 + 3)

**COMPLEX INTEGRATION:** Cauchy's integral theorem, Cauchy's integral formula, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). (9 + 3)

**LAPLACE TRANSFORMS:** Laplace transform, inverse transform, linearity, s-shifting, transforms of derivatives and integrals, unit step function, t - shifting, Dirac's delta function, periodic functions, method of solving differential equations by using Laplace transform technique. (9 + 3)

**FOURIER SERIES:** Fourier series- convergence and sum of Fourier series, functions of any period  $2L$ , even and odd functions, half range expansions. (9 + 3)

**FOURIER TRANSFORMS:** Fourier transform, Fourier cosine and sine transforms, Discrete Fourier transform, Fast Fourier transform – DIT algorithm. (9 + 3)

**Total L: 45 +T: 15 =60**

### TEXT BOOKS:

1. Erwin Kreyszig "Advanced Engineering Mathematics", John Wiley & Sons., New Delhi, 2015.
2. Wylie C. R. and Barrett L. C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019.

### REFERENCES:

1. Mathews J. H. and Howell R. W "Complex Analysis for Mathematics and Engineering", Narosa Publishing House., New Delhi, 2012.
2. Peter V.O Neil "Advanced Engineering Mathematics", Cengage., New Delhi, 2016.
3. Dennis G Zill "Advanced Engineering Mathematics", Jones & Bartlett India Pvt Ltd., New Delhi, 2017.
4. Dean G Duffy "Advanced Engineering Mathematics with MATLAB", CRC., USA, 2017.

## 19R202 MATERIALS SCIENCE

2 0 0 2

**QUANTUM MECHANICS:** Wave particle duality, de Broglie waves- Heisenberg's uncertainty principle. Wave function-normalization. The wave equation. Schrodinger's equation of motion: Time dependent form, steady-state form. Particle in a box. Quantum Tunneling and applications to Scanning Tunneling Microscope and Tunnel diode. (8)

**ELECTRICAL PROPERTIES:** Conducting materials-quantum free electron theory -Fermi Dirac Statistics-Band theory of solids-the density of states. Dielectrics-types of polarization-measurement of dielectric permittivity-Loss Factor-Dielectric loss mechanisms. Magnetostriction. Electron ballistics- materials for thermionic (7)

**PHYSICS OF SEMICONDUCTORS:** P type and N type semiconductors-the effective mass. Free electron and hole concentration in semiconductors. Band gap determination. Carrier concentration in n and p type semiconductor. P- N junction, rectifier equation -Hall effect-Quantum tunneling. Hetero junction-Quantum well, wire, dots-Optical properties of Semiconductors: LD, LED, Photo diode. Introduction to MEMS (8)

**MAGNETIC PROPERTIES:** Types of magnetic materials-domain theory-hysteresis- hard and soft magnetic materials-Applications-eddy current brakes, regenerative braking. Magnetic lenses. Superconductivity –Meissners effect- Josephson junction, SQUID magnetometer, applications . (7)

**Total L: 30**

### TEXT BOOKS:

1. William D Callister Jr "Materials Science and Engineering - An Introduction", 6<sup>th</sup> Edition, John Wiley and Sons Inc., New York, 2007.
2. Arthur Beiser "Concepts of Modern Physics", Tata McGraw Hill., India, 2002.

### REFERENCES:

1. James F Shackelford S "Introduction to Materials Science for Engineers", 3<sup>rd</sup> Edition, Macmillan Publishing Company., India, 1992.
2. Van Vleck "Elements of Material Science and Engineering", Pearson Education., India, 2008
3. Sze S.M "Physics of Semiconductor Devices", John Wiley and Sons., USA, 2007
4. Donald R Askeland, Wendelin J Wright "Essentials of Materials Science and Engineering", 3<sup>rd</sup> Edition, Cengage Learning., USA, 2013.

## 19R203 ELECTRICAL CIRCUIT THEORY

3 1 0 4

**INTRODUCTION:** Ohm's law - Resistors, Capacitors and Inductors - Series and Parallel Combination circuit - Magnetically coupled circuit - Illustration of dot conventions - Sources - Introduction to Dependent Sources - Kirchoff's Laws - Source Transformation - Star Delta Transformation - Mesh Analysis - Super mesh analysis -Nodal Analysis – Super node Analysis. (12 +4)

**NETWORK THEOREMS:** Superposition theorem - Thevenin's theorem - Norton's theorem – Maximum power transfer theorem. (8 +3)

**SINGLE PHASE AC CIRCUITS :** Introduction to Alternating Quantities - Terms Related to Alternating Quantity - Average and RMS values - Phasor Representation of Alternating Quantities - Mathematical representation of Phasor - Behavior of Pure Resistor, Pure Inductor and Pure Capacitor in an AC circuit - Series RL circuit – Series RC circuit - Series RLC circuit - Parallel and Series circuit - Real power, Reactive power, Apparent power, Complex power - Introduction to Resonance in parallel and series circuits. (10 +3)

**THREE PHASE CIRCUIT ANALYSIS:** Introduction - Advantages of Three Phase System - Interconnection of three phases Star and Delta connection - Voltage, Current and Power Relations in Balanced Star and Delta connected Load - Comparison between Star and Delta connection - Introduction to Three Phase Circuit analysis with star and delta unbalanced loads -Measurement of Three Phase Power. (10 +3)

**TRANSIENT ANALYSIS OF FIRST AND SECOND ORDER LINEAR CIRCUITS:** Transient Concepts -Transient response of Simple RL, RC and RLC Circuits - Solution of RL, RC and RLC Circuits for Step Input and Sinusoidal Excitations using Laplace Transform method. (5 +2)

**Total L: 45 +T: 15 =60**

**TEXT BOOKS:**

1. Charles K Alexander and Mathew N O Sadiku "Fundamentals of Electric Circuits", Tata McGraw Hill., 2013
2. William H. Hayt, Jr., Jack E. Kemmerly and Steven M. Durbin "Engineering Circuit Analysis", Tata McGraw Hill., 2013

**REFERENCES:**

1. Ravish R Singh "Electrical Networks", Tata McGraw Hill., New Delhi, 2017.
2. Joseph A Edminister and Mahmood Nahvi "Electric Circuits", Tata McGraw Hill., 2013.
3. Richad C Dorf and James A Svoboda "Introduction to Electric Circuits", John Wiley and Sons Inc., 2013.
4. David A Bell "Electric Circuits", PHI Pvt. Ltd., 2009.

**19R204 STRENGTH OF MATERIALS****3 0 0 3**

**STRESSES AND STRAINS:** Stress and strain due to axial force, elastic limit, Hooke's law-factor of safety – stepped bars, uniformly varying sections, stresses in composite bar due to axial force and temperature. (8)

**CHANGES IN DIMENSIONS AND VOLUME:** Lateral strain -Poisson's ratio, volumetric strain, changes in dimensions and volume, shear stress, shear strain, relationship between elastic constants. (8)

**PRINCIPAL STRESSES AND STRAINS:** (Two dimensional only) State of stress at a point - normal and tangential stresses on a given plane, principal stresses and their planes, plane of maximum shear stress -Mohr's circle method, application to simple problems. (7)

**BEAMS:** Relationship between load, shear force and bending moment - shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads, uniformly varying loads, concentrated moments, maximum bending moment and point of contra flexure. Theory of simple bending and assumptions - derivation of equation, section modulus, normal stresses due to flexure. (15)

**TORSION:** Theory of torsion and assumptions-derivation of the equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft (7)

**Total L: 45****TEXT BOOKS:**

1. Punmia B C, Ashok Kumar Jain, Arun Kumar Jain "Mechanics of materials", Laxmi Publications., New Delhi, 2017.
2. Hibbeler R C "Mechanics of Materials", 9<sup>th</sup> Edition, Pearson Education., 2018.

**REFERENCES:**

1. Ramamrutham S, Narayan R "Strength of Materials", Dhanpat Rai and Sons, New Delhi, 2018.
2. Egor P Popov "Engineering Mechanics of Solids", 2<sup>nd</sup> Edition, Pearson Education., 2015.
3. Gere &Timoshenko "Strength of Materials", 2<sup>nd</sup> Edition, CBS Publisher, 2006.
4. Don H Morris, William F Riley, Leroy D Sturges "Mechanics of Materials", John Wiley and Sons Inc., 2007.

**19R205 MANUFACTURING TECHNOLOGY****3 0 0 3**

**METAL CASTING:** Foundry –Pattern layouts – Parting lines – Mould and Core making –Melting: Types of furnace- Casting Processes –Sand casting - Shell, Investment casting – Pressure die casting – Centrifugal casting. Case Study: Mould preparation and casting for a specified robot part. (9)

**METALFORMING AND WELDING:** Forging - Extrusion - Injection moulding – Compression moulding. Sheet metal forming process. Welding – Metal inert gas (MIG) welding, Tungsten Inert Gas (TIG) welding and Shielded metal arc welding (SMAW). Case Study: Robotic welding. (9)

**METAL CUTTING FOR CYLINDRICAL COMPONENT:** Theory of metal cutting – Types of Lathe –Specifications - Lathe operations - Facing – Turning – Taper turning – Grooving – Boring – Drilling – Cutting off/Parting off – Threading – Knurling – Profiling and Forming process. Case Study: Machining process using Lathe for a specified robot part. (9)

**METAL CUTTING FOR PRISMATIC COMPONENT:** Introduction to special machines - Shaping – Planing – Slotting – Milling, Drilling, Boring, Grinding and Broaching process. Case Study: Machining process using Special machines for specified robot part. (9)

**NON-CONVENTIONAL MACHINING PROCESS:** Electrical Discharge Machining (EDM) – Wire cut EDM – Laser Jet Machining – Water Jet Machining and Electron Beam Machining (EBM). Case Study: Development of a specified robot component. (9)

**Total L: 45**

**TEXT BOOKS:**

1. P. N. Rao "Manufacturing Technology vol I", Tata-McGraw-Hill Publishing Limited., 2010.
2. HMT- "Production Technology", McGraw-Hill Education, 2014.

**REFERENCES:**

1. Ghosh A, Mallik A.K "Manufacturing Science", Affiliated East west Press Ltd., 2001.
2. Serope Kalpakjian "Manufacturing Engineering and Technology", 4<sup>th</sup> Edition, Pearson India., 2014.
3. Hajra Choudhury "Elements of Workshop Technology, Vol. I &II", Media Promoters Pvt. Ltd., 2009.
4. Radhakrishnan "Manufacturing Technology I", SciTech Publications Pvt. Ltd., 2010.

**19R210 ELECTRIC CIRCUITS AND NETWORKS LABORATORY**

**0 0 4 2**

- 1) Study of materials used for conducting wires, Wire-gauge measurement and Industrial standards for insulators and cables.
- 2) Experimental verifications using Resistors, Inductors and Capacitors: Series - Parallel combination of resistors, inductors and capacitors; Resistors use in Current limiting circuits, Voltage division and Wheatstone bridge; Capacitors use in Filtering
- 3) Verification of Ohm's, Kirchoff's laws and Series - Parallel combination of DC Sources – Circulating current.
- 4) Verification of Thevenin's theorem and Norton's Theorem
- 5) Verification of Superposition theorem and Maximum power transfer theorem.
- 6) Measurement of Power factor in RL and RC Circuit.
- 7) Series and Parallel resonance circuits.
- 8) Three phase power measurement by two wattmeter method in balanced and unbalanced loads
- 9) DC and AC circuit analysis using Pspice.
- 10) Transient analysis of RL, RC and RLC circuit using Pspice and experimental verification.

(60)

**Total P: 60**

**REFERENCE:**

1. Department of Robotics and Automation Engineering "Electric Circuits and Networks Laboratory Manual", 2019.

**19R211 ENGINEERING PRACTICES**

**0 0 4 2**

**ELECTRICAL:**

- 1) Measurements and operations using CRO, DSO, Function Generator and RPS.
- 2) Soldering, de-soldering and crimping practices.
- 3) Study and practice of electrical wiring for two-way, three phase selector and fluorescent lamp.
- 4) Study of single and three phase power system in domestic applications.
- 5) Measurement of electrical parameters using hand held devices.

(26)

**MECHANICAL:**

- 1) Welding: Tools, operations and types of joints - Exercises to make "Lapp", "Butt" and "T" joints.
- 2) Fitting: Tools, operations and types of joints - Exercises to make "T" and "L" Joints.
- 3) Sheet metal work: Tools and operations - Exercises to make tray and cone.
- 4) Lathe: Tools and Holding devices - Exercises on Facing, Turning and Drilling operations.
- 5) Drilling: Tools and Holding devices - Exercises on Drilling, Reaming and Tapping operations
- 6) Plumbing: Tools, operations and types of joints

(34)

**Total P: 60**

**REFERENCE:**

1. Department of Robotics and Automation Engineering "Engineering Practices Laboratory manual", 1<sup>st</sup> Edition, PSG CT., Coimbatore, 2019.

**19R214 INTERNSHIP**

**0 0 0 2**

**ROBOTIC KITS:** Study of robot components and types of robots.



**ROBOT ASSEMBLING AND PROGRAMMING:** Assembly and programming of robots -Lego, Vex and Tetrix Kits - Five-minute bot using NXT software, Robot C and ROS platform, Line follower, Obstacle avoidance robot, Wall following robot, robot arm and other simple applications.

**e-YANTRA FIREBIRD KIT:** Introduction, Architecture, programming using Atmel studio, Programming: Buzzer, Line following, LCD display and other simple applications.

- 1) Visit to PSG Heavy Engineering Division.
- 2) Visit to PSG- Fanuc Centre for Advanced CNC &Robotics.
- 3) Visit to TIFAC – CORE.
- 4) Visit to PSG foundry division.
- 5) Visit to PSG-DHI CoE in Welding Engineering and Technology

**Total P: 40**

### **SEMESTER - 3**

#### **19R301 LINEAR ALGEBRA AND NUMERICAL ANALYSIS**

**3 1 0 4**

**VECTOR SPACE :** General vector spaces, real vector spaces, Euclidean n-space, subspaces, linear independence, basis and dimension. (9 + 3)

**SYSTEM OF LINEAR EQUATIONS, EIGENVALUES AND EIGENVECTORS :** Errors - approximations and round-off errors—truncation errors, system of linear equations- Naive Gauss elimination method, Crout's method, Gauss– Seidel method, eigenvalues and eigenvectors using power method (9 + 3)

**INTERPOLATION, DIFFERENTIATION AND INTEGRATION :** Newton's divided-difference interpolating polynomials, Lagrange interpolating polynomials, equally spaced data-Newton's forward and backward interpolating polynomials, numerical differentiation—evenly spaced data, numerical integration - Newton-cotes formulae, trapezoidal rule, Simpson's 1/3 rule. (9 + 3)

**NUMERICAL SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS :** Numerical methods for initial value problem, Taylor-series, Euler's method, modified Euler's method, Runge-Kutta method of 4th order, multi step methods - Milne method. (9 + 3)

**NUMERICAL SOLUTION TO PARTIAL DIFFERENTIAL EQUATIONS :** Finite difference: elliptic equations - the Laplace equation, Poisson equation—Liebmann method, parabolic equations—heat conduction equation—Crank Nicolson's method, hyperbolic equations – vibrating string. (9 + 3)

**Total L: 45 +T: 15 = 60**

#### **TEXT BOOKS:**

1. Howard Anton and Chris Rorres, "Elementary Linear Algebra", Wiley India, New Delhi, 2018.
2. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers", Tata McGraw Hill, New Delhi, 2017.

#### **REFERENCES:**

1. David C Lay, "Linear Algebra and its Applications", Pearson, New Delhi, 2016.
2. Curtis F Gerald and Patrick O Wheatly, "Applied Numerical Analysis", Pearson, New Delhi, 2017.
3. Richard L Burden and Douglas J Faires, "Numerical Analysis", Thomas Learning, New York, 2017.
4. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Cengage Learning, USA, 2018.

#### **19R302 ANALOG ELECTRONICS**

**3 0 0 3**

**SEMICONDUCTOR PHYSICS AND DIODE THEORY :** Intrinsic and Extrinsic semiconductors — Doping a semiconductor - Ideal diode - Unbiased diode - Forward bias - Reverse Bias — Breakdown - Barrier potential and temperature — Reverse biased diode — DC resistance of a diode - Load lines — Clipper — Clamper - Half-wave rectifier - Full-wave rectifier — Bridge Rectifier — Peak inverse voltage and surge current - Zener diode as a voltage regulator. Datasheet interpretation of diode (7)

**BIPOLAR JUNCTION TRANSISTOR :** Unbiased and biased transistor - Transistor Currents – CE Connection - Base curve – Collector curve – Load line – Operating point - Transistor as switch – Emitter Bias - Voltage divider bias: Load line and Q-point - Two-supply emitter bias. Datasheet interpretation of transistor (6)

**AMPLIFIERS :** Two-transistor model – Analyzing an amplifier - Voltage gain – Loading effect of input impedance - Multistage amplifiers – CC amplifier - Output impedance - Cascading CE and CC - Darlington connections – Class A, Class B - Class C, Class D operation - Push-pull Emitter Follower (9)

**OPERATIONAL AMPLIFIER :** The 741 opamp – Inverting Amplifier – Non-inverting Amplifier - Characteristics and applications of opamp - Differential amplifier – Instrumentation amplifier - Summing Amplifier - Current Boosters - Low –pass filter. High pass filter - Bandstop filter – All-pass filter - Comparators with zero reference, non-zero reference, hysteresis - Window comparator - Integrator – Waveform conversion - Waveform generation – Datasheet interpretation of opamp (14)

**OSCILLATORS AND VOLTAGE REGULATORS :** Theory of sinusoidal oscillation — Wien-bridge oscillator - RC oscillator — Colpitts oscillator - LC oscillator — 555 Timer - Monostable and Astable operation of 555 timer - 555 timer applications - Phase-locked loop – Function generator ICs - Supply characteristics – Shunt regulator – Series Regulator — Current boosters - Fixed and adjustable three terminal regulators. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Albert Malvino, David J. Bates , "Electronic Principle", Pearson Education, New Delhi, 2012.
2. Gayakwad A R, "OP-Amps and Linear Integrated circuits", Pearson Education, New Delhi, 2004.

**REFERENCES:**

1. Roy Choudhury, Shail Jain, "Linear Integrated Circuits", New Age International Limited, 2003.
2. Millman J, Halkias C C, Satyabrata J, "Electronic Devices and Circuits", Tata McGraw Hill, New Delhi, 2011.
3. Boylestead.L.R, Nashelsky.L, "Electronic Devices and Circuit Theory", Pearson Education India, New Delhi, 2002.
4. Anant agarwal, Jeffrey H.Lang , "Foundations of Analog and Digital Electronic Circuits", 1<sup>st</sup> Edition, Morgan Kaufmann, 2005.

## 19R303 ELECTRICAL MACHINES AND POWER SYSTEMS

**3 0 0 3**

**DC MACHINES :** Electromechanical energy conversion - Rotating machines - Driving and opposing torque - Faradays law - Generator mode and Motor mode - Constructional details of DC Machines - EMF equation - Methods of excitation — Self and separately excited Shunt generator - Principle of operation of DC Motor — back emf and torque equation - Characteristics of DC series and shunt motors - Starting of DC Motors, Need for Starters - Speed control and Braking of DC motors (Voltage Control & Dynamic Braking Only) - Principle of Brushless DC motors - Direct Drive High Torque Motors. (11)

**TRANSFORMERS:** Constructional Details — Principle of Operation — EMF Equation — Transformation ratio - Transformer on no load — Parameters referred to HV/LV windings — Equivalent circuit - Dot Convention - Transformer on load- Regulation - Losses and efficiency- Load test - Three phase transformer connections - Introduction to Current and Potential Transformers - Applications of Transformer in Robotics and Automation. (10)

**INDUCTION MOTORS :** Construction — Types — Principle of operation of three phase induction motors - Speed Torque characteristics - Equivalent circuit - Starting and Speed control - Single-phase induction motors (only qualitative analysis) - Introduction to Linear induction motor - PMSIM - Applications (10)

**SYNCHRONOUS AND SPECIAL MACHINES:** Construction of Synchronous machines - Types — Induced emf - Working principles of: Brushless alternators-Stepper motor - Servomotor — Universal motor -. Applications – rating and duty cycle - Sizing of Motor for a Industrial application (10)

**INTRODUCTION TO POWER SYSTEM:** Structure of electric power systems - Generation, transmission, sub- transmission and distribution systems - EHVAC and EHVDC transmission systems - Substation layout. (Concepts only). (4)

**Total L: 45**

**TEXT BOOKS:**

1. K Murugesh Kumar, "DC Machines and Transformers", Vikas Publishing House Pvt Ltd, 2010.
2. K Murugesh Kumar, "Induction and Synchronous machines", Vikas Publishing House Pvt Ltd, 2010.

**REFERENCES:**

1. V K Mehta, Rohit Mehta, "Principles of Power System", S.Chand and Company Ltd, 2003.
2. Haruhiko Asada, Kamal Youeef-Toumi, "Direct-Drive Robots Theory and Practice", The MIT Press, Cambridge, 1987.
3. AE Fitzgerald, Charles Kingsley, Stephen.D.Umans, "Electric Machinery", Tata McGraw Hill publishing Company Ltd, 2003.
4. J B Gupta, "Theory and Performance of Electrical Machines", S.K. Kataria and Sons, 2002.

## 19R304 THEORY OF MACHINES

**3 0 0 3**

**BASICS OF MECHANISMS :** Definitions: Link, Kinematic pair, Kinematic chain, Mechanism and Machine - Degree of freedom — Mobility — Kutzbach criterion - Grashoff's law - Kinematic inversions: Four bar and slider crank

mechanism - Mechanical advantage - Transmission angle - Description of common mechanisms, applications of mechanisms. (7)

**KINEMATIC ANALYSIS:** Displacement, velocity and acceleration analysis in simple mechanisms using graphical method. (10)

**SYNTHESIS AND FORCE ANALYSIS:** Number and dimensional synthesis- two and three positions synthesis of four bar mechanisms. Free body diagrams, Inertia forces and moments. Balancing of rotating and reciprocating masses. (10)

**CAMS :** Introduction to Cams- Classifications, law of cam design, cam function / follower motion schemes: uniform velocity, parabolic, simple harmonic motion, cycloid motion paths and introduction to high speed cams. Layout of cam profiles for different types of followers - knife-edged and roller. (9)

**GEARS :** Spur gear terminology and definitions. Fundamental law of toothed gearing and tooth forms. Helical, bevel, worm, and rack and pinion gears (basics only). Gear trains, epicyclic gear trains, differentials, automotive transmission gear trains and harmonic drives. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Rattan S S, "Theory of Machines", Tata McGraw -Hill Publishers, New Delhi, 2009.
2. Norton L, "Kinematics and Dynamics of Machinery", 5<sup>th</sup> Edition, Tata McGraw -Hill Publishers, 2016.

**REFERENCES:**

1. Myszka, DH, "Machines and Mechanisms: Applied kinematic analysis", 4<sup>th</sup> Edition, 2012.
2. Shigley J E, Uicker J J, "Theory of Machines and Mechanisms", McGraw -Hill Inc., New Delhi, 2003.
3. Bevan.T, "Theory of Machines", CBS Publishers and Distributors, New Delhi, 2002.
4. Ghosh, Mallick.A K, "Theory of Machines and Mechanisms", Affiliated East West Private Limited, New Delhi, 1988.

