# M.E. (Industrial Automation and Robotics)

# 2015 Regulations, Curriculum & Syllabi


**BANNARI AMMAN INSTITUTE OF TECHNOLOGY**

(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NBA New Delhi, NAAC with 'A' Grade and ISO 9001:2008 Certified)
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## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the M.E. Industrial Automation and Robotics will be able to

I. To produce engineering graduates who are competent to apply principles of science and engineering for solving current problems related to industrial automation and robotics.

II. To produce engineering graduates who are responsible to the society and discharge their duties.

III. To produce engineering graduates who are capable of communicating effectively and exhibit a desire for research and development and lifelong learning.

## PROGRAMME OUTCOMES (POs)

On completion of this program the graduates will be able to

a. Work effectively in a team, exercise initiative, and function as a leader

b. Design and conduct experiments to analyze the data and interpret the results

c. Provide an appropriate solution for a given application related to automation.

d. Apply modelling and analysis to provide solutions for automation

e. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability

f. Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice

g. Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of sustainable development

h. Demonstrate knowledge and understanding of engineering principles to manage projects and in multidisciplinary environments.

i. Engage in independent and life-long learning in the broadest context of technological change

j. Communicate effectively through verbal, written and visual communication with engineering community and with society at large

k. Function effectively as an individual, as a part of team and in a multi-disciplinary environment and actively participate in research and development activities

## MAPPING OF PEOs AND POs

| PEO(s) | Programme Outcome (s) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) |
| I | x | x | x | x | | | | | | | |
| II | | | | | x | x | x | | | | |
| III | | | | | | | | x | x | x | x |

**M.E. Industrial Automation and Robotics (Full Time)**
**(Minimum credits to be earned: 78)**

**First Semester**

| Code No. | Course | Objectives & Outcomes | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| | | PEOs | POs | | | | |
| 15IR11 | Advanced Numerical Methods[1] | I | (a),(c),(d) | 3 | 2 | 0 | 4 |
| 15IR12 / 15IR13 | Bridge Course Mechanical / Bridge Course Electrical[2] | I | (a),(e),(g),(h),(k) | 3 | 2 | 0 | 4 |
| 15IR14 | Microcontroller and Embedded Systems | I,III | (b),(c),(d),(e),(i) | 3 | 0 | 0 | 3 |
| 15IR15 | Fluid Power System | I | (b),(c),(e),(g),(h) | 3 | 2 | 0 | 4 |
| 15IR16 | Sensors and Signal Conditioning | I,II,III | (b),(c),(e),(d),(h),(k) | 3 | 0 | 0 | 3 |
| | Elective I | | | 3 | 0 | 0 | 3 |
| 15IR18 | Fluid Power System and PLC Laboratory | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 4 | 2 |
| 15IR19 | Microcontroller Laboratory | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 4 | 2 |
| 15GE19 | Business English - I$^{\alpha}$ | | | 1 | 0 | 2 | 2 |
| | | | **Total** | **19** | **6** | **10** | **27** |

**Second Semester**

| Code No. | Course | Objectives & Outcomes | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| | | PEOs | POs | | | | |
| 15IR21 | Research Methodology | I,III | (a),(b),(c),(i),(k),(d) | 3 | 0 | 0 | 3 |
| 15IR22 | Machine Vision System | I,III | (c),(d),(e),(f),(g),(k) | 3 | 0 | 0 | 3 |
| 15IR23 | Kinematics and Dynamics of Robots | I,III | (c),(d),(e),(f),(g),(k) | 3 | 2 | 0 | 4 |
| 15IR24 | Industrial Drives | I,II,III | (c),(d),(e),(f),(h) | 3 | 2 | 0 | 4 |
| | Elective II | | | 3 | 0 | 0 | 3 |
| | Elective III | | | 3 | 0 | 0 | 3 |
| 15IR27 | Sensors and Robotics Laboratory | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 4 | 2 |
| 15IR28 | Technical Seminar | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 2 | 1 |
| 15GE29 | Business English - II$^{\alpha}$ | | | 1 | 0 | 0 | 1 |
| | | | **Total** | **19** | **4** | **6** | **24** |

**Third Semester**

| Code No. | Course | Objectives & Outcomes | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| | | PEOs | POs | | | | |
| | Elective IV | | | 3 | 0 | 0 | 3 |
| | Elective V | | | 3 | 0 | 0 | 3 |
| | Elective VI | | | 3 | 0 | 0 | 3 |
| 15IR34 | Project Work - Phase I | I,II,III | (a),(b),(c),(d),(e),(g),(h),(i) | - | - | - | 6 |
| | | | **Total** | **9** | **0** | **0** | **15** |

**Fourth Semester**

| Code No. | Course | Objectives & Outcomes | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| | | PEOs | POs | | | | |
| 15IR41 | Project Work - Phase II | I,II,III | (a),(c),(d),(e),(f),(g),(h),(i),(j) | - | - | - | 12 |
| | | | **Total** | **-** | **-** | **-** | **12** |

[1] Common to Industrial Automation and Robotics, Engineering Design & CAD/CAM

[2] 15IR12 for Electrical Stream UG Students; 15IR13 for Mechanical stream UG Students

$^{\alpha}$ Common to all M.E. / M.Tech. Programmes

## M.E. Industrial Automation and Robotics (Part Time)

| Code No. | Course | Objectives & Outcomes | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| | | PEOs | POs | | | | |
| **First Semester** | | | | | | | |
| 15IR11 | Advanced Numerical Methods[1] | I | (a),(c),(d) | 3 | 2 | 0 | 4 |
| 15IR12/ 15IR13 | Bridge Course Mechanical / Bridge Course Electrical[2] | I | (a),(e),(g),(h),(k) | 3 | 2 | 0 | 4 |
| 15IR14 | Microcontroller and Embedded Systems | I,III | (b),(c),(d),(e),(i) | 3 | 0 | 0 | 3 |
| 15IR18 | Fluid Power System and PLC Laboratory | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 4 | 2 |
| 15GE19 | Business English - I$^{\alpha}$ | | | 1 | 0 | 2 | 2 |
| | | | **Total** | **10** | **4** | **6** | **15** |
| **Second Semester** | | | | | | | |
| 15IR21 | Research Methodology | I,III | (a),(b),(c),(i),(k), (d) | 3 | 0 | 0 | 3 |
| 15IR22 | Machine Vision System | I,III | (c),(d),(e),(f),(g),(k) | 3 | 0 | 0 | 3 |
| 15IR23 | Kinematics and Dynamics of Robots | I,III | (c),(d),(e),(f),(g),(k) | 3 | 2 | 0 | 4 |
| 15IR27 | Sensors and Robotics Laboratory | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 4 | 2 |
| 15GE29 | Business English - II$^{\alpha}$ | | | 1 | 0 | 0 | 1 |
| | | | **Total** | **10** | **2** | **4** | **13** |
| **Third Semester** | | | | | | | |
| 15IR15 | Fluid Power System | I | (b),(c),(e),(g),(h) | 3 | 2 | 0 | 4 |
| 15IR16 | Sensors and Signal Conditioning | I,II,III | (b),(c),(e),(d),(h),(k) | 3 | 0 | 0 | 3 |
| 15IR24 | Industrial Drives | I,II,III | (c),(d),(e),(f),(h) | 3 | 2 | 0 | 4 |
| 15IR19 | Microcontroller Laboratory | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 4 | 2 |
| | | | **Total** | **9** | **4** | **4** | **13** |
| **Fourth Semester** | | | | | | | |
| | Elective I | | | 3 | 0 | 0 | 3 |
| | Elective II | | | 3 | 0 | 0 | 3 |
| | Elective III | | | 3 | 0 | 0 | 3 |
| 15IR28 | Technical Seminar | I,II,III | (a),(b),(c),(d),(e),(f),(k) | 0 | 0 | 2 | 1 |
| | | | **Total** | **9** | **0** | **2** | **10** |
| **Fifth Semester** | | | | | | | |
| | Elective IV | | | 3 | 0 | 0 | 3 |
| | Elective V | | | 3 | 0 | 0 | 3 |
| | Elective VI | | | 3 | 0 | 0 | 3 |
| 15IR34 | Project Work - Phase I | I,II,III | (a),(b),(c),(d),(e),(g),(h),(i) | - | - | - | 6 |
| | | | **Total** | **9** | **0** | **0** | **15** |
| **Sixth Semester** | | | | | | | |
| 15IR41 | Project Work - Phase II | I,II,III | (a),(c),(d),(e),(f),(g),(h),(i),(j) | - | | | **12** |

[1] Common to Industrial Automation and Robotics, Engineering Design & CAD/CAM

[2] 15IR12 for Electrical Stream UG Students; 15IR13 for Mechanical stream UG Students

