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)

TEXT BOOKS:

REFERENCES:

19R102 PHYSICS


TEXT BOOKS:

REFERENCES:

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

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 (Tg) – factors affecting Tg, 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.


ELECTROCHEMICAL POWER SOURCES: Batteries- characteristics-construction and working of lechianche, 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.


19R104 INTRODUCTION TO MECHANICAL SYSTEMS

3 0 0 3

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)


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:

REFERENCES:

19G105 ENGLISH LANGUAGE PROFICIENCY

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:

19R110 ENGINEERING GRAPHICS

INTRODUCTION:
1) Introduction to Engineering Drawing, BIS, Principles of dimensioning
2) Geometric constructions
3) Curves — Conic section, Cycloids and Involutes. (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)

**REFERENCES:**

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**19R111 BASIC SCIENCES LABORATORY**

**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) Measurement of magnetic field using a magnetic material
7) Determination of Hysteresis loss of a ferromagnetic material
8) Determination of hardness of a sample using a microhardness tester
9) Determination of the band gap of a semiconductor
10) Determination of the band gap of a semiconductor using a photoluminescence spectrometer

**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 Ferroxyl 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 photocolorimetry
10) Determination of kinematic viscosity of lubricating oil using Redwood/ Saybolt viscometer

**REFERENCES:**
19R112 C PROGRAMMING LABORATORY

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

Total P: 60

REFERENCES:
2. Ajay Mittal "Programming in C-APractical approach", Pearson., New Delhi, 2010

19IP15 INDUCTION PROGRAMME

As per AICTE guidelines

SEMESTER - 2

19R201 COMPLEX VARIABLES AND TRANSFORMS

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:

REFERENCES:
19R202 MATERIALS SCIENCE


TEXT BOOKS:

REFERENCES:

19R203 ELECTRICAL CIRCUIT THEORY

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 - Kirchhoff’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)


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)


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

**REFERENCES:**

### 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)

**TEXT BOOKS:**

**REFERENCES:**

### 19R205 MANUFACTURING TECHNOLOGY

#### 3 0 0 3


**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 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)

TEXT BOOKS:

REFERENCES:

19R210 ELECTRIC CIRCUITS AND NETWORKS LABORATORY

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, Kirchhoff’s laws and Series - Parallel combination of DC Sources – Circulating current.
4) Verification of Thvenin’s theorem and Norton’s Theorem
5) Verification of Superposition theorem and Maximum power transfer theorem.
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 Psipice.
10) Transient analysis of RL, RC and RLC circuit using Psipice and experimental verification.

REFERENCE:

19R211 ENGINEERING PRACTICES

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.

MECHANICAL:
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

REFERENCE:

19R214 INTERNSHIP

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.


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 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:

REFERENCES:

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)


TEXT BOOKS:

REFERENCES:

19R303 ELECTRICAL MACHINES AND POWER SYSTEMS

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.


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

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

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).

19R304 THEORY OF MACHINES

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)

**TEXT BOOKS:**

**REFERENCES:**

**19R305 DATA STRUCTURES AND ALGORITHMS**

**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)

**TEXT BOOKS:**

**REFERENCES:**


Total L: 45

TEXT BOOKS:

REFERENCES:

19R310 ANALOG ELECTRONICS LABORATORY

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
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
10. Design and Implementation of Active Filter: Low pass and High pass Filter; Band pass and Band reject Filter

Total P: 30

REFERENCE:

19R311 MECHANICS AND MACHINES LABORATORY

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.
4. Load test on single phase transformers.
5. Study of typical power system and developing single line diagram. 

Total P: 30

REFERENCE:

19K312 ENVIRONMENTAL SCIENCE

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. 


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 


Total L: 30

TEXT BOOKS:

REFERENCES:

SEMESTER - 4

19R401 PROBABILITY AND STATISTICS

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. 

Total: 30
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)

TEXT BOOKS:

REFERENCES:

19R402 AUTOMATIC CONTROL SYSTEMS

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)


TEXT BOOKS:

REFERENCES:
19R403 BASICS OF ROBOTICS


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

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

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.

TEXT BOOKS:

REFERENCES:

Total L: 45

19R404 DIGITAL ELECTRONICS

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

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


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

TEXT BOOKS:

Total L: 45
REFERENCES:

19R405 HYDRAULICS AND PNEUMATICS

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.

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.

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.

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.

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.