## 19R305 DATA STRUCTURES AND ALGORITHMS

**2 2 0 4**

**INTRODUCTION :** Object oriented programming concepts - Structure of C++ program - Implementation of classes and objects in C++ - Data Structures - Types of Data Structures - Abstract Data Types - Algorithms : Properties - Complexity Analysis - Recurrence Relations - Asymptotic Notations (5 + 4)

**ARRAYS AND LISTS:** Representation of linear and multidimensional arrays - Operations — Applications - Representation of linked list - Operations on linked list: Traversal — Search — Insertion — Deletion - Doubly linked list - Circularly linked list - Applications: Addition of Polynomials; Sparse Matrix representation (7 + 7)

**STACK AND QUEUE:** Operations - Applications: Recursion handling, Evaluation of expressions - Queue Representation - Operations — implementation - Stack Representation - Circular Queues -Deque - Priority Queue - Applications (6 + 7)

**TREES AND GRAPHS:** Tree Terminologies -Binary Trees - Representation - Traversals - Threaded Binary Tree - Applications - Graph: Terminologies - Types of Graphs - Representation - Traversal - Breadth first search- Depth first search - Applications (6 + 6)

**SORTING AND SEARCHING :** Insertion sort, Selection sort, Bubble sort - Heap sort, Quick sort, Merge sort - Linear search, Binary search - Hashing: Hash functions - Collision resolution techniques - Searching using Hashing (6 + 6)

**Total L: 30 +T: 30 = 60**

**TEXT BOOKS:**

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education, New Delhi, 2014.
2. Seymour Lipschutz, Vijayalakshmi Pai G.A, "Data Structures", Tata McGraw Hill, New Delhi, 2013.

**REFERENCES:**

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, "Introduction to Algorithms", MIT Press, New Delhi, 2014.
2. Yedidayah Langsam, Moshe J Augenstein, Aaron M Tannenbaum , "Data Structures using C and C++", PHI Learning, New Delhi, 2013.
3. Jean Paul Tremblay, Paul G Sorenson, "Introduction to Data Structures With Applications", Tata McGraw Hill, New Delhi, 2012.
4. Ellis Horowitz, Sartaj Sahni, Susan Anderson Freed, "Ellis Horowitz, Fundamentals of Data structures in C", Universities Press, Hyderabad, 2014.

## 190306 ECONOMICS FOR ENGINEERS

3 0 0 3

**INTRODUCTION** : Definition – Nature and Scope – Central Problems of an Economy – Positive and Normative Economics– Micro Economics and Macro Economics, Significance of Economics, Economic Assumptions (9)

**THEORY OF CONSUMER BEHAVIOR**: Utility — Indifference Curve Analysis - Properties, Consumer's Budget Line - Demand Analysis: Demand Function and Law of Demand, Elasticity of Demand. Demand forecasting using Econometric Techniques. Supply—Factors Affecting Supply, Market Equilibrium Price, Consumer Surplus (9)

**PRODUCTION, COST AND REVENUE** : Production Function, Total Product, Average Product and Marginal Product, Returns to Scale. Costs, Nature of Costs, Short-run and Long-run Cost Curves, Revenue concepts (9)

**MARKET STRUCTURE** : Types of Markets - Perfect Competition — Characteristics — Imperfect Competition: Monopoly – Monopolistic Competition – Oligopoly and Duopoly - Price Discrimination and Product Differentiation under Different Markets — Price and Output Determination in Short run and Long run and profit maximization. (9)

**PERFORMANCE OF AN ECONOMY (MACRO ECONOMICS)** : Demand and Supply of Money— Quantity Theory of Money, Banking — Functions of Commercial Banks and Central Bank — Inflation — Causes — Control Measures — National Income — Concepts — Methods of Calculating National Income — Problems in Calculating National Income. (9)

**Total L: 45**

### TEXT BOOKS:

1. Varian H.R. , "Intermediate Microeconomics", East– West Press, New Delhi, 2014.
2. Dewett.K.K, Navalur. M.H. , "Modern Economic Theory", S. Chand, New Delhi, 2015.

### REFERENCES:

1. William A, McEachern, Simrit Kaur, "Micro ECON", Cengage Learning, Noida, 2013.
2. William A, McEachern, Indira A, "Macro ECON", Cengage Learning, Noida, 2014.
3. Deepashree, "Principles of Economics", Ane Books Pvt Ltd, New Delhi, 2010.
4. Dwivedi, "Essentials of Business Economics", Vikas Publishing House Pvt Ltd, New Delhi, 2010.

## 19R310 ANALOG ELECTRONICS LABORATORY

0 0 2 1

1. Characteristics of Diode and its applications: Forward bias and Reverse bias; Rectifier; Clipper and Clamper
2. Characteristics of Zener diode and Zener voltage regulator
3. Characteristics of BJT – CE Configuration & Application of BJT as an amplifier and switch
4. Design and testing of RC phase shift oscillator.
5. Characteristics and linear Applications of Op-Amp: Inverting and Non-inverting amplifier; Slew rate and CMRR; Comparator and Level Detector; Summing and Difference Amplifier
6. Non-linear Applications of Op-Amp: Voltage and Current Sensing circuits; Integrator and Differentiator
7. Generation of waveform using Op-Amp and Pulse Width Modulator: Square, Triangle, Sine waveform
8. Performance characteristics of Voltage Regulator ICs: 7805, 7812, 723
9. Signal Conditioning of Sensor output from Thermocouple using Op-Amp: TTL Driver, Lamp Driver, Buffer, LED Driver
10. Design and Implementation of Active Filter: Low pass and High pass Filter; Band pass and Band reject Filter

**Total P: 30**

### REFERENCE:

1. Forrest M Mims, "A Handbook of Integrated Circuit Applications", Radio Shack, 1982.

## 19R311 MECHANICS AND MACHINES LABORATORY

0 0 2 1

### MECHANICS :

1. Study of the effect of link length parameters on the output of a Four Bar Mechanism and Slider Crank Mechanism
2. Preparation of cam displacement curve and determination of jump speed of the cam.
3. Study on epicyclic gear train and worm wheel reducers.
4. Force analysis for Slider – Crank mechanism using Simulation Software.
5. Force analysis for four bar mechanism using Simulation Software. (15)

**MACHINES :**

1. Load characteristics of DC series and shunt motor.
2. Load test on three-phase induction motor.
3. Electrical braking of three-phase induction motor.
4. Load test on single phase transformers.
5. Study of typical power system and developing single line diagram.

(15)

**Total P: 30****REFERENCE:**

1. Department of Robotics and Automation Engineering, "Mechanics and Machines Laboratory Manual", 2019.

**19K312 ENVIRONMENTAL SCIENCE****2 0 0 0**

**INTRODUCTION TO ENVIRONMENT:** Environment - Definition, scope and importance. Types and composition of atmosphere — particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats — India as a mega-diversity nation — hotspots of biodiversity — endangered and endemic species of India — conservation of biodiversity. (6)

**ENERGY RESOURCES :** Introduction — National and International status- exploitation - sustainable strategies- Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources - tidal –geothermal - hydroelectric. (6)

**ENVIRONMENTAL POLLUTION :** Definition — Sources, causes, impacts and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards (h) RF hazards - Role of an individual in prevention of pollution. **DISASTER MANAGEMENT:** Floods, earthquake, cyclone and landslides — Case studies, consequences and rescue measures (6)

**WASTE MANAGEMENT:** Wastewater - Characteristics of domestic and industrial wastewater - COD and BOD — Various stages of treatment — primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management — Characteristics of municipal solid waste(MSW), biomedical, automobile and e-wastes and their management — landfills, incineration, pyrolysis, gasification and composting. (6)

**SOCIAL ISSUES AND THE ENVIRONMENT:** Environmentally Sustainable work practices- Rain water harvesting — Role of non-governmental organizations. Human ethics and rights- impact on environment and human health — role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act — Air (Prevention and Control of Pollution) act — Water (Prevention and control of Pollution)act—Wildlife protection act—Forest conservation act. (6)

**Total L: 30****TEXT BOOKS:**

1. Gilbert M.Masters , "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi, 2004.
2. De A K , "Environmental Chemistry", New Age International P Ltd, New Delhi, 2006.

**REFERENCES:**

1. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Koteswara Rao MVR, "Energy Resources: Conventional & Non-Conventional", BSP Publications, New Delhi, 2006.
3. Deswal S and Deswal A, "A Basic Course in Environmental Studies", Dhanpat Rai and Co, New Delhi, 2004.

**SEMESTER - 4****19R401 PROBABILITY AND STATISTICS****2 1 0 3**

**PROBABILITY AND DISCRETE RANDOM VARIABLES :** Probability, axiomatic approach to probability, Baye's theorem, probability distributions and probability mass functions, cumulative distribution functions, mean and variance, binomial, Poisson and geometric distributions. (6 + 3)

**CONTINUOUS RANDOM VARIABLES** : Probability distributions and probability density functions, cumulative distribution functions, mean and variance, exponential, normal and Weibull distributions. (6 + 3)

**JOINT PROBABILITY DISTRIBUTIONS** : Two dimensional discrete and continuous random variables, marginal probability functions, independence, covariance, correlation and linear regression. (6 + 3)

**STATISTICAL INFERENCE** : Point estimation - interval estimation — testing of hypothesis for means — large, small samples and matched pairs tests — testing of hypothesis for proportions, chi square test for goodness of fit and independence of attributes. (6 + 3)

**VARIANCE TESTS AND ANALYSIS OF VARIANCE** : Hypothesis concerning one variance, two variances, analysis of variance - completely randomized design, randomized block design. (6 + 3)

**Total L: 30 +T: 15 = 45**

**TEXT BOOKS:**

1. Douglas C. Montgomery and George C. Runger , "Applied Statistics and Probability for Engineers", Wiley India, New Delhi, 2018.
2. Richard A. Johnson, "Miller & Freund's, Probability and Statistics for Engineers", Prentice Hall, New Delhi, 2017.

**REFERENCES:**

1. Jay L. Devore , "Probability and Statistics for Engineering and the Sciences", Brooks/Cole, USA, 2015.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye , "Probability & Statistics for Engineers & Scientists", Pearson, New Delhi, 2016.
3. Robert V. Hogg, Elliot Tanis and Dale Zimmerman, "Probability and Statistical Inference", Pearson Education, USA, 2014.
4. J. Susan Milton and Jesse Arnold, "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 2017.

## 19R402 AUTOMATIC CONTROL SYSTEMS

**3 1 0 4**

**INTRODUCTION** : Components of Automatic control systems- Open loop and closed loop systems - Examples - Transfer function - Modeling of physical systems - Mechanical Systems - Translational and Rotational systems - Hydraulic systems and Electrical Systems - Transfer function of DC servomotor - AC servomotor - Block diagram - reduction techniques - Signal flow graph - Mason's gain formula. (10 + 3)

**TIME DOMAIN ANALYSIS** : Continuous time signals - Standard Test signals - Classification of continuous time systems - Linear- Nonlinear - Time variant - Time invariant - Static - Dynamic - Time response of second order system - Time domain specifications - Types of systems - Steady state error constants -Generalized error series - Introduction to P, PI and PID modes of feedback control. - Introduction to lead, lag and lead-lag compensators (10 + 3)

**FREQUENCY DOMAIN ANALYSIS** : Frequency domain specifications - Estimation for second order systems- Correlation between time and frequency domain specifications for second order systems - . Bode plot — Determination of Transfer Function from Bode plot - All pass minimum phase and non-minimum phase systems - Polar plot - Determination of gain and phase Margins from the plots. (7 + 3)

**STATE SPACE ANALYSIS** : Limitations of conventional control theory - Concepts of state, state variables and state model - state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables - State equations - Transfer function from the State model - Solutions of the state equations -State Transition Matrix - Concepts of controllability and observability. (9 + 3)

**SYSTEM STABILITY** : Concept of stability - stability & location of the poles in S-plane - Characteristic equation - Routh-Hurwitz stability criterion - Root Locus concepts- Construction of root locus — Root contours - Absolute and Relative stability - Nyquist stability - Nyquist stability criterion - Assessment of relative stability - Gain and Phase Margin. (9 + 3)

**Total L: 45 +T: 15 = 60**

**TEXT BOOKS:**

1. Smarajit Ghosh, "Control Systems Theory and Applications", 2<sup>nd</sup> Edition, Pearson Education, New Delhi, 2012.
2. Ogata K, "Modern Control Engineering", 5<sup>th</sup> Edition, Pearson Education, New Delhi, 2009.

**REFERENCES:**

1. Nagrath I J, Gopal M, "Control Systems Engineering", 5<sup>th</sup> Edition, Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf , Robert H Bishop , "Modern Control Systems", 12<sup>th</sup> Edition, Addison-Wesley, New Delhi, 2010.
3. Norman S Nise, "Control System Engineering", 6<sup>th</sup> Edition, John Wiley & Sons, Singapore, 2012.
4. S Palani, "Control Systems Engineering", 2nd Edition, McGraw Hill Education Pvt. Ltd, New Delhi, 2010.

## 19R403 BASICS OF ROBOTICS

3 0 0 3

**INTRODUCTION** : Classification of Robots based on Geometry, Workspace, Actuation, Control and Application - Advantages and Disadvantages of Robots - Robot Components: Link, Joint, Manipulator, Wrist, End-effector : Gripper — Types, Actuator and Sensor - Configuration space — Joint Space — Workspace, Robot Specifications: Number of Axes: Internal and External (7-axis robot) - Capacity and Speed, Reach and Stroke, Tool Orientation, Repeatability, Precision and Accuracy, Operating Environment. (5)

**HOMOGENEOUS TRANSFORMATIONS** : Degrees of Freedom — Matrix Representation: Representation of a point and vector in space, Global and Local Coordinate axes - Homogeneous Transformation Matrices — Transformations: Representation of pure translation, Representation of pure Rotation - Representation of Combined Transformations - Inverse of Transformation Matrices - Euler Angles — Roll, Pitch, Yaw angles - Quaternions—Spinors and Rotators (6)

**FORWARD KINEMATICS** : Denavit-Hartenberg Notation - Transformation between two Adjacent Coordinate Frames Forward Kinematics of Two, Three, Four, Five and Six axis Robots. (12)

**INVERSE KINEMATICS** : Decoupling Technique - Inverse Transformation Technique - Inverse position: Geometric Approach — Inverse Orientation - Inverse Kinematics of Two, Three, Four, Five and Six axis Robots. (10)

**VELOCITY KINEMATICS** : Angular Velocity — Linear Velocity - Jacobian representation of Linear and Angular Velocity Calculation of Jacobian for Two, Three and Four axis Robots - Inverse Jacobian - Singularities: Wrist and Arm Singularities - Manipulability - Induced joint torques and forces. (12)

**Total L: 45**

### TEXT BOOKS:

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", Wiley, 2012.
2. Niku S B, "Introduction to Robotics, Analysis, Control, Applications", John-Wiley & Sons Inc, 2011.

### REFERENCES:

1. Robert J. Schilling, "Fundamentals of Robotics, Analysis and Control", PHI Learning, 2009.
2. Reza N Jazar, "Theory of Applied Robotics", Springer, 2010.
3. Saha S K, "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd, 2010.
4. Tadej Bajd, Matjaž Mihelj, Marko Munih, "Introduction to Robotics", Springer, 2013.

## 19R404 DIGITAL ELECTRONICS

3 0 0 3

**NUMBER SYSTEMS AND BOOLEAN ALGEBRA** : Review of Number Systems - Number representation: Signed , Unsigned, Fixed point, Floating point - Computer codes-BCD, Gray code, Excess 3 code, Error detection and correction codes, Parity, Hamming codes - Boolean algebra-Basic Postulates and theorems - Switching functions Canonical forms - Logic gates (6)

**DIGITAL LOGIC FAMILIES** : Characteristics of digital ICs — Voltage and current ratings, Noise margin, Propagation delay, Power dissipation - TTL logic family-Inverter - Totem pole, Open collector and tri-state outputs – NMOS Inverter, CMOS Inverter - ECL logic families - comparison of performance of various logic families (9)

**COMBINATIONAL LOGIC DESIGN** : Standard representation of logic functions - Incompletely specified functions - Simplification of logic functions through K-maps and Quine–McClusky method - Implementation using logic gates. Decoders, Encoders, Multiplexers and Demultiplexers - Implementation of Combinational circuits using Multiplexers and Demultiplexers - Arithmetic circuits: Binary /BCD adders and subtractors - Magnitude comparator (11)

**SEQUENTIAL CIRCUITS:** General model of sequential circuits - Latches, Flip Flops - Latches, Flip Flops - Master slave configuration - Binary counters - Shift register, Ring counter, Johnson counter-Timing diagram - Mealy/Moore models - Concept of state, State diagram, state assignment, State table - Design of synchronous sequential circuits—Up-down/Modulus counters—Sequence detector. (11)

**MEMORY AND PROGRAMMABLE LOGIC DEVICES** : Classification of memories - Types of ROM- PROM, EPROM, EEPROM, RAM-static RAM, Dynamic RAM - Introduction to PLDs-ROM-PAL-PLA - architecture of PLDs - implementation of digital functions using PLDs (8)

**Total L: 45**

### TEXT BOOKS:

1. Alan B Marcovitz , "Introduction to Logic Design", Second, Tata McGraw Hill, New Delhi, 2005.
2. Tocci R J, Widmer N and Moss G, "Digital Systems: Principles and Applications", Pearson, New Delhi, 2013.

**REFERENCES:**

1. Donald Givone, "Digital Principles and Design", Tata McGraw Hill, New Delhi, 2012.
2. Floyd T L , "Digital Fundamentals", Pearson Education, New Delhi, 2009.
3. Tokheim R L, "Digital Electronics - Principles and Applications", Tata McGraw Hill, New Delhi, 2007.
4. John F Wakerly, "Digital Design Principles and Practices", Prentice Hall of India, New Delhi, 2005.

**19R405 HYDRAULICS AND PNEUMATICS****3 0 0 3**

**INTRODUCTION TO FLUID POWER :** Introduction to fluid mechanics: Pascal's Law, Bernoulli's equation, Properties hydraulic fluids, air, Selection of hydraulic fluids, comparison between hydraulics and pneumatics, Symbols of hydraulic and pneumatic elements. (9)

**ELEMENTS OF HYDRAULIC SYSTEMS :** Pumps - types, characteristics, Valves for control of direction, flow and pressure - types, typical construction details. Actuators — types and constructional details, Accumulators — types and application circuits, Intensifiers, Servo and Proportional valves — types and operation. (9)

**HYDRAULIC SYSTEM DESIGN :** Industrial Circuits: Deceleration circuit, regenerative circuits, feed circuits, sequencing circuits, synchronizing circuits, fail-safe circuits, Power pack—elements, design, Pipes- material, pipe fittings, Maintenance of hydraulic systems, Selection criteria for cylinders, valves, hydraulic system design for robotic application. (9)

**ELEMENTS OF PNEUMATIC SYSTEM :** Compressors-types, constructional details of filter, regulator, lubricator, constructional features- types of actuators, control valves for direction, pressure and flow, air motors, air hydraulic equipments. (9)

**PNEUMATIC CONTROL SYSTEM DESIGN :** General approach to circuit design, schematic layout, travel step diagram, control modes, program control, sequence control, cascade method, Karnaugh-Veitch mapping, Electro pneumatics, ladder diagram and PLC programming for specific hydraulic and pneumatic applications, Pneumatic system design for robotic application (9)

**Total L: 45****TEXT BOOKS:**

1. Anthony Esposito , "Fluid Power with Application", Pearson Education Pvt. Ltd, 2003.
2. Srinivasan R , "Hydraulic and Pneumatic Controls", McGraw –Hill education Pvt. Ltd, 2011.

**REFERENCES:**

1. Majumdar S R, "Oil Hydraulic Systems: Principles and Maintenance", Tata McGraw- Hill, New Delhi, 2003.
2. Majumdar S R, "Pneumatic Systems: Principles and Maintenance", Tata McGraw- Hill, 1996.
3. Werner Deppert , Kurt Stoll , "Pneumatic Controls: An Introduction to Principles", Vogel-Druck Wurzburg, 1975.
4. Peter Rohner, "Fluid Power Logic Circuit Design – Analysis, Design, Method and Worked Examples", Macmillan Press Ltd., 1979.

**19R406 PLC AND SCADA****3 0 0 3**

**INTRODUCTION :** History and developments in Industrial Automation - Vertical Integration of Industrial Automation - Control elements in Industrial Automation — Safety standards - PLC Introduction : Basics of PLC — Advantages- Capabilities of PLC - Architecture of PLC - Scan cycle - Types of PLC : Types of I/O modules - Configuring a PLC - PLC wiring (9)

**PROGRAMMING OF PLC :** Introduction to state machine theory - Types of Programming - Process Control Programs using Relay Ladder Logic - PLC arithmetic functions - Timers and counters –data transfer-Comparison and manipulation instructions - PID instructions - PTO /PWM generation (9)

**NETWORKING OF PLCs :** Industrial Networking Buses (Flow Diagram Only) — Comparison of Industrial Buses - Protocols-Fieldbus-Processbus and ControlNet—DeviceNet-Ethernet-EtherCAT—CANbus protocol (9)

**SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) :** SCADA overview — Developer and runtime packages — Architecture - Tools - Tag - Internal & External graphics - Alarm logging - Tag logging - Trends – History - Report generation - Communication Protocols of SCADA - Proprietary and Open Protocols. OLE/OPC - DDE - Server/Client - Interfacing of SCADA with PLC and other field devices (10)

**HMI SYSTEMS :** Necessity and Role of HMI in Industrial Automation — Types of HMI panels :Text display – operator panels - Touch panels - Panel PCs - Integrated displays, interfacing PLC to HMI (4)

**APPLICATIONS OF PLC & SCADA:** Case studies of Machine automation, Process automation (4)

**Total L: 45**



**TEXT BOOKS:**

1. John W Webb and Ronald A Reis , "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2011.
2. Hans Berger , "Automating with Simatic S7-1200", Publicis Publishing, 2018.

**REFERENCES:**

1. W. Bolton , "Mechatronics", Pearson Education, 2011.
2. Kelvin T Erikson , "Programmable Logic Controllers", Dogwood Valley Press, 2016.
3. Rajesh Mehra , "PLCs & SCADA : Theory and Practice", Laxmi Publications, 2016.
4. R.S.Manoj , "Industrial Automation with SCADA : Concepts, Communications and Security", Notion Press, 2019.

**19R410 DIGITAL AND CONTROL SYSTEMS LABORATORY****0 0 2 1****DIGITAL :**

1. Study of basic digital ICs and implementation of arithmetic circuits (Adder and Subtractor)
2. Design and implementation of code converters.
3. Design and testing of Multiplexers/Demultiplexers using gates
4. Design and implementation of counters and shift registers
5. Real time Implementation of A/D conversion (15)

**CONTROL SYSTEMS :**

1. Determination of transfer function and speed control of AC servomotor
2. PID tuning in temperature control applications
3. Single axis control and disturbance rejection of BLDC and Inverted pendulum using PID
4. Time domain Response of Quad Copter
5. Frequency response of 1D single axis Robot manipulator, 2D point mass, 3DoF differential drive (15)

**Total P: 30****REFERENCE:**

1. Department of Robotics and Automation Engineering, "Digital and Control Systems Laboratory Manual", 2019.

**19R411 HYDRAULICS AND PNEUMATICS LABORATORY****0 0 2 1**

1. Design of simple pneumatic and hydraulic circuits using basic components
2. Construction and testing of multiple pneumatic actuator circuit using Cascade/ KV map method
3. Testing of multiple pneumatic actuator circuit with time delay valve and pneumatic counter
4. Co-ordinated motion of actuators using electro – pneumatic elements
5. Construction and testing of a hydraulic actuator application circuit
6. Co-ordinated motion of actuators using electro – hydraulic elements
7. Design and Simulation of hydraulic circuits using simulation software
8. Design and Simulation of pneumatic circuits using simulation software
9. Design and Testing of two hand safety circuit in a hydraulic punching machine
10. Design and testing of pneumatic grippers

**Total P: 30****REFERENCE:**

1. Department of Robotics and Automation Engineering, "Hydraulics and Pneumatics Laboratory Manual", 2019.

**19R412 PLC AND SCADA LABORATORY****0 0 4 2**

1. PLC wiring for three phase induction motor starting and direction control
2. Developing Ladder logic diagram for Boolean functions and verification using I/O devices
3. Implementation of Timer, Counter, Compare and Math instructions using PLC
4. Implementation of analog and PWM control using PLC and HMI
5. Tuning of PID based temperature control

6. Speed control of AC servo motor using PLC
7. Design of conveyor automation system using SCADA
8. Design of SCADA based water management system
9. Picture window control in SCADA
10. Control and monitoring of VFD

**Total P: 60**

**REFERENCE:**

1. Department of Robotics and Automation Engineering, " PLC and SCADA Laboratory Manual", 2019.

**19Q413 SOFT SKILLS DEVELOPMENT**

**0 0 2 1**

1. Body Language and Professionalism
2. Interpersonal skills
3. Goal setting
4. Impression Management
5. Team Building
6. Time Management
7. Stress Management
8. Convincing Skills
9. Motivation
10. Change Management
11. Communication Confidence
12. Group discussion basics
13. Personal Interview basics
14. Resume writing

**Total P: 30**

**REFERENCES:**

1. Jeff Butterfield , "Soft Skills for Everyone", 6<sup>th</sup> Edition, Cengage Learning, Delhi, 2015.
2. Rao M S, "Soft Skills - Enhancing Employability", LK International Publishing House, New Delhi, 2011.

**19O412 INDIAN CONSTITUTION**

**2 0 0 0**

**INTRODUCTION** : Evolution of Indian Constitution; Significance of Constitution; Composition; Preamble and its Philosophy. (4)

**RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES** : Fundamental Rights- Writs and Duties, Directive Principles of State Policy. (6)

**COMPOSITION OF PARLIAMENT AND FEDERALISM** : Union Government, President and Vice President, Houses of the Parliament and their functions; Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. (8)

**BILLS AND CONSTITUTION AMENDMENT PROCEDURE:** Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. (6)

**JUDICIARY** : Supreme Court and High Court; Functions and powers, Judicial Review. (6)

**Total L: 30**

**TEXT BOOKS:**

1. Subash C. Kashyap , "Our Constitution", 5<sup>th</sup> Edition, NBT, India, New Delhi, 2015.
2. Basu D D , "Introduction to the Constitution of India", 20<sup>th</sup> Edition, Prentice Hall of India, New Delhi, 2011.

**REFERENCES:**

1. Brij Kishore Sharma , "Introduction to the Constitution of India", 8<sup>th</sup> Edition, Prentice Hall of India, New Delhi, 2017.
2. Hoshier Singh , "Indian Administration", 1<sup>st</sup> Edition, Pearson Education, New Delhi, 2011.
3. Jain M C , "The Constitution of India", 5<sup>th</sup> Edition, State Mutual Book & Periodical Service, Limited, New Delhi, 1988.
4. Shukla V N , "Constitution of India", 13<sup>th</sup> Edition, Eastern Book Company Limited, New Delhi, 2017.

## SEMESTER - 5

### 19R501 CNC MACHINES

3 0 0 3

**INTRODUCTION** : History - Advantages and disadvantages of CNC, block diagram of CNC - Features available in CNC systems - Types- Turning centres, machining centres, grinding machines, EDMs, turret punch press, laser and water jet cutting machines - Constructional details of Turning centres, and machining centres - Machine accessories, Axis representations, Operator panel - Various modes of operation - Feed selection and MPG (8)

**CNC PART PROGRAMMING PROCESS** : Basic G and M codes, Structure of part program - Absolute and Incremental systems - Tooling concepts, Tool offsets, part geometry and writing of tool motion statements - Development of simple manual part programs for turning operations - Simple part programming for milling - CNC turning and milling part programming using canned cycles - Post processors - CNC part programming with CAD/CAM systems (9)

**CNC SYSTEMS** : Functions of CNC, system hardware, CPU, PLC, Servo control, Interfacing with keyboard, monitor, field inputs, outputs - Contouring control - interpolation, Parameters and diagnosis, compensation for machine accuracies - Open architecture systems and PC based controllers - Networking of CNC machines — Ethernet, IoT- Interfacing of robot with CNC (7)

**DRIVE UNITS** : Axis drive arrangements, guide ways, ball screw and nut, bearing arrangements, timing belts and couplings - sizing of servomotors for axis drives - DC and AC servo drives and servomotors, servo tuning - Selection criteria - drive optimization and protection - Spindle motors and drives- DC and AC (7)

**CONTROL AND FEEDBACK DEVICES** : Electrical cabinet and control panel wiring, Electrical standards - Control panel layout and arrangement of control elements, cables and terminations - Applications of feedback devices in CNC machines- Absolute and incremental encoders, resolvers, linear scales, Proximity switches, limit switches — Thermal sensors, pressure and float switches - Hydraulic systems of a CNC lathe (7)

**ECONOMICS AND MAINTENANCE** : Factors influencing the selection of CNC Machines - Machine accessories- Conveyors, Turret, ATC, APC - Cost of operation of CNC Machines, Testing of CNC Machines - Safety considerations- software and hardware interlocks - Maintenance of CNC Machines, Preventive Maintenance, TPM - Selection and sizing of Isolation Transformer for CNC Machine - Earthing standards for CNC machines (7)

**Total L: 45**

#### TEXT BOOKS:

1. HMT Limited, "Mechatronics", Tata McGraw Hill, New Delhi, 1998.
2. Radhakrishnan P, "Computer Numerical Control Machines", New Central Book Agency, 1992.

#### REFERENCES:

1. Yorem Koren, "Computer Control of Manufacturing Systems", Pitman, London, 1987.
2. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.
3. Peter Smid, "CNC Programming Techniques", 1<sup>st</sup> Edition, Industrial Press, Inc., 2005.
4. B. S. Pabla, M Adithan, "CNC Machines", 3<sup>rd</sup> Edition, New Age International, New Delhi, 2014.

### 19R502 DYNAMICS AND CONTROL OF MANIPULATORS

2 1 0 3

**ACCELERATION AND MOTION DYNAMICS** : Angular Acceleration Vector and Matrix - Rigid Body Acceleration — Forward Acceleration Kinematics — Inverse Acceleration Kinematics - Force and Moment — Rigid Body Translational and Rotational Kinetics - Mass Moment of Inertia Matrix - Lagrange's form of Newton Equations - Lagrangian Mechanics (6 + 2)

**ROBOT DYNAMICS:** Rigid-link Newton Euler Dynamics - Robot Lagrange Dynamics - Lagrange Equations and Link Transformation Matrices. (7 + 3)

**PATH PLANNING:** Cubic Path — Polynomial path - Manipulator motion by Joint path - Cartesian path — Rotational Path - Manipulator motion by end-effector path (6 + 4)

**TIME OPTIMAL CONTROL:** Minimum time and bang-bang control - Floating Time Method - Time-optimal Control for Robots (4 + 2)

**CONTROL TECHNIQUES:** Open and Closed loop control - Computed Torque Control - Linear Control Technique - Sensing and Control (7 + 4)

**Total L: 30 +T: 15 = 45**

#### TEXT BOOKS:

1. Reza N Jazar, "Theory of Applied Robotics", Springer, 2010.

- Niku S B, "Introduction to Robotics, Analysis, Control, Applications", John-Wiley & Sons Inc, 2011.

**REFERENCES:**

- Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", Wiley, 2012.
- Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", PHI Learning, 2009.
- Saha S K, "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd, 2010.
- Mark W. Spong, M.Vidyasagar, "Robot Dynamics and Control", Wiley, 2008.

**19R503 MICROPROCESSORS AND MICROCONTROLLERS**

**3 0 0 3**

**ARCHITECTURE AND PROGRAMMING OF 8 BIT MICROPROCESSOR** : Functional Block Diagram — Registers - ALU, Bus systems - Addressing modes - Instruction set - Development of Assembly language programs – Machine cycles and Timing diagrams (12)

**8051 MICROCONTROLLER** : Architecture of 8051 - Memory organization - Register Banks - Bit addressable area - SFR area — Addressing modes - Instruction set - Programming examples 8051 Interrupt structure – Timer modules - Serial features - Port structure - Powersaving modes (13)

**TYPICAL APPLICATIONS** : Multiplexed seven segment LED Display systems - Stepper Motor Control - Servo motor control - AC Power Control - Interfacing A/D Converter and D/A Converter - Square Waveform generation (6)

**ARM PROCESSORS** : ARM Programmer's Model –Registers - Processor Modes –State of the processor - Condition Flags–ARM Pipelines - Exception Vector Table — ARM Processor Families - Typical 3 stage pipelined ARM organization - Introduction to ARM Memory Management Unit (9)

**PROGRAMMING OF ARM PROCESSORS** : ARM Addressing Modes - ARM Instruction Set Overview - Thumb Instruction Set Overview. (5)

**Total L: 45**

**TEXT BOOKS:**

- Ramesh S Goankar, "Microprocessor Architecture: Programming and Applications with the 8085", Penram International, 2000.
- Muhammed Ali Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearson Education India, 2000.

**REFERENCES:**

- INTEL, "8-bit Embedded Controllers", User's Manual, Intel Corporation, 1990.
- William Hohl, "ARM Assembly Language Fundamental and Techniques", CRC Press Taylor & Francis, 2009.
- Andrew Sloss, "ARM System Developer's Guide", Morgan Kaufmann Publishers, 2005.
- Steve Furber, "ARM Systems on-Chip Architecture", Pearson Education, 2009.

**19R504 DESIGN OF MECHANICAL TRANSMISSION SYSTEMS**

**2 1 0 3**

**DESIGN OF SHAFTS, KEYS AND COUPLINGS** : Shafts -Types and application - Forces on shafts due to gears and belts, estimation of shaft size based on strength–Keys, types and applications, Design of keys - Couplings, types and applications, design of rigid couplings. (7 + 4)

**ROLLING CONTACT BEARINGS** : Bearings — Types and application, Rolling contact bearings - Static and dynamic load capacity, Equivalent bearing load, probability of survival, Bearing life -Selection of deep groove ball bearings. (5 + 2)

**DESIGN OF GEARS** : Gears — Types- Applications — Gear materials — Gear tooth failures - Nomenclature, interference, gear forces, backlash and lubrication, Design of spur gear and helical gears (7 + 4)

**DESIGN OF GEAR BOXES** : Geometric progression- standard step ratio- Ray diagram, Kinematics layout- Design of sliding mesh gear box and constant mesh gear box, Introduction to harmonic drives. (5 + 2)

**BELTS AND CHAINS** : Belts -Types and application - Selection of flat and timing belts for given power and velocity ratio - Chains -Types and application - Selection of roller chain for specific applications (6 + 3)

**Total L: 30 +T: 15 = 45**

**TEXT BOOKS:**

- Robert L Norton, "Machine Design - An Integrated Approach, Pearson Education", New Delhi, 2013.
- Bandari V B, "Design of Machine Elements", 4<sup>th</sup> Edition, McGraw Hill Education India, 2016.

**REFERENCES:**

1. Shigley and Mische , "Mechanical Engineering Design", McGraw Hill Education India, 2003.
2. Faculty of Mechanical Engineering, PSG College of Technology, "PSG Design Data Book", Kalaikathir Achchagam, 2015.
3. Robert L. Mott , "Machine Elements in Mechanical Design", Pearson Prentice Hall, 2014.
4. Prabhu.T.J, "Design of Transmission Elements", Mani Offset, Chennai, 2003.

### **19R510 CNC AND CAD LABORATORY**

**0 0 4 2**

1. Basic part programming and machining for turning centre using FANUC controller
2. Part programming and machining using turning and drilling cycle for turning centre using FANUC controller
3. Part programming and machining using grooving and threading cycle for turning centre using FANUC controller
4. Basic part programming and machining for machining centre using FANUC controller
5. Programming and simulation for turning center using simulation software
6. Programming and simulation for machining center using simulation software
7. Troubleshooting of CNC machines
8. Modeling of engineering components using modeling software
9. Assembly of engineering components using modeling software
10. Extraction of production drawing from solid model using modeling software

**Total P: 60**

#### **REFERENCE:**

1. Department of Robotics & Automation Engineering, "CNC and CAD Laboratory Manual", 1<sup>st</sup> Edition, PSG CT, Coimbatore, 2019.

### **19R511 MICROPROCESSORS AND MICROCONTROLLERS LABORATORY**

**0 0 2 1**

1. Addition and Subtraction using 8051 microcontroller
2. Multiplication and Division using 8051 microcontroller
3. Seven-segment display interfacing with 8051 microcontroller
4. Interfacing 8051 with keypad
5. LCD interfacing with 8051 microcontroller
6. Interfacing DAC and ADC with 8051
7. Generating PWM with ARM7 processor and interfacing with power MOSFET
8. Traffic light control using ARM7 processor
9. Sensor interfacing with ARM7
10. Relay and Switch interfacing with ARM7 processor

**Total P: 30**

#### **REFERENCE:**

1. Department of Robotics and Automation Engineering, "Microprocessor and Microcontroller Laboratory Manual", 2019.

### **19R512 ROBOTICS LABORATORY**

**0 0 2 1**

1. Forward kinematics of two axis planar articulated robot using analytical and DH algorithm
2. Inverse kinematics of two axis planar articulated robot using geometric approach and DH algorithm
3. Jacobian and induced force-torque analysis of two axis planar articulated robot
4. Implementation of trajectory planning algorithm for straight line motion of two axis planar articulated robot
5. Implementation of trajectory planning algorithm for curved path of two axis planar articulated robot
6. Newton Euler and Lagrangian method to relate force and torque for different configurations
7. Programming of Four-axis Systemantics and Five-axis TAL Brabo industrial robots
8. Programming of Six-axis Universal industrial robots
9. Analysis and Simulation using Fanuc Robo guide software and real time Programming of Fanuc M 710i robot
10. Programming of Kinova Robotic Arm

**Total P: 30**

#### **REFERENCE:**

1. Department of Robotics and Automation Engineering , "Robotics Laboratory Manual", 2019.

### **19Q513 BUSINESS AND MANAGERIAL COMMUNICATIONS**

1. Advanced Group discussion
2. Advanced Resume writing
3. Mock Group discussion
4. Advanced Personal Interview
5. Mock Personal Interview
6. Cracking special Interviews
7. Essential Grammar for Placements
8. Vocabulary for Placements
9. Email writing
10. Paragraph writing
11. Essay writing

**Total P: 30**

**REFERENCES:**

1. Priyadarshi Patnaik , "Group Discussion and Interview Skills", Cambridge, New Delhi, 2011.
2. Hari Mohan Prasad, Rajnish Mohan , "How to Prepare for Group Discussion and Interview", 2<sup>nd</sup> Edition, Tata McGraw-Hill, New Delhi, 2009.

## SEMESTER - 6

### 19R601 POWER ELECTRONICS AND DRIVES

**3 0 0 3**

**POWER SEMICONDUCTOR DEVICES** : Power diodes - Power transistors - Characteristics of SCR - TRIAC – Power MOSFET - IGBT - Thyristor protection circuits - Thyristor triggering circuits- Selection of device (9)

**CONVERTERS** : Single phase - Three phase - Fully controlled rectifiers - Effect of source and load inductance -single phase- Three phase AC voltage controller -Control Circuits for AC to DC and AC toAC converters (8)

**INVERTERS AND CHOPPERS** : Voltage Source inverters - bridge inverters- 120° and 180° conduction - Pulse Width Modulation - Single and Multiple PWM - SPWM - Generation of pulses for SPWM - DC choppers : Buck- Boost - Buck Boost - Generation of timing pulses for DC choppers - Applications (Block diagram approach) Uninterrupted power supplies - SMPS - Basics of Magnetic design for power electronics (13)

**INTRODUCTION TO DRIVES** : Basic Elements of Drive - Load characteristics - Selection of Drive (2)

**DRIVES FOR AUTOMATION** : Operating modes - quadrant operation of chopper - Closed loop control of DC drives. Stator and rotor voltage control - frequency and voltage control - Current Control - Basics of vector control- Block diagram - Stepper Motor Drive - BLDC Motor Drive - PMSM Drive-protection devices for drives (11)

**POWER QUALITY** : Overview of Harmonics - Introduction to Power quality (2)

**Total L: 45**

**TEXT BOOKS:**

1. Rashid M H , "Power Electronics –Circuits, Devices and Applications", PHI, 2014.
2. Ramu Krishnan , "Electric Motor Drives: Modeling, Analysis, and Control", Prentice Hall, 2001.

**REFERENCES:**

1. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education, 2002.
2. Roger C Dugan, Surya Santoso, Mark F McGranaghan , "Electrical Power Systems Quality", McGraw Hill, 2003.
3. Mohan, Undel, "Power Electronics", John Wiley and sons, 2003.
4. Vedam Subramaniam , "Thyristor control of Electrical Drives", Tata McGraw-Hill, 1998.

### 19R602 AUTOMATION SYSTEM DESIGN

**2 1 0 3**

**INTRODUCTION TO PROCESS AUTOMATION** : Process Automation — paper industry, packaging industry, food processing industry, Integrated design issues in automation systems, the Mechatronics design process- benefits, modeling of electromechanical systems, bond graph technique, Automation migration strategy - building blocks of automation systems. (6+2)

**SELECTION OF MOTION COMPONENTS** : Selection of motor for automation system, Calculation of inertia force for motor, LM Guide ways, Ball screws, Selection, from the manufacturer's catalogue based on the applications. (8+3)

**TRANSFER LINES AND AUTOMATED ASSEMBLY** : General terminology-takt time, setup time and cycle time, Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines - modular fixturing - Flow line balancing. (6+3)

**DESIGN FOR HIGH SPEED AUTOMATIC ASSEMBLY** : Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion, Analysis of an assembly, General rules for product design for automation – Application of high speed automatic assembly. (5+5)

**SYSTEM INTEGRATION** : Issues and systematic approaches, design and simulation using CIROS software, economics of automation systems design and implementation (5 + 2)

**Total L: 30 +T: 15 = 45**

**TEXT BOOKS:**

1. Mikell P Groove, "Automation Production Systems and Computer Integrated Manufacturing", Pearson education, New Delhi, 2016.
2. Geoffery Boothroyd, "Assembly Automation and Product Design", CRC Press, USA, 2016.

**REFERENCES:**

1. DevadasShetty , "Mechatronics System Design", PWS Publishing Company, USA, 2010.
2. Wilfried Voss, "A Comprehensible Guide to Servo Motor Sizing", Copperhill Technologies Corporation, Massachusetts, 2007.

## 19R603 AI FOR ROBOTICS

**3 1 0 4**

**INTRODUCTION TO AI AND INTELLIGENT AGENTS** : Foundations, History - Intelligent agents, Agents - Nature of Environments, Structure of agents - Problem solving agents - Problem formulation - State space, Search space - Problem reduction - Searching for solutions: Uninformed search strategies — Informed search strategies - Heuristic functions (9 + 3)

**ROBOTIC PARADIGMS** : Overview of the Three Paradigms - Hierarchical Paradigm: attributes — representative architectures - Reactive paradigm: attributes - subsumption architecture - potential field methodologies - Designing a reactive implementation: a primitive move-to-goal behavior, an abstract follow-corridor behavior - Designing a Reactive Behavioral System - The Hybrid Deliberative/Reactive Paradigm- Attributes - Architectural Aspects- Managerial Architectures- State-Hierarchy Architectures Model-Oriented Architectures (12 + 3)

**TOPOLOGICAL AND METRIC PATH PLANNING:** Landmarks and gateways - relational methods — associative methods - case study - Metric Planning: Configuration Space-Cspace representations - graph based planners - wavefront based planners - Interleaving Path Planning and Reactive Execution (9 + 3)

**LOCALIZATION AND MAP MAKING:** Sonar sensor model - Bayesian – Dempster-Shafer theory - HIMM - comparison of methods - localization – exploration (8 + 3)

**LEARNING AND NATURAL LANGUAGE PROCESSING:** Forms of learning - NLP: Language models - Natural language for communications - Speech recognition (7 + 3)

**Total L: 45 +T: 15 = 60**

**TEXT BOOKS:**

1. Robin R. Murphy, "Introduction to AI Robotics", MIT Press, 2000.
2. Start Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", Pearson Education, New Delhi, 2015.

**REFERENCES:**

1. Francis X. Govers, "Artificial Intelligence for Robotics", Packt, 2018.
2. Roland Siegwart, Illah R. Nourbakhsh , "Introduction to Autonomous Mobile Robots", MIT Press, 2004.
3. Kevin Knight, Elaine Rich, Nair , "Artificial Intelligence", Tata McGraw Hill, New Delhi, 2017.
4. Jon Gabriel, "Artificial Intelligence: Artificial Intelligence for Humans", 1<sup>st</sup> Edition, Createspace Independent Publishers, 2016.

## 19R604 VISION SYSTEMS

**3 0 0 3**

**INTRODUCTION TO COMPUTER VISION:** Cameras: Pinhole cameras-Cameras with lenses-Sensing - Geometric Camera Models: Elements of Analytical Euclidean geometry - Camera parameters & perspective projection-Affine Cameras& Affine Projection - Radiometry: Light in space-Light at surfaces- Image formation: Geometry primitives and transformation (7)

**SINGLE IMAGE VISION** : Image Processing: Point operators-Linear Filtering- Neighborhood operators - Fourier transform — Pyramids and Wavelets-global optimization - -Feature detection & matching: Points & Patches-Edges-Lines-Segmentation - Active contours-Split & merge-Mean shift & Mode finding (10)

**MULTIPLE IMAGE VISION** : Geometry of multiple views-Camera Calibration for stereo Cameras - Structure from motion: Triangulation-Two frame structure from motion - Factorization- Bundle adjustment- Constrained structure from motion - Dense motion estimation: Transactional alignment-parametric motion-spline band motion-optical flow-Layered motion - Image stitching: Motion models-global alignment-compositing (10)

**HIGH LEVEL VISION** : Stereo correspondence: Epipolar geometry-sparse correspondence-Dense correspondence-Multi view stereo - 3D reconstruction: shape from X- Active range fringing- surface representation - Recognition-Object detection-Face recognition-Instance recognition - Introduction to deep learning in computer vision (11)

**ROS FOR COMPUTER VISION** : Basic introduction to Robotic operating System (ROS) - installing and testing ROS camera Drivers - ROS to OpenCV - The CV\_bridge Package - Introduction to OpenCV image processing library and MATLAB programming (7)

**Total L: 45**

**TEXT BOOKS:**

1. David.A. Forsyth, Jean Ponce , "Computer Vision a Modern Approach", Pearson, Upper Saddle River, 2010.
2. Richard Szeliski , "Computer Vision: Algorithms and Applications", Springer, London, 2014.

**REFERENCES:**

1. Damian M Lyons , "Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.
2. Richard Hartley, Andrew fisherman , "Multiple view geometry in computer vision", 2012.
3. Carsten Steger, Markus Ulrich, Christian Weidman , "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim, 2008.
4. Kenneth Dawson-Howe , "A Practical Introduction to Computer Vision with OpenCV", Wiley, Singapore, 2014.

## 19R605 SENSORS AND INSTRUMENTATION

**3 0 0 3**

**FUNCTIONAL DESCRIPTIONS OF MEASURING INSTRUMENTS** : Functional elements of an instrument - Measurement Errors: Gross errors and systematic errors, Absolute and relative errors - I/O configuration of measuring instruments - Static characteristics: Meaning of static calibration, accuracy, precision and bias, Static sensitivity, linearity, threshold, resolution, hysteresis and dead space, Scale readability, Span, generalized static stiffness and input impedance - Basics of Dynamic characteristics - Inertia Measurement Unit. (8)

**TEMPERATURE MEASUREMENT** : Principle of operation- Bimetallic thermometer, Resistance Temperature Detectors, Thermistors, Thermocouples, IR thermometers, Integrated circuit temperature transducer (7)

**PRESSURE AND FLOW MEASUREMENT** : Principle of operation - Liquid manometers, Resistive transducer, Capacitance transducer, Piezoelectric transducer, Venturi flow meters, Electro-Magnetic flow meter - liquid level measurement using float (7)

**DISPLACEMENT AND VELOCITY MEASUREMENT** : Linear and angular measurement systems — Resistance potentiometer, strain gauge - capacitive transducers and variable inductance transducers, resolvers, LVDT, proximity sensors, ultrasonic and photo-electric sensors - linear scales - Laser Interferometers, tachogenerator - Encoders: absolute and incremental – Piezoelectric (8)

**OTHER SENSORS** : Sensors for measurement of vibration, Acoustics, humidity, weight, volume and radiation - Tactile sensors: force, torque, pressure, Gyroscope - Vision based sensors- Smart sensors (7)

**SIGNAL CONDITIONING AND INTERFACING** : Signal conditioning, Passive interfacing- matching power, signal and impedance - operational amplifier circuits, Modulation, filters - A/D converters, Interfacing to computer - effects of EMI and EMC- DAQ systems (8)

**Total L: 45**

**TEXT BOOKS:**

1. Peter Elgar , "Sensors for Measurement and Control", Addison-Wesley Longman Ltd, 1998.
2. A K Sawhney , "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Co, 2010.

