**ANNA UNIVERSITY, CHENNAI**
**NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY**
**M.E. MECHATRONICS**
**REGULATIONS 2021**
**CHOICE BASED CREDIT SYSTEM**
**I TO IV SEMESTERS CURRICULA & SYLLABI**

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

I. To create a high qualified mechatronics engineer, who have ability to design, develop and analyze the mechatronic system and provide optimal solutions with basic and advanced technology for industrial and societal problems.
II. To develop innovative and sustainable products with multidisciplinary expertise.
III. To develop a successful entrepreneur in their field with strong communication and high ethics.
IV. To develop industry readiness engineer with complex solving capability and lifelong learning.
V. To develop high employability in industry and academia.

**PROGRAMME OUTCOMES (POs):**

| PO | Programme Outcome |
|---|---|
| 1 | An ability to independently carry out research/investigation and development work to solve practical problems |
| 2 | An ability to write and present a substantial technical report/document |
| 3 | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. |
| 4 | Post Graduates able to acquaint the knowledge in key concepts, methods, core elements, design, modern tools and techniques for unified mechatronic systems and their intelligence. |
| 5 | Post Graduates will apply to develop the solution for various engineering system needs using a mechatronics-based approach. |
| 6 | Post Graduates able to build the real-time/virtual mechatronics system within realistic constraints such as industrial, economic, environmental, ethical, social, health and safety aspects. |

**PEO & PO Mapping**

| | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| I. | 3 | - | - | 2 | 2 | 3 |
| II. | 2 | - | - | 1 | 1 | 3 |
| III. | - | 3 | 2 | - | - | 1 |
| IV. | 2 | - | 1 | 1 | 1 | 1 |
| V. | - | - | - | - | - | - |
| VI. | | | | | | |

**PROGRAMME ARTICULATION MATRIX**

| | | COURSE NAME | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|
| YEAR I | SEMESTER I | Applied Mathematics for Mechatronics Engineers | 2 | - | - | - | 2 | - |
| | | Concepts in Electronics Engineering | 1.8 | - | 2.4 | 2 | 1.8 | 2.2 |
| | | Concepts of Machines and Mechanisms | 1.8 | - | 2.4 | 2 | 1.8 | 2.2 |
| | | Sensors and Actuators | 2.2 | - | - | 3 | 3 | 3 |
| | | Control System Design | 1 | - | 2 | 3 | 3 | 3 |
| | | Industrial Automation | 2 | - | - | 3 | 3 | 3 |
| | | Research Methodology and IPR | - | 3 | - | - | 1 | 1 |
| | | Professional Elective I | | | | | | |
| | | Audit Course I | | | | | | |
| | | Sensors and Actuators Laboratory | - | 2 | 3 | 3 | 2 | 1.3 |
| | | Industrial Automation Laboratory | - | 2 | 3 | 3 | 2 | 1.3 |
| | SEMESTER II | Mechatronics System Design | 2 | - | - | 3 | 3 | 3 |
| | | Industrial Robotics and Control | 2 | - | - | 3 | 3 | 3 |
| | | Machine Vision systems | 2 | - | - | 3 | 3 | 3 |
| | | Intelligence in systems | 2 | - | - | 3 | 3 | 3 |
| | | Smart Embedded Systems | 1 | - | - | 3 | 2 | 2 |
| | | Professional Elective – II | | | | | | |
| | | Audit Course II | | | | | | |
| | | Industrial Robotics and Embedded Systems Laboratory | - | 1.3 | 3 | 2 | 2 | 2 |
| | | Machine Vision and Intelligence Laboratory | - | 1.3 | 3 | 2 | 2 | 2 |
| YEAR I | SEMESTER III | Professional Elective - III | | | | | | |
| | | Professional Elective - IV | | | | | | |
| | | Open Elective | | | | | | |
| | | Project Work I | 2 | 1 | 2 | 3 | 3 | 3 |
| | SEMESTER IV | Project Work II | 2 | 1 | 2 | 3 | 3 | 3 |

**ANNA UNIVERSITY, CHENNAI**

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**M.E. MECHATRONICS**

**REGULATIONS – 2021**

**CHOICE BASED CREDIT SYSTEM**

**I TO IV SEMESTERS CURRICULA AND SYLLABI**

**SEMESTER I**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1 | MA4104 | Applied Mathematics for Mechatronics | FC | 3 | 1 | 0 | 4 | 4 |
| 2 | MR4101 | Concepts in Electronics Engineering | FC | 2 | 0 | 2 | 4 | 3 |
| | MR4102 | Concepts of Machines and Mechanisms | | | 0 | 2 | | |
| 3 | MR4103 | Sensors and Actuators | PCC | 3 | 0 | 0 | 3 | 3 |
| 4 | MR4104 | Control System Design | PCC | 3 | 0 | 2 | 5 | 4 |
| 5 | MR4105 | Industrial Automation | PCC | 3 | 0 | 0 | 3 | 3 |
| 6 | RM4151 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | 2 |
| 7 | | Professional Elective – I | PEC | 3 | 0 | 0 | 3 | 3 |
| 8 | | Audit Course -I | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICAL** | | | | | | | | |
| 9 | MR4111 | Sensors and Actuators Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 10 | MR4112 | Industrial Automation Laboratory | PCC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **21** | **1** | **10** | **32** | **25** |

* Audit Course is optional

## SEMESTER II

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MR4201 | Mechatronics System Design | PCC | 4 | 0 | 0 | 4 | 4 |
| 2. | MR4202 | Industrial Robotics and Control | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | MR4203 | Machine Vision Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | MR4204 | Intelligence in Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | MR4205 | Smart Embedded Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective – II | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Audit Course II* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICAL** | | | | | | | | |
| 8. | MR4211 | Industrial Robotics and Embedded Systems Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | MR4212 | Machine Vision and Intelligence Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **21** | **0** | **8** | **29** | **23** |

* Audit Course is optional

## SEMESTER III

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | | Professional Elective - III | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | | Professional Elective - IV | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Open Elective | OEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICAL** | | | | | | | | |
| 4. | MR4311 | Project Work - I | EEC | 0 | 0 | 12 | 12 | 6 |
| | | | **TOTAL** | **9** | **0** | **12** | **21** | **15** |

## SEMESTER IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICAL** | | | | | | | | |
| 1 | MR4411 | Project Work-II | EEC | 0 | 0 | 24 | 24 | 12 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** |

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75**

## FOUNDATION COURSES (FC)

| S. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEMESTER |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| 1. | MA4104 | Applied Mathematics for Mechatronics | 3 | 1 | 0 | 4 | 1 |
| 2. | MR4101 | Concepts in Electronics Engineering | 2 | 0 | 2 | 3 | 1 |
| | MR4102 | Concepts of Machines and Mechanisms | 2 | 0 | 2 | | 1 |

## PROFESSIONAL CORE COURSES (PCC)

| S. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEMESTER |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| 1. | MR4103 | Sensors and Actuators | 3 | 0 | 0 | 3 | 1 |
| 2. | MR4104 | Control System Design | 3 | 0 | 2 | 4 | 1 |
| 3. | MR4105 | Industrial Automation | 3 | 0 | 0 | 3 | 1 |
| 4. | MR4111 | Sensors and Actuators Laboratory | 0 | 0 | 4 | 4 | 2 |
| 5. | MR4112 | Industrial Automation Laboratory | 0 | 0 | 2 | 1 | 1 |
| 6. | MR4201 | Mechatronics System Design | 3 | 0 | 2 | 5 | 2 |
| 7. | MR4202 | Industrial Robotics and Control | 3 | 0 | 0 | 3 | 2 |
| 8. | MR4203 | Machine Vision Systems | 3 | 0 | 0 | 3 | 2 |
| 9. | MR4204 | Intelligence in Systems | 3 | 0 | 0 | 3 | 2 |
| 10. | MR4205 | Smart Embedded Systems | 3 | 0 | 0 | 3 | 3 |
| 11. | MR4211 | Industrial Robotics and Embedded Systems Laboratory | 0 | 0 | 4 | 4 | 2 |
| 12. | MR4212 | Machine Vision and Intelligence Laboratory | 0 | 0 | 4 | 4 | 2 |

## PROFESSIONAL ELECTIVES

### SEMESTER I, ELECTIVE - I

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | MR4001 | Computer Aided Inspection | PEC | 3 | 3 | 0 | 0 | 3 |
| 2. | MR4002 | Digital Manufacturing | PEC | 3 | 3 | 0 | 0 | 3 |
| 3. | MR4003 | Computer Aided Production and Automation of Plants | PEC | 3 | 3 | 0 | 0 | 3 |
| 4. | MR4004 | Design of Machine Elements and Product Development | PEC | 3 | 3 | 0 | 0 | 3 |
| 5. | MR4005 | Multi-Body Dynamics | PEC | 3 | 3 | 0 | 0 | 3 |
| 6. | MR4006 | Onboard Computers and Python Programming | PEC | 3 | 3 | 0 | 0 | 3 |

### SEMESTER II, ELECTIVE - II

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | MR4007 | Micro and Nano Systems | PEC | 3 | 3 | 0 | 0 | 3 |
| 2. | MR4008 | Advanced Control Systems | PEC | 3 | 3 | 0 | 0 | 3 |
| 3. | MR4009 | Biomechatronics | PEC | 3 | 3 | 0 | 0 | 3 |
| 4. | MR4010 | Solid State Drives | PEC | 3 | 3 | 0 | 0 | 3 |
| 5. | MR4011 | Automotive Electronics | PEC | 3 | 3 | 0 | 0 | 3 |
| 6. | MR4012 | Unmanned Aerial Vehicle | PEC | 3 | 3 | 0 | 0 | 3 |

### SEMESTER III, ELECTIVE - III & IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | MR4013 | Intelligent Product Design | PEC | 3 | 3 | 0 | 0 | 3 |
| 2. | IL4073 | Human Industrial Safety and Hygiene | PEC | 3 | 3 | 0 | 0 | 3 |
| 3. | MR4071 | Internet of Things for Manufacturing | PEC | 3 | 3 | 0 | 0 | 3 |
| 4. | MR4014 | Communication Protocols | PEC | 3 | 3 | 0 | 0 | 3 |
| 5. | MR4015 | Advanced Computer Vision | PEC | 3 | 3 | 0 | 0 | 3 |
| 6. | MR4016 | Mechatronics in Aero Systems | PEC | 3 | 3 | 0 | 0 | 3 |
| 7. | MR4017 | Medical Mechatronics | PEC | 3 | 3 | 0 | 0 | 3 |
| 8. | MR4018 | Mobile Robotics | PEC | 3 | 3 | 0 | 0 | 3 |
| 9. | CM4091 | Green Manufacturing | PEC | 3 | 3 | 0 | 0 | 3 |
| 10. | MR4019 | Haptics and Augmented Reality | PEC | 3 | 3 | 0 | 0 | 3 |
| 11. | MR4020 | Industrial Instrumentation and Control | PEC | 3 | 3 | 0 | 0 | 3 |
| 12. | MR4021 | Modeling and Analysis of Electromechanical Systems | PEC | 3 | 3 | 0 | 0 | 3 |

## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| S. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEMESTER |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| 1. | MR4311 | Project Work - I | 0 | 0 | 12 | 6 | 3 |
| 2. | MR4411 | Project Work-II | 0 | 0 | 24 | 12 | 4 |
| | | | | | | TOTAL CREDITS | 18 |

## RESEARCH METHODOLOGY AND IPR COURSES (RMC)

| S. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEMESTER |
|---|---|---|---|---|---|---|---|
| | | | | Tutorial | Practical | | |
| 1. | RM4151 | Research Methodology and IPR | 2 | 0 | 0 | 2 | 1 |
| | | | | | TOTAL CREDITS | 2 | |

## AUDIT COURSES (AC)

**Registration for any of these courses is optional to students**

| SL. NO. | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | AX4091 | English for Research Paper Writing | 2 | 0 | 0 | 0 |
| 2. | AX4092 | Disaster Management | 2 | 0 | 0 | 0 |
| 3. | AX4093 | Constitution of India | 2 | 0 | 0 | 0 |
| 4. | AX4094 | நற்றமிழ் இலக்கியம் | 2 | 0 | 0 | 0 |

## LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

| SL. NO. | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | OCE431 | Integrated Water Resources Management | 3 | 0 | 0 | 3 |
| 2. | OCE432 | Water, Sanitation and Health | 3 | 0 | 0 | 3 |
| 3. | OCE433 | Principles of Sustainable Development | 3 | 0 | 0 | 3 |
| 4. | OCE434 | Environmental Impact Assessment | 3 | 0 | 0 | 3 |
| 5. | OIC431 | Blockchain Technologies | 3 | 0 | 0 | 3 |
| 6. | OIC432 | Deep Learning | 3 | 0 | 0 | 3 |
| 7. | OBA431 | Sustainable Management | 3 | 0 | 0 | 3 |
| 8. | OBA432 | Micro and Small Business Management | 3 | 0 | 0 | 3 |
| 9. | OBA433 | Intellectual Property Rights | 3 | 0 | 0 | 3 |
| 10. | OBA434 | Ethical Management | 3 | 0 | 0 | 3 |
| 11. | ET4251 | IoT for Smart Systems | 3 | 0 | 0 | 3 |
| 12. | ET4072 | Machine Learning and Deep Learning | 3 | 0 | 0 | 3 |
| 13. | PX4012 | Renewable Energy Technology | 3 | 0 | 0 | 3 |
| 14. | PS4093 | Smart Grid | 3 | 0 | 0 | 3 |
| 15. | CP4391 | Security Practices | 3 | 0 | 0 | 3 |
| 16. | MP4251 | Cloud Computing Technologies | 3 | 0 | 0 | 3 |
| 17. | IF4072 | Design Thinking | 3 | 0 | 0 | 3 |
| 18. | MU4153 | Principles of Multimedia | 3 | 0 | 0 | 3 |
| 19. | DS4015 | Big Data Analytics | 3 | 0 | 0 | 3 |
| 20. | NC4201 | Internet of Things and Cloud | 3 | 0 | 0 | 3 |
| 21. | MX4073 | Medical Robotics | 3 | 0 | 0 | 3 |
| 22. | VE4202 | Embedded Automation | 3 | 0 | 0 | 3 |
| 23. | CX4016 | Environmental Sustainability | 3 | 0 | 0 | 3 |
| 24. | TX4092 | Textile Reinforced Composites | 3 | 0 | 0 | 3 |
| 25. | NT4002 | Nanocomposite Materials | 3 | 0 | 0 | 3 |
| 26. | BY4016 | IPR, Biosafety and Entrepreneurship | 3 | 0 | 0 | 3 |

**MA4104 APPLIED MATHEMATICS FOR MECHATRONICS**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

1. Mathematical foundations of numerical techniques for solving linear systems, eigenvalue problems and generalized inverse.
2. To expose the students to variational formulation and numerical integration techniques and demonstrate solution methodology for the variational problems.
3. To understand the basics of random variables with emp0hasis on the standard discrete and continuous distributions.
4. To make the students appreciate the purpose of using Laplace transforms to solve the partial differential equation.
5. To introduce the Fourier transforms and its properties.

**UNIT – I MATRIX THEORY 12**

Matrix representation of Linear Transformation – Eigen values – Generalized Eigenvectors – Rank of Matrix – The Cholesky decomposition – Canonical basis – QR factorization – Least squares method – Singular value decomposition.

**UNIT – II CALCULUS OF VARIATIONS 12**

Concept of variation and its properties – Euler's equations – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – Direct methods: Ritz and Kantorovich methods – Taylor polynomials and Taylor series.

**UNIT – III PROBABILITY AND RANDOM VARIABLES 12**

Probability – Axioms of probability – Conditional probability – Bayes' theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

**UNIT – IV LAPLACE TRANSFORM TECHNIQUES FOR PDE 12**

Laplace transform – Definitions – Properties – Transform error function – Bessel's functions – Dirac delta function – Unit step functions – Convolution theorem – Inverse Laplace transform: Complex inversion formula – Solutions to Partial Differential Equations (PDE): Heat equations – Wave equation.



**UNIT – V FOURIER TRANSFORM TECHNIQUES FOR PDE 12**

Fourier transform: Definitions, properties – Transform of elementary functions - Dirac Delta function – Convolution theorem - Parseval's identity – Solutions to partial differential equations: Heat equation - Wave equation - Laplace and Poisson's equations.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, students will be able to

1. apply various methods in matrix theory to solve system of linear equations.
2. maximizing and minimizing the functional that occur in various branches of Engineering disciplines.
3. computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
4. application of Laplace transforms to initial value, initial- boundary value and boundary value problems in Partial Differential Equations.
5. obtain Fourier transforms for the functions which are needed for solving application problems.

**REFERENCES:**


1. Andrews, L. C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India, New Delhi, 2003.
2. Bronson, R.," Matrix Operations", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2004.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. O'Neil P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.
6. Sankara Rao,K., " Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.


**MR4101 CONCEPTS IN ELECTRONICS ENGINEERING**

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 2 | 3 |

**COURSE OBJECTIVES**

1. To understand the functionality of fundamental electronic components.
2. To understand the functions of the operational amplifier and its applications.
3. To review and use the logic gates for various digital circuit development.
4. To understand the functions and uses in measurement.
5. To learn the power management of various electronic units.

**UNIT I ELECTRONIC COMPONENTS AND DEVICES 6**

Resistors, capacitors, inductors, transformers – types and properties - junction diodes, Zener diodes, transistors and thyristors - types-operating mechanism-characteristics and applications. LED – characteristics and applications

**UNIT II OPERATIONAL AMPLIFIERS AND APPLICATIONS 6**

Operational amplifiers – principles, specifications, characteristics and applications- arithmetic operations, integrator, differentiator, comparator, Schmitt trigger, instrumentation amplifiers, active filters, linear rectifiers, waveform generators, A/D converters, feedback and power amplifiers, sine wave oscillators

**UNIT III DIGITAL ELECTRONICS 6**

Number systems – Logic gates – Boolean algebra – Simplification of Boolean functions– Study of Combinational Logic Circuits-Full Adder, Code Converters, Multiplexers, Encoder and Decoders, Study of Sequential Logic Circuits-Flip-flops, Counters, Shift registers – D/A Converters.

**UNIT IV SIGNAL PROCESSING AND MEASURING DEVICES 6**

Rectifiers and Filters - Regulated Power Supply – Switching Power Supplies, Thermal Considerations. Measurement of voltage, current, frequency and power using Multi meters, oscilloscopes, recorders, data loggers, signal sources, counters, analyzers and printers.

**UNIT V POWER MANAGEMENT** **6**

Pulse width modulation and pulse position modulation – batteries–SMPS - sensors, actuators and controllers' energy consumption -power optimization of integrated system.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Apply the fundamental electronic components in various circuits.
**CO2:** Create the basic electronic circuits using op-amp for various applications.
**CO3:** Create the digital electronic circuits using logic gate ICs'.
**CO4:** Apply the power supply and measurement system appropriately for various applications.
**CO5:** Measure, estimate and monitor the power for various applications to use battery or electrical power sources.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | - | 3 | 2 | 1 | 3 |
| CO3 | 2 | - | 2 | 2 | 2 | 2 |
| CO4 | 1 | - | 2 | 3 | 2 | 2 |
| CO5 | 2 | - | 3 | 1 | 2 | 2 |
| AVG. | 1.8 | - | 2.4 | 2 | 1.8 | 2.2 |

**REFERENCES**


1. Helfrick A.D and Cooper .W. D. "Modern Electronic Instrumentation and Measurements Techniques", Prentice Hall, 2008.
2. Jocob Mill Man, Microelectronics Digital and Analog Circuits & Systems – McGraw-Hill, 2004.
3. Malvino & Leach, Digital Principles &Application, TMH, 2015.
4. Mill Man and Halkias, "Electron Devices and Circuits", McGraw-Hill 2010.
5. Ray & Chaudary, Linear Integrated Circuits, New Age, 2006.


**LABORATORY**



**LIST OF EXPERIMENTS**

1. Study of digital storage oscilloscope.
2. Experimentation with CRO.
3. Design of DC power supplies
4. Design of inverting amplifier and non-inverting amplifiers
5. Design of Instrumentation amplifier.
6. Design of analog filters.
7. Design of combinational circuits and sequential circuits.
8. Design of A/D converters and D/A converters.
9. RC Servo motor driver circuit.
10. Design of stepper motor driver circuit.

**TOTAL: 30 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

1. CRO-1
2. DSO-1
3. DC Power supply
   5V – 5 No's

12V, 10A - 1 No
24V, 10A or higher - 1 No

4. Function generator-1
5. OP-Amp trainer kit (inverting and non-inverting amplifier module)
6. Analog filters trainer kit
7. Sequential circuit trainer kit
8. Combination circuit trainer kit
9. A/D Converter trainer kit -1 No
10. D/A Converter Trainer kit-1 No
11. Driver Circuit Module for servomotor-1 No
12. Driver Circuit module for stepper motor-1 No
13. Multi-Meter, bread board, and solder machine.
14. Electronic components for power supply (transformer, regulator, diode, capacitors) -5 No's.

**MR4102 CONCEPTS OF MACHINES AND MECHANISMS**

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 2 | 3 |

**COURSE OBJECTIVES**

1. To understand the functionality of basic mechanisms and to determine the position, velocity, and acceleration profiles of these mechanisms.
2. To recognize the effect of friction in joints and to know the various types of mechanical power transmission using belt drives.
3. To identify the nomenclature of gear and to understand the functions and typical uses of various types of gears and Cams.
4. To understand the behaviours of the vibration in various machines.
   To make use of various conventional machine tools for component development.

**UNIT I MECHANISMS 6**

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinematic pairs – Constraint& motion - Degrees of freedom – Slider crank – Single and double – Crank rocker mechanisms – Inversions – applications. Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.

**UNIT II FRICTION 6**

Types of friction – friction in screw and nuts – pivot and collar – thrust bearings – collar bearing – plate and disc clutches – belt (flat &vee) and rope drives – creep in belts – Jockey pulley – open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tension – condition for maximum power transmission.

**UNIT III GEARING AND CAMS 6**

Gear profile and geometry-nomenclature of spur and helical gears – law of gearing – interference requirement of minimum number of teeth in gears-gear trains-simple and compound gear trains determination of speed and torque in epicyclic gear trains-Cam profile-different types of followers.

**UNIT IV VIBRATION 6**

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – torsional vibration of shafts – single and multirotor systems – geared shafts – critical speed of shafts.

**UNIT V MACHINE TOOLS 6**

Machine tool construction-features – operations of lathe, milling machine, drilling machine – Drive system for machine tools – mechanical, hydraulic and electric stepped and variable speeds – spindle speeds and feed drives-linear and reciprocation motion generation.

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Apply the fundamental mechanism in machinery development.

**CO2:** Consider the functions of friction in joints and select of appropriate belt drives for the typical applications.

**CO3:** Select and use of appropriate gears and cams for system development.

**CO4:** Evaluate the possibility of vibration generation in the system design.

**CO5:** Demonstrate the various conventional machine tools and CNC Machines.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | - | 3 | 2 | 1 | 3 |
| CO3 | 2 | - | 2 | 2 | 2 | 2 |
| CO4 | 1 | - | 2 | 3 | 2 | 2 |
| CO5 | 2 | - | 3 | 1 | 2 | 2 |
| AVG. | 1.8 | - | 2.4 | 2 | 1.8 | 2.2 |

**REFERENCES**


1. Bansal R.K, “Theory of Machines”, Laxmi Publications (P) ltd., New Delhi. 2016.
2. G.C.Sen and A. Bhattacharya, “Principles of Machine Tools”, New Central book Agency, 2009.
3. Joseph Edward Shigley, Charles R.Mischke, “Mechanical Engineering Design”, Mcgraw Hill International Edition, 2008.
4. Malhotra .D.R. and Gupta .H.C. “The Theory of Machines” SatyaPrakasam, Tech. India Publications, 1989.
5. R.S.Khurmi and Gupta, “Theory of Machines” Eurasia Publishing House Pvt Ltd. 2020.




**LABORATORY**

**LIST OF EXPERIMENTS**

1. 2D modeling and 3D modeling of Bearing, and Couplings.
2. 2D modeling and 3D modeling of Gears and Ball screw.
3. 2D modeling and 3D modeling of Sheet metal components
4. 2D modeling and 3D modeling of Jigs, fixtures and Die.
5. 2D modeling and 3D modeling of Structures and frames
6. Modeling and simulation of mechanism of 4 Bar chain
7. Modeling and simulation of mechanism of Slider crank,
8. Modeling and simulation of mechanism of Ball and screw and Rack and pinion.
9. Modeling and simulation of mechanism of Belt and chain drives.
10. Modeling and simulation of mechanism of Quick return and elliptical trammel.

**TOTAL: 30 PERIODS**

**LIST OF SOFTWARES**

Solid Works/ OpenCAD /CREO /CATIA/ NX CAD/MSC-Adams – 15 No’s

| MR4103 | SENSORS AND ACTUATORS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of motion, proximity and ranging sensors.
3. To understand and analyse the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyse the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
   To understand basic working principle, construction, Application and characteristics of linear and rotary actuators.

**UNIT I INTRODUCTION TO SENSORS 9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types. Temperature – IC, Thermistor, RTD, Thermocouple.

**UNIT II MOTION, OPTICAL AND RANGING SENSORS 9**

Motion Sensors – Brush Encoders, Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer.,– GPS, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR). Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors.

**UNIT III FORCE, MAGNETIC, AND HEADING SENSORS 9**

Strain Gage, Load Cell Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

**UNIT IV FLUID POWER ACTUATORS 9**

Hydraulic and Pneumatic System– ISO Symbols for their Elements - Hydraulic Pumps and Motor - Linear Actuators and Types - Control and Regulating Elements — Direction, Flow and Pressure Control Valves - Methods of Actuation, Types, Sizing of Ports - Spool Valves - Electro Hydraulic Servo Valves - Types - Sequencing Circuits Design - Combinational Logic Circuit Design – Interfacing to PLC.

**UNIT V ELECTRICAL DRIVES AND ACTUATORS 9**

DC Motors and Types – Single Phase and Three Phase AC Motors – Servomotors - Stepper Motors - BLDC Motor and its Operating Modes - Piezo Electric Actuators – Linear Electrical Actuators - Switching Devices - Relay, BJT, MOSFET, IGBT, SCR - H-Bridge DC Drives under PWM Mode**.** VFD Drives – AC Servo Drives – Stepper Motor Drives - Drives for BLDC Motor - Selection of Drives – Protection and Switchgears.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyse the sensor response.
2. Analyze and select suitable sensor for motion, proximity and range measurement.
3. Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.
4. Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.
5. Understand the working principles of various actuators and their applications.

**REFERENCES**


1. Bolton W., "Mechatronics", Pearson; 5th edition, 2015
2. Bradley D.A., and Dawson, Burd and Loader, "Mechatronics", Thomson Press India Ltd., 2004
3. Ernest O. Doeblin, "Measurement system, Application and Design", Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004
4. Patranabis D., "Sensor and Actuators", Prentice Hall of India (Pvt) Ltd., 2005.
5. Renganathan S., "Transducer Engineering", Allied Publishers (P) Ltd., 2003
6. Antony Esposito, "Fluid Power Systems and Control", Prentice-Hall, 2006.
7. Austin Hughes, "Electric Motors and Drives Fundamentals, Types and Applications", Fourth Edition, Elsevier, 2013


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 3 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 3 | - | - | 3 | 3 | 3 |
| CO5 | 2 | - | - | 3 | 3 | 3 |
| AVG. | 2.2 | - | - | 3 | 3 | 3 |

| MR4104 | CONTROL SYSTEM DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES**

1. To represent and simplify the mathematical models for various types of physical systems.
2. To recognize the time domain specifications and to analyze of various types of system and its characteristics in time domain.
3. To know the frequency domain specifications and to analyze of various types of system and its characteristics in frequency domain methods.
4. To design compensator and controller using time and frequency domain.
5. To evaluate, analyse and design a control system of servomotors for motion control.

**UNIT I SYSTEM REPRESENTATION AND MODELLING 9**

Introduction and need for Control Systems with examples – Feedback systems – Block Diagram – Definition of Process variable, Set-point, Manipulated variable and Final control element with examples -Open loop and Closed loop systems – Transfer Function Model – State Space Model – Mathematical Modelling of Mechanical, Electrical, Pneumatic and Hydraulic systems – Block Diagram reduction – Signal flow graph.

**UNIT II DESIGN OF FEEDBACK CONTROL SYSTEM 9**

Feedback systems – Block Diagram – Definition of process variable, set –point, manipulated variable and final control element with examples – characteristics of on –off,P, PI, PD and PID controllers – Implementation issues of PID controller – Modified PID controller – Tuning of controller.

**UNIT III TIME AND FREQUENCY DOMAIN ANALYSIS 9**

Time response of First & Second order systems – Time domain specifications - steady state errors and error constants – Routh Hurwitz criterion – Root locus – Bode Plot – Polar Plot – Nyquist stability criterion – Stability analysis – Experimental determination of Transfer Functions

**UNIT IV CONTROL SYSTEM DESIGN 9**

Root locus approach to control system design – lead, lag, lag-lead compensation using time domain analysis. Control system design using frequency domain analysis - lead, lag, lag-lead compensation using frequency domain analysis– P, PI, and PID controllers – tuning methods and rule.

**UNIT V CONTROL AND ANALYSIS OF SERVO MOTOR 9**

Servo motor – Mathematical Modelling of Servo Motor – Analysis of Servo motor system using Routh Hurwitz criterion, Root locus, Bode Plot, Polar Plot and stability analysis – Implementation of P, PI , PD and PID controllers for servo motor and analysis - bumpless control transfer between manual and PID Control- anti-windup control using PID Controller.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Develop the mathematical model of physical systems.

**CO2:** Characterize the responses and evaluate the range of stability for the physical systems using time domain techniques.

**CO3:** Describe and assess the range of stability for the physical systems using frequency domain technique.

**CO4:** Design an appropriate control system and compensator for system dynamics.

**CO5:** Evaluate and demonstrate the motion control of motors.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | 2 | 3 | 3 | 3 |
| CO2 | 1 | - | 2 | 3 | 3 | 3 |
| CO3 | 1 | - | 2 | 3 | 3 | 3 |
| CO4 | 1 | - | 2 | 3 | 3 | 3 |
| CO5 | 1 | - | 2 | 3 | 3 | 3 |
| AVG. | 1 | - | 2 | 3 | 3 | 3 |

**REFERENCES**


1. A. NagoorKani, “Control Systems”, RBA Publications (P) Ltd., 2020.
2. B.C. Kuo, “Automatic Control Systems”, Prentice Hall of India Pvt. Ltd., New Delhi, 2018.
3. I.J.Nagrath and Gopal, “Control System Engineering”, New Age international (P) Ltd., 2006.
4. K.Ogata, “Modern Controls Engineering“, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. M. Nakamura .S.Gata&N.Kyura, Mechatronic Servo System Control, Springer.


**LABORATORY**

**LIST OF EXPERIMENTS**

1. Mathematical Modelling and Simulation of a Physical Systems.
2. Simulation and Reduction of Cascade and Parallel, and Closed Loop Sub-System.
3. Plot the pole-zero configuration in s-plane for the given Transfer Function.
4. Simulation and Analysis of First and Second Order System Equations in Time and frequency Domain
5. Simulation and Analysis of Root-Locus and Bode Plot.
6. Simulation and Implementation of PID Controller Combinations for First and Second Order Systems.
7. Simulation of Motor velocity, position and torque control.

**TOTAL: 30 PERIODS**

**LIST OF SOFTWARE FOR A BATCH OF 30 STUDENTS:**

1. MATLAB/ SCILAB – Control System Tool Box - 15 No’s

| MR4105 | INDUSTRIAL AUTOMATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To understand the importance of automation in industry and various industrial standard sensors and process parameters to control the production process.
2. To learn PLC hardware, and practice the PLC programming and simulation in real systems.
3. To get knowledge on industrial standard data communication protocols, SCADA, centralized and decentralized control.
4. To get introduced to factory layout, Total Integrated Automation on factory and Industry 4.0.
5. To get exposure on building automation using sensors, controllers and actuators

**UNIT I INDUSTRIAL INSTRUMENTATION AND CONTROL 9**

Introduction and need for automation-Instrumentation system for measurement of process parameters – overview on flow, level, pressure, temperature, speed, current and voltage measurements – proximity and vision based inspection systems – process control systems – continuous and batch process – feedback control system overview.

**UNIT II PROGRAMMABLE LOGIC CONTROLLER 9**

Fundamentals of programmable logic controller - functions of PLCs - features of PLC - selection of PLC - architecture – Basics of PLC programming - logic ladder diagrams – communication in PLCs – Programming Timers and counters – Data Handling - PLC modules - Advanced PLCs.

**UNIT III DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS 9**

Industrial data communications - fiber optics – Modbus – HART – Device Net – Profibus – Fieldbus – Introduction to supervisory control systems – SCADA - Distributed control system (DCS) – Safety systems – man-machine interfaces.

**UNIT IV FACTORY AUTOMATION 9**

Factory layout - Tools and software based factory modeling -case study on automated manufacturing units, assembly unit, inspection systems and PLC based automated systems- Introduction to factory automation monitoring software

**UNIT V BUILDING AUTOMATION 9**

Building layout and its 3D model-Power Distribution System in Buildings- HVAC systems- Systems Design & Operation- PLC in Building Services- Building Automation Systems – control panel- Introduction to building automation software

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course, the students will be able to;

**CO1:** Understand the need of process parameter measurement and control.

**CO2:** Select, configure and program the PLC by interfacing the sensors and actuators and other input and output devices for automation.

**CO3:** Understand and compare various data communication protocols. Able to compare centralized, decentralized and smart control system.

**CO4:** Select and apply suitable sensor, control and actuation for factory automation. Also, they can simulate the same using software.

**CO5:** Select appropriate sensor, controller and actuation

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 3 | 3 |
| CO3 | 2 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 3 | - | - | 3 | 3 | 3 |
| AVG. | 2 | - | - | 3 | 3 | 3 |

**REFERENCES**


1. Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes, 1st Edition, 2004.
2. D.Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Ltd., New Delhi, 2010.
3. Frank D. Petruzella, "Programmable Logic Controller" McGraw – Hill Publications, 2016.
4. Frank Lamb, "Hands on Industrial Automation", McGraw-Hill Profession, 2013.
5. Hughes, T., "Programmable Logic Controllers", ISA Press, 2000.
6. Lucas, M.P., "Distributed Control System", Van Nastrand Reinhold Company, New York, 1986.
7. Shengwei Wang, "Intelligent Buildings and Building Automation", Routledge Publishers, 2009.


**RM4151 RESEARCH METHODOLOGY AND IPR L T P C**
**2 0 0 2**

**UNIT I RESEARCH DESIGN 6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

**UNIT II DATA COLLECTION AND SOURCES 6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

**UNIT III DATA ANALYSIS AND REPORTING 6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

**UNIT IV INTELLECTUAL PROPERTY RIGHTS 6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

**UNIT V PATENTS** **6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

**TOTAL :30 PERIODS**

**REFERENCES**


1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.


| MR4111 | SENSORS AND ACTUATORS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES**

1. To learn about various force, pressure and vibration measuring sensors.
2. To learn about various Temperature, light and magnetic field measuring sensors
3. To learn about various displacement and speed measuring sensors.

**LIST OF EXPERIMENTS**

**SENSORS AND TRANSDUCERS**

1 Experiments Using Strain Gauge Sensor: Load, Torque and Force Measurement.
2 Determine the characteristics of Pressure Sensor and Piezoelectric Force Sensor
3 Displacement Measurement using LVDT.
4 Determine the Characteristics of Various Temperature Sensors.
5 Determine the Characteristics of Various Light Detectors (Optical Sensors).
6 Distance Measurement using Ultrasonic and Laser Sensor.
7 Determine angular velocity using gyroscope, Vibration measurement using Accelerometer and Direction measurement using Magnetometer.
8 Speed and Position Measurement Using Encoders.

**ACTUATORS**

1 Experiments on control of Speed and Direction Control of DC Motor
2 Experiments on control of Position, Speed and Direction Control of Stepper Motor.
3 Experiments on control of Position, Speed and Direction Control of AC Servo Motors.
4 Experiment on control of Position, Speed and Direction Control of DC Servo Motors.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course, the students will be able to;

1. Understand and demonstrate various contact and non-contact sensors.
2. Analyze and Identify appropriate sensors for given applications.
3. Create a sensor system for given requirements.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | - | 2 | 3 | 3 | 2 | 1 |
| CO2 | - | 2 | 3 | 3 | 2 | 2 |
| CO3 | - | 2 | 3 | 3 | 2 | 1 |
| AVG. | - | 2 | 3 | 3 | 2 | 1.3 |

**MR4112 INDUSTRIAL AUTOMATION LABORATORY**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**COURSE OBJECTIVES**

1. To learn the basic operations in PLC.
2. To learn to integrate various sensors and actuators to PLC.
3. To apply the PLC controller to various systems through real-time applications.

**LIST OF EXPERIMENTS**

1. Experiments on Ladder Logic Program for Various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR.
2. Implement Various Mathematical Functions in PLC Using Ladder Diagram Programming Language.
3. Develop Ladder Diagram Programming to set Timer and Counter in PLC.
4. Experiments on Sensor and Actuator Interfacing and PLC to PLC Communication.
5. Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
6. Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
7. Experimental Verification of Pneumatic Sequencing Circuits.
8. Experiments on Control of PLC Based Electro Pneumatic Sequencing Circuits.
9. Experiments on Control of PLC Based Electro Hydraulic Sequencing Circuits.
10. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
11. Develop Ladder Diagram Program in PLC For Material Filling and Object Shorting.
12. Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Pick and Place Operation.

Note : Any of the 10 experiments to be conducted

**TOTAL: 30 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

- PLC Software -2 Users
- PLC Station with Communication Protocol, Sensors and Actuators – 2 No’s
- Electro Pneumatic Sequencing -1 Unit
- Electro Hydraulic Sequencing Circuits – 1 Unit
- PLC station with Pressure and Level in a Bottle Filling System – 1 Unit
- PLC station with Material Handling, Delaying Conveyor, Pick and Place Operation – 1 Unit.

**COURSE OUTCOMES:**

Upon completing this course Students able to

1. Understand and demonstrate PLC controller programming.
2. Analyse and Identify appropriate sensors and its integration with PLC for given applications.
3. Create a PLC controller system for given requirements

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | - | 2 | 3 | 3 | 2 | 1 |
| CO2 | - | 2 | 3 | 3 | 2 | 2 |
| CO3 | - | 2 | 3 | 3 | 2 | 1 |
| AVG. | - | 2 | 3 | 3 | 2 | 1.3 |

**MR4201 MECHATRONICS SYSTEM DESIGN L T P C**

**4 0 0 4**

**COURSE OBJECTIVES:**

1. To enlist the various elements required to design and integrate the mechatronic systems.
2. To acquire the Modelling skills to capture the system dynamics of hybrid systems and to familiar the system identification techniques and to practice the design and assembly of mechanical system in software environment for integrating various system sub-elements.
3. To familiar the standard simulation procedure for algorithm and controller development and to practice simulate and verify interactions and functions of integrated systems and its elements for fine tuning the design and control for real time system development.
4. To apply the optimization procedure for the appropriate selection of mechatronic system elements and process parameter optimization.
5. To understand, apply, analyze and evaluate the functions of systems models for integrating the virtual elements of mechatronics.

**UNIT I ELEMENTS OF MECHATRONICS 12**

Comparison of Conventional System vs. Mechatronic System – Identification of Mechatronic System Requirements in Real World Problems - Mechatronics System Overview – Key Elements – Identification of Key Elements in Various Systems - Application Overview – Mechatronics System Design Process - Recent Advancements in Mechatronics System for Modern Automation.