$^{\alpha}$ Common to all M.E. / M.Tech. Programmes

| **List of Core Electives** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 15IR51 | Modern Material Handling Systems | I,II,III | (c),(e),(f) | 3 | 0 | 0 | 3 |
| 15IR52 | Computer Integrated Manufacturing Systems | I,III | (c),(e),(d) | 3 | 0 | 0 | 3 |
| 15IR53 | Process Automation | I,II,III | (c),(e),(d),(g) | 3 | 0 | 0 | 3 |
| 15IR54 | Design of Intelligent Robotics System | I | (b),(c),(d),(e), (f) | 3 | 0 | 0 | 3 |
| 15IR55 | Virtual Instrumentation | I | (d),(e),(g),(h) | 3 | 0 | 0 | 3 |
| 15IR56 | Modeling, Simulation and Analysis of Manufacturing System | I,III | (b),(c),(d),(e), (f) | 3 | 0 | 0 | 3 |
| 15IR57 | Automatic Control System | I,II,III | (b),(d),(e),(g), (h) | 3 | 0 | 0 | 3 |
| 15IR58 | Communication Protocols | I | (c),(d),(e),(g), (h) | 3 | 0 | 0 | 3 |
| 15IR59 | Rapid Manufacturing | I,II,III | (b),(c),(e),(f), (g),(h) | 3 | 0 | 0 | 3 |
| 15IR60 | Industrial Robotics | I | (b),(c),(d),(e), (f) | 3 | 0 | 0 | 3 |
| 15IR61 | Mechatronics in Manufacturing System | I,III | (c),(d) | 3 | 0 | 0 | 3 |
| 15IR62 | Field and Service Robots | I,II | (d),(e),(h) | 3 | 0 | 0 | 3 |
| 15IR63 | Micro Electro Mechanical System | I,III | (b),(c) | 3 | 0 | 0 | 3 |
| **One Credit Courses** | | | | | | | |
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 15IRXA | Design of Experiments | I,III | (b),(c),(k) | 1 | 0 | 0 | 1 |
| 15IRXB | Shop Floor Safety | I | (d),(f) | 1 | 0 | 0 | 1 |

## 15IR11/15ED11/15CC11 ADVANCED NUMERICAL METHODS
## (Common to CAD/CAM, Engineering Design & Industrial Automation & Robotics)

**3 2 0 4**

**Course Objectives**

- To impart knowledge on numerical methods to find the numerical solution of the problems that arise in engineering and technology.
- To familiarize the advanced mathematical methods to solve engineering research problems.

**Course Outcomes (COs)**

1. Acquire more knowledge in basic concept of engineering mathematics.
2. Improvement in problem evaluation technique.
3. Choose an appropriate method to solve a practical problem.

**Unit I**

**Algebraic Equations**

Systems of linear equations: Gauss Elimination method, Thomas algorithm for tri diagonal system – Gauss Seidel, SOR iteration methods-Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigen value problems: power method, inverse power method, Faddeev – Leverrier Method.

**9 Hours**

**Unit II**

**Ordinary Differential Equations**

Runge Kutta Methods for system of Initial value problems, numerical stability, Adams-Bash forth multi step method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

**9 Hours**

**Unit III**

**Finite Difference Method for Time Dependent Partial Differential Equation**

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations– method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme - Stability of above schemes.

**9 Hours**

**Unit IV**

**Finite Difference Methods for Elliptic Equations**

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes –approximation of derivatives near a curved boundary while using a square mesh.

**9 Hours**

**Unit V**

**Finite Element Method**

Partial differential equations–Finite element method-orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method. Applied Numerical Methods with MATLAB for Engineering Problems- Case Studies.

**9 Hours**

**Unit VI**[$]
**Applications**
Applied Numerical Methods with MATLAB for Engineering Problems- Case Studies.

**Total: 45 + 30 Hours**

**Reference(s)**

1. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson Education, New Delhi, 2003.
2. P.Kandasamy, K. Thilagavathy and K. Gunavathy, *Numerical Methods*, S Chand & Co. New Delhi, 2007.
3. S. Rajasekaran, *Numerical Methods in Science and Engineering – A Practical Approach*, Wheeler Publishing, 2005.
4. J.D. Faires and R. Burden, *Numerical Methods*, Brooks/Cole Publishing Company, 2006.
5. C.S.Chapra and P.R. Canale, *Numerical Methods for Engineers with Software and Programming Applications*, Tata McGraw Hill, New Delhi, 2004

## 15IR12 BRIDGE COURSE MECHANICAL

**3 2 0 4**

**Course Objectives**

- To understand the basics related to mechanical design and manufacturing processes
- To know the mechanisms and able to solve problems related to friction
- To design commonly used mechanical components in transmission of power

**Course Outcomes (COs)**

On completion of this course, student will be able to:

1. Identify mechanisms and determine friction force under various applications
2. Design shafts and springs and explain different mechanical power transmission systems
3. Demonstrate fundamental manufacturing processes

**Unit I**
**Mechanics of Materials**
Classification of engineering materials - mechanical properties of materials - selection of materials for engineering purpose - factor of safety - stress and strain – centroid and moment of inertia: standard and composite sections.

**9 Hours**

**Unit II**
**Equilibrium of Rigid Bodies**
Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions.

**9 Hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Unit III**

**Mechanisms**

Kinematics – links, pairs and mechanisms - degrees of freedom - four bar chain mechanism - slider crank mechanisms - inversion of mechanisms - time ratio – determination of velocity and acceleration in links – introduction to free and forced vibrations (Basics only).

**9 Hours**

**Unit IV**

**Mechanical Drives**

Introduction to power screws - application of journal bearings and rolling elements bearings – re-circulating ball/nut assembly – belt and chain drives – gear drives: spur gear, helical, bevel and worm and worm wheel - design of shafts and springs.

**9 Hours**

**Unit V**

**Manufacturing Processes**

Introduction to sand casting process - Die casting – Casting defects – Welding process: Arc and gas welding, resistance welding - Machining process: Construction and working of center lathe and milling machine - Forming Process: Hot and cold working forging processes - direct and indirect extrusion.

**9 Hours**

**Unit VI**[$]

**Case Study**

Equilibrium of Rigid bodies in three dimensions

**Total: 45 +30 Hours**

**Reference(s)**

1. Joseph Edward Shigley and John Joseph Uicker, *Theory of Machines and Mechanisms*, Tata McGraw-Hill Publishing Company, 2004.
2. Joseph E Shigley and Charles R Mischke, *Mechanical Engineering Design*, McGraw-Hill Co., 2010.
3. T V Sundararaja Moorthy and N Shanmugam, *Machine Design*, Anuradha Publications, 2007.
4. Egor R. Popov, *Engineering Mechanics of Materials*, PHI Learning Private Limited, New Delhi, 2011.
5. Kaushish, J. P., *Manufacturing Processes*, PHI Learning Private Limited, 2014.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## 15IR13 BRIDGE COURSE ELECTRICAL

**3 2 0 4**

**Course Objectives**

- To create basic knowledge in the area of electronics for the mechanical discipline students
- To acquaint the students with the basic characteristics of electronic devices
- To enhance the knowledge of the students in the area of integrated circuits and power electronics

**Course Outcomes (COs)**

The student will be able to

1. Know the basics concepts of electric circuits and magnetic
2. Understand the concepts of Electron devices
3. Know the characteristics of power semiconductor devices

**Unit I**

**Electric Circuits**

Electric Circuits Definition of Voltage, Current, Power & Energy, Ohm's law, Kirchhoff's Law & its applications – simple problems, division of current in series & parallel circuits, generation of alternating EMF, definition of RMS value, average value, peak factor, and form factor. Power in single phase AC – three phase system. Star to delta and delta to star transformations

**9 Hours**

**Unit II**

**Electrical Motors**

Constructional details, principle of operation and performance characteristics of D.C. motors & A.C. motors, single phase induction motor, three phase induction motor, synchronous motors, universal motors, stepper motors, Synchronous motors and reluctance motor.

**9 Hours**

**Unit III**

**Electronic Components and Amplifiers**

Passive components - Intrinsic and Extrinsic semiconductors - PN Junction diodes and its applications - Special purpose diodes: Zener diode –Photodiode - Bipolar Junction Transistor: CE, CB, CC Configurations - Operational amplifier (op-amp) – Characteristics - Arithmetic operations using op-amp - Applications: Instrumentation amplifier, Sample and Hold circuits

**9 Hours**

**Unit IV**

**Power Semi-conductor Devices**

Thyristor families: SCR, DIAC, TRIAC, MOSFET, IGBT, LASCR - Operating mechanism, characteristics and applications

**9 Hours**

**Unit V**

**Power Electronic Circuits**

Phase controlled Rectifier: Single phase and Three phase controlled and uncontrolled rectifiers with R and RL load – Chopper: Time Ratio Control, Types, Four Quadrant operation - Regulated power supply design

**9 Hours**

**Unit VI**[$]
**Case Study**
Resonant Pulse Converters and Cycloconverters

**Total: 45 + 30 Hours**

**Reference(s)**

1. R. Muthusubramaninan, S. Salivahanan and K. A. Muraleedharan, *Basic Electrical, Electronics and Computer Engineering*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
2. T. K. Nagsarkar and M. S. Sukhija, *Basic of Electrical Engineering*, Oxford Press, 2005.
3. Smarjith Ghosh, *Fundamentals of Electrical and Electronics Engineering*, Prentice Hall (India) Pvt. Ltd., 2005
4. Muhammad H. Rashid, Power *Electronics - Circuits, Devices and Applications*, Prentice Hall of India Learning. Ltd., New Delhi, 2004.
5. M. D. Singh and K. B. Khanchandani, *Power Electronics*, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2007.
6. P. S. Bhimbra, *Power Electronics*, Khanna Publishers, New Delhi, 2012.

## 15IR14 MICROCONTROLLER AND EMBEDDED SYSTEMS

**3 0 0 3**

**Course Objectives**

- To acquire knowledge about the different types of microcontroller and their architecture
- To study the important components associated with the microcontroller and embedded system

**Course Outcomes (COs)**

At the end of this course, students are able to:

1. Program the different types of microcontroller
2. Interface different devices with the microcontroller

**Unit I**
**Microcontrollers**

Microprocessors and Micro-controllers, Types of Micro-controllers – Embedded, External memory, Processor Architecture – Harvard v/s Princeton; CISC v/s RISC, Micro-controller Memory types – control storage; variable area; stack; hardware register space, Micro-controller features –clocking; I/O pins, Interrupts, Timers, Peripherals.

**9 Hours**

**Unit II**
**8051 Processor Architecture and Instruction Set**

The CPU, Addressing modes, external addressing, Interrupt handling, Instruction execution, Instruction set – data movement; arithmetic; bit operators; branch, Software development tools like assemblers; simulators; cross-compilers, O/P file formats. Hardware Features : 8051 – Device packaging, Chip technology, Power considerations, Reset, System clock/oscillators, Parallel I/O, Timers, Interrupts, Serial I/O, Control store and External memory devices.

**9 Hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Unit III**

**Pic Microcontrollers and Instruction Set**

PIC Micro-controllers – overview; features, PIC-18 architecture, file selection register, Memory organization, Addressing modes, Instruction set, Interrupt handling. PIC-18 – Reset, low power operations, oscillator connections, I/O ports – serial; parallel, Timers, Interrupts, ADC. Introduction to Raspberry Pi, Arduino

**9 Hours**

**Unit IV**

**Enhanced Features**

Dallas HSM & Atmel Micro-controllers – Architecture enhancements, control store and external memory, scratchpad RAM enhancements, Timers, Serial I/O, Analog I/O, Voltage comparators. PIC-18 Flash Micro-controllers – STATUS; OPTION_REG; PCON registers, Program & Data Memory, Data EEPROM & Flash Program EEPROM, Interrupts, I/O ports, Timers, Capture/Compare/PWM module, Master Synchronous Serial Port module, USART, ADC.

**9 Hours**

**Unit V**

**Introduction to Embedded Systems**

Overview of Embedded System Architecture, Application areas, Categories of embedded systems, specialties of embedded systems. Recent trends in embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC.

**9 Hours**

**Unit VI**[$]

**Case Studies**

Interfacing & Microcontroller Applications: LEDs, Push Buttons, Relays, Latch connections, Keyboard, Seven Segment and LCD displays interfacing, I2C bus operation, Serial EEPROM. Software development tools.

**Total: 45 Hours**

**Reference(s)**

1. Mazidi, Mazidi and McKinlay, *The 8051 Microcontroller and Embedded Systems using Assembly and C*, 2nd edition, Pearson India, New Delhi, 2007.
2. Myke Predko, *Programming and Customizing the 8051 Micro-controller*, Tata McGraw-Hill edition, New Delhi, 1999
3. R A Gaonkar, *Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)*, Penram Publishing India, Mumbai, 2005
4. Shibu K, *Embedded Systems*, Tata McGraw Hill Publishing, New Delhi, 2009.
5. Technical Reference(s) on www.microchip.com

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## 15IR15 FLUID POWER SYSTEM

**3 2 0 4**

**Course Objectives**

- To impart knowledge on fluid power engineering and power transmission systems.
- To create expertise in applications of fluid power systems in automation of machine tools and others equipment and to design hydraulic and electro-hydraulic systems for automation, pneumatic circuits using PLC, cascade, step counter and k-v mapping methods and to design low cost automation systems.

**Course outcomes (COs)**

1. Able to select the appropriate pump for a particular application in a circuit.
2. Designing various circuits used in the industries and Hydro pneumatic circuits.
3. Designing sequential circuits by using various methods.

**Unit I**

**Introduction**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law- Laminar and Turbulent flow – Reynolds's number – Darcy's equation – Losses in pipe, valves and fittings.

**9 Hours**

**Unit II**

**Hydraulic System & Components**

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting, special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Gear, Vane and Piston motors.

**9 Hours**

**Unit III**

**Pneumatic Systems and Components**

Pneumatic Components: Properties of air – Compressors – Piston, Vane and Screw compressors– Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

**9 Hours**

**Unit IV**

**Introduction to Programmable Logic Controller**

Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analog Input/output – Selection of PLC.

**9 Hours**

**Unit V**

**Design of Fluid Power Circuits**

Construction of Control Components : Directional control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves. Accumulators and

Intensifiers: Types of accumulators – Accumulators circuits, Intensifier – Applications of Intensifier – Intensifier circuit. Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves.

**9 Hours**

**Unit VI**[$]

**Case Studies**

Fluidics – Introduction to fluidic devices. Fluid power circuits; failure and troubleshooting.

**Total: 45+30 Hours**

**Reference(s)**

1. Anthony Esposito, *Fluid Power with Applications*, Pearson Education, New Delhi, 2005.
2. Majumdar S.R., *Oil Hydraulics Systems - Principles and Maintenance*, Tata McGraw-Hill, New Delhi, 2001.
3. Srinivasan.R, *Hydraulic and Pneumatic controls*, Vijay Nicole, Chennai, 2006.
4. Shanmugasundaram.K, *Hydraulic and Pneumatic controls*, Chand & Co, New Delhi, 2006.
5. Majumdar S.R., *Pneumatic systems – Principles and maintenance*, Tata McGraw Hill, New Delhi, 1995
6. Anthony Lal, *Oil hydraulics in the service of industry*, Allied publishers, 1982.
7. Harry L. Stevart D.B, *Practical guide to fluid power*, Taraoeala sons and Port Ltd. Broadey, 1976.
8. Michael J, Prinches and Ashby J. G, *Power Hydraulics*, Prentice Hall, 1989.
9. Dudelyt, A. Pease and John T. Pippenger, *Basic Fluid Power*, Prentice Hall, 1987.

## 15IR16 SENSORS AND SIGNAL CONDITIONING

**3 0 0 3**

**Course Objectives**

- To study about the basics of sensors
- To gain knowledge about different types of sensors and signal conditioning
- To understand the Concepts of condition monitoring and identification

**Course Outcomes (COs)**

The student will be able to

1. Know about the different sensor and its applications.
2. Apply knowledge of sensors and condition monitoring

**Unit I**

**Science of Measurement**

Units and Standards – Calibration techniques –Errors in Measurements – Generalized Measurement System – Static and dynamic characteristics of transducers – Generalized Performance of Zero Order and First Order Systems - Response of transducers to different time varying inputs – Classification of transducers

**9 Hours**

**Unit II**

**Mechanical Measurements**

Temperature: Filled thermometer – Bimetallic thermometer – monometers – elastic transducers – bourdon gauge – bellows – diaphragm. Vacuum: McLeod gauge, thermal conductivity gauge –

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Ionization gauge, flow measurement: orifice, venture, nozzle, pilot tube, turbine flow meter, hot wire anemometer.

**9 Hours**

**Unit III**

**Electrical Measurements**

Resistive transducers – Potentiometer– RTD – Thermistor – Thermocouple – Strain gauges – use in displacement, temperature, force measurement – Inductive transducer – LVDT – RVDT – use in displacement – Capacitive transducer – Piezo electric transducer – Digital displacement transducers.

**9 Hours**

**Unit IV**

**Smart Sensors**

Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors – applications - Automobile, Aerospace, Home appliances, Manufacturing, Medical diagnostics, Environmental monitoring.

**9 Hours**

**Unit V**

**Signal Conditioning and Data Acquisition**

Amplification – Filtering – Sample and Hold circuits –Data Acquisition: Single channel and multi-channel data acquisition – Data logging.

**9 Hours**

**Unit VI**[$]

**Case Studies**

Temperature, Pressure, Vibration and displacement measurement using LabVIEW and Matlab .

**Total: 45 Hours**

**Reference(s)**

1. Doebelin. E. O., "*Measurement Systems – Applications and Design*", Tata McGraw Hill, 1992
2. Patranabis. D, "*Sensors and Transducers*", 2nd Edition PHI, New Delhi, 2003.
3. Ian SinclaIr .R "*Sensors and transducers*", Newnes, Elsevier Indian print 2011.
4. Beckwith, Marangoni and Lienhard, "Mechanical Measurements", Addison Wesley, 2000.
5. Venkatesan. S.P, "Mechanical Measurements", Ane Books Pvt Ltd, India 2008.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## 15IR18 FLUID POWER SYSTEM AND PLC LABORATORY

**0 0 4 2**

**Course Objectives**

- Introduction to fluid power systems
- Design and implementation of control systems
- Application of systems modeling and dynamic systems concept

**Course Outcomes (COs)**

The student will be able to

1. Familiarity with common hydraulic components, their use, symbols, and mathematical models
2. Ability to formulate and analyze simple mathematical models of hydraulic circuits
3. Ability to design, analyze and implement simple control systems

**List of Experiments**

1. Design and testing of speed control circuits –Meter in, Meter out
2. Design and testing of Electro-hydraulic circuit with pressure sequence valve
3. Speed control of hydraulic motor
4. Circuits with logic controls –AND valve and OR valve
5. Sequential circuit design with pneumatic timers
6. Circuits with multiple cylinder sequences -Pneumatic control, Electrical control & PLC control
7. Control of bottle filling plant using PLC
8. Control of double acting cylinder using PLC.
9. Development of PLC program timer and counter.
10. Development of PLC program using logic gates

**Total: 60 Hours**

## 15IR19 MICROCONTROLLER LABORATORY

**0 0 4 2**

**Course Objectives**

- To learn about the microcontroller 8051 programming
- To study about the interfacing devices

**Course Outcomes (COs)**

The student will be able to

1. Familiarity with the programming of 8051 microcontroller programs
2. Ability to interface 8051 microcontroller with external devices

**List of Experiments**

1. Multiplication of two numbers using MUL command using 8051 microcontroller kit
2. Division of two numbers using DIV command using 8051 microcontroller kit
3. Pick the smallest number among a given set of numbers using 8051 microcontroller kit
4. Pick the largest number among a given set of numbers using 8051 microcontroller kit
5. Arrange ‘n’ numbers in ascending order using 8051 microcontroller kit
6. Arrange ‘n’ numbers in descending order using 8051 microcontroller kit
7. Generate a specified time delay using 8051 microcontroller kit

8. Interface a ADC and a temperature sensor to measure temperature using 8051 microcontroller kit
9. Interface a DAC & Generate a stair case wave form – with step duration and no. of steps as variables using 8051 microcontroller kit
10. Flash a LED connected at a specified output port terminal using 8051 microcontroller.
11. Interface a stepper motor – and rotate it clock wise or anti clock wise through given angle steps using 8051 microcontroller kit

**Total: 60 Hours**

## 15GE19 BUSINESS ENGLISH I

**1 0 2 2**

**Course Objectives**

- To acquire skills for using English in workplace effectively.
- To communicate for essential business needs.
- To prepare students for taking BEC Vantage level examination which is an International Benchmark for English language proficiency of Cambridge English Language Assessment (CELA).