**REFERENCES:**

1. Richard D Klaffer, Thomas A Chmielewski, Michael Negin , "Robotics Engineering: An Integrated Approach", PHI Learning, New Delhi, 2009.
2. Patranabis D , "Sensors and Transducers", Prentice-Hall of India Private Limited, New Delhi, 2003.
3. Ernest O Doebelin , "Measurement systems Application and Design", Tata McGraw-Hill Book Company, 2010.
4. Robert B. Northrop , "Introduction to Instrumentation and Measurements", 3<sup>rd</sup> Edition, CRC Press, 2014.



## 19R610 POWER ELECTRONICS AND DRIVES LABORATORY

0 0 4 2

1. Single Phase and Three Phase Diode Bridge Rectifier with R and RL Load
2. Single phase fully controlled thyristor converter with R and RL load
3. Three phase fully controlled thyristor converter
4. DC chopper with R and RL load
5. Single phase AC voltage controller with R and RL load
6. Design of MOSFET driver circuit for H-bridge
7. Construction and testing of inverter using Semikron intelligent power Module
8. Performance comparison of IM and PMSM drive
9. Microcontroller based PWM generation techniques
10. Power quality measurement of electrical appliances

Total P: 60

### REFERENCE:

1. Department of Robotics and Automation Engineering, "Power Electronics and Drives Laboratory Manual", 2019.

## 19R611 AI AND VISION SYSTEMS LABORATORY

0 0 4 2

1. Image Basics and Video Handling Using OpenCV API
2. Parallel Programming Using CUDA C
3. POSE Estimation Using Monocular and Stereo Camera
4. Scan Matching and 3D Reconstruction Using RGBD Cameras
5. Geometric Transformation and Filtering Using OpenCV & CUDA C
6. Object Detection and Reconstruction Using CNN
7. Visual SLAM using Stereo Cameras With Deep Learning Libraries
8. Simulating Deterministic Local and Global Path Planning Algorithms
9. Simulating Stochastic Path Planning Algorithms
10. Design of Autonomous Mobile Robo

Total P: 60

### REFERENCE:

1. Department of Robotics and Automation Engineering, "AI and Vision Systems Laboratory Manual", 2019.

## 19Q613 QUANTITATIVE AND REASONING SKILLS

0 0 2 1

1. Number System, Time and Work
2. Percentages , Simple and Compound Interests
3. Time, Speed and Distance
4. Permutation, Combination and Probability
5. Ratio and Proportion
6. Profit, Loss and Partnership
7. Logarithms, Progressions, Geometry and Quadratic Equations
8. Coding and Decoding
9. Series, Analogy and Odd Man Out
10. Visual Reasoning
11. Data Arrangements
12. Blood Relations
13. Clocks, Calendars and Direction Sense
14. Cubes, Logical Connectives and Syllogisms
15. Venn Diagrams, Interpretations and solving

Total P: 30

## REFERENCES:

1. Aggarwal R S , "Quantitative Aptitude for Competitive Examinations", 3<sup>rd</sup> Edition, S Chand Publishing, New Delhi, 2017.
2. ETHNUS , "Aptimithra", 1<sup>st</sup> Edition, McGraw-Hill Education Pvt Ltd, 2013.
3. FACE , "Aptipedia Aptitude Encyclopedia", 1<sup>st</sup> Edition, Wiley Publications, Delhi, 2016.

## SEMESTER - 7

### 19R701 MOBILE ROBOTICS

**2 1 0 3**

**INTRODUCTION TO MOBILE ROBOTS** : Locomotion: Key issues of locomotion - Legged mobile robots- configuration and stability - Wheeled mobile robot: design space and case studies - Aerial mobile robots: Aircraft configuration-VTOL (IO control) (4 + 2)

**KINEMATICS** : Kinematic Models and Constraints: Robot Position - Forward and Inverse Kinematic Models - Maneuverability - Workspace of differential drive, Omni drive and Aerial vehicles (5 + 3)

**PROBABILISTIC ROBOTICS FOR SENSING AND PERCEPTION** : Introduction: Uncertainty and need of Probability Theory - Recursive State Estimation- Bayes filters - Gaussian Filters: Kalman Filter ,EKF, UKF, Information Filter - Non parametric Filters: Particle Filters - Probabilistic Kinematics: Velocity Motion Model and Odometry Motion Model - Mapping : Occupancy Grid Mapping- Learning Inverse Measurement Models - SLAM: EKF with known and Unknown Correspondence—The GraphSLAM—FastSLAM (12 + 5)

**PLANNING AND MOTION CONTROL** : Introduction-Path planning overview - Global path planning - A\* Algorithm - local path planning - Road map path planning - Cell decomposition path planning-Potential field path planning - Obstacle avoidance—Path control (5 + 3)

**HUMANOIDS** : Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control - Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration - Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications (4 + 2)

**Total L: 30 +T: 15 = 45**

## TEXT BOOKS:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza , "Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2011.
2. Sebastian Thrun, Wolfram Burgard, Dieter Fox , "Probabilistic Robotics", MIT Press, 2005.

## REFERENCES:

1. Riadh Siaer , "The future of Humanoid Robots- Research and applications", Intech Publications, 2012.
2. Karsten Berns, Ewald Von Puttkamer , "Autonomous Land Vehicles Steps towards Service Robots", Vieweg Teubner Springer, 2009.
3. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun , "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.
4. Bruno Siciliano, Oussama Khatib , "Springer Hand Book of Robotics", Springer, 2008.

### 19R710 INNOVATION PRACTICES

**0 0 4 2**

Students have to design and make a Mechatronic product based on the given topic. It includes

1. Problem Identification
2. Idea generation and concept selection
3. Specification / Block diagram
4. Simulation and Optimization of the design and process
5. Model / Prototype development / Implementation / Testing and Validation
6. Preparation of a detailed report

**Total P: 60**

### 19R720 PROJECT WORK I

**0 0 4 2**

1. Identification of a real-time problem in thrust areas
2. Review of literature and identification of gaps

3. Finalisation of system requirements and specification
4. Proposing different solutions for the problem based on literature survey
5. Future trends in providing alternate solutions
6. Consolidated report preparation of the above

**Total P: 60**

## **SEMESTER - 8**

### **19R820 PROJECT WORK II**

**0 0 8 4**

1. Identification of a problem domain
2. Need for the current study
3. Literature survey and patent/design registration /trademarks search
4. Problem formulation based on the literature survey
5. Objectives and feasibility study
6. Methodology and Time Line of activities
7. Development of software / Hardware Model
8. Detailed analysis and interpretation of results
9. Testing & Validation of the developed system
10. Consolidated report preparation of the above

**Total P: 120**

## **LANGUAGE ELECTIVES**

### **19G001 COMMUNICATION SKILLS FOR ENGINEERS**

**0 0 4 2**

**COMMUNICATION CONCEPTS:**

Process of Communication  
Inter and Intrapersonal Communication  
Inter and Intrapersonal Communication Activities

(9)

**FOCUS ON SOFT SKILLS:**

Etiquette — Work Place etiquette — Telephone etiquette  
Body Language  
Persuasive Communication  
Public Speaking  
Critical Reasoning and Conflict Management based on Case Studies  
Group Communication  
Meetings  
Interview Techniques

(14)

**TECHNICAL WRITING:**

Technical Writing Principles  
Style and Mechanics  
Technical Definitions – Physical, Functional and Process Descriptions  
Technical Report Writing  
Preparing Instructions and Manuals  
Interpretation of Technical Data

(15)

**BUSINESS CORRESPONDENCE :**

Writing Emails  
Preparing Resumes  
Memos  
Technical and Business Proposals

(7)

**TECHNICAL COMMUNICATION:**

Seminars  
Process Description and Group Discussions  
Use of Visual Aids

(15)

**Total P: 60**

**TEXT BOOKS:**

1. Faculty Incharge "Course Material on "Communication Skills for Engineers"", PSG College of Technology., Coimbatore, 2019

**REFERENCES:**

1. Jeff Butterfield "Soft Skills for Everyone", Cengage Learning., New Delhi, 2013
2. Jean Naterop B and Rod Revell "Telephoning in English", Cambridge University Press., Cambridge, 2011
3. David A Mc Murrey and Joanne Buckley "Handbook for Technical Writing", Cengage Learning., New Delhi, 2011
4. Simon Sweeney "English for Business Communication", Cambridge University Press., New Delhi, 2012

**19G002 GERMAN- LEVEL A1.1****0 0 4 2****GUTEN TAG! :**

1. To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages
2. Vocabulary: related to the topic
3. Grammar: W— Questions, Verbs & Personal pronouns I. (10)

**FREUNDE, KOLLEGEN UND ICH:**

1. To speak about hobbies, jobs, learn numbers from 20; build dialogues and frame simple questions & answers
2. Vocabulary: related to the topic
3. Grammar: Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural (10)

**IN DER STADT:**

1. To know places, buildings, question, know transport systems, understand international words; build dialogues and write short sentences
2. Vocabulary: related to the topic
3. Grammar: Definite & indefinite articles, Negotiation, Imperative with Sien verbs (12)

**GUTEN APPETIT! :**

1. To speak about food, shop, converse; Vocabulary: related to the topic; build dialogues and write short sentences
2. Grammar: Sentence position, Accusative, Accusative with verbs, personal pronouns & prepositions, Past tense of haben & sein verbs (13)

**TAG FÜR TAG/ZEIT MIT FREUNDEN :**

1. To learn time related expressions, speak about family, about birthdays, understand & write invitations, converse in the restaurant; ask excuse, fix appointments onphone
2. Vocabulary: related to the topic
3. Grammar: Time related prepositions, Possessive articles, Modalverbs (15)

**Total P: 60****TEXT BOOKS:**

1. Dengler Stefanie "Netzwerk A1.1", Klett-Langenscheidt Gmbh., München, 2013
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

**REFERENCES:**

1. Stefanie Dengler "Netzwerk A1", Klett-Langenscheidt Gmbh., München, 2013
2. Hermann Funk, Christina Kuhn "Studio d A1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004
4. Christiane Lemcke und Lutz Rohrmann "Grammatik Intensivtrainer A 1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2012

**19G003 FRENCH LANGUAGE LEVEL 1****0 0 4 2****PARTS OF SPEECH:**

1. inviter et répondre à une invitation, Pronoms sujets
2. L'article définis, l'article indéfinis
3. Conjugation : présent, adjectifs possessifs
4. interrogation, décrire les personnes
5. La vie de quatre parisiens de professions différentes (12)

**ELEMENTS OF GRAMMAR:**

1. Exprimer l'ordre et l'obligation demander et commander

2. l'adjectif possessifs, l'article partitif, l'article démonstratif, négation ne
3. pas, l'article contracté
4. verbe pronominaux
5. prepositions (12)

**SENTENCE STRUCTURE:**

1. Raconter et reporter-donner son avis
2. Futur simple, pronom complètement d'objet direct, passé composé
3. plusieurs région de France, imparfait, pronom y/en, imparfait (12)

**TENSES AND NUMBERS:**

1. Demander l'autorisation-passé récent, futur proche
2. La vie administrative et régionale, Pluriel des noms, moyens de transport (12)

**DISCOURSE:**

1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d'un système éducation de France
3. parler de la technologie de l'information (12)

**Total P: 60**

**TEXT BOOKS:**

1. Christine Andant étal "À propos (livre de l'élève", LANGER., NEW DELHI, 2012
2. Myrna Bell Rochester "Easy French Step By Step", MCGrawhill Companies., USA, 2008

**REFERENCES:**

1. Michael D. Oates "Entre Amis: An Interactive Approach", 5<sup>th</sup> Edition, Houghton Mifflin., 2005
2. Bette Hirsch, Chantal Thompson "Moments Literaries : An Anthology for intermediate French"
3. Simone Renaud, Dominique van Hooff "En bonne forme"

**19G004 BASIC JAPANESE**

**0 0 4 2**

**JAPANESE PEOPLE AND CULTURE :**

1. Basic greetings and responses
2. Basic script — Method of writing hiragana and katakana — Combination sounds and simple words
3. Self introductions: "Hajimemashite" -Demonstratives "Kore", "Sore", "Are" — Demonstrative "Kono", "Sono", "Ano"
4. Possessive noun particle "no" — Japanese apartments: Greeting your neighbor (12)

**PARTICLE "NI (AT)" FOR TIME :**

1. kara (from) ~ made(until) — Particle "to (and)"
2. Time periods: Days of the week, months, time of day — Verbs (Present / future and past tense)
3. Telephone enquiry: Asking for a phone no. And business hours- Destination particle "e". (12)

**LIKES AND DISLIKES :**

1. Potential verbs (wakarimasu and dekimasu) — "Kara (~ because)"
2. Adverbs — Asking someone out over the phone- Verbs denoting presence
3. Introduction to Adjectives (na and ii type) -Verb groups — I, II and III — Exercises to group verbs- Please do (te kudasai)
4. Present continuous tenses (te imasu) — Shall I? (~ mashou ka) — Describing a natural phenomenon (It is raining) (12)

**DIFFERENT USAGES OF ADJECTIVES :**

1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabetai desu)- Going for a certain purpose (mi -ni ikimasu)
2. Choosing from a menu-Adjectives ("i" and "na" type) — Adjectives (Positive and negative useage) (12)

**ROLE PLAYS IN JAPANESE :**

1. Framing simple questions & answers
2. Writing Short paragraphs & Dialogues
3. A demonstration on usage of chopsticks and Japanese tea party (12)

**Total P: 60**

**TEXT BOOKS:**

1. Minna no Nihongo, Honsatsu Roma "ji ban (Main Textbook Romanized Version)", International publisher — 3A Corporation., Tokyo, 2012

## REFERENCES:

1. Eri Banno et.al "Genki I: An Integrated Course in Elementary Japanese I -Workbook", .., 1999
2. Tae Kim "A Guide to Japanese Grammar: A Japanese Approach to Learning Japanese Grammar", 2014
3. Minna No Nihongo "Translation & Grammatical Notes In English Elementary",

## PROFESSIONAL ELECTIVES

### 19R001 INDUSTRY 4.0

**3 0 0 3**

**INTRODUCTION TO INDUSTRY 4.0** : The Fourth Industrial Revolution - Sustainability Assessment of Manufacturing - Lean Production System - Smart and Connected Business Perspective - Smart Factories - Cyber -Physical Systems and Next - Generation -Collaboration Platform and Product Life cycle - Augmented Reality and Virtual Reality - Artificial Intelligence – Big Data and Advanced Analysis - Cyber security (12)

**BASICS OF INDUSTRIAL IOT** : Introduction- Industrial Internet Systems - Industrial Sensing and Actuation-Industrial Processes - Business Models and Reference Architecture for IIoT (7)

**KEY ENABLERS OF INDUSTRIAL IOT** : IoT Sensing - IoT Connectivity - IoT Networking - Process control (7)

**IIOT ANALYTICS AND DATA MANAGEMENT** : Introduction - Machine Learning - Cloud Computing - Fog Computing in IIoT - Data Management with Data Center Networks - Advanced Technologies: Software-Defined Networking (SDN) - Security in IIoT (9)

**IIOT APPLICATIONS** : Factories and Assembly Line - Manufacturing Industry - Food Industry - Power Plants -Healthcare - Inventory Management and Quality Control - Plant Security and Safety - Facility Management. (10)

**Total L: 45**

#### TEXT BOOKS:

1. Alasdair Gilchrist , "Industry 4.0: The Industrial Internet of Things", Apress, 2016.
2. Lane Thames, Dirk Schaefer , "Cyber Security for Industry 4.0", Springer, 2017.

#### REFERENCES:

1. Bartodziej, Christoph Jan , "The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gabler, 2017.
2. Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz , "Industry 4.0: Industrial Revolution of the 21<sup>st</sup> Century", Springer, 2019.
3. Giacomo Veneri, Antonio Capasso , "Hands-On Industrial Internet of Things", Packt Publishing Limited, 2018.
4. Jerker Desling , "IoT Automation", CRC Press, 2017.

### 19R002 ROBOTIC CONTROL SYSTEMS

**3 0 0 3**

**INTRODUCTION AND OVERVIEW OF ROBOTIC SYSTEMS AND THEIR DYNAMICS**: Forward and inverse dynamics. Properties of the dynamic model and case studies. Introduction to nonlinear systems and control schemes (8)

**SYSTEM STABILITY AND TYPES OF STABILITY** : Lyapunov stability analysis - both direct and indirect methods. Lemmas and theorems related to stability analysis (8)

**JOINT SPACE AND TASK SPACE CONTROL SCHEMES**: Position control - velocity control - trajectory control and force control (8)

**NONLINEAR CONTROL SCHEMES** : Proportional and derivative control with gravity compensation - computed torque control - sliding mode control - adaptive control - observer based control - robust control and optimal control (9)

**NONLINEAR OBSERVER SCHEMES**: Design based on acceleration - velocity and position feedback. - Numerical simulations using software packages (12)

**Total L: 45**

#### TEXT BOOKS:

1. R Kelly, D. Santibanez, LP Victor, Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.
2. A Sabanovic , K Ohnishi , "Motion Control Systems", John Wiley & Sons (Asia), 2011.

#### REFERENCES:

1. R M Murray, Z. Li, SS Sastry , "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994.

2. J J Craig , "Introduction to Robotics: Mechanics and Control", Prentice Hall, 2004.
3. J J E Slotine , W Li , "Applied Nonlinear Control", Prentice Hall, 1991.
4. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics" , MIT Press, 2005.

## 19R003 INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEMS

**3 0 0 3**

**INTRODUCTION** : Types of industrial robots - Load handling capacity - general considerations in Robotic material handling material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell (6)

**ROBOTS FOR INSPECTION:** Robotic vision systems - image representation - object recognition and categorization - depth measurement - image data compression - visual inspection - software considerations. (8)

**OTHER APPLICATIONS** : Application of Robots in continuous arc welding - Spot welding - Spray painting - assembly operation - cleaning - robot for underwater applications. (7)

**END EFFECTORS:** Gripper force analysis and gripper design for typical applications - design of multiple degrees of freedom - active and passive grippers. (6)

**SELECTION OF ROBOT** : Factors influencing the choice of a robot - robot performance testing - economics of robotisation - Impact of robot on industry and society. (5)

**MATERIAL HANDLING** : concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems - cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS) - bar code technology - radio frequency identification technology -Introduction to Automation Plant design softwares. (13)

**Total L: 45**

### TEXT BOOKS:

1. Richard D Klaffer, Thomas Achmielewski , Mickael Negin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2001.
2. Mikell P Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.

### REFERENCES:

1. James A Rehg , "Introduction to Robotics in CIM Systems", Prentice Hall of India, 2002.
2. Deb S R , "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994.
3. Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, Ashish Dutta , "Industrial Robotics (SIE): Technology, Programming and Applications", 2<sup>nd</sup> Edition, McGraw Hill Education India Pvt Ltd, 2012.
4. Yoram Koren , "Robotics for Engineers", McGraw-Hill, 1987.

## 19R004 MICROROBOTICS

**3 0 0 3**

**INTRODUCTION** : MST ( Micro System Technology) - Micromachining - Working principles of Microsystems - Applications of Microsystems (5)

**SCALING LAWS AND MATERIALS FOR MEMS** : Introduction - Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties - scaling effect on physical forces - Physics of Adhesio - Silicon - compatible material system - Shape memory alloys - Material properties - Piezoresistivity, Piezoelectricity and Thermoelectricity (10)

**FLEXURES, ACTUATORS AND SENSORS** : Elemental flexures - Flexure systems - Mathematical formalism for flexures - Electrostatic actuators - Piezo-electric actuators - Magneto-strictive actuators - Electromagnetic sensors - Optical-based displacement sensors - Motion tracking with microscopes (10)

**MICROROBOTICS:** Introduction - Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro- robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots. (6)

**IMPLEMENTATION OF MICROROBOTS** : Arrayed actuator principles for micro-robotic applications - Micro-robotic actuators - Design of locomotive micro-robot devices based on arrayed actuators - Micro-robotics devices - Micro- grippers and other micro-tools - Micro-conveyors - Walking MEMS Micro-robots - Multi-robot system: Micro-robot powering, Micro-robot communication. (9)

**MICROFABRICATION AND MICROASSEMBLY:** Micro-fabrication principles-Design selection criteria for micromachining - Packaging and Integration aspects - Micro-assembly platforms and manipulators (5)

**Total L: 45**

**TEXT BOOKS:**

1. Mohamed Gad-el-Hak , "The MEMS Handbook", CRC Press, New York, 2002.
2. Yves Bellouard , "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2011.

**REFERENCES:**

1. Nadim Maluf and Kirt Williams , "An Introduction to Microelectromechanical systems Engineering", Artech House, MA, 2002.
2. Julian W Gardner , "Microsensors: Principles and Applications", John Wiley & Sons, 1994.
3. Metin Sitti , "Mobile Microrobotics", MIT Press, 2017.
4. Nicolas Chaillet, Stephane Regnier , "Microrobotics for Micromanipulation", John Wiley & Sons, 2013.

**19R005 COGNITIVE ROBOTICS****3 0 0 3**

**CYBERNETIC VIEW OF ROBOT COGNITION AND PERCEPTION** : Introduction to the Model of Cognition – Visual Perception - Visual Recognition - Machine Learning - Soft Computing Tools and Robot Cognition. (6)

**MAP BUILDING** : Introduction - Constructing a 2D World Map - Data Structure for Map Building - Explanation of the Algorithm - An Illustration of Procedure Traverse Boundary - An Illustration of Procedure Map Building – Robot Simulation - Execution of the Map Building Program. (12)

**RANDOMIZED PATH PLANNING:** Introduction - Representation of the Robot's Environment - Review of configuration spaces - Visibility Graphs - Voronoi diagrams - Potential Fields and Cell Decomposition - Planning with moving obstacles - Probabilistic Roadmaps - Rapidly exploring random trees - Execution of the Quadtree- Based Path Planner Program. (9)

**SIMULTANEOUS LOCALIZATION AND MAPPING (SLAM)** : Problem Definition - Mathematical Basis - Example: SLAM in Landmark Worlds - Taxonomy of the SLAM Problem - Extended Kalman filter - Graph-Based Optimization Techniques - Particle Methods Relation of Paradigms. (12)

**ROBOT PROGRAMMING PACKAGES** : Robot Parameter Display - Program for BotSpeak - Program for Sonar Reading Display - Program for Wandering Within the Workspace - Program for Tele-operation - A Complete Program for Autonomous Navigation. (6)

**Total L: 45****TEXT BOOKS:**

1. Patnaik, Srikanth , "Robot Cognition and Navigation An Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2007.
2. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun , "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.

**REFERENCES:**

1. Sebastian Thrun, Wolfram Burgard, Dieter Fox , "Probabilistic Robotics", MIT Press, 2005.
2. Margaret E. Jefferies, Wai-Kiang Yeap , "Robotics and Cognitive Approaches to Spatial Mapping", Springer- Verlag Berlin Heidelberg, 2008.
3. Hooman Samani , "Cognitive Robotics", 1<sup>st</sup> Edition, CRC Press, 2015.
4. Laxmidhar Behera, Indrani Kar , "Intelligent Systems and Control Principles and Applications", Oxford University Press, 2010.

**19R006 CLOUD ROBOTICS****3 0 0 3**

**INTRODUCTION:** Telerobotics: Overview and background -Brief history (5)

**COMMUNICATIONS AND NETWORKING** : The Internet - Wired Communication Links - Wireless Links - Properties of Networked Telerobotics - Building a Networked Telerobotic system - State command Presentation - Command Execution/ State Generation - Collaborative Control (13)

**FUNDAMENTALS OF ONLINE ROBOTS:** Introduction - Robot Manipulators - Teleoperation - Teleoperation on a local network - Teleoperation via a constrained link (10)

**ONLINE ROBOTS** : Introduction to networked robot system on the Web - Software Architecture and design -Interface design (10)

**CASE STUDY** : Performance of mobile robots controlled through the web - System Description - Software Architecture (7)

**Total L: 45**



**TEXT BOOKS:**

1. Bruno Siciliano, Oussama Khatib , "Springer Handbook of Robotics", Springer Science and Business, 2010.
2. Ken Goldberg, Roland Siegwart , "Beyond Webcams – An Introduction to Online Robots", MIT Press, 2010.