TEXT BOOKS:

REFERENCES:

19R406 PLC AND SCADA


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

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


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

APPLICATIONS OF PLC & SCADA: Case studies of Machine automation, Process automation

Total L: 45
TEXT BOOKS:

REFERENCES:

19R410 DIGITAL AND CONTROL SYSTEMS LABORATORY

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

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

REFERENCE:

19R411 HYDRAULICS AND PNEUMATICS LABORATORY

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

REFERENCE:

19R412 PLC AND SCADA LABORATORY

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

REFERENCE: None
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  

REFERENCE:  

19Q413 SOFT SKILLS DEVELOPMENT  

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  

REFERENCES:  

19O412 INDIAN CONSTITUTION  

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)  

REFERENCES:  
SEMESTER - 5
19R501 CNC MACHINES

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)

TEXT BOOKS:

REFERENCES:

19R502 DYNAMICS AND CONTROL OF MANIPULATORS


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)

TEXT BOOKS:
19R503 MICROPROCESSORS AND MICROCONTROLLERS


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

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

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

PROGRAMMING OF ARM PROCESSORS: ARM Addressing Modes - ARM Instruction Set Overview - Thumb Instruction Set Overview.

TOTAL L: 45

TEXT BOOKS:

REFERENCES:

19R504 DESIGN OF MECHANICAL TRANSMISSION SYSTEMS

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.

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.

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.

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.

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

TOTAL L: 30 +T: 15 = 45

TEXT BOOKS:

REFERENCES:

**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:**

**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:**

**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:**

**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:

SEMESTER - 6

19R601 POWER ELECTRONICS AND DRIVES

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

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 to AC converters

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 - Selection of device - Thyristor triggering circuits - Selection of device - Thyristor protection circuits

INTRODUCTION TO DRIVES: Basic Elements of Drive - Load characteristics - Selection of Drive

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

POWER QUALITY: Overview of Harmonics - Introduction to Power quality

TEXT BOOKS:

REFERENCES:

19R602 AUTOMATION SYSTEM DESIGN

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.
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 fixtureing - 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+6)

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

TEXT BOOKS:

REFERENCES:

19R603 AI FOR ROBOTICS

3 1 0 4


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)


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

TEXT BOOKS:

REFERENCES:

19R604 VISION SYSTEMS

3 0 0 3


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

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

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

TEXT BOOKS:

REFERENCES:
2. Richard Hartley, Andrew fisherman , "Multiple view geometry in computer vision", 2012.

19R605 SENSORS AND INSTRUMENTATION

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.

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

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

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

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

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

TEXT BOOKS:

REFERENCES:
19R610 POWER ELECTRONICS AND DRIVES LABORATORY

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

REFERENCE:

Total P: 60

19R611 AI AND VISION SYSTEMS LABORATORY

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
8. Simulating Deterministic Local and Global Path Planning Algorithms
9. Simulating Stochastic Path Planning Algorithms
10. Design of Autonomous Mobile Robo

REFERENCE:

Total P: 60

19Q613 QUANTITATIVE AND REASONING SKILLS

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

REFERENCE:

Total P: 30
REFERENCES:

SEMESTER - 7

19R701 MOBILE ROBOTICS

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)


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, Am 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:

REFERENCES:

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

50
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

Total P: 120

LANGUAGE ELECTIVES

19G001 COMMUNICATION SKILLS FOR ENGINEERS

Total P: 60
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

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 on phone
2. Vocabulary: related to the topic
3. Grammar: Time related prepositions, Possessive articles,Modalverbs (15)

TEXT BOOKS:
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

REFERENCES:
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004

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

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

TENSES AND NUMBERS:
1. Demander l’autorisation-passé récent, futur proche
2. La vie administrative et régionale, Pluriel des noms, moyens de transport

DISCOURSE:
1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d’système éducation de France
3. parler de la technologie de l’information

TEXT BOOKS:

REFERENCES:
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

PATICLE ”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”.

LIKES AND DISLIKES :
1. Potential verbs (wakarimasu and dekimasu) —”Kara ( ~ because)”
2. Adverbs — Asking some one 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)

DIFFERENT USAGES OF ADJECTIVES :
1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabeti desu)- Going for a certain purpose (mi –ni ikimasu)
2. Choosing from a menu-Adjectives (”i” and ”na” type) — Adjectives (Positive and negative useage)

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

TEXT BOOKS:
REFERENCES:
3. Minna No Nihongo "Translation & Grammatical Notes In English Elementary".

PROFESSIONAL ELECTIVES

19R001 INDUSTRY 4.0


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

KEY ENABLERS OF INDUSTRIAL IOT: IoT Sensing - IoT Connectivity - IoT Networking - Process control


TEXT BOOKS:

REFERENCES:

19R002 ROBOTIC CONTROL SYSTEMS

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

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

JOINT SPACE AND TASK SPACE CONTROL SCHEMES: Position control - velocity control - trajectory control and force control

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

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

TEXT BOOKS:

REFERENCES:
19R003 INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEMS

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

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

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

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

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

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.