**UNIT II MODELLING & SYSTEM IDENTIFICATION 12**

Need for Modelling – Systems Overview – Representation of Systems in State Space – Analogue Approach – Parametric and Non-Parametric Modelling - Bond Graph Approach for Modelling of Electrical, Mechanical, Thermal, Fluid and Hybrid Systems – System Identification – White, Grey and Block Box Modelling - Overview – Types - Least Square Method.

**UNIT III SIMULATION 12**

Simulation Fundamentals – Simulation Life Cycle – Monte Carlo Simulation – Solution for Model Equations and their Interpretations – Hardware-In-Loop Simulation (HIL) - Controller Prototyping – Software's for Simulation and Integration.

**UNIT IV DESIGN OPTIMIZATION 12**

Optimization – Problem Formulation - Constraints – Overview of Linear and Nonlinear Programming Techniques – Other Optimization Techniques - Optimal Design of Mechatronics System with Case Studies.

**UNIT V CASE STUDIES ON MODELING OF MECHATRONIC SYSTEMS 12**

Modelling and Simulation of Automotive System - Power Window, Engine Timing, Building Clutch Look-Up, Antilock Braking System and Automatic Transmission Controller – Modelling of Manufacturing Systems, Inspection System, Transportation System, Industrial Manipulator, Light Motor Vehicle, Aerial Vehicle, Underwater Vehicle.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

CO1. Understand the list of elements required integrate the entire mechatronic systems developments.

CO2. Create the system dynamics of hybrid systems and to trial the system identification techniques and to practice the design, integration and simulation in virtual systems that are closer to the real time systems' functionalities and its parameters.

CO3. Understand standard simulation procedure for algorithm and controller development.

CO4. Apply the optimization concepts mechatronics elements selection and process parameter optimization.

CO5. Integrate and analyze the mechatronics system design virtually and able to fine tune the system design and control algorithms in the software-in-loops before real time development.

**REFERENCES:**


1. Bradley, D. Dawson, N.C.Burd and A.J. Loader, "Mechatronics: Electronics in Product and Process", Chapman and Hall, London, 1999.
2. Bolton, "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", Addison Wesley Longman Ltd., 2009.
3. Brian Morriss, "Automated Manufacturing Systems – Actuators Controls, Sensors and Robotics", McGraw Hill International Edition, 2000.
4. Devadas Shetty, Richard A.Kolkm, "Mechatronics System Design", PWS Publishing Company, 2009.
5. Ogata.K, "Modern Controls Engineering", Prentice Hall of India Pvt. Ltd., 2005.


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 3 | 3 |
| CO3 | 2 | - | - | 3 | 3 | 3 |
| CO4 | 2 | - | - | 3 | 3 | 3 |
| CO5 | 2 | - | - | 3 | 3 | 3 |
| AVG. | 2 | - | - | 3 | 3 | 3 |

| MR4202 | INDUSTRIAL ROBOTICS AND CONTROL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To know the basic terminologies, classification, configurations and components of serial manipulator.
2. To understand the mechanical design and robot arm kinematics
3. To learn and understand the various linear control techniques on manipulators
4. To learn and understand the various non-linear control techniques on manipulators
5. To learn the robot programming and demonstrate the robot in various applications

**UNIT I INTRODUCTION 9**

Definition – Robot anatomy – Classification - Geometrical configurations, wrist and its motions - End effectors and its type - links and joints. Robot drive system: – Hydraulic, Electric and pneumatic drive system, Resolution, accuracy and repeatability, Advantage and disadvantage of drive system. - Robot actuation and Feedback component – position, velocity sensors – Robotic vision

**UNIT II ROBOT ARM KINEMATICS 9**

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenberg representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames:

**UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING 9**

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

**UNIT IV NONLINEAR CONTROL OF MANIPULATORS 9**

Introduction - nonlinear and time - varying systems - multi-input, multi-output control systems - the control problem for manipulators - practical considerations - current industrial-robot control systems - Lyapunov stability analysis – Cartesian - based control systems - adaptive control

**UNIT V ROBOT PROGRAMMING AND APPLICATIONS 9**

Lead through Programming, Robot programming Languages - VAL Programming - Motion Commands, Sensor Commands, End Effector commands and simple Programs – Applications: Robotic Surgery - Manufacturing Industries - Material Handling, Assembly, Inspection - Space – Underwater – Nuclear industry – Humanoid Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

CO1. Understand the basics of Industrial Robotics and Control.
CO2. Create the kinematic solutions for the serial manipulators

CO3. Analyze linear control of manipulators
CO4. Analyze non-linear control of manipulators
CO5. Create robotic program for specific applications.

**REFERENCES:**


1. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 1986.
3. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
4. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & sons, Inc., 2011
5. Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 3 | 3 |
| CO3 | 2 | - | - | 3 | 3 | 3 |
| CO4 | 2 | - | - | 3 | 3 | 3 |
| CO5 | 2 | - | - | 3 | 3 | 3 |
| AVG. | 2 | - | - | 3 | 3 | 3 |

**MR4203 MACHINE VISION SYSTEMS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand the basics concepts of optics and machine vision systems.
2. To learn and understand the fundamentals of image processing
3. To impart knowledge on stereo vision and structure from motion.
4. To understand the design factors in machine vision system design.
5. To demonstrate the various applications of machine vision system.

**UNIT I INTRODUCTION** **9**

Human vision – Machine vision and Computer vision – Benefits of machine vision – Block diagram and function of machine vision system implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation

**UNIT II IMAGE PROCESSING FUNDAMENTALS** **9**

Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding - Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology– Edge extraction– Fitting and Template matching.

**UNIT III COMPUTATIONAL STEREO AND MOTION 9**

Computational Stereopsis – Geometry, parameters –correlation-based methods, feature-based methods – Epipolar Geometry, eight-point algorithm – Reconstruction by triangulation, scale factor and up to a projective transformation – Visual Motion – Motion field of rigid objects – Optical Flow - Estimation of motion field – 3D structure and motion from sparse and dense motion fields – Motion based segmentation.

**UNIT IV SMART VISION SYSTEM DESIGN 9**

Camera types– Field view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of camera, Frame grabber and hardware platform– Pixel rate– Lens design - digital and smart cameras.

**UNIT V APPLICATIONS AND CASE STUDIES 9**

Machine Vision Applications in Manufacturing, Electronics, Printing, Pharmaceutical, Textile, Applications in Non-Visible Spectrum, Metrology and Gauging, OCR and OCV, Vision Guided Robotics – Field and Service Applications – Agricultural, and Bio Medical Field, Augmented Reality, Surveillance, Bio-Metrics.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

CO1. Understand the difference between the vision systems and were able to remember the functions of vision system.
CO2. Understand various image processing techniques and develop algorithms.
CO3. Create the visual serving for mechatronics applications
CO4. Evaluate and select appropriate lighting source, lighting technique, lens, sensor and interfacing.
CO5. Apply various machine vision techniques in various engineering fields.

**REFERENCES:**


1. Alexander Hornberg, “Handbook of Machine Vision”, First Edition
2. Rafael C. Gonzales, Richard. E. Woods, “Digital Image Processing Publishers”, Fourth Edition
3. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition
4. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, “An Invitation to 3-D Vision From Images to Models”, First Edition, 2004
5. Davies E.K., “Machine Vision: Theory, Algorithms, Practicalities”, 3rd Edition, Elsevier, 2005.
6. Milan Sonka, “Image Processing Analysis and Machine Vision”, Vikas Publishing House,2007.


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 3 | 3 |
| CO3 | 2 | - | - | 3 | 3 | 3 |
| CO4 | 2 | - | - | 3 | 3 | 3 |
| CO5 | 2 | - | - | 3 | 3 | 3 |
| AVG. | 2 | - | - | 3 | 3 | 3 |

| MR4204 | INTELLIGENCE IN SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand the basic concepts of artificial intelligence available in systems.
2. To learn and understand the basic concepts of artificial neural networks
3. To impart knowledge genetic algorithm.
4. To understand the components and concepts in fuzzy systems
5. To demonstrate the various applications of Artificial intelligence in systems

**UNIT I INTRODUCTION 9**

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems

**UNIT II ARTIFICIAL NEURAL NETWORKS 9**

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madeline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller - Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems.

**UNIT III GENETIC ALGORITHM 9**

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

**UNIT IV FUZZY LOGIC SYSTEM 9**

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time delay system – Applications: Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.



**UNIT V ADVANCED LEARNING 9**

Learning Sets of Rules – Sequential Covering Algorithm – Learning Rule Set – First Order Rules – Sets of First Order Rules – Induction on Inverted Deduction – Inverting Resolution – Analytical Learning – Perfect Domain Theories – Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

CO1. Understand the various intelligence concepts available in the mechatronics system.
CO2. Demonstrate and design any mechatronics system with artificial neural networks
CO3. Select and implement appropriate techniques and genetic algorithm
CO4. Design and implement the real time application with fuzzy logic.
CO5. Familiar with advanced learning techniques

**REFERENCES:**


1. Padhy.N.P.(2005), Artificial Intelligence and Intelligent System, Oxford University Press.
2. KOSKO.B. "Neural Networks and Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
3. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House,1999.
4. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
5. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
6. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.
7. Goldberg D.E. (1989) Genetic algorithms in Search, Optimization and Machine learning, Addison Wesley.


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 3 | 3 |
| CO3 | 2 | - | - | 3 | 3 | 3 |
| CO4 | 2 | - | - | 3 | 3 | 3 |
| CO5 | 2 | - | - | 3 | 3 | 3 |
| AVG. | 2 | - | - | 3 | 3 | 3 |

**MR4205 SMART EMBEDDED SYSTEMS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand the inclusion of embedded system in smart system design
2. To learn and understand the basic concepts in ARM 7 Core processor
3. To learn and understand the basic concepts in ARM 9 Core processor
4. To impart knowledge on real time models, language and operating systems
5. To demonstrate the embedded processors and various applications of embedded systems

**UNIT I MICROCONTROLLER 9**

Microprocessor - Microcontrollers – CISC and RISC - Introduction to Embedded systems - Architecture 8051 family - Instruction set – Addressing modes – I/O Programming- Timer/Counter - Interrupts – Serial communication of 8051.

**UNIT II PERIPHERAL INTERFACING 9**

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Overview of Advanced Microcontrollers.

**UNIT III INTRODUCTION TO ARM PROCESSOR 9**

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

Introduction about ARM 9 Processor--DSP Processor—Sharc Processor -- Internal Architecture - Modes of Operations – Register set – Pipelining – AMBA - Applications.

**UNIT IV REAL TIME MODELS, LANGUAGE AND OPERATING SYSTEMS 9**

Models and languages – State Machine and state tables in embedded design – High level language descriptions - Java based embedded system design – Petrinet models-Real time languages – The real time Kernel - OS tasks - Task Scheduling - kernel services – Real time languages and their features.

**UNIT V OTHER PROCESSORS AND APPLICATIONS 9**

Architecture and Programming – Single board computers – Introduction to IoT – Specific examples of time-critical and safety-critical embedded systems – interfacing - applications in automation - automotive – aerospace - medical and manufacturing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

CO1. Understand and implement embedded technologies in the field of smart system design.
CO2. Understand and interface the peripherals with 8051.
CO3. Design, program and implement ARM 7 and ARM 9 based system
CO4. Familiarize and select real time models, language and operating system in their system design
CO5. Demonstrate various applications of embedded systems in various fields.

**REFERENCES:**


1. Ball S.R., “Embedded Microprocessor Systems – Real World Design”, Prentice Hall, 2006
2. Frank Vahid and Tony Givagis, “Embedded System Design”, 2011, Wiley.
3. Wayne Wolf, Computers as Components – Principles of Embedded Computing System Design,
4. Morgan Kaufmann Publishers 2009.
5. C.M. Krishna, Kang G. Shin, Real Time systems, McGraw Hill 2009
6. Tim Wilmshurst, An Introduction to the design of small – scale Embedded Systems.
7. Mandler, B., Barja, J., MitreCampista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publication


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 2 | 2 |
| CO2 | 1 | - | - | 3 | 2 | 2 |
| CO3 | 1 | - | - | 3 | 2 | 2 |
| CO4 | 1 | - | - | 3 | 2 | 2 |
| CO5 | 1 | - | - | 3 | 2 | 2 |
| AVG. | 1 | - | - | 3 | 2 | 2 |

| MR4211 | INDUSTRIAL ROBOTICS AND EMBEDDED SYSTEMS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

1. To introduce different types of robotics and demonstrate them to identify different parts and components.
2. To write programming for simple operations.
3. To write program for identification and recognition of object parameters.

**LIST OF EXPERIMENTS**

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place
5. Robot programming and simulation for Color identification.
6. Robot programming and simulation for Shape identification.
7. Robot programming and simulation for machining (cutting, welding).
8. Robot programming and simulation for writing practice.
9. Robot programming and simulation for any industrial process (Packaging, Assembly).
10. Robot programming and simulation for multi process.
11. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
12. Program to construct a Bayesian network. Use this model to implement any application using standard Data Set. You can use Java/Python ML library classes/API.

**TOTAL: 60 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 18 STUDENTS**

1. ROS (Robotic Operating System)
2. 18 Systems with server
3. Verification of direct kinematics equations and inverse kinematics equations of 1DOF “R-configuration” robot.
4. Verification of direct kinematics equations and inverse kinematics equations of 2DOF “R-R-configuration” robot.

**COURSE OUTCOMES:**

Upon the completion of this course, the students will be able to;

CO1. Apply any robotic simulation software to model the different types of robots and calculate work volume for different robots.

CO2. Analyse and estimate the various robotic specifications.

CO3. Create program for object identification and recognition, machining operation and simulate the same in any robotic simulation software.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | - | 2 | 3 | 3 | 2 | 2 |
| CO2 | - | 1 | 3 | 3 | 2 | 2 |
| CO3 | - | 1 | 3 | 3 | 2 | 2 |
| AVG. | - | 1.3 | 3 | 3 | 2 | 2 |

| | | L | T | P | C |
|---|---|---|---|---|---|
| **MR4212** | **MACHINE VISION AND INTELLIGENCE LABORATORY** | **0** | **0** | **4** | **2** |

**COURSE OBJECTIVES:**

1. To gather the practical exposure on machine vision elements, lighting technique, processing software and algorithms.
2. To learn and practice various image processing techniques.
3. To learn various application of machine vision and programming

**LIST OF EXPERIMENTS**

1. Study on different kinds of vision sensors.
2. Study on lighting techniques for machine vision
3. Study on Design of Machine Vision System.
4. Experimentation on image acquisition towards the computation platform.
5. Pre-processing techniques in image processing
6. Edge detection and region of interest extraction.
7. Experimentation with image processing algorithm for feature extraction.
8. Experimentation with pattern recognition.
9. Vision based pallet inspection.
10. Vision based Gear parameter measurement.
11. Vision based classification of objects.
12. Implement the SIFT blob detector and tracker
13. Object recognition by SIFT, SURF

**TOTAL: 60 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 18 STUDENTS**

1. CMOS Camera (USB/Ethernet)- 1 No
2. CCD Camera (USB/Ethernet)- 1 No
3. Standard Boom Stand (Bench top setup) - 2 No's
4. Extension Tube (5mm to 50mm) - 2 No's
5. Lenses (between 3mm to 50mm focal length)- 2 No's
6. Tele-centric lens - 1 No
7. Lighting (Coaxial, ring lighting, Diffused, backlighting) - 1 No Each.
8. Machine vision software - 2 No's
9. PC-2 No's

**COURSE OUTCOMES:**

Upon the completion of this course, the students will be able to;

CO1. To select a vision sensor for any kind of application.

CO2. To understand and implement various image processing techniques.

CO3. To understand and implement industrial applications.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | - | 2 | 3 | 3 | 2 | 2 |
| CO2 | - | 1 | 3 | 3 | 2 | 2 |
| CO3 | - | 1 | 3 | 3 | 2 | 2 |
| AVG. | - | 1.3 | 3 | 3 | 2 | 2 |

**MR4311** **PROJECT WORK - I**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 12 | 6 |

**COURSE OBJECTIVES:**

1. To enable students to select and define a problem/need for analysis in the field of mechatronic and its interdisciplinary area based on the complexity of the problem.
2. To review and analyse literature/ data of selected problem for study and propose objective and scope of dissertation work.
3. To develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the proposed field of dissertation work.
4. To design, model and experiment/develop optimal solution for problem being investigated.
5. To analysis and interpretation of system and its performance, data, and synthesis of the information to provide valid conclusions and submit dissertation.

**EVALUATION:**

1. A project topic may be selected based on the literature survey and the creative ideas of the students themselves in consultation with their project supervisor. The topic should be so chosen that it will improve and develop the skills in design, modelling, simulation, developing algorithms, fabrication and integration of system elements for automation and research. Literature survey and a part of the project work be carried out in Phase–I.
2. The progress of the project is evaluated based on a minimum of three reviews and review committee may be constituted by the Head of the Department.
3. The project work is evaluated jointly by external and internal examiners constituted by anna university based on oral presentation and the project report.
4. A project report for dissertation-I is to be submitted at the end.
5. Project work evaluation is based on the Regulations of the Credit system for the Post graduate programmes of Anna University Obtain Fourier transforms for the functions which are needed for solving application problems.

**TOTAL: 180 PERIODS**

**COURSE OUTCOMES:**

**CO1 -** The students would apply the knowledge gained from theoretical and practical courses in solving problems

**CO2 -** The students would be able to create a novel mechatronics-based solution for an engineering problem and get trained in planning, organizing and executing the method.

**CO3 –** The students would be able to analyse and evaluate the result and can be able to record and write a technical document in form of thesis.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 3 | | 3 | 3 | 3 | 3 |
| CO2 | 3 | | 3 | 3 | 3 | 3 |
| CO3 | | 3 | | 3 | 3 | 3 |
| Avg. | 2 | 1 | 2 | 3 | 3 | 3 |

**MR4411** **PROJECT WORK - II**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 24 | 12 |

**COURSE OBJECTIVES:**

1. The students will be able to propose and define a problem/need for development and analysis in the field of mechatronic and its interdisciplinary area and it may be a continuation phase -I or newly formulated problem for phase - I.
2. To comprehensively review and analyse literature/ data to develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the field of problem.
3. To design, modelling, simulation, developing algorithms, fabrication and integration of system elements for automation for development of sustainable and economical solution for problem being investigated.
4. To analyse and interpretation of system and its performance, data, and synthesize of the factual information's to arrive at valid conclusions
5. To enable students to communicate technical information in form of oral presentation and technical report in form of dissertation

**EVALUATION:**

1. The progress of the project is evaluated based on a minimum of three reviews.
2. The review committee may be constituted by the Head of the Department.
3. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the anna university based on oral presentation and the project report.
4. Project work evaluation is based on the Regulations of the Credit system for Post graduate programmes of Anna University.

**TOTAL: 180 PERIODS**

**COURSE OUTCOMES:**

**CO1 -** The students would apply the knowledge gained from theoretical and practical courses in solving problems

**CO2 -** The students would be able to create a novel mechatronics-based solution for an engineering problem and get trained in planning, organizing and executing the method.

**CO3 –** The students would be able to analyse and evaluate the result and can be able to record and write a technical document in form of thesis.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 3 | | 3 | 3 | 3 | 3 |
| CO2 | 3 | | 3 | 3 | 3 | 3 |
| CO3 | | 3 | | 3 | 3 | 3 |
| Avg. | 2 | 1 | 2 | 3 | 3 | 3 |

| MR4001 | COMPUTER AIDED INSPECTION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To familiar the measurement standards and to know the instruments used and various errors in measurements
2. To recognize the use of basic and advanced instruments for measurements.
3. To learn the applications of opto-electronics device for measurements.
4. To observe the machine vision-based inspections.
5. To acquire the measurement strategies in inspection using CMM.

**UNIT I FUNDAMENTALS AND CONCEPTS IN METROLOGY 9**

Standards of measurement – Analog and digital measuring instruments-comparators – Limits, Fits and Tolerances – Gauge design – Angular measurements – Surface Roughness – Form errors and measurements.

**UNIT II INSPECTION AND GENERAL MEASUREMENTS 9**

Inspection of gears and threads – Tool makers' microscope – Universal measuring machine – use of Laser interferometer in machine tool Inspection – use of laser in on-line Inspection – Laser micrometer – Laser Alignment telescope.

**UNIT III OPTO ELECTRONICS IN ENGINEERING INSPECTION 9**

Use of opto electronics in Tool wear measurement – Micro hole measurement and surface Roughness – Applications in In-Process measurement and on line Inspection.

**UNIT IV MACHINE VISION 9**

Fundamentals of Image Processing – Steps involved in Image Processing – Machine Vision applications in manufacturing and metrology.

**UNIT V COORDINATE METROLOGY AND QUALITY CONTROL 9**

Co-ordinate measuring machines – Applications and case-studies of CMM in Inspection – Use of Computers in quality control – Control charts – Reliability.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, students will be able to

Upon completion of this course, the students will be able to:

CO1: Evaluate the standards in measurements and to avoid the various forms of errors in measurements.

CO2: Apply of basic and advanced metrology instruments for measurements.

CO3: Acquire the knowledge on non-contact opto-electronics device for measurements.

CO4: Apply machine vision-based inspections.

CO5: Create the measurement strategies in inspection using CMM

**REFERENCES**


1. Anil.K.Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt. Ltd., 2015.
2. Dale.H. Besterfield, "Total Quality Management", Pearson Education Asia, 2018.
3. Jain R.K., "Engineering Metrology", Khanna Publishers, 2018.
4. Manuals of C.M.M. and Systems.
5. Robert G. Seippel, "Opto Electronics for technology and engineering", Prentice Hall, New Jersey, 1989.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 2 | 2 |
| CO3 | 1 | - | - | 3 | 3 | 2 |
| CO4 | 2 | - | - | 3 | 2 | 2 |
| CO5 | 2 | - | - | 3 | 2 | 2 |
| AVG. | 1.8 | - | - | 3 | 2.4 | 2.2 |

**MR4002 DIGITAL MANUFACTURING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To learn the concept of NC and CNC technologies on practical problems with feedback and adaptive control.
2. To learn the configuration of CNC system, PLC programming for CNC and also case studies on machine structure elements.
3. To learn the mechatronics elements in CNC measuring system and tooling system, EEPROM tools, automatic tool changing system, tool magazine and sensors in CNC.
4. To learn about the CNC programming tools with computer assisted programming using APT, generation and execution of APT programs.
5. To learn the methods for verification, testing and Maintenance of CNC machines during idle running and machine tooling.

**UNIT I INTRODUCTION OF NC, CNC, DNC AND ADAPTIVE CONTROL 9**

Classification of machine tools – types, functions and processes - fundamentals of NC and CNC technologies Adaptive control - types, application and benefits - general configuration of adaptive control and function – reasons for process change - practical problems with adaptive control - example for feedback and adaptive control.

**UNIT II MECHATRONIC ELEMENTS IN CNC MACHINE TOOLS 9**

CNC systems - configuration of the CNC system – interfacing – monitoring – diagnostics - machine data - compensations for machine accuracies - PLC in CNC – PLC programming for CNC, steps in programming and case studies - machine structure -types of loads on CNC machine - guide ways and types - mechanical transmission elements - elements for rotary motion to linear motion - ball screw and types - roller screw and types - rack and pinion - various torque transmission elements - requirements of feed drives and spindle drive.

**UNIT III MECHATRONICS ELEMENT IN CNC MEASURING SYSTEM AND TOOLING** **9**

Measuring systems - feedback devices - velocity feedback - analog and digital - position feedback - rotary and linear. Tooling - requirement and planning - preset, qualified and semi qualified tools. Fixtures – requirement - unified and modular fixtures - tool identification - touch trigger probe- tool coding - EEPROM tools. 19 Tool condition monitoring - various indirect and direct methods. Identification and gauging of work piece. Tool locking system - ball lock mechanism and contact pressure monitoring. Automatic tool changing system - types and benefits - tool magazine – sensors in CNC.

**UNIT IV CNC PROGRAMMING** **9**

Machine axes identification - primary, secondary and tertiary - manual CNC programming - Milling programming fundamentals - compensation and offset in milling -fixed cycles in milling - repetitive programming - loops, sub programs and macros. Turning programming fundamentals - compensation and offset in turning - fixed cycles in turning. Computer assisted programming in APT - basic geometry definition - cutter motion definition - postprocessor statements - generation and execution of APT programs.

**UNIT V TESTING AND MAINTENANCE OF CNC MACHINES** **9**

Verification of technical specification and functional aspects, Verification during idle running & machine tool and the work piece accuracy - Installation of CNC machines - Maintenance of CNC machines - machine elements – hydraulic elements - electrical and electronic elements – maintenance schedules.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

CO1: Get the knowledge of the differences of NC, CNC and DNC.

CO2: Analyse architecture of CNC and to identify the mechatronic elements and its functions in CNC machine reliable performance.

CO3: Realize the functions of instrumentation systems

CO4: Write the part programming in CNC machine.

CO5: Perform the testing and maintenance of various sub systems of CNC

**REFERENCES**


1. HMT Limited, “Mechatronics”, Tata Mcgraw-Hill Publishing Co Ltd, 2017.
2. Groover, M.P., “Automation, Production System and CIM”, Prentice Hall of India Pvt. Ltd, 2016.
3. Stenerson and Curran, “Computer Numerical Control-Operation and Programming”, PHI Learning Pvt. Ltd., 2008.
4. Jayakumar, V., and Mahendran, B., “Computer Aided Manufacturing”, Lakshmi Publications, 2005.
5. Jonathan Lin, S.C., “Computer Numerical Control (From Programming to Networking)”, Delmar Publishers Inc., 2000.
6. Radhakrishnan, P., “CNC Machine”, New Central Book Agency, 2000.
7. Sehrawatt, M.S., and Narang, J.S., “CNC Machine”, DhanpatRai And Co, 2002.
8. Grahamt.Smith, “Advanced Machining: The Handbook of Cutting Technology”, IFS Publications Ltd., 1989.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 2 | - | - | 3 | 3 | 3 |
| CO2 | 2 | - | - | 3 | 2 | 2 |
| CO3 | 1 | - | - | 3 | 3 | 2 |
| CO4 | 2 | - | - | 3 | 2 | 2 |
| CO5 | 2 | - | - | 3 | 2 | 2 |
| AVG. | 1.8 | - | - | 3 | 2.4 | 2.2 |

**MR4003 COMPUTER AIDED PRODUCTION AND AUTOMATION OF PLANTS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To learn various production planning processes, capacity planning, and shop floor planning processes.
2. To learn about the fundamentals of Automated assembly and part transferring systems.
3. To learn about Group Technology and Flexible manufacturing systems.
4. To learn about automation systems and advanced manufacturing techniques.
5. To familiarize computer-aided production and automation of plants through various case studies.

**UNIT I COMPUTER AIDED PRODUCTION PLANNING 9**

Application – Process, Demand, Volume, Quality, Manufacturing Task. Automated Factory-Requirements- Factory Planning - Layout- Macro, Micro, and Submicro Layouts - Work Cell Design - Manufacturing Task - Equipment, Tools and Resources Identification – Levels of Automation- Device, Machine, Cell, Plant, Enterprises - Computer Aided Process Planning (CAPP) - MRP – Capacity Planning- Shop Floor Planning – Inventory Control. Tools for Digital Factory Modeling

**UNIT II AUTOMATED MATERIAL TRANSFER AND STORAGE SYSTEM 9**

Automated Production Line – System Configurations, Work Part Transfer Mechanisms – Fundamentals of Automated Assembly System – System Configuration, Part Delivery at Workstations – Design For Automated Assembly – Overview of Material Handling Equipment's – Consideration In Material Handling System Design – Conveyor Systems – Types of Conveyors – Operations and Features. Automated Guided Vehicle System – Types of Vehicles And AGVs Applications - Automated Transport System- Cranes - Hoist - Conventional Storage Methods and Equipments – Automated Storage/Retrieval System and Carousel Storage System Deadlocks in Automated Manufacturing Systems – Petrinet Models – Applications in Dead Lock Avoidance.

**UNIT III GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS 9**

FMS - Overview – Levels- Manufacturing Module -Assembly Cell -Manufacturing Group - Production Systems-Manufacturing Line - Part Families – Visual – Parts Classification and Coding – Production Flow Analysis – Grouping of Parts And Machines by Rank Order Clustering Method – Benefits of GT – Case Studies. FMS – Components – Workstations – FMS Layout Configurations – Computer Control Systems – FMS Planning and Implementation Issues – Architecture of FMS – Flow Chart Showing Various Operations in FMS

**UNIT IV AUTOMATION SYSTEMS AND ADVANCED MANUFACTURING TECHNIQUES** **9**

Intelligent Manufacturing – Virtual Manufacturing- Internet Controlled Manufacturing- Intelligent Agents – Advanced Manufacturing Systems - Robots Role in Various Levels of manufacturing- Sensors in Manufacturing Process-Automated Measurement and Inspections- Vision based inspection Manufacturing Process - Network and Computer Interface - Industrial Networks for Production Line Control

**UNIT V CASE STUDIES** **9**

Case studies of Automated Factory – Manufacturing Task - Car Manufacturing & Assembly – Electronics Manufacturing – Food Processing – Textile Processing

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, students will be able to

1. Understand various production planning processes, capacity planning, and shop floor planning processes
2. Understand the fundamentals of Automated assembly and part transferring systems.
3. Understand the concepts of Group Technology and Flexible manufacturing systems.
4. Understand about automation systems and advanced manufacturing techniques.
5. Apply the concepts of “computer aided production and automation” in various manufacturing industries.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES**


1. Alavudeen and Venkateshwaran, — Computer Integrated Manufacturing ‖, PHI Learning Pvt. Ltd., New Delhi, 2008.
2. Marion I. Tobler-Rohr, Handbook of Sustainable Textile Production, Woodhead Publishing Limited, 2011
3. Mikell P.Groover, —Automation, Production system and Computer integrated Manufacturing ‖, Prentice Hall of India Pvt. Ltd., 2008. 3. Kant Vajpayee, S., —Computer Integrated Manufacturing ‖, Prentice Hall of India, New Delhi, 2007.
4. Mohammed A. Omar, The automotive body manufacturing systems and Process, John Willey and Sons, First edition, 2011.
5. P. Fellows, Food Processing Technology: Principles and Practice Second Edition, CRC Press, 2000.
6. Phillip R. Edwards, Manufacturing Technology in the Electronics Industry: An introduction, Springer - Science+Business Media, B.V, First Edition, 1991.
7. SabrieSoloman, Sensors and control systems in Manufacturing, Second Edition, McGrew Hill Publications, 2010.
8. Viswanathan, N., and Narahari, Y., —Performance Modeling and Automated Manufacturing Systems ‖, Prentice Hall of India Pvt. Ltd., 2000.

| MR4004 | DESIGN OF MACHINE ELEMENTS AND PRODUCT DEVELOPMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To introduce the students about basic concepts, practices, standard data, terminology and symbols for designing.
2. To learn the design procedures of shafts and couplings to withstand various loads.
3. To learn the design procedures of transmission components to transfer power and to withstand various loads.
4. To introduce the students about basic concepts of product development.
5. To learn the basic formulation of finite element analysis for various components

**UNIT I INTRODUCTION 9**

Introduction to national and international symbols- Engineering materials and their physical properties and applied to design- Selection of materials- selection for new design and material considerations-Factors of safety in design- Dimensioning and detailing- Fitness and tolerance- Surface finish and machining symbols –Product development- Elementary concept of functional, aesthetic and form design- Principles of design optimization- Future trends- CAD.

**UNIT II STATIC AND VARIABLE STRESSES 9**

Static and variable loading in machine elements- Stress concentration- Goodmen and soderberg method of design- Design of power transmission shafts- Subjected to torsion, bending and axial loads- Design of close coiled helical spring -Design of couplings- Muff, Flange, Bushed and pin types.

**UNIT III DESIGN OF TRANSMISSION ELEMENTS 9**

Design of gears - Selection and specification- Principle of hydrodynamic lubrication – Design of journal bearings – Selection and specification of anti-friction bearings – Life rating of roller bearings.

**UNIT IV PRODUCT DESIGN AND DEVELOPMENT 9**

Quality function development (QFD) - product design and specification, design for manufacturability (DFM), design for assembly and disassembly, human factors in design ergonomics, creativity in design, TRIZ- axiomatic design.

**UNIT V FINITE ELEMENT ANALYSIS 9**

Basic Concept of FEA - finite element analysis of one dimensional and two dimensional problems- variational formulation of B.V.P. – Ritz Method-Examples related to one-dimensional and two-dimensional problems.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students can able to

1. Understand the basic concepts, practices, standard data, terminology and symbols for designing.
2. Create the shafts and couplings for given various types of loads.
3. Create the transmission components to transfer given power and to withstand various types of loads.
4. Understand the basics concepts of product development.
5. Analyze and formulate finite element equations for some general machine components.

**REFERENCES**


1. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 6th Edition, 2021, ISBN 978-007-127189-9.
2. Jain R.K., “Machine design”, Khanna Publishers, Delhi, 2006.
3. Khurmi R.S and Gupta J.K, “A Text Book of Machine Design”, Eurasia Publishing House (P) Ltd, New Delhi, 2006.
4. PSG Design data Handbook, Kalaikhathir Publications, CBE 2002.
5. Ramamurthi, V., “Finite Element Method in Machine Design”, Narosa Publishing House, January 2009, ISBN: 978-81-7319-965-3
6. Shigley J.E. “Mechanical Engineering Design”, McGraw-Hill Book Co., Delhi, 2004.
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**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**MR4005 MULTI-BODY DYNAMICS**

| L | T | P | C |
|---|---|---|---|
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**COURSE OBJECTIVES**

1. To understand the important concepts of multi-body dynamics.
2. To familiar the various computational methods multi-body dynamics.
3. To characterize the nonlinear concepts of multi-body dynamics.
4. To recognize the need of control in nonlinear dynamics multi body interactions.
5. To interpret the nonlinear dynamics of multi body systems and its realization of control.

**UNIT I INTRODUCTION TO DYNAMICS 9**

Importance of Multibody Dynamics - Particle Mechanics - Rigid Body Mechanics - Deformable Bodies - Constrained Motion- -Kinematics - Rotation - Translation - Velocity- Acceleration Equations – Mechanics of Deformable Bodies - Floating Frame Reference Formulation – Inertia - Generalized Forces - Equation of Motions - Multi Body Systems - Sub Systems - Friction and Spring Nonlinear Model - Nonlinear Dynamic Equations Formulation

**UNIT II COMPUTATIONAL METHODS FOR DYNAMIC ANALYSIS 9**

Jacobian Matrix - Newton-Raphson Method - Nonlinear Kinematic Constrain Equation – System Mass Matrix - External and Elastic Forces - Acceleration Vector – Lagrangean Multiplier - Langrage’s Equation – Kinetic Energy – Hamilton Equation - Hamilton vector Field- Euler - Langrage Equation- Generalized Reaction Forces – State Vector and Equation Formulation.

**UNIT III NONLINEAR SYSTEMS AND CONCEPTS 9**

Linear Time Varying and Linearization – Input and Output Stability - Lyapunov Stability Analysis – Asymptotic Stability - Popov's and Circle Criterion - Perturbed System – Chaos – Periodic Orbits- Index theory and Limit Cycle – Centre Manifold Theory- Normal Forms- Nonlinear analysis- Poincare Maps - Bifurcations – Maps - Vector Fields - Methods – Control System Design using Lyapunov's Direct Method.

**UNIT IV SYSTEM CHARACTERIZATION 9**

Stability, Controllability, Observability - Phase Plane Analysis - Phase Portrait - Limit Cycle - Describing Function - Assumption – Limit Cycles.

**UNIT V CONTROL OF NONLINEAR MECHANICAL SYSTEMS 9**

Double Inverted Pendulum – Nonlinear Machineries – Robots - Suspension System - Aircraft.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Apply the important concepts in multi-body dynamics.
**CO2:** Create mathematical model for capturing the dynamics of multi-body interactions.
**CO3:** Understand the nonlinear behaviour of multi-body dynamics.
**CO4:** Evaluate the control in nonlinear dynamics of multi body interactions.
**CO5:** Apply control for the nonlinear behaviour of multi body systems.

**REFERENCES**


1. Ahmed A. Shabana, "Dynamics of Multibody Systems", Cambridge University Press, 2013.
2. Brian L. Stevens, Frank L. Lewis, "Aircraft Control and Simulation", Wiley India Pvt Ltd, 2010.
3. Hasan Khalil, "Nonlinear Systems and Control", Prentice Hall, 2002.
4. Mahmut Reyhanoglu, "Dynamics and Control of a Class of Under Actuated Mechanical Systems", IEEE Transactions on Automatic Control, 44(9), 1999.
5. Stephen Wiggins, "Introduction to Applied Nonlinear Dynamics System and Chaos", Springer-Verlag, 2000.
6. Wei Zhong and Helmut Rock, "Energy and Passivity Based Control of the Double Inverted Pendulum on a Cart", IEEE, 2001.


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

| MR4006 | ONBOARD COMPUTERS AND PYTHON PROGRAMMING | L | T | P | C |
|---|---|---|---|---|---|
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**COURSE OBJECTIVES**

1. To understand the basics of single board computers.
2. To learn about real-time operating system.
3. To get knowledge on python programming basics.
4. To learn to embed python in various hardware
5. To learn various case studies of python and onboard computers.

**UNIT I INTRODUCTION TO SINGLE BOARD COMPUTERS 9**

On-Board System Architecture- Processor- Architecture – Features - SPI-I2C- UART- USB - Ethernet- CAN Protocol - Wi-Fi – Bluetooth- HDMI- GPIO- Memory- Input Devices – Camera Interfacing.

**UNIT II REAL TIME OPERATING SYSTEM 9**

Operating System Architecture – File Systems- Resource Management – Process Scheduling – Applications.

**UNIT III PYTHON PROGRAMMING 9**

Python Language – Using The Interpreter – Python Data types And Functions – Working With Data – List, Dictionary and Set – Processing Primitives – List Comprehensions – File Handling – Object Model Including Variables, Reference Counting, Copying, and Type Checking – Error Handling Iterative Statement- Conditional Statement –Operators – Arrays Libraries- Library - GUI Development.

**UNIT IV EMBEDDED PYTHON PROGRAMMING 9**

GPIO Programming – Numerical Library- Communication Library- Image Processing – Machine Learning.

**UNIT V APPLICATIONS 9**

Case Studies in Automotive- Robotics - IOT- Factory Automation - Home Automation.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course, the students will be able to;

1. Understand the basics of single board computers.
2. Understand about real-time operating system.
3. Understand basics of python programming.
4. Apply python programming concepts in various hardware.
5. Apply python programming and onboard computer concepts in various systems.

**REFERENCES**


1. Gabriele Manduchi and Ivan Cibrario Bertolotti, Real-Time Embedded Systems: Open-Source Operating Systems, CRC Press, 2012.
2. Guttag, John. Introduction to Computation and Programming Using Python. MIT Press, 2013.
3. Mark Lutz,"Learning Python, Powerful OOPs,O'reilly,2011
4. NInad Sathaye, Learning python application development, Packt publishing, 2016
5. Sai Yamanoor, Srihari Yamanoor, Raspberry Pi Mechatronics Projects Packt publishing, 2016.
6. Warren Gay, Mastering the Raspberry Pi, Apress, 1st ed. edition, 2014

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**MR4007 MICRO AND NANO SYSTEMS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To introduce to microsystem of MEMS, material and fabrication technique
2. To provide overview of characterization tools for MEMS
3. To create awareness about principles and applications of various sensors
4. To impart knowledge on different kind of Micro-Nano actuators
5. To introduce Bio MEMS, Microfluidic and Nano position system

**UNIT I INTRODUCTION TO MICRO AND NANO TECHNOLOGY 9**

Overview of Nanotechnology and MEMS - Nano Structuring - Nano Particles and Nano Layers - Properties - Science and Synthesis of Nano Materials – Lithography - Micromachining - Photolithography, Deposition Methods, DIRE, LIGA and Laser-Assisted Processing - Overview of Materials for MEMS – Si Wafer, Si Based Products, Polymers.

**UNIT II CHARACTERIZATION OF MATERIALS 9**

Principles and Applications of Nano Measuring Systems – Microscopy Techniques, Confocal LASER Scanning Microscopy - Scanning Electron Microscopy - Transmission Electron Microscopy, Scanning Tunnelling Microscopy, Atomic Force Microscopy, Diffraction Techniques – Auger Electron Spectroscopy (AES), X-Ray Photoelectron Spectroscopy (XPS), Electron Probe Micro-Analyser (EPMA) - Application.

**UNIT III MICRO AND NANO SENSORS 9**

Si Active Tactile Sensor - Fabric Tactile Sensor and its application – Accelerometer- Capacitive Silicon – Wall in-Tube Flow Sensor and its application- Inertial Sensors – Accelerometer – Gyroscope – Pressure Sensors – Piezoresistive – Capacitive - Micro Channel Heat Sinks – Optical MEMS – Visual Display– Optical Data Switching – RF MEMS – MEMS Variable Capacitors – MEMS Switches – Resonators - Pressure Sensor - Nano Tweezers.

**UNIT IV MICRO AND NANO ACTUATORS 9**

Requirement for Micro Actuators - Nano Positioners, Micro Mechanical Testing Apparatus - Classification of Micro Actuator - Electrostatic Distributed Actuator- Force Distance various Actuators– Inch Worm, Zipper and Scratch Drive. Thermal Actuation-Bimorph-Buckle Beam -Frequency and Force Characteristics and Advantages -Electro thermal Actuator - Electro Thermal Relay with Mechanical Latch – Force vs Displacement Curve - Piezoelectric Actuation Advantages - MEMS Switch -Thin Film Bulk Acoustic Resonator (FBAR) - Magnetic Actuation - External Magnetic Field Actuators & Issues - Variable Reluctance Actuators - Shape Memory Actuators - Micro Pump and Micro Fluidics.

**UNIT V MICRO AND NANO SYSTEM 9**

Micro Fluidic Systems - Micro Engine Driven by Electrostatically Actuated Comb Drive – Micro Robots and Nano Robots – Micro Insects, Night Vision System, BioMEMS- Principle and Application of Micro and Nano position Systems.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

CO1. Understand material and fabrication involved in Microsystem.
CO2. Explain techniques to visualize and measure geometrical features of MEMS system and chemical composition.
CO3. Select a type of sensors based on application with working knowledge and principles.
CO4. Select a type of factor based on application with knowledge of working principle.
CO5. Discuss on Micro fluidic, Bio MEMS and Nano position systems.

**REFERENCES:**


1. Mahalik N P, “MEMS”, McGraw Hill (India), 2009
2. Marc Madou, “Fundamentals of Micro Fabrication”, CRC Press, 2011.
3. Mohamed Gad-el-Hak, “MEMS Handbook”, CRC Press, 2006,
4. Sami Franssila, Introduction to Micro Fabrication, John Wiley & Sons Ltd, 2010.
5. Tai – Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata-McGraw Hill, New Delhi, 2007.
6. Waqar Ahmed and Mark J. Jackson, “Emerging Nanotechnologies for Manufacturing”, Elsevier Inc., 2014.


**CO-PO MAPPING :**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**MR4008 ADVANCED CONTROL SYSTEMS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To recall the fundamentals of PID control and familiar various performance measures used in control systems.
- To interpret the single loop control and it's tuning.
- To model, analyse the system in state space and its observer design in detail
- To familiar the nonlinear control system and its concepts.
- To learn the functions and used of various control methodology.

**UNIT - I CONTROLLER AND PEREOFRMANCE MEASURES 9**

Review of Feedback Systems and Design of PID Controllers - Electronic PID Controller – Digital PID Algorithm – Auto/Manual Transfer - Reset Windup – Practical Forms of PID Controllers - Evaluation Criteria – IAE, ISE, ITAE And ¼ Decay Ratio – Tuning Using Process Reaction Curve Method, Continuous Cycling Method and Damped Oscillation Method – Pole Placement – Lamda Tuning.

**UNIT- II ENHANCEMENT TO SINGLE LOOP CONTROL 8**

Feed-Forward– Ratio Control – Cascade Control – Inferential Control – Split-Range – Override Control – Selective Control – Sliding Mode Control - Auto Tuning.

**UNIT - III STATE SPACE ANALYSIS 10**

Concepts of State Variable and State Model – State Space to Transfer Function and Transfer Function to State Space Modes – Solving Time Invariant State Equation – Controllability – Observability – State Observers – Design of Control Systems with Observers.

**UNIT – IV NONLINEAR SYSTEMS AND CONTROL 10**

Non-Linear Systems – Common Physical Nonlinearities – Linearization of Nonlinear Systems – Phase Portrait Analysis – Isocline Method – Liapnov's Stability Concept – Popov Criterian – Kalman Algorithm.

**UNIT - V OTHER CONTROL METHODS 8**

LQR - Adaptive Control – Optimal Control – Robust Control – Model Predictive Control – Multivariable Control systems.



**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to:

**CO1:** Develop the PID control and capable to analyze performances of the control systems.
**CO2:** Know the functions of various types of single loop control and its tuning.
**CO3:** Examine the system in state space and its observer design in detail
**CO4:** Approach the nonlinear control system and its concepts.
**CO5:** Recognize the uses of various control methodology.

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Bequette. B.W., “Process Control Modelling, Design and Simulation”, Prentice Hall of India, 2004.
2. Gopal. M, “Control Systems Principles and Design”, Tata McGraw Hill Publishing Ltd, 2003.
3. Kuo .B.C, “Automatic Control Systems”, Prentice Hall, 2004.
4. Nagrath .I.J. and Gopal, “Control System Engineering”, New Age International (P) Ltd., 2006.
5. Ogata.K, “Modern Controls Engineering“, Prentice Hall, 2005.
6. Zbigniew Ogonowski , “Advanced Control with MATLAB and Simulink”, Ellis Horwood, Ltd, 1995


| MR4009 | BIOMECHATRONICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

- To familiarize the fundamentals of biomechanics.
- To characterize and relate the behaviours of skeletal and muscular systems for engineering solutions.
- To understand the servomechanism of biological systems.
- To design artificial structural elements for replacements.
- To simulate and develop the applications of bio-mechatronics.

**UNIT- I BIOMECHANICS 9**

Introduction to Bio-Mechanics, Relation between Mechanics and Medicine, Newton’s Laws, Stress, Strain, Shear Rate, Viscosity, Visco-Elasticity, Non-Newtonian Viscosity, Soft Tissue Mechanics, Mechanical Properties of Soft Biological Tissues - Bio Fluid Mechanics - Introduction to Biomechatronic Systems

**UNIT- II MECHANICS IN SKELETAL AND MUSCULAR SYSTEM 9**

Bones, Types and Functions - Axial and Appendicular Skeleton. Joints: Definition, Types and Functions, Mechanical Properties of Bones. Kinetics and Kinematics Relationship of Skeletal and Muscular System.

**UNIT - III CONTROL MECHANISM OF BIOLOGICAL SYSTEMS 9**

Skeletal Muscles Servo Mechanism, Cardio Vascular Control Mechanism, Respiratory Control Mechanism – Interfacing Techniques with Natural Servo Mechanism.

**UNIT - IV PROSTHETIC AND ORTHOTIC DEVICES 9**

Analysis of Force in Orthopaedic Implants, Hand and Arm Replacement, Different Types of Models for Externally Powered Limb Prosthetics, Lower Limb, Upper Limb Orthotics, and Material for Prosthetic and Orthotic Devices, Functional Electrical Stimulation, Sensory Assist Devices. Exoskeletons, Exo musculatures, Space Suits, Physical Therapy and Rehabilitation, Wheelchairs and other Mobility Assistance.

**UNIT - V SIMULATION AND MODELLING OF BIOMECHANTRONICS 9**

Physics-Based Modelling and Simulation of Biological Structures - Variables of Interest – Geometry - Introduction to Model the Skeletal System Using Open Source Software – Human Leg Prosthesis And Normal Gait vs. Prosthesis Leg Analysis - Upper Extremity Kinematic Model – Application in Sports, exercise, entertainment.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to:

**CO1:** Know the fundamentals of biomechanics.
**CO2:** Describe and relate the behaviours of skeletal and muscular systems
**CO3:** Realize the servomechanism of biological systems for bio mechatronics development.
**CO4:** Design the artificial bio Mehatronics systems.
**CO5:** Establish and develop the applications of bio mechatronics.

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES**


1. Dawson. D and Right, “Introduction to Bio-mechanics of Joints and Joint Replacement”, Mechanical Engineering Publications Ltd., 1989.
2. Fung. Y.C, “Biomechanics: Mechanical Properties in Living Tissues”, Springer Verlag, 1981.
3. Susan J.Hall, “Basics Bio-Mechanics”, McGraw-Hill, 2002.
4. Gillian Pocock & Christopher D.Richards, “The Human Body”, Oxford University Press, 2009.
5. Jacob Segil, “Handbook of Biomechatronics”, Acadamic Press, 2018.
6. Marko Popovic, Biomechatronics, Academic Press, 2019.
7. Ranganathan T S, “Text Book of Human Anatomy” S. Chand and Company, 1994.
8. Scott L. Delp., “OpenSim: Open-Source Software to Create and Analyze Dynamic Simulations of Movement”, IEEE Transaction on Biomedical Engineering, Vol.54 No.11, 2007.

| MR4010 | SOLID STATE DRIVES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand electrical actuator steady state operation and transient dynamics of a motor load system.
2. To learn the operation and construction of solid-state switching devices.
3. To study the operation of various D.C Motor drives and to select appropriate drive for speed and position control.
4. To study the operation of various A.C Motor drives and to select appropriate drive for speed control.
5. To study the operation of various Special Motor drives.

**UNIT I ELECTRICAL ACUATORS AND DRIVE CHARACTERISTICS 9**

AC - DC Power Sources -Types – Electrical Actuator Input Types - DC Motors, AC Motors, Special Electrical Motors - Solenoids - Electric Drives – Equations Governing Motor Load Dynamics – Steady State Stability – Multi Quadrant Dynamics - Acceleration, Deceleration, Starting & Stopping – Typical Load Torque Characteristics – Selection of Motor.

**UNIT II SOLID STATE SWITCHING DEVICES 9**

Solid State Relay - Switching Characteristics - Bipolar Junction Transistor (BJT), Metal Oxide Semiconductor - Field Effect Transistor Silicon Controlled Rectifier (SCR) - DIAC- TRIAC- Gate Turn-Off Thyristor (GTO) – Insulated Gate Bipolar Transistor (IGBT) - Classification of PWM Techniques.

**UNIT III D.C. MOTOR DRIVES 9**

Thyristor D.C. Drives – Single and Three Phase Converter - Control Arrangements for D.C. Drives - Chopper-Fed D.C. Motor Drives - D.C. Servo Drives – Speed - Position Control -Digitally Controlled Drives – H Bridge Circuits.

**UNIT IV A.C. MOTOR DRIVES 9**

Induction Motor Drives –Inverter Fed Drives – Open and Closed Loop Speed Control - Energy Efficient Drive–V/F Control– Voltage / Current Fed Inverter – Closed Loop Control -Synchronous Motors - V/F Control and Self - Control of Synchronous Motor: Power Factor Control – Permanent Magnet Synchronous Motor Drives.



**UNIT V SPECIAL ELECTRICAL MOTOR DRIVES 9**

Stepper Motor Driver Circuits –Constant Voltage Drive – Current Forced Drive- Chopper Drive – Single Phase and Three Phase BLDC Driver Circuits – Sensorless Motor Drives.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to:

CO1. Understand electrical actuator steady state operation and transient dynamics of a motor load system.
CO2. Select suitable solid-state switching devices.
CO3. Identify and apply appropriate drive for speed and position control for various D.C Motors.
CO4. Identify and apply appropriate drive for speed control for various A.C Motors.
CO5. Select suitable drives for special motors

**REFERENCES:**


1. Austin Hughes, “Electric Motor and Drives: Fundamentals, Types and Applications”, Newnes Publications, 2013
2. Bimal K.Bose, “Modern Power Electronics and AC Drives”, Academic Press, 2010,.
3. Gopal K.Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
4. Krishnan R, “Electric Motor & Drives: Modelling, Analysis and Control”, Prentice Hall of India, 2001.
5. Muhammad H.Rashid, “Power Electronics Handbook”, Butterworth-Heinemann Publications, 2017.


**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**MR4011 AUTOMOTIVE ELECTRONICS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To impart knowledge to the students in the principles of operation and constructional details of various Automotive Electrical and Electronic Systems
- To understand the need for starter batteries, starter motor and alternator in the vehicle.
- To differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols
- To list common types of sensor and actuators used in vehicles.
- To understand dash – Board Instruments, various sensors and networking in vehicles.

**UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS 9**

Components for an electronic engine management system, open and closed-loop control strategies, PID control, Lookup tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

**UNIT II ELECTRONIC SENSORS IN AUTOMOBILE 9**

Throttle position, mass air flow, crankshaft position, cam position, engine speed sensor, exhaust oxygen level (two step, linear lambda and wideband), knock, manifold temperature, and pressure sensors. Solenoid, relay (four and five pins), stepper motor

**UNIT III ELECTRONIC COMPONENTS FOR ENGINE CONTROL 9**

Cold start and warm-up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop and closed-loop control – Integrated engine control system, Electromagnetic compatibility – EMI Suppression techniques – Electronic dashboard instruments – Onboard diagnosis system.

**UNIT IV ELECTRONIC COMPONENTS FOR IGNITION AND INJECTION SYSTEMS 9**

Types of electronic ignition systems - variable ignition timing, distributor less ignition. Spark timing control. TBI, MPFI, GDI Systems. Engine mapping.

**UNIT V MICROPROCESSOR IN AUTOMOBILES 9**

Microprocessor and Microcomputer controlled devices in automobiles such as instrument clusters, Voice warning systems, Travel information systems, and Keyless entry system. Environmental requirements (vibration, Temperature, and EMI).

**OUTCOMES:**

At the end of this course the student should be able to

- Explain the fundamentals, operation, function of various sensors and actuators in engine management systems.
- Define the glossary related to vehicle electrical and electronic system
- Understand the need for starter batteries, starter motor, and alternator in the vehicle.
- Differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control units using different communication protocols
- List common types of sensors and actuators used in vehicles.
- Understand networking in vehicles.

**CO PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Judge. A.W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 1992.
2. William B. Ribbens -Understanding Automotive Electronics, 5th edition- Butter worth Heinemann, 1998.
3. Young. A.P., & Griffiths. L., Automobile Electrical Equipment, English Language Book Society & New Press, 1990.
4. Vinal. G.W., Storage Batteries, John Wiley & Sons inc., New York, 1985.
5. Crouse.W.H., Automobile Electrical Equipment, McGraw Hill Book Co Inc., New York, 1980.
6. Spreadbury.F.G., Electrical Ignition Equipment, Constable & Co Ltd., London, 1962.
7. Robert N Brady Automotive Computers and Digital Instrumentation, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.

**MR4012** **UNMANNED AERIAL VEHICLE** **L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

1. To understand the basic concepts of UAVs.
2. To learn and understand the various components of UAVs.
3. To familiarize the basic concepts of flights.
4. To impart knowledge on maintenance of drone equipment.
5. To understand the various regulatories and regulations.

**UNIT I INTRODUCTION TO UNMANNED AERIAL VEHICLES (UAV) 9**

Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas. Operational considerations like liability / legal issues, ethical implications LOS / BLOS

**UNIT II UNMANNED AERIAL SYSTEM (UAS) COMPONENTS 9**

Platforms - configurations - characteristics – applications. Propulsion: internal combustion engines, turbine engines, electric systems. On-board flight control – Payloads: sensing/surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations

**UNIT III BASIC CONCEPTS OF FLIGHT 9**

Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.

**UNIT IV DRONE EQUIPMENT MAINTENANCE 9**

Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.

**UNIT V REGULATORIES AND REGULATIONS 9**

Homeland regulatories: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to:

CO1. Understand and familiarize the basic concepts on UAVs
CO2. Select and choose the components of UAV
CO3. Understand the basic concepts of flight
CO4. To maintain the drone equipment.
CO5. To understand various regulatories and regulations.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**
1. Paul Fahlstrom, Thomas Gleason, “Introduction to UAV Systems”, 4th edition, John Wiley & Sons, 2012.
2. Randal W. Beard and Timothy W. McLain, “Small Unmanned Aircraft: Theory and Practice “, Princeton University Press, 2010.
3. Jha, “Theory, Design, and Applications of Unmanned Aerial Vehicles”, CRC Press, 2016.

| MR4013 | INTELLIGENT PRODUCT DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**
1. To understand the basics of intelligent design and manufacturing.
2. To learn and understand the knowledge representation techniques.
3. To learn and understand the intelligent product modelling techniques.
4. To demonstrate the applications of neural networks.
5. To study the applications of internet based collaborative CAD/CAM.

**UNIT – I INTRODUCTION TO INTELLIGENT DESIGN AND MANUFACTURING 9**

Need - Internet technology and Manufacturing Industry - Digital enterprises - Manufacturing portals – Benefits.

**UNIT – II TECHNIQUES OF KNOWLEDGE REPRESENTATION 9**

Artificial Neural Networks, Fuzzy Logic, Genetic Algorithms, Expert Systems with case studies.

**UNIT – III INTELLIGENT PRODUCT MODELING TECHNIQUES 9**

Intelligent CAD systems, integrating product and process design, manufacturing analysis and CAD/CAM integration, design methodology for automated manufacture, the impacts of intelligent process control on product design, and fuzzy knowledge-based controller design.

**UNIT – IV APPLICATION OF NEURAL NETWORKS 9**

Neural Networks for Intelligent Process Monitoring and Control : Applications to CNC machining, Metal Forming - Intelligent Manufacturing Planning, Scheduling and Control - Intelligent Assembly and Layout Planning.

**UNIT – V INTERNET BASED COLLABORATIVE CAD/CAM 9**

Applications to web based CAD, CAPP, CNC, Assembly planning, and Rapid Prototyping - Challenging issues of Collaborative CAD/CAM.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:
1. Identify and understand the intelligent design and manufacturing.
2. Familiarize the knowledge representation techniques.
3. Understand the various techniques in intelligent product modeling.
4. Demonstrate the applications of neural networks
5. Apply internet on collaborative CAD/CAM

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 2 | 2 | 2 |
| CO2 | 1 | - | - | 2 | 2 | 2 |
| CO3 | 1 | - | - | 2 | 2 | 2 |
| CO4 | 1 | - | - | 2 | 2 | 2 |
| CO5 | 1 | - | - | 2 | 2 | 2 |
| AVG. | 1 | - | - | 2 | 2 | 2 |

**REFERENCES:**


1. Dagli, C.H., "Intelligent systems in design and manufacturing", ASME, 1994.
2. Huang, G.Q. and Mak, K.L., "Internet Applications in Product design and Manufacturing", Springer, 2003.
3. Kusiak, A., "Intelligent Design and Manufacturing", Wiley-Inter science, 1992.
4. Parsaei, H.R. and Jamshidi, M., "Design and implementation of intelligent manufacturing systems", Prentice Hall, 1995.


**IL4073 HUMAN INDUSTRIAL SAFETY AND HYGIENE L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Identify and prevent operational hazard
- Categorize, analyze and interpret the accidents data based on various safety techniques.
- Use proper safety techniques on safety engineering and management.
- Design the system with environmental consciousness by implementing safety regulation
- Use safety management practices in Industries.

**UNIT I OPERATIONAL SAFETY 9**

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipes- metal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

**UNIT II SAFETY APPRAISAL AND ANALYSIS 9**

Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation .Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

**UNIT III OCCUPATIONAL HEALTH 9**

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

**UNIT IV SAFETY AND HEALTH REGULATIONS 9**

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

**UNIT V SAFETY MANAGEMENT 9**

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

CO1: Ability to Identify and prevent operational hazard
CO2:Ability to collect, analyze and interpret the accidents data based on various safety techniques.
CO3: Ability to apply proper safety techniques on safety engineering and management.
CO4: Ability to design the system with environmental consciousness by implementing safety regulation
CO5: Ability to apply safety management practices in Industries.

**REFERENCES:**


1. John. V. Grimaldi and Rollin. H Simonds, “Safety Management”, All India traveler Book seller, New Delhi – 1989.
2. John V Grimaldi, Safety Management. AITB publishers, 2003.
3. Krishnan N.V, “Safety in Industry”, Jaico Publisher House, 1996.
4. Singh, U.K and Dewan, J.M., “Sagety, Security and Risk Management”, APH publishing company, New Delhi, 1996.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | - | - | - | 1 | - | - |
| CO2 | 1 | - | - | - | 1 | - |
| CO3 | 2 | - | - | 1 | 1 | - |
| CO4 | - | - | 2 | - | - | 1 |
| CO5 | - | - | - | - | 1 | 1 |
| Avg. | (1+2)/2=1.5 | (1+2)/2=1.5 | 2/1=2 | (1+1)/2=1 | (1+1+1)/3=1 | (1+1)/2=1 |

**1-low, 2-medium, 3-high, ‘-“- no correlation**

**MR4071 INTERNET OF THINGS FOR MANUFACTURING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To understand the basics of IoT, Opportunities and challenges in IoT
2. To design a IoT solution
3. To develop an IoT protype
4. To explain the various protocols used in IoT and Localization
5. To examine the applications of IoT in Manufacturing

**UNIT I INTRODUCTION 9**

Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

**UNIT II DESIGN OF IoT 9**

Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

**UNIT III PROTOTYPING OF IoT 9**

Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

**UNIT IV PREREQUISITES FOR IoT 9**

IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems

**UNIT V APPLICATION IN MANUFACTURING 9**

Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

**TOTAL : 45 PERIODS**

**COURSE OUTCOME:**

On completion of the course, the students will be able to

CO1: Identify the Opportunities and challenges in IoT
CO2: Propose a suitable IoT design
CO3: Develop an optimized IoT protype
CO4: Understand the various protocols used in IoT and Localization
CO5: Understand the applications of IoT in Manufacturing

**REFERENCES:**


1. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013
2. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.

3. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence" Elsevier
5. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014.

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **1** | 1 | | 2 | 1 | | |
| **2** | 1 | | 2 | | | 3 |
| **3** | 1 | | 2 | | | 3 |
| **4** | 1 | | 2 | | | 3 |
| **5** | 1 | | 2 | | | 3 |
| **Avg** | **(5/5)=1** | | **(10/5)=2** | **(1/1)=1** | | **(12/4)=3** |

**MR4014 COMMUNICATION PROTOCOLS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

1. To study the various types wired protocols for electronic system.
2. To know the various types wireless protocols for electronic system.
3. To aware the various industrial wired protocols in automation.
4. To study the various types wireless protocols for industrial automation.
5. To develop the wired and wireless functions of various protocols

**UNIT – I WIRED BUSES AND PROTOCOLS** **9**

Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232-UART-SPI - I2C –UNI/O Bus -1 Wire - Camara Link - Parallel Communication - PPI - Wishbone Bus – AMBA – JTAG - Fireware IEEE 1394 Bus - Ethernet Overview - RS485.

**UNIT – II WIRELESS PROTOCOLS** **9**

Antenna Technology- Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless Industrial Automation Protocols.

**UNIT – III INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS** **9**

Overview of Industrial Wired Networks – Terminal Bus- Modbus - HART Network - Mechatrolink-II – Ether CAT- Sercos II/III – CAN- Canopen - Modbus IDA-PROFINET-PROFIBUS-Ethernet/IP- Ethernet Powerlink- AG Automation and Drives (AS-I) - Device Net.

**UNIT – IV INDUSTRIAL WIRELESS NETWORKS** **9**

Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks-Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.

**UNIT – V APPLICATION OF COMMUNICATION PROTOCALS** **9**

Wired Machine Networking of Sub-elements and Machines - Wireless Machine Networking of Sub-elements and Machines – Networking of Industry - Communication Network Layout Design - Networking for TIA- Cloud Computing – IOT - Case Studies in Automation Applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Design wired protocols for electronic system.
2. Use wireless protocols for electronic system.
3. Practice industrial wired protocols in automation.
4. Select wireless protocols for industrial automation.
5. Demonstrate the wired and wireless functions of various protocols in application development.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Bolton W., “Mechatronics”, Pearson; 5th edition, 2015.
2. Bradley D.A., and Dawson, Burd and Loader, “Mechatronics”, Thomson Press India Ltd., 2004.
3. Ernest O. Doeblin, “Measurement system, Application and Design”, Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004.
4. Renganathan S., “Transducer Engineering”, Allied Publishers (P) Ltd., 2003.
5. Antony Esposito, “Fluid Power Systems and Control”, Prentice-Hall, 2006.
6. Austin Hughes, “Electric Motors and Drives Fundamentals, Types and Applications”, Fourth Edition, Elsevier, 2013.




**MR4015 ADVANCED COMPUTER VISION**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To understand the various fundamental mathematics behind computer vision algorithms.
2. To expose students to various image formation and camera calibration techniques
3. To expose students to various 3D surface reconstruction algorithms.
4. To impart knowledge on stereo vision and structure from motion.
5. To impart knowledge on applying the computer vision techniques to robots

**UNIT – I BASIC CONCEPTS FOR COMPUTER VISION** **9**

Sampling Theorem – Numerical Differentiation – Differential Geometry – Singular Value Decomposition – Robust Estimators and Model Fitting

**UNIT – II IMAGE FORMATION AND CAMERA CALIBRATION 9**

Projective Geometry - Imaging through lenses and pin-hole – Basic Photometry – Basic model of imaging geometry – Ideal Camera – Camera with intrinsic parameters – Approximate camera models – Camera Calibration – Methods and Procedure

**UNIT – III SURFACE RECONSTRUCTION TECHNIQUES 9**

Depth Perception in Humans, Cues – Shape from Texture, Shading, Focus, Defocus, Structured Light Reconstruction – Time of Flight Methods

**UNIT – IV COMPUTATIONAL STEREO AND MOTION 9**

Computational Stereopsis – Geometry, parameters –correlation-based methods, feature-based methods – Epipolar Geometry, eight-point algorithm – Reconstruction by triangulation, scale factor and up to a projective transformation – Visual Motion – Motion field of rigid objects – Optical Flow – Estimation of motion field – 3D structure and motion from sparse and dense motion fields – Motion based segmentation.

**UNIT – V ROBOT VISION 9**

Visual Tracking – Kalman Filtering and Sequential Monte Carlo – Visual SLAM, solutions, EKF-SLAM, FastSLAM – 3D SLAM – Advanced Visual Servoing, hybrid visual servo, partitioned visual servo.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Understand the basic concepts behind computer vision algorithms.
**CO2:** Understand various image formation and camera calibration techniques.
**CO3:** Understand various 3D surface reconstruction algorithms.
**CO4:** Understand stereo vision and structure from motion.
**CO5:** Apply the computer vision techniques to robots

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Eugene Hecht, A.R. Ganesan “Optics”, Fourth Edition, 2001.
2. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition, 1998.
3. Boguslaw Cyganek, J. Paul Siebert, An Introduction To 3D Computer Vision Techniques and Algorithms, First Edition, 2009.
4. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, An Invitation to 3-D Vision from Images to Models, First Edition, 2004.


| MR4016 | MECHATRONICS IN AERO SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To learn about the aircraft system and its automation requirements.
2. To learn about various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
3. To learn various actuators and other mechanisms related to aircraft.
4. To understand the stability and control of an aircraft.
5. To learn about GPS and other navigation techniques used in aircraft.

**UNIT – I OVERVIEW OF AIRCRAFT ENGINEERING 9**

Aircraft Systems Engineering Overview - Concept Map - The Seven Steps Systems Engineering - Conceptual System Design - Fundamentals - Components of an Airplane - Functions - Motions of a Plane - Components of a Helicopters - Functions Helicopters. Types of Aerial Vehicles – functions – Unmanned aerial vehicles - Quadcopter – Drone – Micro Aerial Vehicles.

**UNIT – II SENSORS AND MEASUREMENTS 9**

Sensors – Gyroscope - Rate Gyros - Rate Integration and Free Gyro, Vertical and Directional Gyros, Laser Gyroscopes, Accelerometers. Direct Reading Compass, Classification of Aircraft Instruments - Engine Power and Control Instruments - Measurement of RPM, Manifold Pressure, Torque, Exhaust Gas Temperature, EPR, Fuel Flow, Engine Vibration, Monitoring Air Data Instruments - Airspeed, Altitude, Vertical Speed Indicators. Static Air Temperature, Angle of Attack Measurement - Instrument Displays Panels and Cockpit Layout.

**UNIT – III MECHANISMS AND ACTUATORS 9**

Types of Actuation Systems - Linear and Non-Linear Actuation System, Valves, Modelling of Actuation Systems, Flight Control - Landing Gear - Brake Actuation - Servo-Loop Analysis Actuator Design - Testing Methodologies, Performance Testing Equipment’s for Sensors and Actuation Systems

**UNIT – IV STABILITY AND CONTROL 9**

Automatic Flight Control Systems – Auto Pilot – Longitudinal – Lateral - Fly-By-Wire Flight and Digital Fly-By-Wire Flight Control Systems - Elements, Architecture, System Design. Longitudinal and Lateral Control Law Design - Back Stepping Algorithm – Active Control Technology

**UNIT – V NAVIGATION** **9**

Introduction to Navigation – Types – Inertial Navigation Systems - Radio Navigation - Approach and Landing Aids - Ground Controlled Approach System – Surveillance Systems-Radio Altimeter – GPS - Integration of GPS and INS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course, the students will be able to;

1. Understand the aircraft system and its automation requirements.
2. Understand various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
3. Understand various actuators and other mechanisms related to aircraft.
4. Understand the stability and control of an aircraft.
5. Understand GPS and other navigation techniques used in aircraft.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. AGARD-AG-234, "Active controls aircraft Design", 1978.
2. Collinson R.P.G, ‗Introduction to Avionics', Chapman and Hall, India, 1996.
3. Ian Moir and Allan Seabridge, Aircraft Systems Mechanical, electrical, and avionics subsystems integration, John Wiley & Sons Ltd, 2009.
4. Jane's Unmanned Aerial Vehicles and Targets, Jane's Information Group; ASIN: 0710612575, 1999.
5. Nelson R.C ‗Flight stability & Automatic Control', McGraw Hill, 1989.
6. Pallet, E.H.J. Aircraft Instruments & Integrated systems‖, Longman Scientific and Technical, McGraw-Hill, 1992.
7. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
8. Stevens B.L & Lewis F.L, Aircraft control & simulation', John Wiley Sons, New York, 1992.


**MR4017 MEDICAL MECHATRONICS** **L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

1. To know the various types of human functional system and basic human functional measurement instrumentations.
2. To understand the mechatronic elements in various assisting and therapeutics equipment.
3. To realize the integrations of in cardiac and regulatory functions assist systems.
4. To acquire the architecture and functions of medical imaging equipment.
5. To introduce the sensory assist devices and automated analysed in medical field.

**UNIT – I INTRODUCTION TO MEDICAL MECHATRONICS 9**

Role of Mechatronics in Medical – Overview of Human Functional System – Cell and Origin Bioelectric Potential - Measurement of Blood Pressure - Invasive and Non-invasive Methods- Transducers Role in Measurement – Heart Rate – Pressure - Temperature- Heart Sound – Pulmonary Function Measurements. ECG, EEG and EMG Systems.

**UNIT – II ASSISTING AND THERAPEUTIC EQUIPMENTS 9**

Diathermy – Heart Lung Machine –– Dialyzers – Centrifuge- Coagulators- Aspirator – Oximeter – Spirometer - Nebulizer – Anaesthesia Machine - Operating Table – Examination Couches - Infusion Systems – Surgical Robots.

**UNIT – III CARDIAC AND REGULATORY ASSIST SYSTEM 9**

Pacemakers – Defibrillators – Ventilators – Nerve and Muscle Stimulators - Location for Stimulation - Synchronous Counter Pulsation, assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and Closed Chest Type, Intra-Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves, Principle and Problem, Biomaterials for Implantable Purposes, its Characteristics and Testing. Lithotripsy - Indication and Principle of Haemodialysis, Membrane, Dialysate, Different Types of Haemodialysis, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

**UNIT – IV MEDICAL IMAGING 9**

Radio Graphic and Fluoroscopic Techniques – XRAY Machine - Computer Tomography – MRI – FMRI- Ultrasonography – Endoscopy – Colonoscopy -Thermography – Different Types of Biotelemetry Systems and Patient Monitoring – PET- Introduction to Biometric Systems.

**UNIT – V SENSORY ASSIST DEVICES AND AUTOMATED ANALYZER 9**

Types of Deafness, Hearing Aids, Application of DSP in Hearing Aids - Ear Irrigator- Voi Synthesizer, Speech Trainer. Ultra-Sonic and Laser Canes, Intra Ocular Lens, Braille Reade Tactile Devices for Visually Challenged - Ophthalmoscopy - Text Voice Converter - Scre Readers and Automated Analyzer.

**TOTAL: 42 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Understand the uses of human functional measurement instrumentations.
**CO2:** Evaluate the mechatronic elements in various assisting and therapeutics equipment.
**CO3:** Apply the integrations of in cardiac and regulatory functions assist systems.
**CO4:** Understand the elements and functions of medical imaging equipment.
**CO5:** Evaluate the appropriate sensory assist devices and automated analysed in medical field.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Albert M Cook and Webster J G, “Therapeutic Medical Devices’’, Prentice Hall Nee York, 1982.
2. Alfred Horowitz, “MRI Physics for Radiologists – A Visual Approach”, Springer Verlag Network, 1991.
3. Geddes L A and Baker L.E, “Principals of Applied Biomedical Instrumentation”, John Wiley and Sons Newyork, 1989.
4. Jerry L.Prince and Jnathan M.Links, ”Medical Imaging Signals and Systems”, Pearson Education Inc., 2006
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6. Kolff W.J., “Artificial Organs”, John Wiley and Sons, New York, 1979.
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| MR4018 | MOBILE ROBOTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT – I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles – Teleportation and Control.

**UNIT – II KINEMATICS 9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots – Open Loop and Feedback Motion Control – Humanoid Robot - Kinematics Overview.

**UNIT – III PERCEPTION 9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Vision Based Sensors – Uncertainty - Statistical Representation - Error Propagation - Feature Extraction Based on Range Data (Laser, Ultrasonic, Vision-Based Ranging) - Visual Appearance based Feature Extraction.

**UNIT – IV LOCALIZATION 9**

The Challenge of Localization - Sensor Noise and Aliasing - Effector Noise – Localization Based Navigation Versus Programmed Solutions - Belief Representation – Single - Hypothesis Belief And Multiple-Hypothesis Belief - Map Representation - Continuous Representations - Decomposition Strategies - Current Challenges In Map Representation - Probabilistic Map-Based Localization - Markov Localization - Kalman Filter Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Stochastic Map Technique - Other Mapping Techniques.

**UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Modularity for Code Reuse and Sharing - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Evaluate the appropriate mobile robots for the desired application.
**CO2:** Create the kinematics for given wheeled and legged robot.
**CO3:** Analyse the sensors for the intelligence of mobile robotics.
**CO4:** Create the localization strategies and mapping technique for mobile robot.
**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
2. Mohanta Jagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017.
4. Roland Siegwart and Illah R.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.
5. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.
6. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.

| CM4091 | GREEN MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To expose the students to the basics of environmental sustainability and impact assessment objectives.
2. To incorporate knowledge about the environmental based improvements towards lean manufacturing systems.
3. To analyze various machineries with intent to conserve energy
4. To analyze hazardous and solid wastes with intent to point out areas of adverse environmental impact and how this impact could be minimized or prevented.
5. To impart the knowledge about the need, procedure and benefits of Green-Co rating.

**UNIT – I ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT 9**

Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive. Strategic environmental assessment and sustainability appraisal. Regional spatial planning and environmental policy.

**UNIT – II LEAN MANUFACTURING AND GREEN ENERGY SYSTEM 9**

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing. World energy consumption – Greenhouse effect, Global warming. Energy conservation and measurement principles with their applicability in engineering and process industries.

**UNIT – III ENERGY SAVING MACHINERY AND COMPONENTS 9**

Electricity Billing: Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption. Selection of fans, pumps and Compressors – Performance Evaluation – Cause for inefficient operation – scope for energy conservation.

**UNIT – IV HAZARDOUS AND SOLID WASTE MANAGEMENT 9**

Hazardous waste: definition, terminology, classification and Sources – Need for hazardous waste management: Need, Handling, methods of collection, storage and transport with suitable examples. Solid waste management: Need, Waste prevention and Life cycle assessment. Collection, storage, reuse and recycling of solid waste with suitable examples.

**UNIT – V GREEN CO-RATING 9**

Ecological Footprint - Need for Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types of Rating – Green Co-Benefits – Case Studies of Green Co-Rating.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Understand the Concepts of environmental sustainability and environmental impact assessment objectives

**CO2:** Apply suitable schemes towards design of green manufacturing requirements.

**CO3**: Analyze manufacturing processes towards conservation of energy.

**CO4**: Analyze manufacturing processes towards minimization or prevention of hazardous and solid wastes.

**CO5**: Acquire Knowledge of green co-rating and its benefits are well known to the students.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 1 | 1 | 1 |
| CO2 | 1 | - | - | 1 | 1 | 1 |
| CO3 | 1 | - | - | 1 | 1 | 1 |
| CO4 | 1 | - | - | 1 | 1 | 1 |
| CO5 | 1 | - | - | 1 | 1 | 1 |
| AVG. | 1 | - | - | 1 | 1 | 1 |

**REFERENCES:**


1. Dornfield David, Green Manufacturing, Springer, 2013
2. Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013
3. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
4. World Commission on Environment and Development (WCED), Our Common Future, Oxford
5. University Press 2005.
6. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015


**MR4019 HAPTICS AND AUGMENTED REALITY L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

1. To identify the terminologies of haptic devices.
2. To understand the structure of haptic system and to aware the tele-operation for various applications.
3. To acquire the knowledge on modelling for haptic system development relevant to the human.
4. To emphasize the significance of knowledge in virtual and augmented reality.
5. To know the concepts and hardware of mixed reality.

**UNIT – I INTRODUCTION TO HAPTICS 9**

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices -Types of Kinesthetic Devices

**UNIT – II KINESTHETIC HAPTIC DEVICES AND TELEOPERATION 9**

Mechatronics in Haptics System - Haptic Kinematics - Haptic Dynamics - Existing Kinesthetic Devices - Haptic Device Static Rendering - Haptic Device Dynamic Rendering - Control of Haptic Devices - Stability Analysis of Haptic Devices - Stability Analysis of the Rendered Model -Passivity of the Rendered Model. Types of Sensors - Measurement of Haptic Parameters - Types of Actuators - Genesis of Tele-Operation - Tele-Operation Controllers -Tele-Operator Transparency - Stability Analysis of Tele-operator - Tracking and Transparency - Surface Haptic - Exogenous Force Inputs.

**UNIT – III HUMAN HAPTICS ITS PLATFORM 9**

Introduction - Types of Haptic Sensing - Active vs. Passive Touch - Mechanoreception- Mechanoreceptive Afferents - Kinesthetic Sensing - Force Sensing and Proprioception- Introduction to Psychophysics - Measurement Thresholds - Laws of Psychophysics - Weber's Law - Fechner's Law - Fitt's Law - Psychophysical Methods of Limit, Constant Stimuli and Adjustment - Introduction to Virtual Reality Modelling Language (VRML) – Open Haptic Platform - OpenGL- Virtual Environment Manager - Modelling of Simple Haptic System.

**UNIT – IV VIRTUAL AND AUGMENTED REALITY 9**

The Reality – Virtuality Continuum - Virtual Reality Definitions - Software, Hardware, Sensation and Perception - Multi-Modal Interaction Challenges - System Architecture of Virtual Reality. Aspects of Geometrical Modelling and Environmental Modelling General Solution for Calculating Geometric & Illumination Consistency in the Augmented Environment. Usability Guidelines - Design and Implementation of an Immersive User Experience - Case Study for VR and AR.

**UNIT – V MIXED REALITY 9**

System Architecture of a Mixed Reality System - Common Interaction Techniques for Mixed Reality Environments - Common Navigation Techniques - Common Interface for MR - Menu Design Directions - Haptic Control Panel - Performance of an Interaction Techniques, Advanced Interaction Techniques, Design and Implementation of an Immersive User Experience - Case Study for MR.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

CO1. Recognize the haptic technology and its concepts in various haptic systems.
CO2. Classify the elements of haptics system and tele-operation in detail.
CO3. Design and use the devices in human haptic applications.
CO4. Combine and build the virtual and augmented reality-based models.
CO5. Develop the design and model the hardware of mixed reality.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Burdea, G. C. and P. Coffet. “Virtual Reality Technology”, Wiley-IEEE Press, 2006.
2. Eckehard Steinbach et al, “Haptic Communications”, Vol. 100, 4:937-956, 2012
3. Hannaford B and Okamura A. M “Haptics: Handbook of Robotics”, Springer, pp. 718-735, 2008.
4. Kenneth Salisbury, Francois Conti and Federico Barbagli, “Haptic Rendering: Introductory Concepts”, pp. 24 -32, 2004.
5. Jean-Pierre Bresciani, Knut Drewing and Marc O. Ernst. “Human Haptic Perception and the Design of Haptic-Enhanced Virtual Environments: The Sense of Touch and Its

Rendering", STAR 45, pp. 61–106, 2008.
6. MacLean K. E, "Haptic Interaction Design for Everyday Interfaces: Reviews of Human Factors and Ergonomics", 4:149-194, 2008.
7. Weir D. W and Colgate J. E "Stability of Haptic Display: Haptic Rendering: Foundations, Algorithms, and Applications". AK Peters, 2008.
8. Sherman, William R. and Alan B. Craig. "Understanding Virtual Reality – Interface, Application, and Design", Morgan Kaufmann, 2002.
9. Yuichi Ohta, Hideyuki Tamura, "Mixed Reality: Merging Real and Virtual Worlds", Springer-Verlag, 2013.

| MR4020 | INDUSTRIAL INSTRUMENTATION AND CONTROL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To understand the overview of the industrial automation and control.
2. To familiarize with data communication and supervisory control systems.
3. To learn and understand the basic concepts of factory automation.
4. To understand various control elements in industry.
5. To understand and select final control element for process control.

**UNIT – I INDUSTRIAL INSTRUMENTATION 9**

Introduction and Need for Automation - Instrumentation System for Measurement of Process Parameters – Overview on Flow, Level, Pressure, Temperature, Speed, Current and Voltage Measurements – Proximity and Vision Based Inspection Systems – Process Control Systems – Continuous and Batch Process – Feedback Control System Overview.

**UNIT – II DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS 9**

Industrial Data Communications - Fiber Optics – Modbus – HART – DeviceNet – Profibus – Fieldbus – Introduction to Supervisory Control Systems – SCADA - Distributed Control System (DCS) – Safety Systems – Man-Machine Interfaces - Total Integrated Automation (TIA) – Industry 4.0.

**UNIT – III FACTORY AUTOMATION 9**

Factory Layout - Tools and Software Based Factory Modelling - Case Study on Automated Manufacturing Units, Assembly Unit, Inspection Systems and PLC Based Automated Systems - Introduction to Factory Automation Monitoring Software.

**UNIT – IV CONTROL ELEMENTS 9**

Characteristic of on-off, proportional, single speed floating, integral and derivative controllers – P+I, P+D and P+I+D control modes – Electronic PID controller – Auto/manual transfer - Reset windup – Practical forms of PID Controller.

**UNIT – V FINAL CONTROL ELEMENTS 9**

I/P converter - Pneumatic and electric actuators – Valve Positioner – Control Valves – Characteristic of ControlValves:- Inherent and Installed characteristics – Modeling of pneumatic control valve – Valve body:-Commercial valve bodies – Control valve sizing – Cavitation and flashing – Selection criteria.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Understand the concepts of industrial instrumentation.
2. Select and design a system with data communication and supervisory control.
3. Understand the concepts and layout of automation in factory.
4. Understand the various control elements in industry.
5. Evaluate and select control elements for the system design.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. B.G.Liptak, 'Process Control', Chilton Book Company, 1994.
2. Curtis D. Johnson, 'Process Control Instrumentation Technology', 7th Edition, Pearson Education, New Delhi, 2002 / PHI.
3. Lucas, M.P., "Distributed Control System", Van Nastrand Reinhold Company, 1986.
4. Mackay S., Wrijut E., Reynders D. and Park J., "Practical Industrial Data Networks Design, Installation and Troubleshooting", Newnes Publication - Elsevier, 2004.
5. Patranabis. D, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Ltd., 1999.
6. Mackay, S., Wrijut, E., Reynders, D. and Park, J., "Practical Industrial Data Networks Design, Installation and Troubleshooting", Newnes Publication, Elsevier, 1st Edition, 2004.
7. Frank Lamb, "Hands on Industrial Automation", McGraw-Hill Profession, 2013.
8. Bequette, B.W., "Process Control Modeling, Design and Simulation", Prentice Hall of India, 2004.




| MR4021 | MODELING AND ANALYSIS OF ELECTRO MECHANICAL SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To equip students with fundamentals of finite element principles.
2. To enable them to understand the behavior of various finite elements and to be able to select appropriate elements to solve physical and engineering problems to emphasis on structural, thermal, Electrical and fluid engineering applications.
3. To make them to understand to shape functions and higher order formulation.
4. To learn various quantities in engineering problems and also make them to work on preprocessing, meshing, boundary condition assigning and post processing.
5. To make them to work on real time problem by giving various case studies and explore them to the FEM software available in the market.

**UNIT – I FINITE ELEMENT MODELLING 9**

Basics of FEM – Initial Value and Boundary Value Problems – Weighted Residual Galerkin and Raleigh Ritz Methods – Review of Variational Calculus – Integration by Parts – Basics of Variational Formulation.

**UNIT – II ONE DIMENSIONAL ANALYSIS 9**

Steps in FEA – Discretization, Function – Derivation of Element Characteristics Matrix, Shape Function, Assembly and Imposition of Boundary Conditions – Solution and Post Processing – One Dimensional Analysis in Solid Mechanics, Heat Transfer, Fluid Dynamics, Electrostatics and Electromagnetics.

**UNIT – III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS 9**

Global and Natural Co-Ordinates – Shape Functions for One and Two Dimensional Elements – Three Noded Triangular and Four Noded Quadrilateral Element – Nonlinear Analysis – Isoparametric Elements – Jacobian Matrices and Transformations – Basics of Two Dimensional Axi Symmetric Analysis.

**UNIT – IV ELECTROMECHANICAL SYSTEMS AND IMPLEMENTATION 9**

Basic quantities – Energy Stored in Electric Field – Capacitance – Magnetic Field – Linked Flux – Inductance – Force – Torque – Stress- Flow- Pre Processing, Mesh Generation, Elements Connectivity, Boundary Conditions, Input of Material and Processing Characteristics – Solution and Post Processing.

**UNIT – V CASE STUDIES 9**

FE Analysis of biomechanical Modelling – Tissue Modelling - Actuators – Rotating Machines- Sensors - Robot Arm- Overview of Application Packages - ANSYS, ABAQUS and COMSOL – Development of Model and Validation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Understand the fundamentals of finite element principles.

**CO2:** Evaluate and select appropriate elements to solve Physical and Engineering problem in structural, thermal, Electrical and fluid engineering applications.

**CO3:** Understand shape functions and higher order formulation.

**CO4:** Evaluate and select appropriate element, boundary condition, meshing and Post processing for any engineering problem.

**CO5:** create FEM model on various software packages used for FEM analysis tool toi analyse a production process through FEA and control it's parameters.

**CO-PO MAPPING:**

| Course Outcomes | PO | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 1 | - | - | 3 | 3 | 3 |
| CO2 | 1 | - | - | 3 | 3 | 3 |
| CO3 | 1 | - | - | 3 | 3 | 3 |
| CO4 | 1 | - | - | 3 | 3 | 3 |
| CO5 | 1 | - | - | 3 | 3 | 3 |
| AVG. | 1 | - | - | 3 | 3 | 3 |

**REFERENCES:**


1. Bathe, K. J. “Finite Element Procedures” Klaus-Jürgen Bathe, 2014.
2. Binns K.J, Lawrenson P.J, Trowbridge C.W, “The Analytical and Numerical Solution of Electric and Magnetic Fields”, John Wiley & Sons, 1993.
3. Matthew. N.O. Sadiku, “Elements of Electromagnetics”, Oxford University Press, 2007.
4. Nathan Ida, Joao P.A.Bastos , “Electromagnetics and Calculation of Fields”,
5. Springer Verlage, 1992.
6. Nicola Biyanchi , “Electrical Machine Analysis using Finite Elements”, Taylor and
7. Francis Group, CRC Publishers, 2005.
8. Reddy, J.N, “An Introduction to the Finite Element Method”, McGrawHill, 1985.
9. Salon S.J, “Finite Element Analysis of Electrical Machines” Kluwer Academic Publishers, 1995.


## AUDIT COURSES

**AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C**
**2 0 0 0**

**COURSE OBJECTIVES**

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

**UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT II PRESENTATION SKILLS 6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

**UNIT III TITLE WRITING SKILLS 6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

**UNIT IV RESULT WRITING SKILLS 6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

**UNIT V VERIFICATION SKILLS 6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES**

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

**REFERENCES**


1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.


**AX4092 DISASTER MANAGEMENT L T P C**
**2 0 0 0**

**COURSE OBJECTIVES**

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

**UNIT I INTRODUCTION 6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**UNIT III DISASTER PRONE AREAS IN INDIA 6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

**UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

**UNIT V RISK ASSESSMENT 6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES**

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

**REFERENCES**


1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.


**AX4093 CONSTITUTION OF INDIA L T P C**

**2 0 0 0**

**OBJECTIVES**

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

**UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION**

History, Drafting Committee, (Composition & Working)

**UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION**

Preamble, Salient Features

**UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT IV ORGANS OF GOVERNANCE**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

**UNIT V LOCAL ADMINISTRATION**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT VI ELECTION COMMISSION**

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

**TOTAL: 30 PERIODS**

**OUTCOMES**

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

**SUGGESTED READING**


1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.


**AX4094** **நற்றமிழ் இலக்கியம்** **L T P C**
**2 0 0 0**

**UNIT I சங்க இலக்கியம்** **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம் – எழுத்து, சொல், பொருள்
2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)

- போரை நிறுத்திய ஔவையார்

**UNIT II** **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து

– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல் )

**UNIT III** **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

**UNIT IV** **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்தினை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

**UNIT V** **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,

- நாடகம்,

2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

**TOTAL: 30 PERIODS**

**<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதின வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

## LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

| SL. NO. | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 27. | OCE431 | Integrated Water Resources Management | 3 | 0 | 0 | 3 |
| 28. | OCE432 | Water, Sanitation and Health | 3 | 0 | 0 | 3 |
| 29. | OCE433 | Principles of Sustainable Development | 3 | 0 | 0 | 3 |
| 30. | OCE434 | Environmental Impact Assessment | 3 | 0 | 0 | 3 |
| 31. | OIC431 | Blockchain Technologies | 3 | 0 | 0 | 3 |
| 32. | OIC432 | Deep Learning | 3 | 0 | 0 | 3 |
| 33. | OBA431 | Sustainable Management | 3 | 0 | 0 | 3 |
| 34. | OBA432 | Micro and Small Business Management | 3 | 0 | 0 | 3 |
| 35. | OBA433 | Intellectual Property Rights | 3 | 0 | 0 | 3 |
| 36. | OBA434 | Ethical Management | 3 | 0 | 0 | 3 |
| 37. | ET4251 | IoT for Smart Systems | 3 | 0 | 0 | 3 |
| 38. | ET4072 | Machine Learning and Deep Learning | 3 | 0 | 0 | 3 |
| 39. | PX4012 | Renewable Energy Technology | 3 | 0 | 0 | 3 |
| 40. | PS4093 | Smart Grid | 3 | 0 | 0 | 3 |
| 41. | CP4391 | Security Practices | 3 | 0 | 0 | 3 |
| 42. | MP4251 | Cloud Computing Technologies | 3 | 0 | 0 | 3 |
| 43. | IF4072 | Design Thinking | 3 | 0 | 0 | 3 |
| 44. | MU4153 | Principles of Multimedia | 3 | 0 | 0 | 3 |
| 45. | DS4015 | Big Data Analytics | 3 | 0 | 0 | 3 |
| 46. | NC4201 | Internet of Things and Cloud | 3 | 0 | 0 | 3 |
| 47. | MX4073 | Medical Robotics | 3 | 0 | 0 | 3 |
| 48. | VE4202 | Embedded Automation | 3 | 0 | 0 | 3 |
| 49. | CX4016 | Environmental Sustainability | 3 | 0 | 0 | 3 |
| 50. | TX4092 | Textile Reinforced Composites | 3 | 0 | 0 | 3 |
| 51. | NT4002 | Nanocomposite Materials | 3 | 0 | 0 | 3 |
| 52. | BY4016 | IPR, Biosafety and Entrepreneurship | 3 | 0 | 0 | 3 |

**OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVE**

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

**UNIT I CONTEXT FOR IWRM 9**

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

**UNIT II WATER ECONOMICS 9**

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

**UNIT III LEGAL AND REGULATORY SETTINGS 9**

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

**UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9**

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

**UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9**

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

**TOTAL: 45 PERIODS**



**OUTCOMES**

- On completion of the course, the student is expected to be able to

| | |
|---|---|
| **CO1** | Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management. |
| **CO2** | Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies. |
| **CO3** | Apply law and governance in the context of IWRM. |
| **CO4** | Discuss the linkages between water-health; develop a HIA framework. |
| **CO5** | Analyse how the virtual water concept pave way to alternate policy options. |

**REFERENCES:**

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

**CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT**

| POs/PSOs | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 2 | 2 | 2 | 2 | 2 |
| PO2 | Problem analysis | 1 | 3 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | | 2 | 2 | 2 | 2 | 2 |
| PO4 | Investigation | 1 | 2 | | | 1 | 1 |
| PO5 | Modern Tool Usage | 1 | 1 | 2 | 1 | 1 | 1 |
| PO6 | Individual and Team work | | 2 | 2 | | | 2 |
| PO7 | Communication | | 2 | 2 | | | 2 |
| PO8 | Engineer and Society | 2 | 2 | 3 | 2 | 3 | 3 |
| PO9 | Ethics | | 2 | 3 | 2 | 2 | 2 |
| PO10 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | | 1 | 1 |
| PO12 | Life Long Learning | | 2 | 2 | 2 | 2 | 2 |
| PSO1 | Knowledge of field research methodology, gender, legal and environmental aspects in the context of integrated water resources management | 3 | 2 | 2 | 2 | 2 | 2 |
| PSO2 | Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO3 | Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water resources management | 2 | 2 | 2 | 2 | 2 | 2 |

**OCE432 WATER, SANITATION AND HEALTH L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

**UNIT I FUNDAMENTALS WASH 9**

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

**UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9**

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality-Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

**UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9**

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:-Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

**UNIT IV GOVERNANCE 9**

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

**UNIT V INITIATIVES 9**

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

| | |
|---|---|
| **CO1** | Capture to fundamental concepts and terms which are to be applied and understood all through the study. |
| **CO2** | Comprehend the various factors affecting water sanitation and health through the lens of third world scenario. |
| **CO3** | Critically analyse and articulate the underlying common challenges in water, sanitation and health. |
| **CO4** | Acquire knowledge on the attributes of governance and its say on water sanitation and health. |
| **CO5** | Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects. |

**REFERENCES**


1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, “Basic Epidemiology”, 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda

3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary***.** Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

**CO PO MAPPING : WATER, SANITATION AND HEALTH**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | | 1 | 1 | M | 1 | 1 |
| PO2 | Problem analysis | | 2 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | | | 2 | 1 | 2 | 2 |
| PO4 | Investigation | | 2 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | | | | 1 | | 1 |
| PO6 | Individual and Team work | | 2 | 2 | 1 | 2 | 2 |
| PO7 | Communication | | | | 2 | 2 | 2 |
| PO8 | Engineer and Society | | 3 | 3 | 3 | 3 | 3 |
| PO9 | Ethics | | | 1 | 2 | 2 | 2 |
| PO10 | Environment and Sustainability | | 3 | | | 3 | 3 |
| PO11 | Project Management and Finance | | | | | 1 | 1 |
| PO12 | Life Long Learning | 2 | 3 | 2 | 3 | 3 | 3 |
| PSO1 | Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management | | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to work towards sustainability. | | 3 | 2 | 3 | 3 | 3 |
| PSO3 | Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering. | | 3 | 3 | 3 | 2 | 3 |

**OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

**UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9**

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation – climate change – desertification.

**UNIT II PRINCIPLES AND FRAME WORK 9**

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

**UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9**

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

**UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10**

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation –– Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

**UNIT V ASSESSING PROGRESS AND WAY FORWARD 8**

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- On completion of the course, the student is expected to be able to

| | |
|---|---|
| CO1 | Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises. |

| | |
|---|---|
| CO2 | Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals |
| CO3 | Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption |
| CO4 | Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems. |
| CO5 | Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability. |

**REFERENCES:**


1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.


**CO – PO Mapping –Principles of Sustainable Development**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | | | | | | |
| PO2 | Problem analysis | 3 | 3 | | | | 3 |
| PO3 | Design / development of solutions | | | | 3 | 3 | 3 |
| PO4 | Investigation | | 2 | 2 | 2 | 2 | 2 |
| PO5 | Modern Tool Usage | | | | | | |
| PO6 | Individual and Team work | | 2 | 2 | | | 2 |
| PO7 | Communication | | | | | 1 | 1 |
| PO8 | Engineer and Society | 3 | | | 3 | | 3 |
| PO9 | Ethics | | | | 2 | 2 | 2 |
| PO10 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO11 | Project Management and Finance | | | | | | |
| PO12 | Life Long Learning | | | | | 1 | 1 |
| PSO1 | Knowledge of Environmental Management discipline | 3 | 3 | 3 | 3 | | 3 |
| PSO2 | Environmental Performance Evaluation and coordination | | | | | | |
| PSO3 | Conceptualization of Environmental Management Systems | | | | | | |

**OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

**UNIT I INTRODUCTION 9**

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

**UNIT II IMPACT INDENTIFICATION AND PREDICTION 10**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological –– cumulative impact assessment

**UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8**

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

**UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9**

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

**UNIT V CASE STUDIES 9**

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

**TOTAL: 45 PERIODS**



**OUTCOMES:**

- On completion of the course, the student is expected to be able to

| | |
|---|---|
| **CO1** | Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles |
| **CO2** | Understand various impact identification methodologies, prediction techniques and model of impacts on various environments |
| **CO3** | Understand relationship between social impacts and change in community due to development activities and rehabilitation methods |
| **CO4** | Document the EIA findings and prepare environmental management and monitoring plan |
| **CO5** | Identify, predict and assess impacts of similar projects based on case studies |

**REFERENCES:**

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and

Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

**CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to Pos |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | | 3 | | | 3 | 3 |
| PO2 | Problem analysis | | 2 | 2 | | | 2 |
| PO3 | Design / development of solutions | | 3 | 3 | 3 | | 3 |
| PO4 | Investigation | | 2 | 2 | | 2 | 2 |
| PO5 | Modern Tool Usage | | 2 | 2 | 3 | | 2 |
| PO6 | Individual and Team work | | 2 | 2 | 2 | | 2 |
| PO7 | Communication | | | | 1 | | 1 |
| PO8 | Engineer and Society | 2 | | | 2 | | 2 |
| PO9 | Ethics | 3 | 3 | 3 | 2 | 2 | 3 |
| PO10 | Environment and Sustainability | 3 | | | 2 | | 2 |
| PO11 | Project Management and Finance | | | | 1 | | L |
| PO12 | Life Long Learning | | 1 | 1 | | | L |
| PSO1 | Knowledge of Environmental Engineering discipline | 2 | | | | | 2 |
| PSO2 | Environmental Performance Evaluation and coordination | | 2 | 2 | 2 | | 2 |
| PSO3 | Conceptualization of Environmental Engineering Systems | | 2 | | 2 | | 2 |

**OIC431 BLOCKCHAIN TECHNOLOGIES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

**UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9**

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

**UNIT II BITCOIN AND CRYPTOCURRENCY 9**

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

**UNIT III INTRODUCTION TO ETHEREUM 9**

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

**UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10**

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

**UNIT V BLOCKCHAIN APPLICATIONS 8**

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After the completion of this course, student will be able to

**CO1**: Understand and explore the working of Blockchain technology
**CO2:** Analyze the working of Smart Contracts
**CO3:** Understand and analyze the working of Hyperledger
**CO4:** Apply the learning of solidity to build de-centralized apps on Ethereum
**CO5**: Develop applications on Blockchain

**REFERENCES:**


1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.


**CO-PO Mapping**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | 2 | 1 | 3 | 2 | 2 | 3 |
| 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| 3 | 2 | 1 | 3 | 1 | 2 | 1 |
| 4 | 2 | 1 | 2 | 3 | 2 | 2 |
| 5 | | | | | | |
| Avg | 2.00 | 1.00 | 2.50 | 2.25 | 2.00 | 2.00 |

| OIC432 | DEEP LEARNING | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

**UNIT I DEEP LEARNING CONCEPTS** **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

**UNIT II NEURAL NETWORKS** **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

**UNIT III CONVOLUTIONAL NEURAL NETWORK** **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

**UNIT VI NATURAL LANGUAGE PROCESSING USING RNN** **10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

**UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING** **10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

**COURSE OUTCOMES:**

**CO1:** Feature Extraction from Image and Video Data
**CO2:** Implement Image Segmentation and Instance Segmentation in Images
**CO3**: Implement image recognition and image classification using a pretrained network (Transfer Learning)
**CO4:** Traffic Information analysis using Twitter Data

**CO5:** Autoencoder for Classification & Feature Extraction

**TOTAL : 45 PERIODS**

**REFERENCES**


1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017


**OBA431 SUSTAINABLE MANAGEMENT LT P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

**UNIT I MANAGEMENT OF SUSTAINABILITY 9**

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

**UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9**

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

**UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9**

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

**UNIT IV SUSTAINABILITY AND INNOVATION 9**

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

**UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9**

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.

CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

**REFERENCES:**


1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006


**MAPPING OF POs AND COs:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 1 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 1 | 2 |
| **CO3** | 3 | 3 | 1 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 1 | 1 | 2 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 2 |

**OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

**UNIT I INTRODUCTION TO SMALL BUSINESS 9**

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

**UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9**

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

**UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9**

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

**UNIT IV FINANCING SMALL BUSINESS 9**

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

**UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9**

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

**REFERENCES**


1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.


**MAPPING OF POs AND COs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 1 | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 2 | 2 | 1 | 1 |
| **CO5** | 3 | 2 | 2 | 3 | 2 | 1 |

**OBA433** **INTELLECTUAL PROPERTY RIGHTS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVE**

- To understand intellectual property rights and its valuation.

**UNIT I INTRODUCTION** **9**

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

**UNIT II PROCESS** **9**

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

**UNIT III STATUTES** **9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

**UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY** **9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

**UNIT V MODELS** **9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR



**REFERENCES**

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

**MAPPING OF POs AND COs**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 1 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 3 |

**OBA434** **ETHICAL MANAGEMENT** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVE**

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

**UNIT I ETHICS AND SOCIETY** **9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

**UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS** **9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

**UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT** **9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

**UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT** **9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

**UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS** **9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

**REFERENCES**


1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.


**MAPPING OF POs AND COs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO2** | | 3 | 2 | 3 | 1 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 3 |

**ET4251 IoT FOR SMART SYSTEMS LT P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

**UNIT I INTRODUCTION TO INTERNET OF THINGS 9**

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

**UNIT II IOT ARCHITECTURE 9**

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

**UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9**

**PROTOCOLS:**

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

**Wireless technologies for IoT:** WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

**UNIT IV IOT PROCESSORS 9**

**Services/Attributes:** Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

**Embedded processors for IOT** :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

**UNIT V CASE STUDIES 9**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | 2 | 1 | - | - | - |
| 2 | - | 2 | - | - | - | - |
| 3 | 1 | 2 | - | 1 | 3 | - |
| 4 | 2 | | 3 | 3 | 3 | 3 |
| 5 | 3 | 2 | 3 | 3 | 3 | 3 |
| Avg. | 1.75 | 2 | 2.33 | 2.33 | 3 | 2 |

**REFERENCES:**


1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

**ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

**UNIT I LEARNING PROBLEMS AND ALGORITHMS 9**

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

**UNIT II NEURAL NETWORKS 9**

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

**UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9**

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

**UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9** Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

**UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9** State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES (CO):**

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | 3 | 1 | - | - | - |
| 2 | 2 | 3 | 2 | - | - | - |
| 3 | 3 | - | 3 | - | 3 | - |
| 4 | 2 | 3 | 3 | - | - | - |
| 5 | 3 | 3 | 3 | - | 3 | - |
| 6 | 3 | 3 | 3 | - | 3 | - |
| 7 | 3 | 3 | 3 | - | 3 | - |
| Avg. | 2.42 | 3 | 2.57 | - | 3 | - |

**REFERENCES:**


1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.


**PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C**

**3 0 0 3**

**OBJECTIVES:**

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

**UNIT I INTRODUCTION 9**

Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - $CO_2$ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

**UNIT II SOLAR PHOTOVOLTAICS 9**

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

**UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9**

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

**UNIT IV WIND ENERGY CONVERSION SYSTEMS 9**

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

**UNIT V OTHER RENEWABLE ENERGY SOURCES 9**

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

After completion of this course, the student will be able to:

CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

**REFERENCES:**


1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.


**CO-PO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | | 2 | 2 | 2 | 1 |
| CO2 | 3 | | 2 | 3 | 3 | 3 |
| CO3 | 3 | | 2 | 3 | 3 | 3 |
| CO4 | 3 | | 2 | 3 | 3 | 2 |
| CO5 | 3 | | 2 | 2 | 2 | 2 |

**PS4093** **SMART GRID** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

**UNIT I INTRODUCTION TO SMART GRID 9**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

**UNIT II SMART GRID TECHNOLOGIES 9**

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

**UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9**

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

**UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

**Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9**

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

**TOTAL : 45 PERIODS**

**COURSE OUTCOME:**

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

**REFERENCES**


1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.


**MAPPING OF CO'S WITH PO'S**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| 1 | 3 | 2 | - | 2 | 2 | 2 |
| 2 | 3 | - | 2 | 2 | - | 2 |
| 3 | 2 | - | 1 | - | - | - |
| 4 | 1 | - | - | 3 | 3 | 1 |
| 5 | - | 2 | 2 | 2 | 2 | 3 |
| AVG | 2.25 | 2 | 1.66 | 2.25 | 2.3 | 2 |

**CP4391 SECURITY PRACTICES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

**UNIT I SYSTEM SECURITY 9**

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

**UNIT II NETWORK SECURITY 9**

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

**UNIT III SECURITY MANAGEMENT 9**

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

**UNIT IV CYBER SECURITY AND CLOUD SECURITY 9**

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices

for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

**UNIT V PRIVACY AND STORAGE SECURITY 9**

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Understand the core fundamentals of system security
**CO2:** Apply the security concepts to wired and wireless networks
**CO3**: Implement and Manage the security essentials in IT Sector
**CO4:** Explain the concepts of Cyber Security and Cyber forensics
**CO5:** Be aware of Privacy and Storage security Issues.

**REFERENCES**


1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.


**CO-PO Mapping**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | 1 | 2 | 1 | 1 | 2 | 1 |
| 2 | 2 | 1 | 3 | 1 | 1 | 2 |
| 3 | | | 2 | 3 | 3 | 3 |
| 4 | 2 | 2 | 1 | 2 | 1 | 3 |
| 5 | 1 | | 1 | 1 | 2 | 3 |
| Avg | 1.50 | 1.67 | 1.60 | 1.60 | 1.80 | 2.40 |

**MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution

- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

**UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization –– Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

**UNIT II CLOUD PLATFORM ARCHITECTURE 12**

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

**UNIT III AWS CLOUD PLATFORM - IAAS 9**

**Amazon Web Services:** AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

**UNIT IV PAAS CLOUD PLATFORM 9**

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

**UNIT V PROGRAMMING MODEL 9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Employ the concepts of virtualization in the cloud computing
**CO2:** Identify the architecture, infrastructure and delivery models of cloud computing
**CO3:** Develop the Cloud Application in AWS platform
**CO4:** Apply the concepts of Windows Azure to design Cloud Application
**CO5:** Develop services using various Cloud computing programming models.

**REFERENCES**


1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.

3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

**IF4072** **DESIGN THINKING** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

**UNIT I** **UX LIFECYCLE TEMPLATE** **8**

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

**UNIT II** **CONTEXTUAL INQUIRY** **10**

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

**UNIT III** **DESIGN THINKING, IDEATION, AND SKETCHING** **9**

Design-informing models: second span of the bridge . Some general "how to" suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

**UNIT IV** **UX GOALS, METRICS, AND TARGETS** **8**

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed

results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

**UNIT V ANALYSING USER EXPERIENCE 10**

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

**SUGGESTED ACTIVITIES:**

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Build UI for user Applications
**CO2:** Use the UI Interaction behaviors and principles
**CO3:** Evaluate UX design of any product or application
**CO4:** Demonstrate UX Skills in product development
**CO5:** Implement Sketching principles

**REFERENCES**


1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017


**MU4153 PRINCIPLES OF MULTIMEDIA L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

**UNIT I INTRODUCTION 9**

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

**Suggested Activities:**

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

**Suggested Evaluation Methods:**

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

**UNIT II ELEMENTS OF MULTIMEDIA 9**

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

**Suggested Activities:**

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

**Suggested Evaluation Methods:**

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

**UNIT III MULTIMEDIA TOOLS 9**

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

**Suggested Activities:**

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

**Suggested Evaluation Methods:**

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

**UNIT IV MULTIMEDIA SYSTEMS 9**

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics,

basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

**Suggested Activities:**

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

**Suggested Evaluation Methods:**

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

**UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9**

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

**Suggested Activities:**

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

**Suggested Evaluation Methods:**

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:**Handle the multimedia elements effectively.
**CO2:**Articulate the concepts and techniques used in multimedia applications.
**CO3:**Develop effective strategies to deliver Quality of Experience in multimedia applications.
**CO4:**Design and implement algorithms and techniques applied to multimedia objects.
**CO5:**Design and develop multimedia applications following software engineering models.

**REFERENCES**:


1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017


**DS4015 BIG DATA ANALYTICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

**UNIT I INTRODUCTION TO BIG DATA 9**

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

**UNIT II SEARCH METHODS AND VISUALIZATION 9**

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

**UNIT III MINING DATA STREAMS 9**

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

**UNIT IV FRAMEWORKS 9**

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

**UNIT V R LANGUAGE 9**

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

**COURSE OUTCOMES:**

CO1:understand the basics of big data analytics
**CO2:** Ability to use Hadoop, Map Reduce Framework.
**CO3:** Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4:gain knowledge on R language
**CO5:** Contextually integrate and correlate large amounts of information to gain faster insights.

**TOTAL:45 PERIODS**

**REFERENCE:**


1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.


**CO-PO Mapping**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | 3 | 3 | 3 | 3 | 2 | 1 |
| 2 | 3 | 3 | 3 | 3 | 2 | 1 |
| 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| 4 | 3 | 3 | 3 | 3 | 2 | 1 |
| 5 | 3 | 3 | 3 | 3 | 2 | 1 |
| Avg | 3 | 3 | 3 | 3 | 2 | 1 |

**NC4201 INTERNET OF THINGS AND CLOUD L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

**UNIT I FUNDAMENTALS OF IoT 9**

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

**UNIT II PROTOCOLS FOR IoT 9**

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

**UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9**

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

**UNIT IV CLOUD COMPUTING INTRODUCTION 9**

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

**UNIT V IoT AND CLOUD 9**

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, the student will be able to:**

**CO1:** Understand the various concept of the IoT and their technologies..
**CO2:** Develop IoT application using different hardware platforms
**CO3**: Implement the various IoT Protocols
**CO4**: Understand the basic principles of cloud computing.
**CO5:** Develop and deploy the IoT application into cloud environment

**REFERENCES**


1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.


**MX4073 MEDICAL ROBOTICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

**UNIT I INTRODUCTION TO ROBOTICS 9**

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

**Sensors and Actuators**

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

**UNIT II MANIPULATORS & BASIC KINEMATICS 9**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

**Navigation and Treatment Planning**

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

**UNIT III SURGICAL ROBOTS 9**

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

**UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9**

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

**UNIT V WEARABLE ROBOTS 9**

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Describe the configuration, applications of robots and the concept of grippers and actuators
**CO2:** Explain the functions of manipulators and basic kinematics
**CO3:** Describe the application of robots in various surgeries
**CO4:** Design and analyze the robotic systems for rehabilitation
**CO5:** Design the wearable robots

**REFERENCES**


1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015


**CO-PO Mapping**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | | | | 1 | | |
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|---|---|---|---|---|---|---|
| **3** | 2 | | 2 | 2 | 2 | 2 |
| **4** | 2 | | 2 | 2 | 3 | 2 |
| **5** | 2 | | 2 | 2 | 3 | 3 |
| **Avg** | **2** | | **2** | **1.8** | **2.6** | **2.3** |

**VE4202 EMBEDDED AUTOMATION L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

**UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9**

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

**UNIT - II AVR MICROCONTROLLER 9**

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

**UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9**

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

**UNIT – IV VISION SYSTEM 9**

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

**UNIT – V HOME AUTOMATION 9**

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor -Proximity Garage Door Opener - Vision Based Authentic Entry System

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, students will be able to

**CO1:** analyze the 8-bit series microcontroller architecture, features and pin details
**CO2:** write embedded C programs for embedded system application
**CO3**: design and develop real time systems using AVR microcontrollers

**CO4**: design and develop the systems based on vision mechanism
**CO5**: design and develop a real time home automation system

**REFERENCES:**


1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.


**CO-PO Mapping**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | 1 | | 1 | 1 | 1 | |
| 2 | 1 | 3 | 1 | 1 | 1 | 3 |
| 3 | 1 | 3 | 1 | 1 | 1 | 3 |
| 4 | 1 | 3 | 1 | 1 | 1 | 3 |
| 5 | 1 | 3 | 1 | 1 | 1 | 3 |
| Avg | (5/5)=1 | (12/4)=3 | (5/5)=1 | (5/5)=1 | (5/5)=1 | (12/4)=3 |

**CX4016 ENVIRONMENTAL SUSTAINABILITY** **L T P C**
**3 0 0 3**

**UNIT I INTRODUCTION** **9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

**UNIT II CONCEPT OF SUSTAINABILITY** **9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

**UNIT III SIGNIFICANCE OF BIODIVERSITY** **9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

**UNIT IV POLLUTION IMPACTS** **9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

**UNIT V ENVIRONMENTAL ECONOMICS 9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

**TOTAL : 45 PERIODS**

**REFERENCES**


1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019


**TX4092 TEXTILE REINFORCED COMPOSITES L T P C**

**3 0 0 3**

**UNIT I REINFORCEMENTS 9**

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

**UNIT II MATRICES 9**

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

**UNIT III COMPOSITE MANUFACTURING 9**

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

**UNIT IV TESTING 9**

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

**UNIT V MECHANICS 9**

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

**TOTAL: 45 PERIODS**

**REFERENCES**


1. BorZ.Jang,“Advanced Polymer composites”,ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,SecondEdition,CRCPress,NewJersey,1996.
3. George LubinandStanley T.Peters, “Handbook of Composites”, Springer Publications,1998.

4. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. RichardM.Christensen,“Mechanics of compositematerials”,DoverPublications,2005.
6. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”,CRCPress,2001

**NT4002 NANOCOMPOSITE MATERIALS L T P C**
**3 0 0 3**

**UNIT I BASICS OF NANOCOMPOSITES 9**

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

**UNIT II METAL BASED NANOCOMPOSITES 9**

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

**UNIT III POLYMER BASED NANOCOMPOSITES 9**

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

**UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9**

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.



**UNIT V NANOCOMPOSITE TECHNOLOGY 9**

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

**TOTAL : 45 PERIODS**

**REFERENCES:**

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization-Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.

4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Veprįek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

**BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C**
**3 0 0 3**

**UNIT I IPR 9**

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

**UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9**

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies



**UNIT III BIOSAFETY 9**

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

**UNIT IV GENETICALLY MODIFIED ORGANISMS 9**

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

**UNIT V ENTREPRENEURSHIP DEVELOPMENT 9**

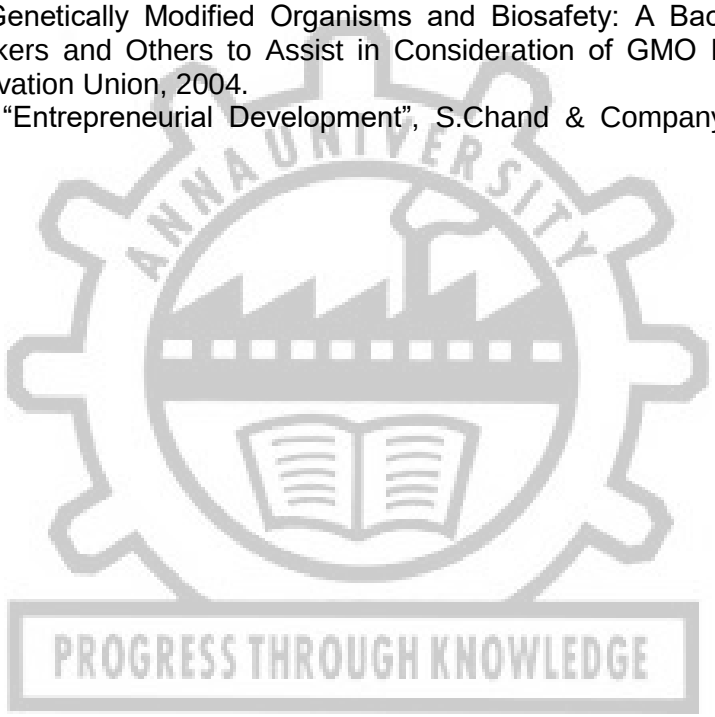
Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship

Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

**TOTAL : 45 PERIODS**

**REFERENCES**


1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

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