**REFERENCES:**

1. Borko Furht, Armando Escalante , "Handbook of Cloud Computing", Springer Science & Business, 2010.
2. Peter Sinčák, Pitojo Hartono, Mária Virčíková, Ján Vaščák, Rudolf Jakša , "Emergent Trends in Robotics and Intelligent Systems", Springer, 2014.
3. Manuel Ferre, Martin Buss, Rafael Aracil, Claudio Melchiorri, Carlos Balaguer , "Advances in Telerobotics", 1<sup>st</sup> Edition, Springer-Verlag Berlin Heidelberg, 2007.
4. Tyler Schilling, "Telerobotic Applications", 1<sup>st</sup> Edition, Wiley, 2000.

**19R007 MEDICAL ROBOTICS****3 0 0 3**

**INTRODUCTION:** Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare-DICOM (7)

**LOCALIZATION AND TRACKING :** Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems. (8)

**SURGICAL ROBOTICS :** Minimally invasive surgery and robotic integration - surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging -Cardiac Surgery – Neurosurgery - case studies (10)

**REHABILITATION:** Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - case studies (6)

**ROBOTS IN MEDICAL CARE:** Assistive robots –types of assistive robots - case studies (6)

**DESIGN OF MEDICAL ROBOTS :** Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security. (8)

**Total L: 45****TEXT BOOKS:**

1. Achim Schweikard, Floris Ernst , "Medical Robotics", Springer, 2015.
2. Paula Gomes , "Medical robotics Minimally invasive surgery", Woodhead, 2012.

**REFERENCES:**

1. Jaydev P Desai, Rajni V Patel , "The Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2018.
2. Jocelyne Troccaz , "Medical Robotics", Wiley-ISTE, 2012.
3. Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.
4. Farid Gharagozloo, Farzad Najam , "Robotic Surgery", 1<sup>st</sup> Edition, McGraw-Hill Education, 2008.

**19R008 ROBOTIC WELDING TECHNOLOGY****3 0 0 3**

**WELDING AUTOMATION:** Concept of manual, automatic and automated welding; Need for Welding Automation — merits, limitations, arc and work motion devices, Robotic part-holding positioners, Flexible automation of arc welding, remote welding. (6)

**WELDING PROCESS FOR ROBOTIC WELDING:** Review of welding process GTAW, GMAW — welding power sources, electrodes, shielding gases, process parameters, Hot wire, ATIG processes, synergic GMAW, CMT, Rapid Arc GMAW process, Wire Arc additive manufacturing process, LBW — solid state lasers, gas lasers, process parameters, RSW — power sources, electrodes, process variables, FSW - equipment, process parameters, Thermal Assisted FSW, process variants (11)

**WELDING ROBOTS:**Types of welding robots—features of welding Robot—Wrist motions -Specifying the welding Robot - controllers- major components, functions- Interfacing welding power source with robotic controller — welding control system (10)

**ROBOTIC WELDING:** Robotic welding system, Programmable and flexible control facility -Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding (10)

**APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES** : Application of robot in production: Exploration of practical application of robots in welding: robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering - Applications in nuclear, aerospace and ship building, case studies for simple and complex applications (8)

**Total L: 45**

**TEXT BOOKS:**

1. Pires J N, Loureiro A, Bolmsjo G , "Welding Robots: Technology, System Issues and Application", 1<sup>st</sup> Edition, Springer, 2006.
2. Howard B, Carry , "Arc Welding Automation", Marcel Dekker, Inc, New York, 1995.

**REFERENCES:**

1. Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2012.
2. Shimon Y N , "Handbook of Industrial Robotics", 2<sup>nd</sup> Edition, John Wiley & Sons, 2013.
3. John A. piotrowski, William T. Randolph , "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.
4. Jack D Lane , "Robotic Welding", IFS Publication, 1987.

## 19R010 ELECTRICAL MACHINES FOR AUTOMATION

**3 0 0 3**

**STEPPER MOTORS** : Constructional features - Principle of operation - Types: Variable reluctance motor - Single and Multi stack configurations - Permanent Magnet Stepper motor - Hybrid Stepper motor. Modes of Excitation - Static and Dynamic characteristics of stepper motors - Drive systems - Open loop and Closed loop control of stepper motor- Sizing of stepper motors - Applications (12)

**SERVOMOTORS:** Types- Constructional feature -Principle of operation-Feedback system-Sizing of servomotors Applications (8)

**BRUSHLESS DC MOTORS** : Principle of operation - Types: Square wave and Sine wave - Magnetic circuit analysis - EMF and torque equations - Torque speed characteristics - control of BLDC Motors- Applications (9)

**PERMANENT MAGNET SYNCHRONOUS MOTORS:** Principle of operation - EMF - Input power and torque expression- Steady state phasor diagram - Torque speed characteristics - control of PMSM Motors - Applications. (8)

**LINEAR MOTORS:** Linear Induction motor classification - Construction - Principle of operation - DC Linear motor (DCLM) types - Circuit equation - DCLM Control applications - Linear Synchronous motor (LSM)- Types - Applications. (8)

**Total L: 45**

**TEXT BOOKS:**

1. Kenjo T , "Stepping Motors and their Microprocessor Controls", Clarendon Press London, 2003.
2. J. R. Hendershot, Timothy John Eastham Miller , "Design of Brushless Permanent-magnet Machines", Motor Design Books, 2010.

**REFERENCES:**

1. Jacek F. Gieras, Zbigniew J. Piech, Bronislaw Tomczuk , "Linear Synchronous Motors: Transportation and Automation Systems", CRC Press.New York, 2011.
2. Bonfiglioli Riduttori , "Gear Motor Handbook", Springer, 1995.
3. Wilfried Voss , "A Comprehensive Guide to Servomotor Sizing", Copperhill Media, 2007.
4. Theodore Wildi , "Electrical Machines, Drives and Power Systems", Pearson, 2014.

## 19R011 INDUSTRIAL NETWORKING

**3 0 0 3**

**INTRODUCTION** : Modern instrumentation and control systems - Terminology - Topology - Mechanisms - Protocols - Standards - Common problems and solutions - Grounding/shielding and noise - EIA-232 interface standard - EIA-485 interface standard - Current loop and EIA-485 converters - Fibre optic cable components and parameters - Basic cable types - Connection fibers - troubleshooting. (10)

**COMMUNICATION BUS PROTOCOLS** : Overview - Protocol structure - Function codes - Modbus plus protocol - Data Highway - AS interface (AS-i)-DeviceNet: Physical layer - Topology - Device taps - Profibus PA/DP/FMS: Protocol stack - System operation.CAN BUS: Concepts of bus access and arbitration - CAN: Protocol-Errors: Properties - detection - processing - Introduction to CAN 2.0B and EtherCAT. (10)

**ETHERNET SYSTEMS** : IEEE 802.3 - Physical layer - Medium access control - Collisions - Ethernet design rules - Fast and gigabit Ethernet systems - design considerations - Internet layer protocol - UDP - TCP/IP - ProfiNet – LAN system components - Structured cabling - Industrial Ethernet - Troubleshooting Ethernet. (10)

**WIRELESS COMMUNICATIONS:** Radio spectrum - Frequency allocation - Radio modem - Intermodulation - Implementing a radio link - RFID: Basic principles of radio frequency identification - Transponders - Interrogators - Wireless HART. (8)

**APPLICATIONS :** Automotive communication technologies - Design of automotive X-by-Wire systems - The LIN standard - The IEC/IEEE Train communication network: Applying train communication network for data communications in electrical substations. (7)

**Total L: 45**

**TEXT BOOKS:**

1. Steve Mackay, Edwin Wright, Deon Reynders and John Park , "Practical Industrial Data Networks: Design, Installation and Troubleshooting", Newnes (Elsevier), 2004.
2. Dominique Paret , "Multiplexed Networks for Embedded Systems", John Wiley & Sons, 2007.

**REFERENCES:**

1. Richard Zurawski , "The Industrial Communication Technology Handbook", Taylor and Francis, 2005.
2. Deon Reynders and Edwin Wright, "Practical TCP/IP and Ethernet Networking", IDC Technologies, 2006.
3. James Powell, Henry Vandelinde , "Catching the Process Fieldbus an Introduction to PROFIBUS for Process Automation", Momentum Press, 2013.
4. Albert Lozano-Nieto , "RFID Design Fundamentals and Applications", CRC Press, 2011.

## 19R012 VIRTUAL INSTRUMENTATION SYSTEMS

**3 0 0 3**

**INTRODUCTION :** Definition and Architecture of Virtual Instrumentation - Virtual Instruments Versus Traditional Instruments - Conventional Virtual Instrumentation - Virtual Instruments using LabVIEW - Virtual Instrumentation in the Engineering process (5)

**VIRTUAL INSTRUMENTATION SYSTEM OVERVIEW :** Virtual Instrumentation System Environment- Front panel and Block Diagram - Tools palette - Data flow programming - 'G' programming - Data types and Conversion - Representation and precision - Creating and saving VIs - Writing - Editing - Debugging and Running a VI - Creating subVIs (8)

**PROGRAMMING STRUCTURES :** FOR loop - WHILE loop - Shift register - Feedback node - CASE structure - Sequence structures - Formula nodes - Arrays - Array operations - Clusters - Cluster functions - Waveform Graphs and Waveform Charts - Strings - String functions -File I/O - File I/O Functions - Attribute modes: Local and Global variables (8)

**I/O AND HARDWARE ASPECTS :** Components of measuring system - Classification of signals - Transducers and sensors - Signal conditioning functions - Signal Grounding - Digital I/O techniques - Data Acquisition using VI - Components of DAQ - DAQ Assistant - Measurement and Automation Explorer - DAQ Hardware and Software (10)

**INSTRUMENT INTERFACES AND BUSES :** Drivers and Communication standards -RS232- GPIB: Types of GPIB messages - Physical Bus structure - VISA Programming - VISA Attributes - USB: Architecture - Electrical specifications - Functions (8)

**APPLICATIONS OF VIRTUAL INSTRUMENTATION :** Developing Remote front panel VI applications - Client server applications in VI - Machine vision system - Introduction to image processing modules -Motion Control: Components of a motion control system - Software for configuration - Prototyping and Development (6)

**Total L: 45**

**TEXT BOOKS:**

1. Sumathi S., P Surekha , "LabVIEW based Advanced Instrumentation Systems", Springer, 2007.
2. Jeffrey Travis , Jim Kring , "LabVIEW for Everyone", Prentice Hall, 2009.

**REFERENCES:**

1. Jovitha Jerome , "Virtual Instrumentation Using Lab VIEW", Prentice Hall of India, 2011.
2. Christopher G Relf , "Image Acquisition and Processing with LabVIEW", CRC Press, 2004.
3. Rick Bitter, Taqi Mohiuddin , Matt Nawrocki , "LabVIEW Advanced Programming Techniques", CRC Press, 2006.
4. Robert H. Bishop , "Learning with LabVIEW", 1<sup>st</sup> Edition, Pearson, 2014.

## 19R013 SENSOR NETWORKS

**3 0 0 3**

**INTRODUCTION :** Challenges for wireless sensor networks - Comparison of sensor network with ad hoc network. Sensor Localization - Clock synchronization - power management - Special WSNs - WSN Applications (9)

**ARCHITECTURE** : Single node architecture - Hardware components - Sensor Mote Architecture and design - Mica mote design - Telos Mote - Network architecture - Sensor network scenarios - Design principles – Gateway Concepts (9)

**NETWORKING SENSORS** : MAC protocols - MAC low duty cycle protocols and wakeup concepts - contention-based protocols - Schedule-based protocols (9)

**ROUTING IN WIRELESS SENSOR NETWORKS** : Energy-efficient unicast - Broadcast and multicast - Data centric Routing protocols in WSNs - Hierarchical Routing protocols Location based routing protocols and Multipath routing (9)

**SENSOR NETWORK PLATFORMS AND TOOLS** : Programming Challenges - Node-level software platforms - Node-level Simulators - Tinyos - Component model - main features - ContikiOs - Proto threads (9)

**Total L: 45**

**TEXT BOOKS:**

1. HolgerKarl , "Protocol and Architecture for Wireless Sensor Networks", John Wiley publication, 2007.
2. FeiHu, Xiaojun Cao , "Wireless Sensor Networks, Principles and Practice", CRC Press, 2010.

**REFERENCES:**

1. WalteneusDargie, Christian Poellabauer , "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley, 2010.
2. KazemSohraby, Daniel Minoli, TaiebZnati , "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Interscience, 2007.
3. Ian Akyildiz , "Wireless Sensor Networks", John Wiley & Sons, 2010.
4. Ibrahim M. M. El Emary, S. Ramakrishnan , "Wireless Sensor Networks: From Theory to Applications", CRC Press, 2013.

## 19R014 DIGITAL CONTROL SYSTEMS

**3 0 0 3**

**Z – TRANSFORM** : Sampled data theory — Sampling process — Sampling theorem - Signal reconstruction — Sample and hold circuits - Z Transform — Theorems on Z Transforms - Inverse Z Transforms (6)

**SAMPLED DATA SYSTEMS** : Pulse transfer function - Response of sampled data system to step and ramp inputs - mapping between s-plane and z-plane: Primary strips and Complementary Strips. (8)

**STATE SPACE ANALYSIS** : State Space Representation of discrete time systems - Solving discrete time- state-space equations - Pulse Transfer Function Matrix - Discretization of continuous time state–space equations (11)

**STABILITY ANALYSIS** : Stability Analysis of closed loop systems in the Z-Plane - Jury stability test - Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion - Stability analysis using Lyapunov Theorems. (11)

**POLE PLACEMENT AND OBSERVER DESIGN** : Controllability, Observability - Useful Transformations in State-Space analysis and Design - Design via Pole Placement - State Observers - Servo Systems (9)

**Total L: 45**

**TEXT BOOKS:**

1. Ogata K , "Discrete-Time Control systems", 2<sup>nd</sup> Edition, PHI Learning Pvt. Ltd, 2009.
2. Kuo B.C , "Digital Control Systems", 2<sup>nd</sup> Edition, Oxford University Press, 2007.

**REFERENCES:**

1. Gopal M , "Modern Control Systems Theory", 3<sup>rd</sup> Edition, New Age International Publications, 2014.
2. Richard C. Dorf, Robert H. Bishop , "Modern Control Systems", 12<sup>th</sup> Edition, Pearson Education, 2004.
3. C. L. Philips, Troy Nagle, Aranya Chakraborty , "Digital Control System Analysis and Design", Prentice-Hall, 2014.
4. M. Gopal , "Digital Control and State Variable Methods", Tata McGraw-Hill, 2006.

## 19R015 AUTOMOBILE ENGINEERING

**3 0 0 3**

**AUTOMOBILE ARCHITECTURE AND CHASSIS** : Brief history, introduction about an automobile, layout of an automobile, automobile sub systems and their role, Role and requirement of a chassis frame, Types of chassis — Light, medium and heavy duty vehicle chassis, ladder chassis, integral body - Types of bodies, coach built, convertibles. (9)

**ENGINE ARCHITECTURE AND PERFORMANCE** : Types of engine, multi valve engine, in-line engine, vee-engine, Petrol engine-direct, single point and multipoint injection, diesel engine-common rail diesel injection, supercharging and turbo charging. (9)

**TRANSMISSION SYSTEMS** : Clutch: Types-coil spring and diaphragm type clutch, single and multi-plate clutch, centrifugal clutch, Gear box: Types-constant mesh, sliding mesh and synchromesh gear box, layout of gear box, gear selector and shifting mechanism, overdrive, automatic transmission. (9)

**STEERING AND SUSPENSION SYSTEM** : Steering: Types of steering systems, Ackermann principle, Davis steering gear, steering gear boxes, steering linkages, power steering, wheel geometry-caster, camber toe-in, toe out. Suspension: Types-front and rear suspension, conventional and independent type suspension, leaf springs, coil springs, air suspension systems. (9)

**WHEEL, TYRES AND BRAKING SYSTEM** : Types of wheels, construction, wired wheels, Tyres- construction, Radial, bias and belted bias, slip angle, road patterns, Tyre retreading cold and hot, Tubeless tyres, Brakes: Types of brakes - Mechanical, Hydraulic, Air brakes, Disc and Drum brakes, anti-lock braking system. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Gupta RB, "Automobile Engineering", Satya Prakashan, 2009.
2. Kirpal Singh, "Automobile Engineering Vol-I & II", Standard publishers, New Delhi, 2011.

**REFERENCES:**

1. Julian Happian Smith, "An Introduction to Modern Vehicle Design", Butterworth-Heinemann, New Delhi, 2002.
2. Crouse W H, "Automotive Transmissions and Power trains", McGraw Hill Book Co, New Delhi, 1976.
3. Heinz Heisler, "Vehicle and Engine Technology", SAE International and Elsevier, 1999.
4. Allan W. M. Bonnick, "Automotive Computer Controlled Systems: Diagnostic Tools and Technique", USA, 2001.

## 19R016 RENEWABLE ENERGY SYSTEMS

**3 0 0 3**

**PRINCIPLES OF SOLAR RADIATION** : World energy status, Current energy scenario in India - Environmental aspects of energy utilization - Role and potential of new and renewable source, physics of the sun, the solar constant - extraterrestrial and terrestrial solar radiation - solar radiation on tilted surface - instruments for measuring solar radiation and sun shine, solar radiation data (9)

**SOLAR ENERGY COLLECTION, STORAGE AND APPLICATIONS** : Solar thermal collectors — Flat plate collectors, concentrating collectors, classification of concentrating collectors - Different methods of solar energy storage - Sensible, latent heat and stratified storage, solar ponds - Solar Applications - Solar heating and cooling techniques — solar distillation and drying - Solar photo voltaic conversion — Solar cells — Sizing of solar PV systems. (10)

**WIND ENERGY** : Sources and potentials, Wind energy conversion systems, site characteristics - wind turbines types — horizontal and vertical axis - performance characteristics, and Betz criteria - Wind energy Applications — Hybrid systems - Wind energy storage, Safety and environmental aspects. (8)

**BIOMASS ENERGY** : Energy from Biomass - Biomass as Renewable Energy Source - Types of Bio Mass Fuels - Solid, Liquid and Gas - Biomass Conversion Techniques- Wet Process, Dry Process-Photosynthesis - Biogas Generation - Factors affecting Bio- digestion - Classification of bio gas plant - Continuous, Batch and Fixed Dome types - Advantages and Disadvantages. (9)

**TIDAL, OTEC, HYDEL AND GEOTHERMAL ENERGY** : Tidal energy: Tide — Spring tide, Neap tide — Tidal range — Tidal Power - Types of tidal power plant — Single and dual basin schemes - Requirements in tidal power plant - Ocean Thermal Energy Conversion (OTEC): Principle - Open and closed OTEC Cycles - Energy and power from the waves, wave energy conversion devices - Hydel Energy: Mini and Micro hydro - Geothermal Energy: Geothermal energy sources - types of wells, methods of harnessing the energy (9)

**Total L: 45**

**TEXT BOOKS:**

1. GD Rai, "Non-Conventional Energy Sources", 4<sup>th</sup> Edition, Khanna publishers, 2009.
2. RK Rajput, "Non-Conventional Energy Sources and Utilization", S.Chand & Company Ltd, 2012.

**REFERENCES:**

1. John Twidell, Tony Weir, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2006.
2. Tiwari, Ghosal, "Renewable Energy Resources", 1<sup>st</sup> Edition, Narosa Publications, 2007.
3. Ramesh, Kumar, "Renewable Energy Technologies", Narosa Publishing House, 2004.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals Technologies and Applications", 3<sup>rd</sup> Edition, PHI Learning Pvt. Ltd., Delhi, 2015.

## 19R017 FARM AUTOMATION

**3 0 0 3**

**INTRODUCTION TO FARM AUTOMATION** : History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot. (9)

**PRECISION AGRICULTURE** : Sensors — types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks. (9)

**TRACTOR HITCHING, TRACTION, AND TESTING** : Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction- Traction models, Traction predictor spreadsheet, Soil Compaction, Traction Aids, Tractor Testing. (9)

**SOIL TILLAGE AND WEED MANAGEMENT** : Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation. (9)

**CONVEYING OF AGRICULTURAL MATERIAL SAND MACHINERY SELECTION** : Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster , "Engineering Principles of Agricultural Machines", ASAE Publication, 2006.
2. Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2013.

**REFERENCES:**

1. Qin Zhang, Francis J. Pierce , "Agricultural Automation Fundamentals and Practices", CRC Press, 2013.
2. Stephen L. Young, Francis J. Pierce , "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3. R.A. Kepner, Roy Bainer, E.L. Barger , "Principles of Farm Machinery", 3<sup>rd</sup> Edition, CBS Publishers, New Delhi, 2017.
4. Guangnan Chen , "Advances in Agricultural Machinery and Technologies", 1<sup>st</sup> Edition, CRC Press, 2018.

## **19R018 ADVANCED CONTROL SYSTEMS**

**3 0 0 3**

**CONTROLLER DESIGN** : Design and Performance analysis of P, PI, PID Controllers - Ziegler-Nichols tuning of PID Controller, Cohen Coon tuning Method, Universal PID design tool (10)

**COMPENSATOR DESIGN** : Classical design, Examples - Realization of compensating Networks - Lead, lag, lag-lead networks - Lead compensation, lag compensation, lag lead compensation - Network compensation — root locus approach. (8)

**SAMPLED DATA SYSTEM** : Sampling process — Sample and hold - Reconstruction of sampled signals – Hold circuits zero and first order hold - Z and Inverse Z transform - Pulse transfer function - Step response. (7)

**NON-LINEAR SYSTEMS** : Introduction — Properties of Non-Linear systems - Describing function for simple nonlinearities like on-off relay, dead zone, saturation and relay with hysteresis - Basic concepts — singular points — construction of phase plane trajectory for linear and non linear second order system — Isocline method — stability evaluation and limit cycle. (11)

**STATE VARIABLE DESIGN** : Introduction to state Model- effect of state Feedback on controllability and observability - Pole placement by state feedback - pole placement Design - Design of state Observers- Full order observer - separation principle, reduced order observer. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Ogata K , "Modern Control Engineering", Pearson/Prentice-Hall of India, New Delhi, 2010.
2. Gopal M , "Modern Control Systems Theory", New Age International publishers, 2011.

**REFERENCES:**

1. Gopal M , "Control Systems – Principles and Design", Tata McGraw-Hill Co. Ltd, New Delhi, 2008.
2. Norman S. Nise , "Control system Engineering", John Wiley & Sons, 2010.
3. Aggarwal K K , "Control Systems Analysis and Design", Khanna Publishers, New Delhi, 2004.
4. Benjamin C Kuo , "Automatic Control Systems", John Wiley & sons, 2009.

## **19R020 IMAGE ANALYTICS**

**3 0 0 3**

**IMAGE FORMATION AND PROCESSING** : Introduction - Geometric primitives and Transformations - Photometric Image formation - The digital camera. Introduction to image processing - point - spatial - Fourier Transform - Pyramids and wavelets - Geometric transformations - global optimization (9)

**FEATURE DETECTION AND MATCHING** : Introduction - Points and patches - Feature detectors - Feature Descriptors - SIFT - PCA SIFT - Gradient location orientation histogram (9)

**SEGMENTATION** : Introduction - Active contours - Snakes - Scissors - Level sets - Split and merge - Watershed - Region splitting - region merging - and graph based segmentation - mean shift and mode finding - Normalized cuts - graph cuts and energy based methods - application (9)

**COMPUTATIONAL PHOTOGRAPHY** : Photometric calibration - Radiometric response function - Noise level estimation - Vignetting - Optical blur - High dynamic range imaging - Super resolution and blur removal - Color image demosaicing - application (9)

**IMAGE RECOGNITION** : Object detection - Face recognition - Instance recognition - category recognition - Bag of words - Part based models - context and scene understanding- Application: Image search. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Richard Szeliski , "Computer Vision: Algorithms and Applications", Springer, 2010.
2. Hartley R , Zisserman A , "Multiple View Geometry in Computer Vision", Cambridge University Press, 2004.

**REFERENCES:**

1. Forsyth D A , Ponce J , "Computer Vision: A Modern Approach", Prentice Hall, 2002.
2. Duda R O , Hart P E , Stork D G , "Pattern Classification", Wiley, 2001.
3. Richard Sc , "Computer Vision: Algorithms and Applications", Springer, 2010.
4. Simon J.D.Prince , "Computer Vision: Models, Learning and Inference", Cambridge University Press, 2012.

## 19R021 SPEECH SIGNAL PROCESSING

**3 0 0 3**

**SPEECH SIGNAL MODELLING** : Speech signal characteristics and classifications - Speech production mechanism - Acoustic Theory of speech production - Source - Filter model - Lossless Tube Models - Digital Model of speech signals (7)

**SPEECH SIGNAL ANALYSIS** : Time domain Analysis for speech processing - Short time energy and magnitude - short time average zero crossing - Speech vs silence discrimination - Pitch period estimation using autocorrelation - function - Short time Fourier analysis- Definition and properties - Design of digital filter banks - Pitch detection - Analysis by synthesis (11)

**SPEECH CODING** : Linear predictive coding - principle - solution of LPC equation - Cholesky decomposition method - Durbin's method - Lattice formulation - Frequency domain interpretation of LPC - LPC Applications - CELP - Subband coding - Transform coding - Vocoders and cepstral vocoders - Vector quantiser coders (11)

**SPEECH RECOGNITION** : Problems in ASR - Dynamic Time warping - Isolated word recognition - pattern matching - speaker-Independent recognition-Pattern classification-Connected-word recognition-Speaker identification/Verification- Hidden Markov model (10)

**CASE STUDY** : NAO: Vocal Interaction - Speech based reaction (6)

**Total L: 45**

**TEXT BOOKS:**

1. Rabiner L R / Schaffer R W , " , Pearson Education, New Delhi, India, 2004.", , 2004.
2. Thomas F Quatieri , "Discrete –Time Speech Signal Processing", Pearson Education, 2004.

**REFERENCES:**

1. Rabiner L R K, Juang B H , "Fundamentals of Speech Recognition", Pearson Education, 2003.
2. John R Deller, Jr, John H L Hansen, John G. Proakis , "Discrete Time Processing of Speech Signal", IEEE press, 2000.
3. Owens F J , "Signal Processing of Speech", Macmillan, 1993.
4. Yiteng Huang , "Handbook of Speech Processing", Springer, 2007.

## 19R022 SIGNAL PROCESSING

**3 0 0 3**

**INTRODUCTION TO SIGNALS AND SYSTEMS** : Elementary signals in continuous and discrete time - graphical and mathematical representation - Elementary operations and classification of continuous and discrete time signals - CT systems and DT systems - Properties of CT systems and DT systems - Classification of systems (9)

**ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS** : The continuous time Fourier series - Fourier Transform properties - Laplace transform and properties - Impulse response - convolution integrals - Fourier and Laplace transforms in Analysis of CT systems - Frequency response of systems characterized by differential Equations (9)

**ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS** : Fourier Transform of discrete time signals (DTFT) Properties of DTFT - Discrete Fourier Transform - Fast Fourier Transform (FFT) - Z Transform and Properties - Impulse response - Convolution sum - System analysis from difference equation model - Stability of systems (9)

**DESIGN OF DIGITAL FILTERS** : Review of design techniques for analog low pass filters - Frequency transformation - IIR filters - Properties - Design of IIR digital filters using bilinear transformation - FIR filters - Characteristics of FIR filters with linear phase - Design of FIR filters using Window functions. (10)

**DIGITAL SIGNAL PROCESSORS AND APPLICATIONS** : Architecture of TMS320C54xx DSP - Addressing Modes - Instructions and Programming - Applications: Signal Compression - Sine wave generators - Noise generators - DTMF Tone Detection - Echo cancellation - Speech enhancement and recognition (8)

**Total L: 45**

**TEXT BOOKS:**

1. Alan V Oppenheim, Alan S Willsky, Hamid Nawab S , "Signals and Systems", PHI Learning, New Delhi, 2013.
2. John G. Proakis, Dimitris K Manolakis , "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Education, New Delhi, 2013.

**REFERENCES:**

1. Lonnie C Ludeman , "Fundamentals of Digital Signal Processing", Wiley & Sons, New Delhi, 2014.
2. Emmanuel C Ifeachor, Barrie W Jervis , "Digital Signal Processing", Pearson Education, New Delhi, 2013.
3. Haykin S, Barry Van Veen , "Signals and Systems", John Wiley and sons, New Delhi, 2002.
4. Vinay K Ingle, John G Proakis , "Digital Signal Processing using MATLAB", Cengage Learning, New Delhi, 2012.

## 19R023 EMBEDDED PROCESSORS

**3 0 0 3**

**MSP430 MICROCONTROLLER** : Introduction to MSP 430 - Functional Block Diagram –Memory - Architecture: Central Processing Unit - Addressing Modes - Instruction set - Clock System, low power modes, Watchdog - Peripherals :Parallel Ports Timer - PWM control - ADC and Comparator - Communication Peripherals, Variants of the MSP430 family viz. MSP430x2x, MSP430x4x, MSP430x5x (9)

**ARM PROCESSOR** : ARM Design Philosophy, Registers, Program Status Register - Instruction Pipeline – Interrupts and Vector Table - ARM7, ARM9 and ARM11 features - advantages and suitability in embedded application - ARM7 data flow model, programmer's model - modes of operations -Instruction set (9)

**ARM7 BASED MICROCONTROLLER AND INTERFACING** : ARM7 Based Microcontroller LPC2148: Features - Architecture - System Control Block - Memory Map - GPIO - Pin Connect Block - timer - interfacing with LED,LCD,KEYPAD - Interfacing the peripherals to LPC2148 - GSM and GPS using UART - on-chip ADC using interrupt - EEPROM using I2C - SDCARD interface using SPI - on-chip DAC for waveform generation. (9)

**ARM CORTEX – M4** : ARM Cortex-M4 Processor Core overview - Programmers Model - Memory Model - Exception and Fault Handling - Power Management - Instruction Set Summary - CMSIS Functions - Hardware-Software Synchronization - Interrupt Synchronization - Multithreading - Register Map - System Timer - Nested Vectored Interrupt Controller - Floating Point Unit (FPU - Optional Memory Protection Unit (9)

**PERIPHERALS OF ARM CORTEX – M4 CONTROLLER** : Cortex-M4 Peripherals - Parallel I/O Ports - Timer Interfacing - Pulse Width Modulation - Frequency Measurement - Binary Actuators - Integral Control of a DC Motor - DAC - ADC - Serial Communication Protocols. (9)

**Total L: 45**

**TEXT BOOKS:**

1. John H. Davies , "MSP430 Microcontroller Basics", 1<sup>st</sup> Edition, Newnes, 2010.
2. Steve Furber , "ARM System-on-Chip Architecture", Pearson Education, 2009.

**REFERENCES:**

1. Steven F.Barret, Daniel J Pack , "Microcontroller Programming and Interfacing: Texas Instruments MSP430", Morgan & Claypool, .
2. J. W. Valvano , "Embedded Systems: Introduction to ARM Cortex -M Microcontrollers", 4<sup>th</sup> Edition, 2013.
3. J. W. Valvano , "Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontroller", 4<sup>th</sup> Edition, 2014.
4. Andrew Sloss , "ARM System Developer's Guide", Morgan Kaufmann, 2009.



## 19R024 ADVANCED MICROPROCESSORS AND MICROCONTROLLERS

3 0 0 3

**AVR MICROCONTROLLER** : Overview of AVR family - AVR Microcontroller architecture - Register - Stack Pointer - Atmel ATmega32 Memory Organization Program and Data Addressing Modes - Instruction Set - Hardware pin configuration - Simple Programming in Assembly and C. (9)

**AVR ON-CHIP PERIPHERALS** : I/O Ports - Timer/ Counter Features - Analog to Digital Converter - Analog Comparator - Serial Communication: SPI - USART - TWI - Interrupts: Reset and Interrupt Handling – Power Management and Sleep Modes. (10)

**APPLICATIONS** : LCD and Keyboard Interfacing - Temperature sensor interfacing - Interfacing of Stepper Motor and DC motor. (9)

**ARM PROCESSORS** : ARM Programmer's Model - Registers - Processor Modes - State of the processor - Condition Flags - ARM Pipelines - Exception Vector Table - ARM Processor Families - Typical 3 stage pipelined ARM organization - Introduction to ARM Memory Management Unit. (9)

**ARM INSTRUCTION SET** : ARM Addressing Modes - ARM Instruction Set Overview - Thumb Instruction Set Overview - Typical ARM Processor Features. (8)

**Total L: 45**

### TEXT BOOKS:

1. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, "The AVR Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2009.
2. Andrew Sloss, "ARM System Developer's Guide", Morgan Kaufmann Publishers, 2005.

### REFERENCES:

1. Steven F Barret, Daniel J Pack, "Atmel AVR Microcontroller Primer Programming and Interfacing", The Morgan & Claypool Publishers series, 2008.
2. Dhananjay V Gadre, "Programming and Customizing the AVR Microcontroller", McGraw Hill Education, 2003.
3. Timothy S. Margush, "Some Assembly Required Assembly Language Programming with the AVR Microcontroller", CRC Press, 2012.
4. Steve Furber, "ARM System-on-Chip Architecture", Pearson Education, 2005.

## 19R030 INTERNET OF THINGS

3 0 0 3

**GENESIS OF IOT** : Things in IoT - Sensors- Actuators- Smart Objects, Sensor Networks, - Communication criteria for connecting Smart Objects - Communication models and APIs - IoT levels and Deployment templates – IoT Challenges, Emerging IoT flavours (8)

**IOT ARCHITECTURES AND PROTOCOLS** : A Simplified IoT Architecture - Core IoT Functional Stack - Architecture for IoT using mobile technologies - Mobile Technologies for Supporting IoT Ecosystem - Low Power Wide Area Networking Technologies - Infrastructure and Service Discovery protocols - Device Integration protocols (9)

**IOT PLATFORMS AND PROGRAMMING** : Embedded computing basics — Microcontroller, - System on Chips — Arduino, pcDuino, Beagle Bone Black, CubieBoard, Electric Imp - Raspberry Pi- About the Board - Raspberry Pi Interfaces - Programming Raspberry Pi with Python - Developing code for writing to Actuators, Blinking Led, Reading from Sensors, Light Switch - Frameworks - Data standards - IoT information Security – Challenges (10)

**DATA ANALYTICS AND CLOUD** : An Introduction to Data Analytics for IoT - Role of Machine Learning - Big Data Analytics Tools and Technology - Edge Streaming Analytics and Network Analytics - Cloud technology, IoT and cloud inspired smarter environments - special purpose clouds - Case studies : Smart and Connected Cities, Healthcare, Agriculture (10)

**INDUSTRIAL IOT AND SECURITY** : Introduction to Industrial IoT - Understanding the Industrial IoT Process - Industrial Data Flow and Devices - Security management of an IoT ecosystem - Case studies : manufacturing- oil and gas- Power utility industry (8)

**Total L: 45**

### TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madiseti, "Internet of Things: A Hands-on Approach", Universities press, 2014.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, 2017.

### REFERENCES:

1. Pethuru Raj, Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC, 2017.

2. Giacomo Veneri, Antonio Capasso , "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt, 2018.
3. Olivier Hersent, David Boswarthick , "The Internet of Things – Key applications and Protocols", John Wiley and sons, UK, 2015.
4. Ovidiu Vermesan, Peter Friess , "Internet of Things-Converging Technologies for Smart Environments and Integrated Ecosystems", River, Denmark, 2013.

## 19R031 COMPUTER ARCHITECTURE

**3 0 0 3**

**INTRODUCTION** : Register transfer language-register - bus and memory transfers - Arithmetic - logic and shift micro operations (4)

**BASIC COMPUTER ORGANISATION** : Instruction codes - Instructions - Timing and Control - Instruction Cycle - Fetch and Decode - Execution - Memory Reference instructions - Input/ Output and Interrupt (7)

**CENTRAL PROCESSOR ORGANISATION** : General register organization - Stack organization - Instruction formats - Addressing modes - Data transfer and manipulation - Program control - Control memory - Address sequencer - Data path structure - CISC characteristics - RISC Characteristics - RISC pipeline (9)

**ARITHMETIC PROCESSING** : Introduction - Addition - Subtraction - Multiplication and Division algorithms – Floating point Arithmetic operations (9)

**MEMORY AND INPUT/OUTPUT ORGANISATION** : Basic concepts - Memory Hierarchy - Main memory - Auxiliary memory - Associative memory - Basic principle of Cache and Virtual memory - Input - Output interface - Modes of transfer (8)

**PIPELINE AND VECTOR PROCESSING** : Parallel Processing - Pipelining - RISC Pipelining - Vector Processing (8)

**Total L: 45**

### TEXT BOOKS:

1. Morris Mano M, "Computer System Architecture", Pearson Education, 2009.
2. Carl Hamacher V, Vranesic Z G, Zaky S G , "Computer Organization", McGraw Hill, New York, 2002.

### REFERENCES:

1. Kai Hwang, Briggs F A, "Computer Architecture and Parallel Processing", McGraw Hill, New York, 1985.
2. David A Patterson and John L Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 5<sup>th</sup> Edition, Morgan Kaufmann, 2014.
3. John P.Hayes , "Computer Architecture and Organization", 3<sup>rd</sup> Edition, McGraw Hill, 2017.
4. NICHOLAS P CARTER, Raj Kamal , "Computer Architecture and Organisation", 2<sup>nd</sup> Edition, McGraw Hill, .

## 19R032 EMBEDDED AND REAL-TIME SYSTEMS

**3 0 0 3**

**INTRODUCTION** : Functional building block - Characteristics - Challenges in embedded system design - Embedded system design processes (7)

**ARCHITECTURE** : Computer Architecture Taxonomy - CPUs –Input and Output Interface Structure - Memory System mechanisms - Memory devices - I/O devices: Timers and Counters - ADC and DAC (9)

**PERIPHERALS AND COMMUNICATION** : Interfacing of Key board – LED - Multiplexed LED Displays – LCD – Serial buses:USART—SPI-I<sup>2</sup>C-CAN (10)

**SOFTWARE ARCHITECTURES** : RoundRobin methods — RTOS: Introduction - Tasks and Processes – Context switching - Scheduling policies - Interprocess communication mechanisms (10)

**DEVELOPMENT AND CASE STUDIES** : Tools: Assembler and Compilers - Program Optimization — SW and HW Debugging and Testing - Case Studies: Touch screen - Cell phones - Digital Still Cameras (9)

**Total L: 45**

### TEXT BOOKS:

1. Wayne Wolf, "Computers as Components: Principles of Embedded Computer Systems Design", Morgan Kaufmann, 2008.
2. David E Simon, "An Embedded software primer", Pearson Education India, New Delhi, 2004.

### REFERENCES:

1. Kai Qian, David den Haring, Li Cao , "Embedded Software Development with C", Springer, 2009.
2. John Catsoulis , "Designing Embedded Hardware", O'Reilly, 2005.
3. Jean J Labrosse , "Embedded Systems Building Blocks", 2<sup>nd</sup> Edition, Elsevier/BSP Books, 2010.
4. Xiacong Fan, "Real-Time Embedded Systems: Design Principles and Engineering Practices", 1<sup>st</sup> Edition, Newnes, 2015.

## 19R033 BIG DATA ANALYTICS

3 0 0 3

**BIG DATA** : Big Data Overview, Evolution of Big Data, Definition of Big Data, Challenges with Big Data - State of practice in Analytics - Big data analytics in industry verticals - Data Analytics Lifecycle: Discovery — Data Preparation — Model Planning — Model Building — Communicating Results — Deployment (8)

**DATA ANALYTICS** : Theory and Methods - Supervised learning: Linear/Logistic regression, Decision Trees, Naïve Bayes - Unsupervised Learning: K-means clustering, Association Rules (10)

**BIG DATA TECHNOLOGY AND TOOLS** : Hadoop - Component of hadoop - Analysing Data with Hadoop - HDFS - MapReduce: MapReduce Programming model, Developing a Map Reduce Application - Data processing operators in Pig - Hive services - Fundamentals of HBase and ZooKeeper (10)

**STREAM COMPUTING** : Introduction to Streams Concepts - Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream - Filtering Streams — Counting Distinct Elements in a Stream - Estimating Moments - Counting Oneness in a Window — Decaying Window - Real time Analytics Platform (RTAP) Applications (9)

**DATA MANAGEMENT AND VISUALIZATION** : NoSQL data management for big data - Schema-less model - Aggregate Data Models - Graph analytics for big data - Visualization Techniques (8)

**Total L: 45**

### TEXT BOOKS:

1. EMC Education Services , "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley and sons, New Delhi, 2015.
2. Tom White , "Hadoop: The Definitive Guide", O'Reilly Publishers, USA, 2015.

### REFERENCES:

1. David Loshin , "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/Elsevier Publishers, 2013.
2. Bill Franks , "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley and sons, 2012.
3. Bart Baesens , "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley, USA, 2014.
4. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos , "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill, 2012.

## 19R034 SOFTWARE PROJECT MANAGEMENT AND QUALITY ASSURANCE

3 0 0 3

**INTRODUCTION TO SOFTWARE PROJECT MANAGEMENT** : The Management Spectrum - The People - The Product - The Process - The Project - The W5HH Principle - Importance of software projects — Problems with software projects (8)

**PROJECT PLANNING AND ESTIMATION** : Steps in project planning, Software Scope and Feasibility - Decomposition Techniques - Project estimates - Preparation of Estimates - COCOMO model - Function Point Analysis - Cost estimation techniques – Resource Estimation techniques (9)

**PROJECT SCHEDULING AND RISK MANAGEMENT** : Project schedules - Sequencing and scheduling projects - Network Planning models - Shortening project duration - Nature and categories of risk - Risk Identification – Risk Projection - Risk Refinement - Risk Mitigation - Monitoring — Management. (10)

**MANAGING CONTRACTS AND PEOPLE** : Types of Contracts - Stages in Contract Placement - Typical Terms of a Contract - Contract Management - Acceptance - Managing People: Understanding Behavior - Organizational behavior: Selecting the Right Person for the Job - Motivation - Working in the Groups - Becoming a Team. Decision Making - Leadership - Organizational Structures. (9)

**SOFTWARE QUALITY ASSURANCE AND CONFIGURATION MANAGEMENT** : The main Characteristics of SQA environment, Software Quality concepts and definitions, - causes of software Errors - Statistical process control, Pareto analysis, Causal analysis, - Quality standards: ISO 9000, Capability Maturity Model, Quality audit - Configuration Management - Configuration management process, Software configuration items - Version control, change control, Configuration audit, Status reporting (9)

**Total L: 45**

### TEXT BOOKS:

1. Mike Cotterel, Bob Hughes , "Software Project Management", Tata McGraw Hill, 2010.
2. Nina S Godbole , "Software Quality Assurance : Principles and Practice", Alpha Science International Ltd, 2016.

## REFERENCES:

1. Robert K Wysocki, Robert Beck Jr, David B Crane , "Effective Project Management, Traditional, Agile, Extreme", John Wiley and sons, 2011.
2. Gopaldaswamy Ramesh , "Managing Global Software Projects", Tata McGraw Hill Education, 2003.
3. Ashfaq Ahmed , "Software Project Management – A Process driven approach", CRC Press, 2012.
4. Milind Limaye , "Software Quality Assurance", Tata McGraw Hill, New Delhi, 2011.

## 19R035 NEURAL NETWORKS AND FUZZY SYSTEMS

3 0 0 3

**INTRODUCTION TO NEURAL NETWORKS** : Differences between Biological and Artificial Neural Networks - Typical Architecture - Common Activation Functions - McCulloch - Pitts Neuron - Case study: Modeling the Perception of Hot and Cold - Simple Neural Nets for Pattern Classification - Linear Separability - Hebb Net - Perceptron - Architecture - algorithm - Case study: Character Recognition (9)

**PATTERN ASSOCIATION** : Training Algorithms for Pattern Association - Hebb rule and Delta rule - Heteroassociative - Autoassociative and Iterative Auto associative Net - Bidirectional Associative Memory - Architecture - Algorithm - and Simple Applications - Case study: Character Recognition (9)

**COMPETITION AND BACKPROPAGATION NEURAL NETWORKS** : Kohonen Self Organising Maps - Architecture - Algorithm and Applications - Standard Backpropagation Architecture - Architecture of Boltzmann Machine Learning (9)

**SETS AND RELATIONS** : Properties and Operations on Classical and Fuzzy Sets - Crisp and Fuzzy Relations Cardinality - Properties and Operations - Composition - Tolerance and Equivalence Relations - Simple Problems (6)

**MEMBERSHIP FUNCTIONS** : Features of membership function - various forms - fuzzification - Defuzzification to crisp sets - Lambda Cuts for fuzzy relations Defuzzification to scalars (7)

**APPLICATIONS** : Neural Networks: Robotics - Image compression - Control systems - Fuzzy Logic: Mobile robot navigation - Autotuning a PID Controller (5)

Total L: 45

## TEXT BOOKS:

1. Laurene Fausett , "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", Pearson Education, 2004.
2. Timothy Ross , "Fuzzy Logic with Engineering Applications", Mc Graw Hill, 2002.

## REFERENCES:

1. Sivanandam S N, Sumathi S, Deepa S N , " Introduction to Neural Networks using Matlab 6.0," , New Delhi, 2006.
2. Nikola K. Kasabov , "Foundations of neural networks, fuzzy systems, and knowledge engineering", Marcel Alencar, 1996.
3. Laxmidhar Behera, Indrani Kar , "Intelligent Systems and Control: Principles and Applications", OUP India, 2009.
4. Bart Kosko , "Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence", Prentice-Hall International, 1992.

## 19R036 INTERNET TOOLS AND JAVA PROGRAMMING

3 0 0 3

**INTERNET SERVICES AND PROTOCOLS** : Fundamentals - Internet Addresses - File Transfer Protocol (FTP) – HTTP - HTTPS - SMTP- DNS - Net Telephony - Internet Relay Chat - Newsgroups - Remote Login - Telnet - UDP – TCP (6)

**OBJECT ORIENTED CONCEPTS** : Introduction - Data Types - Operators - Declarations - Control Structures - Arrays and Strings - Input/Output-Java Classes - Fundamentals - Methods - Constructors - Scope rules - this keyword - object based Vs oriented programming- Inheritance-Reusability - Composing class - Abstract classes – Abstract Functions - Method Overloading and Method Overriding- Wrapper Classes. (9)

**PACKAGES, INTERFACES AND MULTITHREADING** : Packages - Access protection - Importing packages - Interface - Defining and Implementing Interface - Applying Interface - Variables in Interfaces. - Multi Threaded Programming: Java thread model - Priorities - Synchronization - Messaging - Thread class and runnable Interface – Interthread Communication (9)

**INPUT/OUTPUT AND USER INTERFACE** : Stream classes — Byte Streams — Character Streams — Serialization - AWT-Swing classes - Components - Labels, Buttons, Check Boxes, combo box- Controls Menus – Frames – Event delegation model –listener and listener methods –Event classes- Applets. (9)

**EXCEPTION HANDLING AND DATABASE CONNECTIVITY** : JaException types - Uncaught Exception - Using Try and Catch - Multiple catch clauses - Nested Try statements - Throw - Throws - Java Built-in Exception - Creating user defined exceptions - JDBC AND SOCKET: Java Database Connectivity: Driver loading, Connection establishment — Query execution—Resultset—Sockets (12)

Total L: 45

**TEXT BOOKS:**

1. Patrick Naughton, Herbert Schildt , "Java 2 - The Complete Reference", McGraw Hill, New Delhi, 2015.
2. James K L , "The Internet: A Users Guide", Prentice Hall of India, New Delhi, 2003.

**REFERENCES:**

1. Deitel and Deitel , "JAVA - How to Program", Prentice Hall International, 2013.
2. Cay S Horstmann, Gary Cornell , "Core Java", Pearson Education, 2013.
3. Walter Slavic , "Absolute Java", Pearson Education, 2013.
4. Reese G , "Database Programming with JDBC and Java", O'Reilly Publications, 2000.

**19R037 MACHINE LEARNING FOR ROBOTICS****3 0 0 3**

**PROBABILISTIC MODELS** : Introduction to Machine learning - Varieties of Machine learning - Types of learning - Vector and Matrix Notations - Probability theory: Random Numbers and their Probability density Functions - Multinomial, Bernoulli, Uniform, Normal and Chi-square distribution, Density Function of multiple random numbers - Bayes Rule - Probabilistic sensor and motion models (11)

**SUPERVISED LEARNING** : Regression, Minimization of cost function and Gradient Descent - Classification: Logistic Regression - Discriminant Analysis - Bias-Variance tradeoff - Cross-validation — Learning curves – Bayesian Networks: Markov Chains and Bayes Filters - Obstacle Avoidance in a mobile robot (11)

**GENERAL LEARNING MACHINES** : Perceptron - Network Representation - Feed-forward Networks, Back propagation - Support Vector Machine: Non linear Margin classifier - Kernel function - Introduction to Convolutional Networks and Deep Learning (10)

**UNSUPERVISED LEARNING** : K-means Clustering - Expectation Maximization Algorithm - Dimensionality Reduction - Principal Component Analysis - Restricted Boltzmann Machine - Sparse Representation - Navigation and Path Planning of a mobile robot (8)

**REINFORCEMENT LEARNING** : Markov Decision Process - Temporal Difference Learning - Function Approximation (5)

**Total L: 45****TEXT BOOKS:**

1. Kevin P. Murphy , "Machine Learning – A Probabilistic Perspective", The MIT Press, 2010.
2. Ethem Alpaydin , "Introduction to Machine Learning", The MIT Press, 2004.

**REFERENCES:**

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman , "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer, 2010.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville , "Deep Learning", MIT Press, 2012.
3. Tom M Mitchell , "Machine Learning", Mc Graw Hill, 2017.
4. Gilbert Strang , "Linear Algebra and Learning from data", 2019.

**19R040 LEAN MANUFACTURING****3 0 0 3**

**INTRODUCTION** : Origins and OUTCOME of lean manufacturing — lean process, 3M - concept key principles and implications of lean manufacturing — traditional Vs lean manufacturing characteristics—roadmap for lean implementation and lean benefits - study of Ford and Toyota production systems - JIT manufacturing, Lean building blocks (9)

**LEAN MANUFACTURING CONCEPTS** : Value creation and waste elimination — seven types of waste — pull production-different models of pull production -the Kanban system-continuous flow-the continuous improvement process / Kaizen-Worker involvement, Design of Kanban quantities — Leveled production - tools for continuous improvement (9)

**VALUE STREAM MAPPING** : The value stream– benefits mapping process - the current state map–mapping icons mapping steps, VSM exercises - Takttime calculations (9)

**LEAN MANUFACTURING TOOLS AND METHODOLOGIES** : Standardized work–standard work sequence timing and working progress, Quality at source — Autonomation /Jidoka, Visual management system, Mistake proofing / Poke- Yoke, 5S technique — Elements and waste elimination through 5S, advantages and benefits — KANBAN – KAIZEN (9)

**TOTAL PRODUCTIVE MAINTENANCE** : Goals and benefits — Hidden factory, the six big losses, types of maintenance, Overall equipment effectiveness - pillars of TPM and implementation, Change over and setup time reduction techniques, Temple of quality, OEE calculations (9)

**Total L: 45**

**TEXT BOOKS:**

1. Micheal Wader, "Lean Tools: A Pocket guide to Implementing Lean Practices", Productivity and Quality Publishing, 2002.
2. William M Feld , "Lean Manufacturing: Tools, Techniques and How to use them", APICS, 2001.

**REFERENCES:**

1. Richard B Chase, "Production and Operations Management", McGraw-Hill, 2003.
2. Taiichi Ohno , "Toyota Production Systems: Beyond Large Scale Production", Productivity Press, 1988.
3. Askin R G , Goldberg J B , "Design and Analysis of Lean Production Systems", John Wiley and Sons, 2003.
4. Mahadevan B , "Operations Management", Pearson, 2010.

## **19R041 SUPPLY CHAIN MANAGEMENT**

**3 0 0 3**

**INTRODUCTION TO SUPPLY CHAIN MANAGEMENT** : Definition - global optimization - OUTCOME of SCM. Logistics networks- data collection - model and data evaluation - solution techniques. (7)

**INVENTORY MANAGEMENT** : Introduction - single warehouse - Inventory examples - economic lot size model - effect of demand uncertainty, Risk pooling - centralized and decentralized system - managing inventory in the supply chain - forecasting. (8)

**VALUE OF INFORMATION** : Bullwhip effect - information and supply chain technology, Supply chain integration- push - pull and push-pull system. Demand driven strategies - impact of internet on SCM - distributionstrategies (8)

**STRATEGIC ALLIANCES** : Framework for strategic alliance - third party logistics - retailer - supplies partnership - distributor- integration - procurement and out servicing strategies. (8)

**INTERNATIONAL ISSUES IN SCM** : Introduction - risks and advantages- design for logistics - supplies integration into to new product development - mass customization, Issues in customer value. (7)

**INFORMATION TECHNOLOGY FOR SCM** : Goals - standardization - infrastructure - DSS for supply chain management. (7)

**Total L: 45**

**TEXT BOOKS:**

1. Simchi – Levi Davi, Kaminsky Philip , Simchi-Levi Edith , "Designing and Managing the Supply Chain", Tata M.Graw- Hill, 2003.
2. Sahay B S , "Supply Chain Management", Macmillan, 2000.

**REFERENCES:**

1. Chopra S , Meindl P , "Supply Chain Management: Strategy, Planning, and Operation", Prentice Hall India, 2007.
2. David Brunt , David Taylor , "Manufacturing Operations and Supply Chain Management: The Lean Approach", Vikas Publishing House, 2001.
3. Hartmud Stadler , Christoph Kilger , "Supply Chain Management and Advanced Planning: Concepts, Models, Software", Springer-Verlag, 2000.
4. David F Ross , "Introduction to E-Supply Chain Management", CRC Press, 2003.

## **19R042 PROCESS PLANNING AND COST ESTIMATION**

**3 0 0 3**

**INTRODUCTION TO PROCESS PLANNING** : Introduction- methods of process planning-Drawing interpretation- Material evaluation — steps in process selection-Production equipment and tooling selection (10)

**PROCESS PLANNING ACTIVITIES** : Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set o f documents for process planning-Economics of process planning-case studies (10)

**INTRODUCTION TO COST ESTIMATION** : Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates — Estimating procedure- Estimation labor cost, material cost allocation of over head charges- Calculation of depreciation cost (8)

**PRODUCTION COST ESTIMATION** : Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop (8)

**MACHINING TIME CALCULATION** : Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding (9)

**Total L: 45**

**TEXT BOOKS:**

1. Peter scalon , "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.
2. Kesavon R , "Process Planning and Cost Estimation", New Age International, Chennai, 2005.

**REFERENCES:**

1. Ostwalal P F, Munez J , "Manufacturing Processes and systems", 9<sup>th</sup> Edition, John Wiley, 1998.
2. Russell R S, Tailor B.W , "Operations Management", 4<sup>th</sup> Edition, PHI, 2003.
3. Chitale A.V, Gupta R.C , "Product Design and Manufacturing", 2<sup>nd</sup> Edition, PHI, 2002.
4. Ken Hurst , "Engineering Design Principles", Elsevier Science and Technology Books, 2006.

**19R043 MAINTENANCE AND SAFETY ENGINEERING****3 0 0 3**

**MAINTENANCE** : Types - breakdown - preventive - predictive - TPM, elements of preventive maintenance - checklist schedule - procedure. (6)

**TOTAL PRODUCTIVE MAINTENANCE** : Principles, preparatory stages of implementation - T P M organization structure - creation, basic TPM policies and aids - master plan. (6)

**TPM IMPLEMENTATION** : Small group activities - autonomous maintenance - establishing planned maintenance - training - developing equipment management program. (6)

**SAFETY SYSTEMS ANALYSIS** : Definitions - safety systems, safety information system: basic concept - safety cost benefit analysis, industrial safety engineering - OSHA regulations. (6)

**HAZARD ANALYSIS** : General hazard analysis: electrical - physical and chemical hazard - detailed hazard analysis, Cost effectiveness in hazard elimination, Logical analysis: map method - tabular method - fault tree analysis and hazop studies. (5)

**FIRE PROTECTION SYSTEM** : Chemistry of fire - water sprinkler - fire hydrant - alarm and detection system, Suppression system: CO2 system - foam system - Dry Chemical Powder (DCP) system - halon system – portable extinguisher. (6)

**SAFETY IN MACHINE OPERATION** : Design for safety - lock out system - work permit system - safety in use of power press - cranes, Safety in foundry - forging - welding - hot working and cold working - electroplating and boiler operation. (5)

**SAFETY AND LAW** : Provisions in factory act for safety - explosive act - workmen compensation act – compensation calculation, Boiler act and pollution control act. (5)

**Total L: 45****TEXT BOOKS:**

- 1 John Ridley , "Safety at Work", Butter Worth Publisher, 1997.
- 2 Robinson C J , Ginder A P , "Implementing TPM", Productivity Press, 1995.

**REFERENCES:**

- 1 Dhillon B S , "Maintainability, Maintenance and Reliability for Engineers", CRC Press, 2006.
- 2 Heinrich H W , "Industrial Accident Prevention", National Safety Council, 1998.
- 3 , "Personal Protective Equipment", National Safety Council, 1998.
- 4 , "Accident Prevention Manual for Industrial Operations", National Safety Council, 1995.

**19R044 INDUSTRIAL DESIGN AND APPLIED ERGONOMICS****3 0 0 3**

**INTRODUCTION TO HUMAN FACTORS ENGINEERING** : Definition - human technological system - multidisciplinary engineering approach - human - machine system - manual - mechanical - automated system - human system reliability conceptual design - advanced development - detailed design and development. (8)

**INFORMATION INPUT** : Input and processing - text - graphics - symbols - codes - visual display of dynamic information - auditory - tactual - olfactory displays - speech communications. (8)

**HUMAN OUTPUT AND CONTROL** : Physical work - manual material handling - motor skill - human control of systems - controls and data entry devices - hand tools and devices. (8)

**WORKPLACE DESIGN** : Applied anthropometry - workspace design and seating - arrangement of components within a physical space - interpersonal aspects of work place design - design of repetitive task - design of manual handling task - work capacity - stress -and fatigue. (8)

**ENVIRONMENTAL CONDITIONS** : Illumination - climate - noise - motion - sound - vibration - colour and aesthetic concepts. (8)

**HUMAN FACTORS APPLICATIONS** : Human error - accidents - human factors and the automobile – organizational and social aspects - steps according to ISO/DIS6385 - OSHA's approach - virtual environments. (5)

**Total L: 45**

**TEXT BOOKS:**

- 1 Chandler Allen Phillips, "Human Factors Engineering", John Wiley and Sons, 2000.
- 2 Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, 1993.

**REFERENCES:**

- 1 Bridger R S , "Introduction to Ergonomics", Taylor and Francis, 2003.
- 2 Mayall W H , "Industrial Design for Engineers", London ILIFFE Books Ltd., 1998.
- 3 Martin Helander , "A Guide to Human Factors and Ergonomics", 2<sup>nd</sup> Edition, CRC Press, 2005.
- 4 Mark Lehto, Steven J. Landry , "Introduction to Human Factors and Ergonomics for Engineers", 2<sup>nd</sup> Edition, CRC Press, 2012.

## **19R045 PRODUCT DESIGN AND DEVELOPMENT**

**3 0 0 3**

**INTRODUCTION** : Product Development – Characteristics, Duration, Challenges, Organizations, Development Process — Processes, Process Flow, Product Planning — Identifying Opportunities, Prioritization, Resource allocation and Pre-Project Planning, Customer Needs — Data gathering, Organizing Needs (8)

**CONCEPT DEVELOPMENT** : Product and Target specification, various steps in concept generation, Brainstorming, Morphological analysis, Selection of Concepts — Subjective decision-making, Criteria ranking, Criteria weighting, Datum method, EVAD (Design Evaluation) method, Principles of Computer aided decision making (8)

**DESIGN PROCESS** : Design models — Shighely, Paul and Beitz, Ohsuga and Earle models, Concept Testing — Survey, Response and Interpretation, Product Architecture, Platform planning, System level design issues, Embodiment design - Introduction, Size and strength, Scheme drawing, Form design, Provisional material and process determination, Design for assembly and manufacture, Industrial design. (12)

**PLANNING FOR MANUFACTURE AND MANAGEMENT** : Detail Design - Factor of safety, Selection procedure for bought out components, Material Selection, Robust design, Experimental Plan, Design Management - Management of design for quality, Project planning and control, Production design specification (PDS), Quality function deployment (QFD), Design review, Value analysis/engineering. (10)

**INTELLECTUAL PROPERTY RIGHTS AND PROJECT ECONOMICS** : Intellectual Property Rights — Introduction, Study prior inventions, Write the description of the invention, Refine Claims, Pursue application, Economics and Management – Financial Model, Project Trade – Off, Accelerating Projects, Project Execution. (7)

**Total L: 45**

**TEXT BOOKS:**

- 1 Dieter G E , "Engineering Design", McGraw – Hill, 2009.
- 2 T Karl, Ulrich and D Steven, Eppinger , "Product Design and Development", McGraw Hill, 2009.

**REFERENCES:**

- 1 Ken Hurst , "Engineering Design Principles", Elsevier Science and Technology Books, 2006.
- 2 E Deborah , Bouchoux , "Intellectual Property Rights", Cengage Learning, 2008.
- 3 Dobrivoje Popovic and Ljubo Vlacic , "Mechatronics in Engineering Design & Product Development", Marcel Dekker Inc, 1999.
- 4 Peter scalon , "Process planning, Design/Manufacture Interface", Elsevier science technology Books, 2002.

## **19R046 COMPUTER INTEGRATED MANUFACTURING**

**3 0 0 3**

**THE MEANING AND SCOPE OF CIM** : Introduction to CIM, definition of CIM, CIM wheel, evolution of CIM, benefits of CIM, Needs of CIM hardware, CIM software, Fundamentals of communications: Network topologies - the seven layers-OSI model, local area network (LAN), manufacturing automation protocol (MAP), CIM workstations. (7)

**PRODUCT DESIGN** : Needs of the market, design and engineering, the design process, computer-aided design (CAD), benefits of CAD, Geometric modeling: wire frame, Surface and solid modeling, Three-dimensional capabilities - principles of curve generation, representation of 3D surfaces, CAD/CAM workstations, Computer- aided engineering (CAE) - finite element technique. (12)

**PRODUCTION PLANNING** : Introduction, production planning and control –MRP I, MRP II and ERP History of Group Technology— role of G.T in CAD/CAM Integration — part families, classification and coding — DCLASS, MICLASS and OPTIZ coding systems –benefits of G.T – cellular manufacturing, Process planning - role of Process, planning in



CAD/CAM Integration — approaches to computer aided process planning — variant approach and generative approaches. (12)

**SHOP-FLOOR CONTROL** : Automated data collection methods, Flexible Manufacturing Systems – components of FMS— types — FMS workstation — FMS layout- computer control systems — Reconfigurable manufacturing systems applications and benefits. (7)

**MANAGEMENT OF CIM** : Role of management in CIM, cost justification, expert systems, participative management, Impact of CIM in industry, role of manufacturing engineers - CIM engineer and technologist, CIM technicians. (7)

**Total L: 45**

**TEXT BOOKS:**

- 1 Kant Vajpayee S , "Principles of Computer Integrated Manufacturing", PHI Learning Private Limited, New Delhi, 2010.
- 2 Mikell P Groover , "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 2016.

**REFERENCES:**

- 1 Mikell P Groover and Emory Zimmers Jr , "CAD/CAM", Prentice hall of India Pvt. Ltd, 1998.
- 2 Rao P N , "CAD/CAM Principles and Applications", Tata McGraw Hill Publications, 2007.
- 3 Radhakrishnan P, Subramanyam S and Raju V , "CAD/CAM/CIM", New Age International, 2008.
- 4 A.WilhelmScheer , "Computer Integrated Manufacturing:Towards the factory of the Future", Springer, Verlag Berlin Heidelberg, 1994.

## 19R047 ADDITIVE MANUFACTURING

**3 0 0 3**

**INTRODUCTION TO ADDITIVE MANUFACTURING** : Overview – History – Need-Classification -Additive Manufacturing Technology in Product Development-Materials for Additive Manufacturing Technology – Tooling – Applications (9)

**CAD AND REVERSE ENGINEERING** : Basic Concept — Digitization Techniques — Model Reconstruction — Data Processing for Additive Manufacturing Technology: CAD Model Preparation — Part Orientation and Support Generation — Model Slicing –Tool Path Generation — Softwares for Additive Manufacturing Technology: MIMICS, MAGICS. (9)

**LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS** : Classification — Liquid Based System — Stereo lithography Apparatus (SLA)- Principle, Process, Advantages and Applications — Solid Based System — Fused Deposition Modeling – Principle, Process, Advantages and Applications, Laminated Object Manufacturing (9)

**POWDER BASED ADDITIVE MANUFACTURING SYSTEMS** : Selective Laser Sintering – Principles of SLS Process – Process, Advantages and Applications, Three Dimensional Printing — Principle, Process, Advantages and Applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting. (9)

**MEDICAL AND BIO-ADDITIVE MANUFACTURING** : Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE)– Case studies (9)

**Total L: 45**

**TEXT BOOKS:**

- 1 Liou L.W. and Liou F.W , "Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development", CRC Press, 2007.
- 2 Ian Gibson, David W.Rosen, Brent Stucker , "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

**REFERENCES:**

- 1 Chua C.K, Leong K.F, Lim C.S , "Rapid Prototyping: Principles and Applications", 3<sup>rd</sup> Edition, World Scientific Publishers, 2010.
- 2 Kamrani A.K, Nasr E.A , "Rapid Prototyping: Theory and Practice", Springer, 2006.
- 3 Gebhardt A , "Rapid Prototyping", Hanser Gardener Publications, 2003.
- 4 Hilton P.D., Jacobs P.F , "RapidTooling: Technologies and Industrial Applications", CRC Press, 2000.

## ONE-CREDIT COURSES

### ROBOTICS AND AUTOMATION ENGINEERING

#### 19RF01 CAD TOOLS FOR INDUSTRIAL AUTOMATION

**1 0 0 1**

**COMPUTER-BASED SYSTEM ENGINEERING** : System engineering process, Software product development life cycle software processes, software development project management, software prototyping (5)

**EPLAN** : Familiarization of software, design of electrical power, control and signal circuits - Control panel layout, selection of components, routing of cables. Generating bill of materials (6)

**LAB SESSION** : 1. Creation of control panel Layout. 2. Creation of Automation Components layout. 3. Report creation and Generation of Bill of Materials (4)

**Total L: 15**

**REFERENCES:**

- 1 Department of Robotics and Automation Engineering, "CAD Lab Manual", 2015.
- 2 Department of Robotics and Automation Engineering, "EPlan Manual", 2018.

## **19RF02 DESIGN CONCEPTS AND REALIZATION**

**1 0 0 1**

**INTRODUCTION** : Design briefing or product brief statement, Product Design Specification (PDS) and constraints vs. limits. (2)

**SKILL SETS EVALUATION** : Sketching skills and other skill sets evaluation, Design. (1)

**CONCEPT DESIGN** : Definition, Concept design, Concept generation and evaluation (4)

**DETAILED DESIGN** : Design factors – manufacture, sales, purchase, cost, transport, and disposal (2)

**ERGONOMICS AND ANTHROPOMETRICS** : Overview (1)

**DESIGN PROCESS** : Material selection, Manufacture, Marketing and evaluation of the final design. (5)

**Total L: 15**

**REFERENCES:**

- 1 Mike Ashby, Kara Johnson, "Materials and Design: The Art and Science of Material Selection in Product Design", Butterworth Heinemann, 2009.
- 2 A K Chitale, R C Gupta, "Product Design and Manufacturing", Prentice Hall of India, 2009.
- 3 G K Lal, Vijay Gupta, N Venkata Reddy, "Fundamentals of Design and Manufacturing", Narosa Publishers, 2010.

## **19RF03 DYNAMIC MODELING SIMULATIONS AND CONTROL OF ROBOTS**

**1 0 0 1**

**INTRODUCTION TO ROBOT DYNAMICS AND KINEMATICS** : Forward Dynamics and Inverse Dynamics — Importance — Spatial description and transformations — Different types of dynamic formulation schemes — Lagrangian formulation for equation of motion for robots and manipulators. (5)

**DYNAMIC MODELING AND SIMULATION** : Modeling of motion of robots and manipulators using Newton — Euler equations — State space representation of equation of motion and system properties — Importance of Simulation and its types — Numeric Integration solvers and their role in numeric simulation - Numeric simulation of robots and manipulators using MATLAB/ Simulink module (5)

**INTRODUCTION TO ROBOT CONTROL** :Introduction—Need and types of control schemes for robots—joint space control schemes with an example — task space control schemes with an example (5)

**Total L: 15**

**REFERENCES:**

- 1 R Kelly, V Santibanez, A Loria, "Control of Robot Manipulators in Joint Space", Springer, 2005.
- 2 Devendra K Chaturvedi, "Modeling and Simulation of Systems Using MATLAB and Simulink", CRC Press, 2010.

## **19RF04 MODELING AND SIMULATION OF DYNAMIC SYSTEMS USING ADAMS**

**1 0 0 1**

**INTRODUCTION TO ADAMS** : Introduction — Importance — Model Hierarchy — Interface overview and functional blocks of Adams — creating and modifying parts — constraints and joints — force and motion to models. (2)

**KINEMATICS AND DYNAMICS MODELING** : Kinematic modeling and analysis of mechanical and robotic systems – Forward kinematics and inverse kinematics — Jacobian and velocity analysis — Dynamic/ Kinetic modeling and analysis of mechanical and robotic systems — Forward dynamics, statics and performance analysis. (6)

**KINEMATICS AND DYNAMICS CONTROLLING** : System control of mechanical / robotic systems using Adams — Inverse dynamics, regulatory control and tracking control (5)

**INTERFACING WITH OTHER PACKAGES** : Interfacing with other packages namely MATLAB, SIMULINK and Easy — Forward dynamic and inverse dynamic analysis of mechanical systems (2)

**Total L: 15**

**REFERENCE:**

- 1 Department of Robotics and Automation Engineering , "ADAMS Control Manual: Getting Started Using ADAMS/Controls", 2018.

## 19RF05 ROBOT OPERATING SYSTEMS

**1 0 0 1**

**INTRODUCTION TO ROS** : introduction - history - distributions - difference from other meta - operating systems -services - ROS framework - operating system – releases (2)

**INTRODUCTION TO LINUX COMMANDS** : UNIX commands - file system - redirection of input and output - File system security - Changing access rights - process commands - compiling, building and running commands -handling variables. (2)

**ARCHITECTUREOF OPERATING SYSTEM** : File system - packages - s tacks - messages - services – catkin workspace - working with catkin workspace - working with ROS navigation and listing commands (2)

**COMPUTATION GRAPH LEVEL** : Navigation through file system - Understanding of Nodes - topics - services - messages - bags - master - parameter server - interfacing of Sensors and Actuators (2)

**DEBUGGING AND VISUALIZATION** : Debugging of Nodes - topics - services - messages - bags - master parameter - visualization using Gazebo - Rviz - URDF modeling - Xacro - launch files. (2)

**APPLICATIONS** : Navigation stack - tf - sensors - odometer - imu - laser scan - base controller - robot configuration - cost map - base local planner - global planner - localization - sending goals - tele operation of robot using joystick and mapping (5)

**Total L: 15**

**REFERENCES:**

- 1 Aaron Martinez, Enrique Fernández , "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013.
- 2 Jason M O'Kane , "A Gentle Introduction to ROS", CreateSpace, 2013.

## 19RF06 COMPUTER VISION WITH OPENCV

**1 0 0 1**

**INTRODUCTION TO OPENCV** : Displaying a picture - playing a Video - Moving around - Simple Transformation - getting input and writing to AVI from camera - OpenCV Primitive Data Types - CvMat Matrix Structure - IplImage Data Structure - Matrix and Image Operators - Drawing Things (2)

**IMAGE PROCESSING AND TRANSFORMS** : Smoothing - Image Morphology - Flood Fill - Resize - Image Pyramids - Image Transforms: Convolution - Gradients and Sobel Derivatives - Laplace - Canny - Hough Transforms – Remap - Stretch - Shrink - Warp - and Rotate - Cart to Polar and Polar to Cart - Log Polar - DFT - DCT - Integral Images - Distance Transform - Histogram Equalization Threshold (4)

**CONTOURS, SEGMENTATION, TRACKING AND MOTION** : Parts and Segments - Background Subtraction - Watershed Algorithm Image Repair by Inpainting - The Basics of Tracking - Corner Finding - Subpixel Corners - Invariant Features - Optical Flow - Mean - Shift and Camshift Tracking (3)

**CAMERA CALIBRATION AND 3D VISION** : Camera Model - Calibration - Undistortion - Rodrigues Transform - Projection3D Pose Estimation - Stereo Imaging - Structure from Motion - Fitting Lines in Two and Three Dimensions (3)

**MACHINE LEARNING** : Introduction - Mahalanobis Distance - K-Means - Naïve/Normal Bayes Classifier – Binary Decision Trees - Face Detection or Haar Classifier - Other Machine Learning Algorithms (3)

**Total L: 15**

**REFERENCES:**

- 1 Jayneil Dalal & Sohil Patel , "Instant OpenCV Starter: Get Started With OpenCV Using Practical Hands-On Projects", 1<sup>st</sup> Edition, Shroff/Packt, 2013.

- 2 Daniel Lelis Baggio, Shervin Emami& et al. , "Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing Limited, 2012.

## 19RF07 UNDERWATER ROBOTICS

1 0 0 1

**INTRODUCTION** : Robotics in Water - Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics - Differentiating Aerial and Underwater Robotics - why it is called an perfect engineering product - Overview about Environmental Factors affecting object in water. (4)

**CONTROL SYSTEM AND MANIPULATOR** : Control System and Types of Control Systems in Underwater Robotics - Sensors Connected with the Underwater Robotics - Introduction to Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles. (5)

**AUTONOMOUS UNDERWATER SYSTEMS** : Introduction to AUVs - Development of AUVs, ROV in Market - Case Study on AUV Control System Basics - Case Study on Subsea Manipulator - Case Study on Technologies Used (4)

**SCOPE** : Research and Development - Market Analysis, Job Placement and Future Development (2)

**Total L: 15**

### REFERENCE:

- 1 Gianluca Antonelli , "Underwater Robots", Springer, 2014.

## 19RF08 DIGITAL TECHNOLOGY FOR AUTOMATION DRIVES

1 0 0 1

**INTRODUCTION** : Construction and Principle of operation of PMSM and SynRM - AC drive Hardware Blocks — Control Blocks - Automatic Motor Adaptation — Parameterization of Drives (Local and Remote) (3)

**CONFIGURATIONS OF DIFFERENT I/O CONTROL** : Digital Input and output — Analog Input and output Control-word access - Motion control - Sequential Logic Control (SLC) - Parameterization for different communication protocol: RS485 —MODBUS-PROFIBUS (5)

**CONFIGURATION FOR DIFFERENT APPLICATIONS** :AQUA– HVAC – Automation – Master/ Slave control (3)

**PRACTICAL** : Performance characterization of PMSM and SynRM - Conveyor control — Cascaded Pump Control - Synchronization of Drives with Master Slave Control (4)

**Total L: 15**

### REFERENCES:

- 1 Danfoss , "Programming Guide for FC Drives by Danfoss Industries Pvt. Ltd", 2018  
2 Danfoss , "Monograph prepared by PSG-Danfoss CoE for Climate and Energy.", 2018

## 19RF09 PC BASED INDUSTRIAL AUTOMATION

1 0 0 1

**INTRODUCTION** : PC based Automation: TwinCAT Introduction and Licensing - TC3 Workbench - Source Control - Project compare tool - System I/O Variable - ADS Setting-Global Data types - EtherCAT - Hardware Configuration - EPC and IPC - Introduction to Basic Components - Editors - Library Management - Visualization - Programming References -Library Creation (3)

**TC3 FUNCTIONS** : Measurement Control - Motion - Motion Axis Configuration - NC PTP - NCI - TwinCAT Kinematic transformation-Stepper Motor and Drive terminal Configuration - C/C++ Matlab/ LabVIEW/ Simulink - I/O -Safety PLC. (3)

**CONNECTIVITY** : Serial Communication - RS232, RS485/RS42 - MODBUS RTU, CANOpen, ProfiBus, DeviceNet - Database Server - SMS/SMTP - TCP/IP (3)

**BUILDING AUTOMATION** : Introduction - Hardware Requirements - BA PLC Libraries - HVAC - BACnet IP - EIB - TwinCAT Diagnostics (2)

**LAB SESSION** : TwinCAT Software and Hardware - NC PTP Programming - Motion Control programming with kinematic transformation - Communication programming - Building automation system integration (4)

**Total L: 15**

## REFERENCES:

- 1 Beckoff , "EtherCAT System Documentation Manual", 2018.
- 2 Joel Thomas Langill, Eric D.Knapp , "Industrial Network Security", 2<sup>nd</sup> Edition, Syngress, 2016.

## 19RF10 ROBOT SIMULATION USING OPEN SOURCE TOOLS

1 0 0 1

**V-REP** : Introduction - Need for V-REP - user interface - scenes and models - modeling of environment - entities: shapes - joints - dummies - sensors - lights – camera (3)

**V-REP CALCULATION MODULES** : Distance - collision - forward - inverse - path/motion - geometric constrain Solvers (2)

**V-REP SCRIPTS** : Main and child scripts - call back scripts - Simulation: Line following of differential wheeled mobile robot - Serial Manipulator – Hexapod (3)

**GAZEBO** : Introduction - Need for gazebo - Core concepts - elements within simulation: world - models - links - joints - sensors - visual objects - collision objects - plug-ins - Element Hierarchy and Types (3)

**GAZEBO ANIMATIONS AND DYNAMICS CONTROL** : Differential wheeled mobile robot modeling and controlling - Environment Modeling - ROS integration (4)

**Total L: 15**

## REFERENCES:

- 1 Department of Robotics and Automation Engineering, "V-REP user manual", <http://www.coppeliarobotics.com/assets/V-Repoverviewpresentation.pdf>.
- 2 Lentin Joseph , "Learning Robotics Using Python", Packt Publishing, May 2015.
- 3 AnisKoubaa , "Robot Operating System – The complete reference V1", Springer International Publishing, 2016.
- 4 AnisKoubaa , "Robot Operating System – The complete reference V2", Springer International Publishing, 2017.

## 19RF11 INTRODUCTION TO HAPTIC INTERFACE DESIGN

1 0 0 1

**INTRODUCTION** : Haptic Interfaces - definitions and types - Existing Haptic Systems and Applications (3)

**HUMAN HAPTICS** : Human haptic perception - Psychophysical tests and Haptic illusions - User perception and user performance (4)

**MACHINE HAPTICS** : Haptic device taxonomy - Design Considerations for Haptic systems - Tactile and kinesthetic haptic systems - Process of design and implementation of haptic interfaces - Synthesis of haptic control systems (4)

**COMPUTER HAPTICS** : Basic Haptic Algorithms - Virtual wall and Virtual cube (4)

**Total L: 15**

## TEXT BOOKS:

- 1 Christian Hatzfeld, Thorsten A. Kern , "Engineering Haptic Devices: A Beginner's Guide", , Springer-Verlag London, 2014.
- 2 Martin Grunwald , "Human Haptic Perception: Basics and Applications", , Springer-Verlag London, 2008.

## REFERENCES:

- 1 Ming C. Lin and Miguel Otaduy , "Haptic Rendering: Foundations, Algorithms, and Applications", CRC, 2008.
- 2 AEI Saddik A, Orozco M, Eid M. , "Haptics Technologies: Bringing Touch to Multimedia", Springer-Verlag Berlin Heidelberg, 2011.
- 3 Hiroyuki Kajimoto, Ki-Uk Kyung, Hideyuki Ando , "Haptic Interaction, perception, Devices and Applications", Springer, 2015.
- 4 Dangxiao Wang, Jing Xiao, Yuru Zhang , "Haptic Rendering for Simulation of Fine Manipulation", Springer, 2014.

## 19RF12 CODESYS PROGRAMMING

1 0 0 1

**INTRODUCTION** : Overview of CoDeSys, Overview on the user documentation for CoDeSys, Project components, languages and controls. (2)

**CONFIGURATIONS** : Variable configuration, PLC configuration, Task configuration, Work space, Parameter manager, Tools and operations. (5)

**CODESYS MOTION** : CNC — Development system, Visualization, Runtime, Fieldbus and structure of CNC motion (4)

**ROBOTICS** : Versatile motion planning, Robotics programming with kinematics, generic implementation of robotics applications and integration in the CoDeSys development system. (4)

**Total L: 15**

**REFERENCE:**

- 1 CoDeSys , "CoDeSys user manual – CNC and Robotic applications", 2018.

## 19RF13 OPEN PLC

**1 0 0 1**

**INTRODUCTION** : Introduction to PLC, Proprietary vs. OpenPLC - Various industrial PLC, Introduction to OpenPLC - OpenPLC- software, Hardware and Manufacturer compliance (1)

**INDUSTRIAL STANDARDS** : Overview of Industrial standards IEC, Various modulus of IEC, IEC Sec.1 - General information, IEC Sec.2- Equipment requirements and tests - IEC Sec.3- Programming languages, IEC Sec.4-User guidelines - IEC Sec.5- Communications, IEC Sec.6-Functional safety - IEC Sec.7- Fuzzy control programming, IEC Sec.8- Guidelines for the application and implementation of programming languages - IEC Sec.9- Single-drop digital communication interface for small sensors and actuators - IEC Sec.10- XML exchange formats for programs (2)

**PROGRAMMING USING IEC-61131-3** : Basics- Variables, Data types with structures and arrays, tasks, timing, I/O configuration, Functions, user define functions - IEC Programing- Ladder diagram, Function block diagram, Structured Text - Instruction List, Sequential Function Charts, (Basic Functions of IEC programming – advantages and disadvantages, major operators block libraries) (4)

**OPENPLC FOR MOTION CONTROL** : Function Blocks for Motion Control, Basic set of FBs for single axis multi-axes motion control - Extensions, User Guidelines, Coordinated Motor enabling and power ON - Absolute motion, Relative motion, Group motion, compliance rules and statement - Homing Procedures, Fluid Power Extensions, advanced interpolated motion (4)

**CASE STUDY** : Modelling a two-axis manipulator-Jacobian matrix - forward kinematics and inverse kinematic algorithm - Distributed motion control architecture for manipulator control Coding the algorithm in Structured Code format (IEC 61131-3) - Using the standard FBDs to fetch joint axis encoder values. - Using motor control FBDs to actuate the motors - Using the motion control FBDs to create relative motion and absolute motion – Advance motion control FBDs like interpolated motion (cubic, quantic interpolation) and path move for path planning (4)

**Total L: 15**

**REFERENCE:**

- 1 Department of Robotics and Automation Engineering, "Course material", 2018.

## 19RF14 APPLIED ROBOTICS

**1 0 0 1**

**INTRODUCTION** : Basic transformation - Vector and matrix ways of representing rotations and translation - Properties of Rotation matrices - Quaternion representation of rotations (3)

**DESIGN OF A TWO AXIS ROBOTIC MANIPULATOR** : Development of Inverse kinematic algorithm - Understanding singularity configuration of the manipulator - Avoiding numerical singularity problems - Damped Least Squares Inverse Kinematic (DLSIK) Algorithm - Understanding the problems related to - singularity - sudden motor jerks - motor trips due to over current - high dynamic forces in the manipulator - Defining manipulability of the system - velocity manipulability - force manipulability - Estimation of tracking error of a serial robot, optimizing the damping parameter used in the DLSIK - Robot calibration - Direct and indirect referencing - Estimation of rigid body parameters using the singular value decomposition of the correlation matrix. Novel method used in Steam Generator robotic system calibration - Task space and joint axes interpolation to reduce motor jerks and trips, Design of Cable pusher module for inspection probe insertion and retrieval in the Steam Generator tubes - Design of inspection probes for better flexibility and integrity for tube inspections. (7)

**SERVO MANIPULATOR WITH HIGHER DOF** : Managing higher DOF manipulators - DH-parameters - Transformation matrix - forward Kinematics - IK for higher DOF robots, Kinematic decoupling, pseudo inverse of matrices for non-square Jacobian matrix - Jacobian matrix, Jacobian generating vectors - Force sensing methods - Direct sensing using force-torque (FT) sensors, In-direct sensing using manipulator Jacobian to convert joint axis motor currents - Networking of servo drives

and controlling through a master motion controller, Manipulator work done at joint axes and task space. Electrically looped master slave vs mechanically looped master slave manipulators. Concepts of Forcefeedback manipulators. (5)

**Total L: 15**

**REFERENCE:**

- 1 Department of Robotics and Automation Engineering , "Course material", 2018.

## 19RF15 EVOLUTIONARY OPTIMIZATION TECHNIQUES

**1 0 0 1**

**INTRODUCTION TO OPTIMIZATION :** Introduction — Importance — Formulation of Optimization Problem — Unconstrained Optimization – Constrained Optimization – Multi-objective Optimization (3)

**MULTIPLE ATTRIBUTE DECISION MAKING METHODS FOR OPTIMIZATION :** AHP — TOPSIS — PROMETHEE — Various interdisciplinary real world case studies. (4)

**EVOLUTIONARY OPTIMIZATION TECHNIQUES:** Genetic Algorithms — Particle Swarm Optimization (PSO) Algorithm — Artificial Bee Colony (ABC) Algorithm — Teaching-Learning-Based Optimization (TLBO) Algorithm — Jaya Algorithm (8)

**Total L: 15**

**REFERENCES:**

- 1 Rao R V , "Decision Making in the Manufacturing Environment Using Fuzzy Multiple Attribute Decision Making Methods", Springer Verlag, London, 2007.
- 2 Simon D , "Evolutionary Optimization Algorithms", Wiley, New Jersey, 2013.

## 19RF16 CABLE TECHNOLOGY

**1 0 0 1**

**CLASSIFICATION OF CABLES:** Classification by Voltage level - Classification by Insulation level - Classification by Application—Cross sectional view of Cable (3)

**MATERIALS FOR CABLES:** Types and Properties of different elements in the cable: Electrical – Mechanical - Polymers - Characteristics of Cable Insulation - Supporting Elements for Cables – Sheath and Shielding (3)

**TECHNOLOGY FOR CABLES:** Different types of Technology used in Cables, Types of Twisting, Different Layers in Cables and its Uses (2)

**CABLING SYSTEM AND ITS ACCESSORIES:** Cabling System – Connectors – Cable Trays – Moving Membrane Support System for Various IP Conditions - Flexible Marking Systems (2)

**POWER AND DATA CABLES:** Selection procedure for different types of standards- Applications (2)

**CABLE FAULTS AND TESTING:** Classification of Cable Fault and Symptoms - Detection and Diagnosis of Fault Conditions- Best Practices to minimize Cable and Accessories Failures- Conductor Resistance Tests - Insulation Resistance Tests - HV Tests - Hands-On Practical Exercises (3)

**Total L: 15**

**REFERENCES:**

1. Manuals for Cable Technology by Lapp India Pvt. Ltd.
2. Monograph prepared by PSG-LAPP CoE for Cable Technology

## HUMANITIES

### 19OFA1 EXPORT – IMPORT PRACTICES

**1 0 0 1**

**INTRODUCTION :** Export – Import Business – Preliminaries for starting Export – Import Business Registration. (3)

**EXPORT PROCEDURES:** : Obtaining an Export License – Export Credit Insurance – Procedures and Documentation (4)

**FOREIGN EXCHANGE :** Finance for Exports – Pricing - Understanding Foreign Exchange Rates. (3)

**IMPORT PROCEDURES:** Import Policy – License - Procedure and Documentation. (3)

**EXPORT INCENTIVES:** Incentives - Institutional support (2)

**Total L: 15**

**REFERENCES:**

1. Ramagopal C, "Export Import Procedures - Documentation and Logistics", New Age International, 2014.
2. Cherian and Parab, "Export Marketing", Himalaya Publishing House, New Delhi, 2008.
3. Parul Gupta, "Export Import Management", MC-Graw Hill, 2017.
4. Justin Paul, Rajiv Aserkar, "Export Import Management", Oxford, 2013.

## **190FA2 INSURANCE - CONCEPTS AND PRACTICES**

**1 0 0 1**

**INTRODUCTION TO INSURANCE AND RISK MANAGEMENT:** Origin, History, Nature and Scope of insurance – Meaning, types and significance of risk. (3)

**INSURANCE LAWS AND REGULATIONS:** Insurance Act, IRDA Act, Consumer Protection Act, Ombudsman Scheme. (2)

**INSURANCE UNDERWRITING AND RISK MANAGEMENT:** Meaning of underwriting and underwriter, guidelines and steps in the process of underwriting – characteristics, significance and principles of risk management. (4)

**FINANCIAL ASPECTS OF INSURANCE MANAGEMENT:** Role and functions of financial institutions, determination of premium for various insurance products. (3)

**SETTLEMENT OF INSURANCE CLAIMS:** Documents needed during various claims, Factors affecting insurance claims (3)

**Total L: 15**

**REFERENCES:**

1. Scott Harrington, Gregory Niehaus , "Risk Management and Insurance", McGraw Hill Education, 2017.
2. George E Rejda , "Principles of Risk Management & Insurance", Pearson Education, 2017.
3. John Hull, "Risk Management & Financial Institution", John Wiley and Sons, 2018.
4. Arjun Mittal, D D Chaturvedi , "Insurance and Risk Management", Scholar Tech Press, 2017.

## **190FA3 PUBLIC FINANCE**

**1 0 0 1**

**INTRODUCTION:** Nature and Scope of public finance – Principles of taxation. (2)

**PUBLIC REVENUE AND TAXATION:** Sources of Revenue – Tax and non-tax revenue – Classification of Taxes, GST. (4)

**PUBLIC EXPENDITURE:** Importance – Types – Causes of increase in public expenditure – Effects of public expenditure in India. (3)

**DEFICIT FINANCING AND BUDGET:** Sources of public debt – Debt redemption – Budget – Types – Preparation of Budget in India. (3)

**FEDERAL FINANCE:** Centre-State financial relations – Finance commissions. (3)

**Total: 15**

**REFERENCES:**

1. Richard A Musgrave and Peggy B Musgrave, "Public Finance in Theory and Practice" – Tata McGraw Hill Education, New Delhi, 2004.
2. Bhatia H.L, "Public Finance" – Vikas Publishing House, 29<sup>th</sup> Edition, New Delhi, 2012.
3. David N Hyman, "Public Finance: A contemporary application of theory and policy", Cengage Publication, 11<sup>th</sup> Edition, Noida, 2014.
4. Santhosh Dalvi and Krishnan Venkatasubramanian, "An introduction to Goods and Service Tax: The biggest tax reform in India", CCH Publisher, New Delhi, 2015.

## **190FA4 SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT**

**1 0 0 1**

**INVESTMENT ENVIRONMENT:** Financial Markets - Classification - Financial Instruments – Security Trading. (2)



- TYPES OF SECURITIES:** Trading – Orders, Margin Trading – Clearing and Settlement Procedures. (5)
- SECURITY ANALYSIS I:** Industry Analysis –Estimation of Rates of Return. (2)
- SECURITY ANALYSIS II:** Company Analysis — Estimation of Rates of Return. (2)
- PORTFOLIO MANAGEMENT:** Measuring Risk and Returns and Treatment in Portfolio Management. (4)

**Total L: 15**

**REFERENCES:**

1. William F Sharpe, Gordon J. Alexander, Jeffery V Bailey , "Investments", Prentice Hall, 2012.
2. Prasanna Chandra , "Investment Analysis and Portfolio Management", TATA McGraw Hill Publishing, 2011.
3. Ranganathan , "Investment Analysis and Portfolio Management", Pearson, 2004.
4. Bhalla V K , "Investment Management", TATA McGraw Hill Publishing, 2011

**190FA5SOCIAL ENTREPRENEURSHIP**

**1 0 0 1**

**INTRODUCTION TO SOCIAL ENTREPRENEURSHIP:** Social Entrepreneur - Meaning, qualities and skills. Social Entrepreneurship – Characteristics, process and ecosystem – Case Studies. (3)

**SOURCES OF FUNDING FOR SOCIAL ENTREPRENEURSHIP:** The Social Entrepreneurship Frame work. Start-ups and funding - Internal and External. Schemes for social entrepreneurship. (4)

**STRATEGIES IN SOCIAL ENTREPRENEURSHIP:**Industry and Market Analysis, Business planning, concepts of value creation,new ideas and risk taking. (4)

**PROSPECTS AND PROBLEMSIN SOCIAL ENTREPRENEURSHIP:** Opportunities for Social entrepreneurs, an overview of legal structure, tax structure and other liabilities.(4)

**TOTAL: 15**

**REFERENCE BOOKS:**

- 1.S.S.Khanka, "Creativity and Innovation in Entrepreneurship", Sultan Chand & Sons, 2021.
- 2.C. Paramasivan, "Social Entrepreneurship", New Century Publications, 2016.
- 3.Robert A. Philips Margret Bonefiel Ritesh Sharma, "Social entrepreneurship, the next big business opportunity", Global Vision Publishing House, 2011.
- 4.Drucker, Peter, "Innovation and Entrepreneurship", Harper Business, 2006.

**ENGLISH**

**19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION**

**1 0 0 1**

**INTRA ORGANIZATIONAL COMMUNICATION:** Communication Networks in an Organization; Intra- organizational communication (2)

**INTER ORGANIZATIONAL COMMUNICATION:** Flow Nomenclature; Workplace diversity and intercultural aspects of communication (2)

**COMMUNICATION FUNCTIONS IN ORGANIZATIONS:** Teamwork and team dynamics; Conflict resolution strategies and styles; Leading and influencing others-facilitation skills (3)

**WRITTEN COMMUNICATION:** Email Writing, Professional Reports, and Memos (4)

**INTERPERSONAL SKILLS:** Nature and Dimensions of Interpersonal Communication; Personality and Communication styles; Active listening and intentional responding; Working with emotional intelligence (4)

**Total L: 15**

**REFERENCES:**

1. Bagchi Subroto , "The Professional", Penguin Publications, UK, 2011.
2. PMBOK guide, "A Guide to the Project Management Body of Knowledge", Project Management Institute Inc, USA, 2013.

## 19GF02 HUMAN VALUES THROUGH LITERATURE

1 0 0 1

**PROSE** : Kalam's vision of college education in Wings of fire - Emerson's advocacy of independence of Human will in Self-reliance - Harmony in Education-views of Bertrand Russel (4)

**POETRY** : Maintaining Human relations in Robert Frost's Mending Wall - Quest for identity and freedom in Kamala Das's An Introduction (2)

**DRAMA** : Statesmanship and friendship in Girish Karnad's Tughlaq (3)

**ONE-ACT PLAY** : The theme of love in Chekhov's The Bear (3)

**SHORT STORY** : Empathy in Somerset maugham's Mr. Know-all - Family bond in Anita Desai's Devoted son (3)

**Total L: 15**

### TEXT BOOK:

1. Faculty - Department of English , "Course materials", PSG College of Technology, Coimbatore, 2019.

### REFERENCES:

1. Abrams M .H, Harpham , "A Glossary of Literary Terms", Cengage, Boston, 2015.
2. Scholes R, et.al. , "Elements of Literature", IV, Indian Rpt. OUP, New Delhi, 2013.