Total L: 45

TEXT BOOKS:

REFERENCES:

19R004 MICROROBOTICS

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

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

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


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

Total L: 45
TEXT BOOKS:

REFERENCES:

19R005 COGNITIVE ROBOTICS
3 0 0 3


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:

REFERENCES:

19R006 CLOUD ROBOTICS
3 0 0 3

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


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
19R007 MEDICAL ROBOTICS

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


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

REHABILITATION: Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - case studies

ROBOTS IN MEDICAL CARE: Assistive robots - types of assistive robots - case studies

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

Total L: 45

TEXT BOOKS:

REFERENCES:

19R008 ROBOTIC WELDING TECHNOLOGY

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.

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 GMMAW 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

WELDING ROBOTS: Types of welding robots — features of welding Robot—Wristmotions -Specifying thewelding Robot - controllers- major components, functions- Interfacing welding power source with robotic controller — welding control system

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
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)

TEXT BOOKS:

REFERENCES:

19R010 ELECTRICAL MACHINES FOR AUTOMATION

3 0 0 3

STEP 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)

TEXT BOOKS:

REFERENCES:

19R011 INDUSTRIAL NETWORKING

3 0 0 3


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.

**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.

**REFERENCES:**

**19R012 VIRTUAL INSTRUMENTATION SYSTEMS**

**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

**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

**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

**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

**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

**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

**TEXT BOOKS:**

**REFERENCES:**

**19R013 SENSOR NETWORKS**

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

REFERENCES:

19R014 DIGITAL CONTROL SYSTEMS

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)


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:

REFERENCES:

19R015 AUTOMOBILE ENGINEERING

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 synchronmesh 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, read 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)

TEXT BOOKS:

REFERENCES:

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)


TEXT BOOKS:

REFERENCES:

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)


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)

TEXT BOOKS:

REFERENCES:

19R018 ADVANCED CONTROL SYSTEMS

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)


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 non-linearities 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)

TEXT BOOKS:

REFERENCES:

19R020 IMAGE ANALYTICS

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 denoising - 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)

TEXT BOOKS:

REFERENCES:

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 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)

TEXT BOOKS: 

REFERENCES:

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


TEXT BOOKS:

REFERENCES:

19R023 EMBEDDED PROCESSORS

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

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

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.

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


TEXT BOOKS:

REFERENCES:
19R024 ADVANCED MICROPROCESSORS AND MICROCONTROLLERS

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)


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)

TEXT BOOKS:

REFERENCES:

Total L: 45

19R030 INTERNET OF THINGS

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 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)

TEXT BOOKS:

REFERENCES:

Total L: 45

65
19R031 COMPUTER ARCHITECTURE

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

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

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

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

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

PIPELINE AND VECTOR PROCESSING : Parallel Processing - Pipelining - RISC Pipelining - Vector Processing

Total L: 45

TEXT BOOKS:

REFERENCES:

19R032 EMBEDDED AND REAL-TIME SYSTEMS

INTRODUCTION : Functional building block - Characteristics - Challenges in embedded system design - Embedded system design processes

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

PHERIPHERALS AND COMMUNICATION : Interfacing of Key board —LED - Multiplexed LED Displays — LCD – Serial buses:USART —SPI—I2C—CAN

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


Total L: 45

TEXT BOOKS:

REFERENCES:
19R033 BIG DATA ANALYTICS


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


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

TEXT BOOKS:

REFERENCES:

19R034 SOFTWARE PROJECT MANAGEMENT AND QUALITY ASSURANCE

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

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


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

TEXT BOOKS:
REFERENCES:

19R035 NEURAL NETWORKS AND FUZZY SYSTEMS

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


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

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

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

TEXT BOOKS:

REFERENCES:

19R036 INTERNET TOOLS AND JAVA PROGRAMMING


EXCEPTION HANDLING AND DATABASE CONNECTIVITY: JException 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

Total L: 45

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19R037 MACHINE LEARNING FOR ROBOTICS

3 0 0 3


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)


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

Total L: 45

TEXT BOOKS:

REFERENCES:

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 —Autonamion /Jidoka, Visual management system, Mistake proofing / Poke- Yoke, 5S technique — Elements and waste elimination through SS, 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 setuptime reduction techniques, Temple of quality, OEE calculations (9)
19R041 SUPPLY CHAIN MANAGEMENT

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 - distribution 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)

TEXT BOOKS:

REFERENCES:

19R042 PROCESS PLANNING AND COST ESTIMATION

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 of 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)