**Course Outcomes (COs)**

1. To enable students to get International recognition for work and study.
2. To use English confidently in the International business environments.
3. To be able to take part in business discussion, read company literature, write formal and informal business correspondences and listen and understand business conversations.

**Unit I**

**Grammar and Vocabulary**

Comparison of adjectives – forming questions – asking complex questions – expressing purpose and function – tenses – conditionals – time statements – modal verbs – active and passive voice – articles – direct and indirect speech – cause and effect – relative pronouns – expressions followed by – *ing* forms – countable / uncountable – acronyms – marketing terms / vocabulary – financial terms – collocations – discourse markers.

**10 Hours**

**Unit II**

**Listening**

Purposes of listening – features of listening texts – potential barriers to listening – specific listening skills – strategies to use when listening– distinguishing relevant from irrelevant information – gap filling exercise – multiple-choice options – note completion – matching and multiple choice questions – listening for specific information, gist, topic, context and function.

**7 Hours**

**Unit III**

**Speaking**

Word and sentence stress – clear individual sounds – turn taking – initiating and responding - intonation patterns – pronunciation – mother tongue intrusion– conversation practice – turn-taking and sustaining the interaction by initiating and responding appropriately.

**10 Hours**

**Unit IV**
**Reading**
Purposes of reading – potential barriers to reading – paraphrasing – identifying facts and ideas – skimming and scanning for information – matching statements with texts– spotting reference words – understanding text structure – understanding the ideas in a text – distinguishing between the correct answer and the distractor – understanding cohesion in a text – deciphering contextual meaning of words and phrases – cloze – proof reading - transcoding.

**8 Hours**

**Unit V**
**Writing**
Paragraphing a text – using appropriate connectives – editing practice –Longer Documents: writing a proposal.

**10 Hours**
**Total: 45 Hours**

**Reference(s):**
1. Guy Brook-Hart, "BEC VANTAGE: BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

## 15IR21 RESEARCH METHODOLOGY

**3 0 0 3**

**Course Objectives**
- To import the knowledge on analysis of Research methodology.
- The students will be able to estimate the performance of different testing method for research.

**Course Outcomes (Cos)**
1. The Students will be able to analysis the methods used for data collection hypothesis testing and sampling process for research methodology

**Unit I**
**Introduction**
Definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps.
Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

**9 Hours**

**Unit II**
**Sampling Methods**
Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non-probability sampling method – convenience sampling, judgment sampling, quota sampling.

**9 Hours**

**Unit III**

**Hypotheses Testing**

Testing of hypotheses concerning means -one mean and difference between two means -one tailed and two tailed tests, concerning variance – one tailed Chi-square test.

**9 Hours**

**Unit IV**

**Design of Experiments**

Introduction, Types - Full and Fractional factorial Design- Orthogonal Array Design - Taguchi techniques - Regression Models - Response Surface Methods.

**9 Hours**

**Unit V**

**Optimization and Report Writing**

Optimization – classification- methods- genetic, particle swarm and artificial bee colony algorithms. Report writing- Types of report, guidelines to review report and typing instructions - oral presentation.

**9 Hours**

**Unit VI**[$]

**Application**

Apply Research Methodology principles into design and manufacturing field.

**Total: 45 Hours**

**Reference(s)**

1. C.R. Kothari, *Research Methodology –Methods and techniques*, New Age Publications, New Delhi, 2009.
2. R. Panneerselvam, *Research Methodology*, Prentice-Hall of India, New Delhi, 2004.
3. K. Deb, *Optimization for Engineering Design Algorithms and Examples*, Prentice Hall of India Pvt. 2010.
4. Ashok D. Belegundu, R. Tirupathi and Chandrupatla, *Optimization Concepts and Applications in Engineering*, Pearson Education, 2014.
5. R. PanneerSelvam, *Design and Analysis of Experiments*, Prentice Hall India Learning Private Limited, 2012.
6. http://nptel.ac.in/courses/111105039/.

## 15IR22 MACHINE VISION SYSTEM

**3 0 0 3**

**Course Objectives**

- To learn the fundamentals of vision systems
- To understand the image recognition and retrieval algorithms
- To learn the concepts of object recognition and applications of vision systems.

**Course Outcomes (Cos)**

1. Able to know the basics concepts of vision systems.
2. To apply the vision concept of designing robots.
3. To use the algorithms to image processing

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Unit I**
**Vision System**
Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Compute interfaces

**9 Hours**

**Unit II**
**Vision Algorithms**
Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

**9 Hours**

**Unit III**
**Object Recognition**
Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

**9 Hours**

**Unit IV**
**Applications**
Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking.

**9 Hours**

**Unit V**
**Robot Vision**
Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to Open CV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to Open CV - The CV bridge Package.

**9 Hours**

**Unit VI**[$]
**Application**
Perceiving 3D from 2D Images, 3D Sensing and Object Pose Computation and Integration of a Machine Vision System

**Total: 45 Hours**

**Reference(s)**

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, "*Machine Vision Algorithms and Applications*", WILEY-VCH, Weinheim, 2008.
2. Damian M Lyons, "*Cluster Computing for Robotics and Computer Vision*", World Scientific, Singapore, 2011.
3. Rafael C. Gonzalez and Richard E. Woods, "*Digital Image Processing*", Addition - Wesley Publishing Company, New Delhi, 2007.
4. Shimon Ullman, "*High-Level Vision: Object recognition and Visual Cognition*", A Bradford Book, USA, 2000.
5. R.Patrick Goebel, "*ROS by Example: A Do-It-Yourself Guide to Robot Operating System* – Volume I", A Pi Robot Production, 2012.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## 15IR23 KINEMATICS AND DYNAMICS OF ROBOTS

**3 2 0 4**

**Course Objectives**

- To impart knowledge on direct and inverse kinematics of manipulator
- To understand the basic elements of serial and parallel robots
- To learn trajectory and motion analysis of robotic movements

**Course Outcomes (COs)**

1. Understanding of serial and parallel robots
2. Trajectory planning of robot motion
3. Knowing the controlling aspects of a robot

**Unit I**

**Introduction**

Introduction, position and orientation of objects, objects coordinate frame Rotation matrix, Euler angles Roll, pitch and yaw angles coordinate Transformations, Joint variables and position of end effector, Dot and cross products, coordinate frames, Rotations, Homogeneous coordinates.

**9 Hours**

**Unit II**

**Direct Kinematics**

Link coordinates D-H Representation, The ARM equation. Direct kinematic analysis for Four axis, SCARA Robot and three, five and six axis Articulated Robots.

**9 Hours**

**Unit III**

**Inverse Kinematics**

The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis, articulated robot.

**9 Hours**

**Unit IV**

**Workspace Analysis and Trajectory Planning**

Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning.

**9 Hours**

**Unit V**

**Manipulator Dynamics**

Introduction, Lagrange's equation kinetic and potential energy. Link inertia Tensor, link Jacobian Manipulator inertia tensor. Gravity, Generalized forces, Lagrange-Euler Dynamic model, Dynamic model of a Two-axis planar robot, Newton Euler formulation, Lagrange - Euler formulation, problems.

**9 Hours**

**Unit VI**[$]

**Case Studies**

Introduction to chaos, Non-linear dynamics and chaos in robot equations, Simulations of planar 2 DOF manipulators, Analytical criterion for unforced motion.

**Total: 45 +30 Hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Reference(s)**

1. Robert J. Schilling, *Fundamentals of Robotics Analysis and Control*, PHI Learning. 2009.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, *Robotics Engineering an Integrated Approach*, Phi Learning., 2009.
3. P.A. Janaki Raman, *Robotics and Image Processing An Introduction*, Tata Mc Graw Hill Publishing company Ltd., 1995.
4. Francis N-Nagy Andras Siegler, *Engineering foundation of Robotics*, Prentice Hall Inc., 1987.
5. Bernard Hodges, *Industrial Robotics*, Second Edition, Jaico Publishing house, 1993.
6. Tsuneo Yohikwa, *Foundations of Robotics Analysis and Control*, MIT Press. 2003.
7. John J. Craig, *Introduction to Robotics Mechanics and Control*, Third Edition, Pearson, 2008.
8. Bijay K. Ghosh, Ning Xi, T.J. Tarn, *Control in Robotics and Automation Sensor – Based integration*, Academic Press, 1999.

## 15IR24 INDUSTRIAL DRIVES

**3 2 0 4**

**Course Objectives**

- To create basic knowledge in the area of electrical drives
- To acquaint the students with the basic characteristics of induction motor drives
- To enhance the knowledge of the students in the area of variable reluctance drives

**Course Outcomes (COs)**

The student will be able to

1. Know the basics concepts of electric drives
2. Understand the concepts of induction motor drives
3. Know the characteristics of variable reluctance and brushless DC motor drives

**Unit I**

**Introduction**

Introduction to motor drives – Torque production – Equivalent circuit analysis – Speed – Torque Characteristics with variable voltage operation Variable frequency operation constant v/t operation – Variable stator current operation – Induction motor characteristics in constant torque and field weakening regions.

**9 Hours**

**Unit II**

**Stator Side Control of Induction Drives**

Scalar control – Voltage fed inverter control – Open loop volts/Hz control – speed control slip regulation – speed control with torque and flux control – current controlled voltage fed inverter drive – current – fed inverter control – Independent current and frequency control – Speed and flux control in Current –Fed inverter drive – Volts/Hz control of Current –fed inverter drive – Efficiency optimization control by flux program.

**9 Hours**

**Unit III**

**Rotor Side Control of Induction Drives**

Slip power recovery drives – Static Kramer Drive – Phasor diagram – Torque expression – speed control of Kramer Drive – Static Scheribus Drive – modes of operation.

**Vector control of Induction Motor Drives:** Principles of Vector control – Vector control methods – Direct methods of vector control – Indirect methods of vector control – Adaptive control principles – Self tuning regulator Model referencing control.

**9 Hours**

**Unit IV**

**Control of Synchronous Motor Drives**

Synchronous motor and its characteristics – Control strategies – Constant torque angle control – Unity power factor control – Constant mutual flux linkage control.

**Controllers:** Flux weakening operation – Maximum speed – Direct flux weakening algorithm – Constant Torque mode controller – Flux Weakening controller – indirect flux weakening – Maximum permissible torque – speed control scheme – Implementation strategy speed controller design.

**9 Hours**

**Unit V**

**Variable Reluctance Motor Drive**

Variable Reluctance motor drive – Torque production in the variable reluctance motor Drive characteristics and control principles – Current control variable reluctance motor service drive.

**Brushless DC Motor Drives:** Three phase full wave Brushless dc motor – Sinusoidal type of Brushless dc motor- current controlled Brushless dc motor Servo drive.

**9 Hours**

**Unit VI**[$]

**Application**

Dynamic simulations of the speed controlled DC motor drives – Speed feedback speed controller – command current generator – current controller

**Total: 45+30 Hours**

**Reference(s)**

1. Electric Motor Drives Pearson Modeling, Analysis and control – R. Krishnan – Publications – 1st edition – 2002.
2. Modern Power Electronics and AC Drives B K Bose – Pearson Publications 1st edition
3. Power Electronics and Control of AC Motors – MD Murthy and FG Turn Bull pergman Press 1st edition
4. Power Electronics and AC Drives – BK Bose – Prentice Hall Eagle wood diffs New Jersey - 1st edition
5. Power Electronic circuits Deices and Applications – M H Rashid – PHI – 1995.
6. Fundamentals of Electrical Drives – G. K. Dubey – Narora publications – 1995
7. Power Electronics and Variable frequency drives – BK Bose – IEEE Press – Standard publications - 1st edition – 2002.
8. Power Electronics and Motor Drives Advances and Trends, Bimal Bose, Elsevier.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## 12IR27 SENSORS AND ROBOTICS LABORATORY

**0 0 4 2**

**Course Objectives**

- Introduction to sensor and robotic systems
- Design and implementation of control systems
- Application of systems modeling and dynamic systems concept using different sensors

**Course Outcomes (COs)**

The student will be able to

1. Familiarity with common sensor, their use and symbols.
2. Ability to formulate and analyze simple mathematical models of signal conditioning circuits
3. Ability to design, analyze and implement simple control systems

**List of Experiments**

1. Temperature Measurement using thermistor, thermocouple and RTD using LabVIEW
2. Load Cell Measurement using LabVIEW
3. Strain Measurement using LabVIEW
4. Displacement Measurement using LVDT using LabVIEW
5. Vibration Measurement using Accelerometer using LabVIEW
6. ADC and DAC.
7. Speed and Position Control of Servo Moto using LabVIEW
8. Offline Programming: The previously modeled SCARA robot is then programmed offline, also using the industrial robot simulation system.
9. Forward and Inverse Kinematics: The forward and inverse kinematics of the SCARA robot are derived and calculated in a small C++ Programme.
10. Motion Planning: A small motion planning module for the SCARA robot has to be implemented that can be checked in the framework of the simulation system. The path type to implement in C++ is synchronized point-to-point movement.
11. Programming a parallel kinematic robot for a pick and place application

**Total: 60 Hours**

## 15GE29 BUSINESS ENGLISH II

**1 0 0 1**

**Course Objectives**

- To acquire skills for using English in business environment.
- To communicate appropriately in business contexts.
- To prepare students for taking BEC Vantage level examination conducted by the Cambridge English Language Assessment (CELA).

**Course Outcomes (COs):**

1. To enable students to acquire business terms for communication.
2. To use English confidently in the business contexts.
3. To be able to take part in business discussion and write formal and informal business correspondences.

**Unit I**

**Speaking**

Non-verbal communication – agreeing / disagreeing, reaching decisions, giving and supporting opinions – making mini presentations – extending on conservations – collaborative task – tongue twisters.

**6 Hours**

**Unit II**

**Writing**

Business letters – fax – Shorter Documents: e-mail - memo – message - note – report writing – formal / informal styles.

**9 Hours**

**Total: 15 Hours**

**Reference(s)**

1. Guy Brook-Hart, "BEC VANTAGE: BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

## 15IR51 MODERN MATERIAL HANDLING SYSTEMS

**3 0 0 3**

**Course Objectives**

- To understand the latest material handling system used in industry.
- To study about the concept of Automated Guided Vehicle System

**Course Outcomes (COs)**

At the end of this course, students are able to:

1. Demonstrate knowledge on various material handling equipment used both in automated and non-automated systems
2. Analyze and select a suitable material handling system for the given application

**Unit I**

**Introduction**

Material Handling – Functions, Types, analysis, Importance & Scope, Principles, - Part feeding device – types of material handling system – Unit material movement & Unit loads – Receiving, Shipping, in process handling – bulk handling equipment & methods.

**9 Hours**

**Unit II**

**Material Handling Equipment**

Industrial trucks, lifting device, monorails, manipulators, conveyors, storage systems, elevators, racks, bins, pallets, cranes – Automation of material handling – mechanization of part handling.

**9 Hours**

**Unit III**

**Automated Guided Vehicle System**

Types of AGV's – Guidance techniques – Painted line, wire guided, vision guided method – Applications – Vehicle guidance & routing – Traffic control & safety – system management – Quantitative analysis of AGV system.

**9 Hours**

**Unit IV**

**Storage System**

Conveyor systems – types, Quantitative relationship & analysis – Automated storage system, performance – AS/RS system – Basic components, types, controls, features, applications, Quantitative analysis – carousel storage system – applications.

**9 Hours**

**Unit V**

**Robotics in Material Handling**

General considerations in robot material handling – material transfer application – pick & place operations – machine loading & unloading – characteristics of robot application.

**9 Hours**

**Unit VI**[$]

**Application**

Methods of protecting materials for packages - auxiliary equipment's -automated identifications systems

**Total: 45 Hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Reference(s)**

1. Mikell P. Groover, *Automation Production Systems and Computer Integrated Manufacturing*, PHI Learning Private Ltd, 2008.
2. Mikell P Groover, Mitchel Weiss and Ashish Dutta, *Industrial Robotics*, McGraw Hill Publications, 2014.
3. *Material Handling Handbook*, Institution of Mechanical Engg. Associate (data) Publishers P Ltd, 1996.
4. C Ray Asfahl, *Robots and Manufacturing Automation*, Wiley India, 2012.
5. Charles D Reese, *Material Handling Systems*, Taylor And Francis, 2000,

## 15IR52 COMPUTER INTEGRATED MANUFACTURING SYSTEMS

**3 0 0 3**

**Course Objectives**

- To learn the basics of CAD/CAM integration and concept of the group technology
- To have a exposure to various automation principles
- To know the network management and installation and the DBMS concepts

**Course Outcomes(COs)**

At the end of this course, students are able to:

1. Understand about the group technology and CAPP
2. Understand about the flexible manufacturing system

**Unit I**

**Introduction**

The meaning and origin of CIM- the changing manufacturing and management scene – External communication - islands of automation and software-dedicated and open systems-manufacturing automation protocol – introduction to CAD/CAM integration - Reliability and precision in automation

**9 Hours**

**Unit II**

**Group Technology and Computer Aided Process Planning**

History of group technology- role of G.T. in - part families - classification and coding - DCLASS and MICLASS and OPITZ coding systems-facility design using G.T. - benefits of G.T-cellular manufacturing. Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning - variant approach and generative approaches - CAPP and CMPP process planning systems - Facility layout planning

**9 Hours**

**Unit III**

**Shop Floor Control and Flexible Manufacturing System (FMS)**

Shop floor control-phases -factory data collection system -automatic identification methods - Bar code technology-automated data collection system. FMS-components of FMS - types -FMS workstation material handling and storage systems- FMS layout –computer control systems-application and benefits - introduction to as/rs

**9 Hours**

**Unit IV**

**CIM Implementation and Data Communication**

CIM and company strategy - system modeling tools -IDEF models - activity cycle diagram CIM open system architecture (CIMOSA) - manufacturing enterprise wheel-CIM architecture- Product data

management - CIM implementation-software. Communication fundamentals- local area networks topology –LAN implementations –network management and installations, PDM Tools.

**9 Hours**

**Unit V**

**Open System and Database for CIM**

Open systems-open system inter-connection - manufacturing automations protocol and technical office protocol-(MAP/TOP).Development of databases -database terminology- architecture of database systems-data modeling and data associations -relational data bases - database operators.

**9 Hours**

**Unit VI**[$]

**Case Studies**

Advantages of data base and relational database, OSI model-different types of layer

**Total: 45 Hours**

**Reference(s)**

1. Mikell. P. Groover, *Automation, Production Systems and computer integrated manufacturing*, Prentice Hall of India, New Delhi, 2012.
2. P. Radhakrishnan , S. Subramanyan and V. Raju, *CAD/CAM/CIM*, New Age International (P) Ltd., New Delhi, 2012.
3. S. Kant Vajpayee, *Principles of Computer Integrated Manufacturing*, Prentice Hall of India, 2010.
4. Roger Hanman, *Computer Integrated Manufacturing*, Addison – Wesley, 1995.
5. Mikell. P. Groover and Emory Zimmers Jr., *CAD/CAM*, Prentice Hall of India, New Delhi 2010.

## 15IR53 PROCESS AUTOMATION

**3 0 0 3**

**Course Objectives**

- To impart knowledge on Process automation,
- To create expertise in the field of process automation using PLC, DCS and SCADA.

**Course Outcomes (COs)**

1. Able to select the appropriate controller for a particular application.
2. Designing various controllers used in the industries.
3. Designing safety instrumented systems.

**Unit I**

**Automation Fundamentals**

Automation and its importance, automation applications, expectations of automation. Types of plant and control – categories in industry, open loop and close loop control functions, continuous processes, discrete processes, and mixed processes. Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control. Control system architecture – evolution and current trends, comparison of different architectures.

**9 hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Unit II**

**Programmable Logic Controller Hardware**

Evolution of PLC, Definition, functions of PLC, Advantages, Architecture, working of PLC, Scan time, Types & Specifications. DI-DO-AI-AO examples and ratings, I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules, Memory & addressing- memory organization (system memory and application memory), I/O addressing, hardware to software interface.

**Software-** Development of Relay Logic Ladder Diagram, introduction to PLC Programming, programming devices, IEC standard PLC programming languages, LD programming- basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC instructions.

**9 hours**

**Unit III**

**Distributed Control System**

Introduction to DCS – Evolution of DCS, DCS flow sheet symbols, architecture of DCS – controller, Input and output modules, communication module, data highway, local I/O bus, workstations, specifications of DCS. Introduction to Hierarchical Control and memory: Task listing, Higher & Lower Computer level tasks. Supervisory computer tasks and DCS configuration –Supervisory Computer functions, Control techniques, Supervisory Control Algorithm, DCS & Supervisory Computer displays, advanced control Strategies, Computer interface with DCS. DCS – system integration with PLCs and computer: Man machine interface- sequencing, supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, links between networks.

**9 hours**

**Unit IV**

**Supervisory Control and Data Acquisition (SCADA)**

SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA, MTU- functions of MTU, RTU- Functions of RTU, Protocol Detail SCADA as a real time system, and Communications in SCADA- types & methods used, components, Protocol structure and Mediums used for communications.

**9 hours**

**Unit V**

**Safety Instrumented System (SIS)**

Need for safety instrumentation- risk and risk reduction methods, hazards analysis. Process control systems and SIS. Safety Integrity Levels (SIL) and availability. Introduction to the international functional safety standard IEC61508.

**9 hours**

**Unit VI**[$]

**Applications**

SCADA Development for any one typical application, PID Control using PLC.

**Total: 45 Hours**

**Reference(s)**

1. Samuel M. Herb, "Understanding Distributed Processor Systems for Control", ISA Publication.
2. Thomas Hughes, "Programmable Logic Controller", ISA Publication.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

3. Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication.
4. Gruhn and Cheddie, "*Safety Shutdown Systems"* – ISA, 1998,
5. Poppovik Bhatkar, "Distributed Computer Control for Industrial Automation", Dekkar Publication.
6. S.K.Singh, "Computer Aided Process Control", Prentice Hall of India.
7. Krishna Kant, "Computer Based Process Control", Prentice Hall of India
8. N.E. Battikha, "The Management of Control System: Justification and Technical Auditing", ISA.
9. Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.

## 15IR54 MODELING, SIMULATION AND ANALYSIS OF MANUFACTURING SYSTEM

**3 0 0 3**

**Course Objectives**

- To study basic principles of modelling.
- To use modern approaches to complex systems.
- To use statistical techniques to compare two system designs

**Course Outcomes(COs)**

1. To apply statistical approach for quality problems
2. Ability to generate the random variable for various testing's
3. Acquire more knowledge on modelling and simulation

**Unit I**

**Principles of Modeling & Simulation**

Basic Simulation Modeling, When simulation is appropriate, When simulation is not appropriate, Advantages and disadvantages and pit falls of Simulation, Monte - Carlo Simulation, Areas of Applications, Discrete and Continuous Systems, Modeling of a system, Types of Models, Discrete event simulation.

**9 Hours**

**Unit II**

**Modeling Approaches**

Modeling Complex Systems, List processing in simulation, Simple simulation language, Single server queuing systems, Time shared computer model, Multiteller banking with jockeying, Job shop model.

**9 Hours**

**Unit III**

**Random Number Generation**

Basic Probability and Statistics-Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for generating random numbers, Various tests for random numbers-frequency test and test for Autocorrelation.

**9 Hours**

**Unit IV**

**Random Variate Generation**

Introduction, different techniques to generate random Variate: Inverse transform technique,- exponential, Normal, uniform, Weibull, direct transformation technique for normal and log normal distribution, convolution method and acceptance rejection techniques-Poisson distribution.

**9 Hours**

**Unit V**

**Statistical Techniques**

Comparison of two system designs, Comparison of several system designs – Bonferroni approaches to multiple comparisons for selecting best fit, for screening, Variance reduction Techniques such as simple linear regression, multiple linear regression.

**9 Hours**

**Unit VI**[$]

**Case Studies**

Examples of QN models in manufacturing – Little's law in queuing networks – Tandem queue – An open queuing network with feedback

**Total: 45 Hours**

**Reference(s)**

1. Simulation, Modeling and Analysis –Averill Law & David M.Kelton, TMH, 4th Edition, 2007.
2. Discrete event and Simulation Systems – Banks & Carson, Prentice Hall Inc, 4th edition, 2011.
3. System Simulation- Gordon, PHI, 2nd edition, 2009
4. Probability and statistics for engineers – Richard A. Johnson, Prentice hall, 7th edition, 2006

## 15IR55 DESIGN OF INTELLIGENT ROBOTICS SYSTEM

**3 0 0 3**

**Course Objectives**

- To acquire knowledge about Computer Integrated Manufacturing Systems.
- To learn about the concept of Knowledge Based System
- To acquire knowledge about Machine learning and Automated Process Planning

**Course Outcomes (COs)**

1. Usage of neural network in various application of manufacturing
2. Selection of suitable approach in process planning
3. Know about the importance of computer in automated manufacturing

**Unit I**

**CIM**

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

**9 Hours**

**Unit II**

**Components of Knowledge Based Systems.**

Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

**9 Hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Unit III**

**Machine Learning**

Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

**9 Hours**

**Unit IV**

**Automated Process Planning**

Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approaches in KBSES, Structure of the KRSES.

**9 Hours**

**Unit V**

**Group Technology**

Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System.

**9 Hours**

**Unit VI**[$]

**Applications**

Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning

**Total: 45 Hours**

**Reference(s)**

1. Andrew Kusiak, *Intelligent Manufacturing Systems*, Prentice Hall, 1990.
2. Yagna Narayana, *Artificial Neural Networks*, PHI, 2006.
3. Groover M.P, *Automation, Production Systems and CIM*, PHI, 2007.
4. Simon Hhaykin, *Neural networks: A comprehensive foundation,* PHI, 1999.
5. B.Yegnanarayana, *Artificial neural networks,* PHI, 2006.
6. Li Min Fu, Neural networks in Computer intelligence, TMH, 2003.
7. James A, Freeman David M S, kapura, *Neural networks,* Pearson education, 2004.

## 15IR56 VIRTUAL INSTRUMENTATION

**3 0 0 3**

**Course Objectives**

- To understand basic concepts of virtual instrumentation, programming techniques, data acquisition and interfacing techniques
- To understand about the virtual instrumentation for different application.

**Course Outcomes (COs)**

The student will be able to

1. Know the basics concepts of instrumentation
2. Apply the VI tools to complete the task
3. Differentiate the usage of virtual tool from the physical component

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Unit I**

**Review of Digital Instrumentation**

Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC.

**9 Hours**

**Unit II**

**Fundamentals of Virtual Instrumentation**

Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs.

**9 Hours**

**Unit III**

**Cluster of Instruments in VI System**

Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.

**9 Hours**

**Unit IV**

**Graphical Programming Environment in VI**

Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O.

**9 Hours**

**Unit V**

**Analysis Tools and Simple Applications in VI**

Fourier transform - Power spectrum – Correlation - Windowing and filtering tools - Simple temperature Indicator - ON/OFF controller – PID controller.

**9 Hours**

**Unit VI**[$]

**Applications**

CRO emulation - Simulation of a simple second order system - Generation of HTML page.

**Total: 45 Hours**

**Reference(s)**

1. S. Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control', Instrument society of America, 1994.
2. Peter W. Gofton, 'Understanding Serial Communications', Sybex International.
3. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003.
4. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newness, 2000.
5. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw Hill Professional Publishing, 2001.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## 15IR57 AUTOMATIC CONTROL SYSTEM

**3 0 0 3**

**Course Objectives**

- To apply knowledge of mathematics, science and engineering.
- To use the analysis and design tools of classical linear control.
- To use modern computer tools such as Matlab tools to solve control problems.

**Course Outcomes (COs)**

The student will be able to

1. Know the basics concepts nonlinearity
2. Application of state space on modelling
3. Design the controller for automated systems

**Unit I**

**Introduction**

Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function - Modeling of physical systems – Mechanical, Thermal, Hydraulic systems and Electric Networks - Transfer function of DC generator, DC servomotor, AC servomotor ,Potentiometer, Synchros, Tachogenerator, Stepper motor - Block diagram - reduction techniques, Signal flow graph – Mason‟ gain formula. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

**9 Hours**

**Unit II**

**Time domain analysis**

Standard Test signals – Time response of second order system - Time domain specifications - Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feedback control. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

**9 Hours**

**Unit III**

**Frequency domain analysis**

Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

**9 Hours**

**Unit IV**

**System stability**

Characteristic equation - Routh Hurwitz criterion of stability - Absolute and Relative stability - Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

**9 Hours**

**Unit V**

**Root locus method**

Root locus concepts - Construction of root loci – Root contours.

**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.

**9 Hours**

**Unit VI**[$]
**Applications**
Tutorials Using MATLAB/ Simulink – Toolboxes & Functions related to state space analysis and root locus method.

**Total: 45 Hours**

**Reference(s)**
1. Norman Nise S, "Control system Engineering", John Wiley & Sons, New Delhi,2013
2. Nagrath I J, and Gopal, M, 'Control Systems Engineering" Prentice Hall of India, New Delhi, 2008.
3. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007
4. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.
5. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.

## 151R58 COMMUNICATION PROTOCOLS

**3 0 0 3**

**Course Objectives**
- To study the network reference model for the communication Protocol engineering process.
- To study the Protocol specifications, verification and Validation process.
- To study the performance testing, synthesis and implementation of the Protocols.

**Course Outcomes (COs)**
The student will be able to
1. To become familiar with Network technologies and Network models
2. Ability to analyze improved data services in communication

**Unit I**
**Network Reference Model**
Communication model, software, subsystems, protocol, protocol development methods, Protocol engineering process, Layered architecture, Network services and Interfaces, Protocol functions, OSI model, TCP/IP protocol suite.

**9 Hours**

**Unit II**
**Protocol Specifications**
Components of protocol, Specifications of Communication service, Protocol entity, Interface, Interactions, Multimedia protocol, Internet protocol, SDL, SDL based protocol, other protocol specification languages.

**9 Hours**

**Unit III**
**Protocol Verification/Validation**
Protocol verification, Verification of a protocol using finite state machines, Protocol validation, protocol design errors, Protocol validation approaches, SDL based protocol verification and validation.

**9 Hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Unit IV**

**Protocol Conformance/Performance Testing**

Conformance testing methodology and frame work, Conformance test architectures, Test sequence generation methods, Distributed architecture by local methods, Conformance testing with TTCN, systems with semi controllable interfaces - RIP,SDL based tools for conformance testing, SDL based conformance testing of MPLS Performance testing, SDL based performance testing of TCP and OSPF.

**9 Hours**

**Unit V**

**Protocol Synthesis and Implementation**

Protocol synthesis, Interactive synthesis algorithm, Automatic synthesis algorithm, Automatic synthesis of SDL from MSC, Protocol Re-synthesis; Requirements of protocol implementation, Object based approach to protocol implementation, Protocol compilers, Tool for protocol engineering.

**9 Hours**

**Unit VI**[$]

**Applications**

Interoperability testing, SDL based interoperability testing of CSMA/CD and CSMA/CA protocol using Bridge, Scalability testing.

**Total: 45 Hours**

**Reference(s)**

1. Pallapa Venkataram and Sunilkumar S.Manvi, "Communication protocol engineering", Eastern Economy edition, 2004.
2. Richard Lai and Jirachiefpattana, "Communication Protocol Specification and Verification", Kluwer Publishers, Boston, 1998.
3. Tarnay, K., "Protocol Specification and Testing", Plenum, New York, 1991.
4. Mohamed G. Gouda, "Elements of Network Protocol Design", John Wiley & Sons, Inc. New York, USA, 1998.

## 15IR59 RAPID MANUFACTURING

**3 0 0 3**

**Course Objectives**

- To learn the fundamentals of CNC machines, the concepts of control systems, Feedback devices and tooling.
- To understand the constructional features of CNC machines and CNC part programming.
- To understand the entire process of direct manufacturing from the creation of computer based models to their physical realization by various methods of manufacturing

**Course Outcomes (COs)**

At the end of this course, students are able to:

1. Demonstrate various parts of a CNC machine and its control system
2. Write simple part programming
3. Explain the three methods of rapid prototyping process

**Unit I**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**CNC Machines and Components**

Introduction to Computer Numerical Control: CNC Systems – Features of CNC Machines - Factors influencing selection of CNC Machines: Structure, Drive Mechanism, gearbox, Main drive, feed drive, Spindle Motors, Axes motors. Timing belts and pulleys, Spindle bearing – Slide ways - Re - circulating ball screws – Backlash measurement and compensation, linear motion guide ways. Tool magazines and ATC

**9 Hours**

**Unit II**

**Control Systems, Feed Back Devices and Tooling**

Description of a simple CNC control system. Interpolation systems. Features available in a CNC system – introduction to some widely used CNC control systems. Types of measuring systems in CNC machines – Incremental and absolute rotary encoders, linear scale – resolver – Linear inductosyn – Magnetic Sensors for Spindle Orientation.

**9 Hours**

**Unit III**

**CNC Part Programming**

Part Program Terminology - G and M Codes – Types of interpolation Methods of CNC part programming – Manual part programming – Computer Assisted part programming – APT language – CNC part programming using CAD/CAM-Introduction to Computer Automated Part Programming.

**9 Hours**

**Unit IV**

**Introduction to RPT**

Need for time compression in product development, Product development – conceptual design – development – detail design – prototype –RP Data Formats - Information flow in a RP system - Generation of STL file- Steps in RP- Factors affecting RP process - Materials for RP.

**9 Hours**

**Unit V**

**RPT Processes**

Classification of RP systems, Stereo lithography systems – Principle – process parameters – process details - Application of stereo lithography in bio-medical engineering - Fusion Deposition Modeling – Principle – process parameters – process details - Applications - Laminated Object Manufacturing – Principle – process parameters – process details – Applications - 3D printers – Principle – process parameters – process details

**9 Hours**

**Unit VI**[$]

**Applications**

Applications of RP- RP in Indian scenario - Introduction to rapid tooling – Direct and indirect method

**Total: 45 Hours**

**Reference(s)**

1. Yoram Koren, *Computer Control of Manufacturing Systems*, Tata McGraw-Hill Publishing Company, 2009.
2. Radhakrishnan P., *Computer Numerical Control Machines*, New Central Book Agency, 2001.
3. James Madison, *CNC Machining Handbook: Building*, Industrial Press , 2011.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

4. Mikell P. Groover, *Automation Production Systems and Computer Integrated Manufacturing*, PHI Learning Private Ltd, 2008.
5. Frank W Liou, *Rapid Prototyping and Engineering Applications*, CRC Taylor and Francis, 2011.
6. C K Chuak, F Leongc and S Lim, *Rapid Prototyping*, Yes Dee Publishing, 2014.
7. Journal of Manufacturing Science and Engineering, vol. 19, Nov 1997, pp: 811-815.

## 15IR60 INDUSTRIAL ROBOTICS

**3 0 0 3**

**Course Objectives**

- To acquire knowledge about robot kinematics and dynamics
- To study the techniques of robot drives and transmission and to study the techniques used in manipulator designs
- To execute and design a robot for any application

**Course Outcomes (COs)**

At the end of this course, students are able to:

1. Demonstrate various parts of a CNC machine and its control system
2. Write simple part programming
3. Explain the three methods of rapid prototyping process

**Unit I**

**Introduction**

History of service robotics – Present status and future trends – Need for service robots - applications- examples and Specifications of service and field Robots. Non-conventional - Industrial robots.

**9 Hours**

**Unit II**

**Localization**

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte Carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization.

**9 Hours**

**Unit III**

**Field Robots**

Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

**9 Hours**

**Unit IV**

**Humanoids**

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Tactile Sensing, Models of emotion and motivation.

**9 Hours**

**Unit V**

**Industrial Robots**
Material transfer, Machine loading, Assembly, NDE inspection & applications, Mobile Robots. Robot safety and robustness, Human activity recognition using vision, touch, sound, Vision

**9 Hours**

**Unit VI**[$]
**Case Studies**
Performance, Interaction, Applications, Case studies related humanoids and field robotics.

**Total: 45 Hours**

**Reference(s)**

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, 'Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004
2. Riadh Siaer, 'The future of Humanoid Robots- Research and applications',Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011.

## 15IR61 MECHATRONICS IN MANUFACTURING SYSTEM

**3 0 0 3**

**Course Objectives**

- To know about the various types of sensors and selection procedures.
- To study about the types of actuators used in Mechatronic systems.
- To understand the operation of Programmable Logic Controllers.

**Course Outcomes (COs)**
The student will be able to

1. Understanding the fundamental of robotic system, hydraulic and pneumatic systems
2. Acquiring basic knowledge on microprocessors and PLC for various applications

**Unit I**
**Introduction**
Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems – Control Systems.

**9 Hours**

**Unit II**
**Sensors and Transducers**
Introduction - Performance Terminology – Potentiometers - LVDT – Capacitance sensors - Strain gauges - Eddy current sensor - Hall Effect sensor – Temperature sensors - Light sensors - Selection of sensors - Signal processing.

**9 Hours**

**Unit III**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Actuators**
Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magnetostrictive - Shape memory alloy - applications - selection of actuators.

**9 Hours**

**Unit IV**
**Programmable Logic Controllers**
Introduction - Basic structure - Input and output processing - Programming -Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC.

**9 Hours**

**Unit V**
**Design and Mechatronics Case Studies**
Designing - Possible design solutions-Traditional and Mechatronics design concepts- Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine.

**9 Hours**

**Unit VI**[$]
**Applications**
Manufacturing systems and automated production lines, automated assembly systems and quality control and support systems.

**Total: 45 Hours**

**Reference(s)**

1. Bolton.W, "Mechatronics", Pearson education, second edition, fifth Indian Reprint, 2003
2. Smaili.A and Mrad.F, "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
3. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing Company, 2007.
4. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
5. Nitaigour Premch and Mahalik, "Mechatronics Principles, Concepts and applications" Tata McGraw-Hill Publishing Company Limited, 2003.
6. Michael B.Histand and Davis G.Alciatore,"Introduction to Mechatronics and Measurement systems". McGraw Hill International edition, 1999.
7. Bradley D.A, Dawson.D, Buru N.C and Loader A.J, "Mechatronics" Nelson Thornes Ltd, Eswar press, Indian print, 2004.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## 15IR62 FIELD AND SERVICE ROBOTS

**3 0 0 3**

**Course Objectives**

- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study the control of robots for some specific applications.

**Course Outcomes (COs)**

The student will be able to

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

**Unit I**

**Introduction**

History of service robotics – Present status and future trends – Need for service robots - applications-examples and Specifications of service and field Robots. Non-conventional Industrial robots.

**9 Hours**

**Unit II**

**Localization**

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization-Monte Carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization.

**9 Hours**

**Unit III**

**Planning and Navigation**

Introduction-Path planning overview- Road map path planning- Cell decomposition path planning-Potential field path planning-Obstacle avoidance - Case studies: tiered robot architectures.

**9 Hours**

**Unit IV**

**Field Robots**

Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

**9 Hours**

**Unit V**

**Humanoids**

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing.

**9 Hours**

**Unit VI**[$]

**Applications**

Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies

**Total: 45 Hours**

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

**Reference(s)**

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004
2. Riadh Siaer, „The future of Humanoid Robots- Research and applications", Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011.

## 15IR63 MICRO ELECTRO MECHANICAL SYSTEM

**3 0 0 3**

**Course Objectives**

To acquire a knowledge about fabrication process in MEMS

- To know about various etching techniques in micromachining
- To have a knowledge about applications in micromachining techniques

**Course Outcomes (COs)**

The student will be able to

1. Know the different materials used in MEMS devices
2. Design the MEMS devices
3. Understand the micro system packaging techniques

**Unit I**

**Introduction**

Introduction to MEMS: Introduction to Microsystems and microelectronics – Market scenario for MEMS. Working principle: Trimmer's scaling vector and scaling laws - scaling in geometry – scaling in rigid body dynamics– scaling in electrostatic forces – scaling in electricity - scaling in fluid mechanics – scaling in heat transfer. Materials for MEMS: Silicon as a MEMS material – Crystal structure of silicon – Miller indices - silicon compounds – $SiO_2$, SiC, $Si_3N_4$ and polycrystalline silicon – silicon piezo-resistors - Gallium arsenide - polymers for MEMS – quartz. Use of gold and other metals in MEMS. MEMS devices for automotive applications

**9 Hours**

**Unit II**

**Fabrication of MEMS**

Clean room technology - Substrates and wafer – single crystal silicon wafer formation – ideal substrates – mechanical properties – Processes for bulk micro machining – Wet Vs dry etching - Chemical etching of Silicon – etchant systems and etching process – Reactive ion etching and DRIE - mask layout design. Processes for Surface micromachining – Deposition processes - ion implantation – Diffusion – oxidation – chemical vapor deposition – physical vapor deposition – deposition by epitaxy – photolithography and photoresists. Limitations of Bulk and surface micromachining – LIGA, SLIGA and other micro molding processes such as HeXIL.

**9 Hours**

**Unit III**

**Design Considerations based on Micromechanics**

Micromechanics considerations – static bending of thin plates – circular plates with edge fixed – rectangular plate with all edges fixed – square plate with all edges fixed – mechanical vibration – resonant vibration – micro accelerometers – design theory and damping coefficients – thermo

mechanics – thermal stresses – fracture mechanics – stress intensity factors – fracture toughness – and interfacial fracture mechanics.

**9 Hours**

**Unit IV**

**MEMS Devices**

Micro actuation techniques – piezoelectric crystals – Shape memory alloys – bimetallics - conductive polymers. Micro motors – micro grippers - Microfluidic devices - Micro pumps – mechanical and non-mechanical micro pumps - micro valves – valve less micro pumps – Lab on Chip. Types of micro sensors – Micro accelerometer.

**9 Hours**

**Unit V**

**Micro system packaging**

Materials die level device level – system level – packaging techniques – die preparation – surface bonding – wire bonding – sealing – Case studies. Design considerations – process design — mechanical design – applications of micro system in automotive – bio medical – aerospace - telecommunication industries.

**9 Hours**

**Unit VI**[$]

**Case Studies**

Micro pressure sensors, MEMS switches/resonators, MEMS reliability. Optical MEMS devices.

**Total: 45 Hours**

**Reference(s)**

1. Mohamed Gad-el-Hak, *The MEMS Handbook*, CRC Press Publishers, India, 2002.
2. Tai Ran Hsu, *MEMS and Micro Systems Design and Manufacture*, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. Nadim Maluf, *An Introduction to Micro Electro Mechanical System Design*, Artech House Publishers, London, 2004.
4. Chang Liu, *Foundations of MEMS*, Pearson Education, New Delhi, 2011.
5. James J. Allen, *Micro Electro Mechanical System Design*, CRC Press Publishers, India, 2005.
6. Julian w. Gardner, Vijay K. Varadan and Osama O. Awadelkarim, *Micro sensors MEMS and smart Devices*, John Wiley and Sons Ltd., England, 2002.
7. E.H. Tay, Francis and W.O.Choong, *Micrfluids and Bio MEMS applications*, Springer, 2002.

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

## ONE CREDIT COURSES

### 15IRXA DESIGN OF EXPERIMENTS

**1 0 0 1**

**Course Objectives**

- To understand the details of various design methods
- To understand the details of factorial design
- To know the concept of regression models
- Students will be able to conduct research effectively

**Course Outcomes (COs)**

1. Student able to understand the relationship between cause and effect
2. Students can understand the interactions among causative factors

Guidelines for designing experiments - applications of experimental design - Sampling and Sampling Distributions - Randomized Designs - Experiments with a Single Factor Design - Analysis of Variance - Model Adequacy Checking - Determining Sample Size - Regression Approach to the Analysis of Variance - Factorial Designs - Two-Factor Factorial Design - General Factorial Design - Blocking in a Factorial Design - 2k Factorial Design - Block Designs - Three-Level and Mixed-Level Factorial and Fractional Factorial Designs - Regression Models – Linear – Parameters - Hypothesis Testing in Multiple Regression - Confidence Intervals - Prediction of New Response Observations - Regression Model Diagnostics - Testing for Lack of Fit.

**Total: 20 Hours**

**Reference(s)**

1. www.wiley.com/college/montgomery
2. Phillip J. Ross, Taguchi Techniques for Quality Engineering, McGraw Hill Professional, New Delhi, 1996
3. Jiju Antony, Design of Experiments for Engineers and Scientists, Butterworth-Heinemann, USA, 2003
4. http://www.inderscience.com/browse/index.php?journalID=351&year=2009&vol=1&issue=1
5. http://www.emeraldinsight.com/journals.htm?articleid=840145
6. http://www.statease.com/articles.html

## 15IRXB SHOP FLOOR SAFETY

**1 0 0 1**

**Course Objectives**

- To study the various aspects of safety
- To practically study the various safety system related to human and machine safety

**Course Outcomes (COs)**

1. Students can be able understand the need of safety
2. Students can undergo maintenance activities related to machine safety

Definition of Man and machine safety, En standards on machine safety, Safety design in machinery, Safety component, Positive break, Performance level in safety, Design of performance level of a machine, Solenoid interlock, Two Hand Control system, Pull Chord Switches, Zero Speed relay, Opto electronic safety devices, Tactile safety devices, Safety relay and its uses, Intrinsic safe zone, Ex-proof Products, Safety controllers and safety systems.

**Total: 16 Hours**

**Reference(s)**

1. Hans M. Soekkha., "Aviation Safety: Human Factors - System Engineering, Flight Operations - Economics, Strategies - Management", CRC Press., New York, 1997.
2. David Macdonald., "Practical Machinery Safety", Tata McGraw-Hill., New York, 1995.