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)
19R043 MAINTENANCE AND SAFETY ENGINEERING

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

TOTAL PRODUCTIVE MAINTENANCE: Principles, preparatory stages of implementation - TPM 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)


Total L: 45

TEXT BOOKS:

REFERENCES:

19R044 INDUSTRIAL DESIGN AND APPLIED ERGONOMICS

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 - tactial - 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)

TEXT BOOKS:

REFERENCES:

19R045 PRODUCT DESIGN AND DEVELOPMENT

3 0 0 3


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 — Shigihly, 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)


TEXT BOOKS:

REFERENCES:

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)

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


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)

TEXT BOOKS:

REFERENCES:

19R047 ADDITIVE MANUFACTURING

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


TEXT BOOKS:

REFERENCES:

ONE-CREDIT COURSES

ROBOTICS AND AUTOMATION ENGINEERING

19RF01 CAD TOOLS FOR INDUSTRIAL AUTOMATION

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)


REFERENCES:

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)

REFERENCES:

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)

REFERENCES:

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.

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

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

REFERENCE:

19RF05 ROBOT OPERATING SYSTEMS

INTRODUCTION TO ROS: introduction - history - distributions - difference from other meta - operating systems - services - ROS framework - operating system - releases

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.

ARCHITECTURE OF OPERATING SYSTEM: File system - packages - tasks - messages - services - catkin workspace - working with catkin workspace - working with ROS navigation and listing commands

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

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


REFERENCES:

19RF06 COMPUTER VISION WITH OPENCV

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 - ImageView Data Structure - Matrix and Image Operators - Drawing Things


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

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


REFERENCES:
19RF07 UNDERWATER ROBOTICS

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.


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

SCOPE: Research and Development - Market Analysis, Job Placement and Future Development

REFERENCE:

19RF08 DIGITAL TECHNOLOGY FOR AUTOMATION DRIVES

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)

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

CONFIGURATION FOR DIFFERENT APPLICATIONS: AQUA — HVAC — Automation — Master/Slave control

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

REFERENCE:
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


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


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

REFERENCE:
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
REFERENCES:

19RF10 ROBOT SIMULATION USING OPEN SOURCE TOOLS

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".

19RF11 INTRODUCTION TO HAPTIC INTERFACE DESIGN

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:

REFERENCES:

19RF12 CODESYS PROGRAMMING

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.

CODESYS MOTION: CNC — Development system, Visualization, Runtime, Fieldbus and structure of CNC motion

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

REFERENCE:

19RF13 OPEN PLC

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

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

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

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

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, quartic interpolation) and path move for path planning

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

19RF14 APPLIED ROBOTICS

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

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.

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 Force feedback manipulators.

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

**19RF15 EVOLUTIONARY OPTIMIZATION TECHNIQUES**

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INTRODUCTION TO OPTIMIZATION: Introduction — Importance — Formulation of Optimization Problem — Unconstrained Optimization — Constrained Optimization — Multi-objective Optimization

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

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

REFERENCES:

**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

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

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

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

POWER AND DATA CABLES: Selection procedure for different types of standards- Applications


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**


EXPORT PROCEDURES: Obtaining an Export License – Export Credit Insurance – Procedures and Documentation

FOREIGN EXCHANGE: Finance for Exports – Pricing - Understanding Foreign Exchange Rates.

IMPORT PROCEDURES: Import Policy – License - Procedure and Documentation.
EXPORT INCENTIVES: Incentives - Institutional support

Total L: 15

REFERENCES:

19OFA2 INSURANCE - CONCEPTS AND PRACTICES

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)

REFERENCES:

19OFA3 PUBLIC FINANCE

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:

19OFA4 SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT

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)

REFERENCES:

19OFA5SOCIAL ENTREPRENEURSHIP

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 PROBLEMS IN SOCIAL ENTREPRENEURSHIP: Opportunities for Social entrepreneurs, an overview of legal structure, tax structure and other liabilities. (4)

TOTAL: 15

REFERENCE BOOKS:

ENGLISH

19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION

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: 15

REFERENCES:
19GF02 HUMAN VALUES THROUGH LITERATURE

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 Berndt Russel

POETRY: Maintaining Human relations in Robert Frost’s Mending Wall - Quest for identity and freedom in Kamala Das’s An Introduction

DRAMA: Statesmanship and friendship in Girish Karnad’s Tughlaq

ONE-ACT PLAY: The theme of love in Chekhov’s The Bear

SHORT STORY: Empathy in Somerset maugham’s Mr. Know-all - Family bond in Anita Desai’s Devoted son

Total L: 15

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

REFERENCES: