# NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

**(Deemed to be University Under Section 3 of the UGC Act, 1956)**
**Kumaracoil, Thuckalay**

## DEPARTMENT OF

## ELECTRONICS AND INSTRUMENTATION ENGINEERING

## M.E.CONTROL AND INSTRUMENTATION ENGINEERING

## CURRICULUM AND SYLLABI

## REGULATION 2021

# NOORUL ISLAM CENTRE FOR HIGHER EDUCATION, Kumaracoil

## Regulation: 2021

## Curriculum and Syllabi

## M.E Programme

### DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

### M.E. CONTROL AND INSTRUMENTATION ENGINEERING

**Vision of the University**

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

**Mission of the University**

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instil in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

**Faculty of Electrical and Electronics Engineering**

**Department of Electronics and Instrumentation Engineering**

**Vision of the Department**

To develop innovative, globally competent and high quality instrumentation engineers and entrepreneurs who meet the demands of modern industrial world with societal, environmental and human values.

**Mission of the Department**

Provide suitable learning environment to the graduates with innovative learning resources and adequate infrastructure.
Enhance electronics, instrumentation and automation skills by imparting training in the state of art technologies to fulfill the industrial requirements.
Enrich continuous learning and instill in them high standard of discipline and ethics through value based education to become ethical, social responsible engineers and entrepreneurs.

**Description of the programme**

The Master of Engineering (ME) program in Control and Instrumentation Engineering is framed for the students seeking advanced expertise in the field. The curriculum encompasses a wide scope of advanced topics, including control system design, process control, dynamic control systems, piping & instrumentation, and industrial automation. Elective courses offer opportunities to explore specialized areas such as applied bio-medical instrumentation, robotics and automation, and digital signal processing. Practical training, including laboratory sessions and project work, is an integral part of the program, providing students with hands-on experience and skills applicable to real-world scenarios. Furthermore, the program emphasizes research skills, enabling student's expertise in various domains

such as control theory, sensor technology, instrumentation design, automation systems, and emerging technologies like the IoT and artificial intelligence.

| Programme Educational Objectives - PEO | |
|---|---|
| PEO-01 | Equip graduates with advanced knowledge and skills in Control and Instrumentation Engineering, enabling them to excel in industries, research, and higher education. |
| PEO-02 | Develop the ability to solve complex engineering problems through a strong foundation in mathematical modeling, system dynamics, and control system design. |
| PEO-03 | Train graduates to design, develop, and implement innovative control and instrumentation systems that address real-world challenges in diverse sectors such as automation, robotics, and process industries. |
| PEO-04 | Foster leadership, teamwork, and ethical professionalism, encouraging graduates to contribute effectively in multidisciplinary environments. |
| PEO-05 | Promote lifelong learning by creating an academic atmosphere that supports continuous skill development, research, and adaptation to emerging technologies. |

| Graduate | |
|---|---|
| **GA-1** | **Advanced Engineering Expertise:** Master advanced engineering principles and apply them to design, analyze, and innovate systems that address both present and emerging global challenges across diverse industries. |
| **GA-2** | **Leadership in Research and Innovation:** Lead groundbreaking research and foster innovation by identifying opportunities for technological advancements, contributing original ideas that push the boundaries of engineering knowledge. |
| **GA-3** | **Sustainable Engineering Practices:** Develop and implement engineering solutions that integrate sustainability, environmental stewardship, and resource efficiency, ensuring the long-term impact and responsibility of all projects. |
| **GA-4** | **Ethical and Strategic Decision-Making:** Make informed, ethical decisions in complex engineering contexts, considering societal needs, environmental implications, and the long-term consequences of engineering practices. |
| **GA-5** | **Global Competence in Engineering Solutions:** Exhibit a deep understanding of global engineering standards and practices, addressing international challenges and cultural sensitivities in engineering projects to make a broader societal impact. |
| **GA-6** | **Technological Agility and Lifelong Learning:** Stay ahead of technological trends and exhibit agility in learning new tools, methodologies, and technologies, ensuring continuous professional growth in a rapidly evolving engineering landscape. |

| | |
|---|---|
| **GA-7** | **Interdisciplinary and Collaborative Innovation:** Excel in multidisciplinary collaborations, leveraging knowledge from multiple fields to solve complex, large-scale engineering problems that require comprehensive and innovative solutions. |
| **GA-8** | **Data-Driven Decision Making:** Employ advanced data analytics, machine learning, and computational tools to derive insights and make informed engineering decisions that improve performance, efficiency, and sustainability. |
| **GA-9** | **Entrepreneurial Mindset and Innovation Leadership:** Cultivate an entrepreneurial mindset, translating engineering innovations into viable products, solutions, or services, and leading teams toward commercialization and societal impact. |
| **GA-10** | **Safety, Risk, and Crisis Management:** Implement and manage advanced safety protocols and risk mitigation strategies to protect individuals, communities, and ecosystems in engineering practices, particularly in high-stakes and crisis |

| **Programme Outcome - PO** | |
|---|---|
| PO-A | Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to solve the problems pertaining to Electronics and Instrumentation Engineering. |
| PO-B | Identify, formulate, review and analyze complex instrumentation engineering problems and attain conclusions using first principles of mathematics and engineering sciences. |
| PO-C | Design solutions and system components or processes for complex engineering problems that fulfill the specified needs taking into account the public health and safety, cultural, societal, and environmental considerations. |
| P0-D | Use research-based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to arrive at significant conclusion. |
| PO-E | Form, select, and apply appropriate techniques, resources, and modern engineering and IT tools for Engineering activities like electronic prototyping, modeling and control of systems/processes and also understand their limitations. |
| PO-F | Assess societal, health, safety issues based on the reasoning received from the contextual knowledge and understand the consequent responsibilities of the Professional Instrumentation Engineer. |
| PO-G | Understand the impact of the professional engineering solutions in societal and environmental contexts, and exhibit the knowledge of, and the need for sustainable development. |
| PO-H | Apply the principles of Professional Ethics to adhere to the norms of the engineering practice and to discharge ethical responsibilities. |
| PO-I | Function actively and efficiently as an individual or a member/leader in diverse teams, and in multidisciplinary settings. |

| | |
|---|---|
| PO-J | Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to understand and prepare reports and design documents; to make effective presentations and to frame and follow instructions. |
| PO-K | Demonstrate knowledge and understanding of the engineering and management principles and apply them to own work, as member / leader in teams and multidisciplinary environments. |
| PO-L | Recognize the need for, and have the preparation and ability to engage in independent and life-long learning, keeping pace with technological challenges in the broadest sense. |

**Mapping of Graduate Attributes and Programme Educational Objectives (PEO)**

| GAs / PEOs | GA-01 | GA-02 | GA-03 | GA-04 | GA-05 | GA-06 | GA-07 | GA-08 | GA-09 | GA-10 | GA-11 | GA-12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PEO-01 | H | H | H | H | A | H | H | N | N | N | H | H |
| PEO-02 | H | H | H | H | A | H | H | N | N | N | H | H |
| PEO-03 | H | H | H | H | A | H | H | N | N | N | H | H |
| PE0-04 | H | H | A | H | A | N | H | N | N | N | H | H |
| PEO-05 | A | A | A | A | H | H | H | N | N | N | A | A |

H- Highly Associated A- Associated Not – Not Associated

**Mapping of Graduate Attributes and Programme Outcomes (PO)**

| GAs / PEOs | GA-01 | GA-02 | GA-03 | GA-04 | GA-05 | GA-06 | GA-07 | GA-08 | GA-09 | GA-10 | GA-11 | GA-12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PO-A | H | H | H | A | H | H | A | A | A | A | N | N |
| PO-B | H | H | H | A | H | A | A | A | A | A | N | N |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PO-C | H | H | H | H | H | H | A | A | A | A | N | N |
| P0-D | H | A | A | H | A | A | A | A | A | A | N | N |
| PO-E | A | A | A | A | H | H | A | A | A | A | N | N |
| PO-F | A | A | H | A | A | A | H | A | A | A | N | N |
| PO-G | H | A | H | H | H | H | A | A | A | A | N | N |
| PO-H | H | A | A | H | A | A | A | A | A | A | N | N |
| PO-I | A | A | A | A | A | A | A | A | A | A | N | N |
| PO-J | A | A | A | A | A | A | A | A | A | A | N | N |
| PO-K | A | A | A | A | A | A | A | A | A | A | N | N |
| PO-L | A | A | A | A | A | A | A | A | A | A | N | N |

H- Highly Associated A- Associated Not – Not Associated

**Mapping of Programme Educational Objective (PEOs) and Programme Outcomes (POs)**

| PEO / | PEO-01 | PEO-02 | PEO-03 | PEO-04 | PEO-05 |
|---|---|---|---|---|---|
| PO-A | H | H | H | H | A |
| PO-B | H | H | H | A | A |
| PO-C | H | H | H | H | A |
| P0-D | H | H | H | A | H |
| PO-E | H | A | H | N | H |

| | | | | | |
|---|---|---|---|---|---|
| PO-F | H | N | H | H | H |
| PO-G | A | N | N | H | N |
| PO-H | H | N | N | H | N |
| PO-I | H | N | N | H | H |
| PO-J | H | N | N | N | N |
| PO-K | H | N | N | H | H |
| PO-L | H | H | H | H | A |

H- Highly Associated A- Associated Not – Not Associated

**Duration of the programme:** 2 Years/ 4 Semesters

**Total credits: 70**

## CURRICULUM & SYLLABI

### SEMESTER I

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1. | MA3501 | Advanced Mathematics | 3 | 1 | 0 | 4 |
| 2. | EI3501 | Advanced Process Control | 3 | 0 | 0 | 3 |
| 3. | EI3502 | Control System Design | 3 | 0 | 0 | 3 |
| 4. | EI3503 | Advanced Digital Signal Processing | 3 | 0 | 0 | 3 |
| 5. | EIXXX | Department Elective I | 3 | 0 | 0 | 3 |
| 6. | EIXXX | Department Elective II | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | |
| 7. | EI3571 | Process Control Laboratory | 0 | 0 | 4 | 2 |
| **TOTAL** | | | **18** | **1** | **4** | **21** |

### SEMESTER II

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1. | EI3504 | Dynamic Control System | 3 | 1 | 0 | 4 |
| 2. | EI3505 | Process Instrument Design | 3 | 0 | 0 | 3 |
| 3. | EI3506 | Applied Industrial Instrumentation | 3 | 0 | 0 | 3 |
| 4. | EI3507 | Industrial Automation | 3 | 0 | 0 | 3 |
| 5. | EIXXX | Department Elective III | 3 | 0 | 0 | 3 |
| 6. | EIXXX | Department Elective IV | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | |
| 7. | EI3572 | Automation Laboratory | 0 | 0 | 4 | 2 |
| **TOTAL** | | | **18** | **0** | **4** | **21** |

## SEMESTER III

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1. | EIXXX | Department Elective V | 3 | 0 | 0 | 3 |
| 2. | OEC | Open Elective<br>(Industrial Safety / Operation Research) | 3 | 0 | 0 | 3 |
| 3. | | Audit<br>(Disaster Management / English for Research Paper Writing) | 2 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | | |
| 4. | EI35P1 | Project work – Phase I | 0 | 0 | 12 | 6 |
| **TOTAL** | | | **8** | **0** | **12** | **12** |

## SEMESTER IV

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | EI35P5 | Project work – Phase II | 0 | 0 | 32 | 16 |
| **TOTAL** | | | 0 | 0 | 32 | 16 |

## LIST OF ELECTIVES

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | EI35A1 | Applied Bio-Medical Instrumentation | 3 | 0 | 0 | 3 |
| 2. | EI35A2 | Piping and Instrumentation Design | 3 | 0 | 0 | 3 |
| 3. | EI35A3 | Robotics and Automation | 3 | 0 | 0 | 3 |
| 4. | EI35A4 | Design of Embedded Systems | 3 | 0 | 0 | 3 |
| 5. | EI35A5 | Micro and Nano Electro Mechanical Systems | 3 | 0 | 0 | 3 |
| 6. | EI35A6 | Modeling and Simulation | 3 | 0 | 0 | 3 |
| 7. | EI35A7 | Bio Medical Signal Processing | 3 | 0 | 0 | 3 |
| 8. | EI35A8 | Internet of Things and Applications | 3 | 0 | 0 | 3 |
| 9. | EI35A9 | Digital Control System | 3 | 0 | 0 | 3 |
| 10. | EI35B1 | Digital Image Processing | 3 | 0 | 0 | 3 |
| 11. | EI35B2 | Intelligent Control Techniques | 3 | 0 | 0 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12. | EI35B3 | Digital Instrumentation | 3 | 0 | 0 | 3 |
| 13. | EI35B4 | Wireless Sensor Networks | 3 | 0 | 0 | 3 |
| 14. | EI35B5 | Industrial Data Communication | 3 | 0 | 0 | 3 |
| **OPEN ELECTIVES** | | | | | | |
| 15. | GE35A1 | Business Analytics | 3 | 0 | 0 | 3 |
| 16. | GE35A2 | Industrial Safety | 3 | 0 | 0 | 3 |
| 17. | GE35A3 | Operations Research | 3 | 0 | 0 | 3 |
| 18. | GE35A4 | Cost Management of Engineering Projects | 3 | 0 | 0 | 3 |
| 19. | GE35A5 | Composite Materials | 3 | 0 | 0 | 3 |
| 20. | GE35A6 | Waste to Energy | 3 | 0 | 0 | 3 |

**SEMESTER I**

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1. | MA3501 | Advanced Mathematics | 3 | 1 | 0 | 4 |
| 2. | EI3501 | Advanced Process Control | 3 | 0 | 0 | 3 |
| 3. | EI3502 | Control System Design | 3 | 0 | 0 | 3 |
| 4. | EI3503 | Advanced Digital Signal Processing | 3 | 0 | 0 | 3 |
| 5. | EIXXX | Department Elective I | 3 | 0 | 0 | 3 |
| 6. | EIXXX | Department Elective II | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | |
| 7. | EI3571 | Process Control Laboratory | 0 | 0 | 4 | 2 |
| **TOTAL** | | | **18** | **1** | **4** | **21** |

| MA3501 | ADVANCED MATHEMATICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**OBJECTIVES**

- The course objective is to extend the ability of the students in the areas of Matrix Theory and Stochastic Processes. This will be applicable in Engineering practices and serve as a pre-requisite for higher studies and research

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Apply advanced matrix concepts such as eigenvectors, singular value decomposition, and matrix decompositions to solve complex linear systems and engineering problems. | R, U |
| CO-02 | Formulate and solve optimization problems using the Simplex method, transportation models, and assignment problems | R, U, An |
| CO-03 | Analyze and interpret random processes, including stationary processes, and compute relevant statistical measures such as correlation functions. | U, An |
| CO-04 | Implement dynamic programming techniques to optimize decision-making processes and solve recursive problems | U, A |
| CO-05 | Solve variational problems using Euler's equation and handle functionals with constraints for applications in physics and engineering | An, E |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | S | M | M | L | M | M | M | L | M | M | S | |
| **CO-02** | S | M | M | M | L | M | M | M | M | M | M | M | |
| **CO-03** | S | S | M | M | L | M | M | M | L | M | S | S | |
| **CO-04** | S | M | M | M | L | M | M | M | S | M | M | M | |
| **CO-05** | S | S | M | M | L | M | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: ADVANCED MATRIX THEORY** **9**

Generalized Eigen vectors– Jordan canonical form — Matrix norms – Singular value decomposition – Pseudo inverse – Least square approximations – QR decomposition.

**UNIT II: LINEAR PROGRAMMING** **9**

Formulation-Graphical solution – Simplex method-Two phase method-Transportation and Assignment models.

**UNIT III: RANDOM PROCESSES** **9**

Classification – Stationary random processes – Ergodic process - Auto correlation – Cross correlations – Properties - Power spectral density.

**UNIT IV: DYNAMIC PROGRAMMING** **9**

Bellman's principle of optimality – Characteristics of the dynamic programming model – The recursive equation approach – Solution of discrete dynamic programming problem

**UNIT V: CALCULUS OF VARIATIONS** **9**

Euler's equation – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables -Isoperimetric Problems.

**L: 45 + T: 15, TOTAL: 60 HOURS**

**REFERENCES:**


1. Bronson, R., "Matrix Operations", Schaum's Outline Series, McGraw–Hill, New York
2. Gupta, A.S., "Calculus of Variations with Applications", Prentice-Hall of India, New Delhi.
3. Taha, H.A., "Operations Research – An Introduction", Sixth Edition, Prentice-Hall of India, New Delhi.
4. Gupta, P.K. and Hira, D.S., "Operations Research", S.Chand& Co. New Delhi.
5. Peebles Jr., P.Z., "Probability, Random Variables and Random Signal Principles", McGraw-Hill Inc.

| EI3501 | ADVANCED PROCESS CONTROL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To provide in depth knowledge of controllers, find control elements and the processes.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to learn the basic characteristics of first order and higher order processes. | R, U |
| CO-02 | Ability to get adequate knowledge about the characteristics of various controller modes and methods of tuning of controller. | R, U, An |
| CO-03 | Ability to acquire knowledge about various complex control schemes. | U, An |
| CO-04 | Ability to understand about the construction, characteristics and application of control valves. | U, A |
| CO-05 | Ability to explore the study the five selected unit operations and a case study of distillation column control. | An, E |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | L | M | M | S | |
| **CO-02** | S | S | S | M | M | L | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | L | S | M | L | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | L | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: PROCESS DYNAMICS** **9**

Introduction to process control-objective of modelling-models of industrial process-hydraulic tanks-fluid flow systems-mixing process-chemical reactions-thermal systems-heat exchangers and distillation column.

**UNIT II: CONTROL ACTIONS AND CONTROLLER TUNING** **9**

Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Electronic PID controller –Digital PID algorithm – Auto/manual transfer - Reset windup – Practical forms of PID

Controller - Pneumatic and electric actuators – Valve Positioner – Control Valves – Characteristic of Control Valves:- Inherent and Installed characteristics.

**UNIT III: COMPLEX CONTROL TECHNIQUES 9**

Feed forward-ratio-cascade-split range-inferential-predictive-adaptive and multivariable control.

**UNIT IV: MODEL BASED CONTROLLERS 9**

Single Varible Model Predictive Control- Introduction - Predictive Control structure-IMC Controller-Smith Predictor-Implementation Guidelines-Algorithm Selection Guidelines.

**UNIT V: INDUSTRIAL PROCESS CONTROL 9**

Basic building blocks of computer control system – Interfaces –Serial, Parallel and USB Communication-Data acquisition systems – SCADA – Direct digital control Evolution of PLC – Sequential and Programmable controllers –. Evolution of DCS – DCS Architecture.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. George Stephanopolus, "Chemical Process Control", Prentice Hall India
2. Harriot P., “Process Control”, Tata McGraw-Hill, New Delhi, 1991.
3. Norman A Anderson,”Instrumentation for Process Measurement and Control” CRC Press LLC, Florida, 1998.
4. Thomas E. Marlin “Process Control”, Second Edition McGraw hill, New York, 2000
5. Marlin T.E., “Process Control”, Second Edition McGraw hill, New York, 2000.
6. Balchan J.G. and Mumme G., “Process Control Structures and Applications”, Van NostrandRenhold Co., New York, 1988.
7. Lucas M.P, “Distributed Control System”, Van Nostrand Reinhold Co. NY 1986
8. Pertrezeulla, “Programmable Controllers”, McGraw-Hill, 1989.


| EI3502 | CONTROL SYSTEM DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To provide sound knowledge in the basic concepts of linear control theory and design of control system.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the fundamentals of design and classical PID control performance of system and controllers. | U |
| CO-02 | Ability to provide adequate knowledge in state variable design. | An |
| CO-03 | Ability to understand the design of optimal controllers. | An |

| | | |
|---|---|---|
| CO-04 | Ability to design a controller using Root-locus and Frequency Domain techniques. | A |
| CO-05 | Ability to understand the concept of robustness and adequate case studies. | An, E |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | L | M | M | S | |
| **CO-02** | S | S | S | M | M | L | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | L | S | M | L | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | L | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INTRODUCTION TO DESIGN AND CLASSICAL PID CONTROL 9**

Systems performance and specifications –Proportional, Integral and Derivative Controllers – Structure – Empirical tuning- Zeigler Nichols-Cohen Coon – Root Locus method – Open loop inversion- affine parameterisation – Tuning using ISE, IAE and other performance indices.

**UNIT II: STATE VARIABLE DESIGN 9**

Design by state feedback – Output feedback – Pole assignment technique – Design of state and output feedback controllers – Design of reduced and full order observers – PI feedback – Dynamic state feedback.

**UNIT III: OPTIMAL CONTROLLER DESIGN 9**

Statement of optimal control problem – Solution using vibrational approach – Ricatti equation – Solution – Infinite time problems.

**UNIT IV: ROBUST CONTROL SYSTEMS 9**

H∞ and H norms .– System Sensitivity – Analysis of Robustness – Systems with uncertain Parameters – Design of Robust Control Systems –Control synthesis –loop shaping techniques.

**UNIT V: CASE STUDIES 9**

Aircraft control – Control of Fuel-Air ratio in automotive engine – Control of Hard Disk Drive – Control of CSTR process – pH process.

**TOTAL: 45 HOURS**

**REFERENCES:**

1. G. C. Goodwin and etal, “Control system design’, Pearson Education, 2003.

2. G. F. Franklin and etal, “Feedback Control of Dynamic Systems”, Pearson Education systems, 2002.
3. Nagrath I J and Gopal M, “Control Systems Engineering”, New Age International Publishers, Fifth Edition, 2008.
4. Kemin Zhou and John Doyle, “Essentials of Robust Control”, Prentice-Hall Inc., 1998.
5. W. J. Granttham, T.L. Vincent, “Modern Control Systems Analysis and Design, John Wiley & Sons, 1993.
6. Gopal M, “Control Systems Principles and Design”, Tata McGraw Hill Publishing Company Limited, Eighth Edition, 2008.

| EI3503 | ADVANCED DIGITAL SIGNAL PROCESSING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To introduce the concept of analyzing discrete time signals & systems in the time and frequency domain.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to classify signals and systems & their mathematical representation. | R, A |
| CO-02 | Ability to analyse the discrete time systems. | U, A |
| CO-03 | Ability to study various transformation techniques & their computation. | U, A |
| CO-04 | Ability to study about filters and their design for digital implementation. | A |
| CO-05 | Ability to study about multiresolution techniques. | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | S | M | M | M | S | L | M | L | L | L | S | |
| **CO-02** | S | S | M | S | S | L | M | S | M | S | S | M | |
| **CO-03** | M | S | S | S | L | M | M | L | S | S | L | S | |
| **CO-04** | M | M | L | M | S | S | S | M | S | M | S | L | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-05** | L | L | M | L | S | L | S | L | L | S | M | L | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: DISCRETE TIME SIGNALS AND SYSTEMS 9**

Representation of discrete time signal – classifications – Discrete time – system – Basic operations on sequence – linear – Time invariant – causal – stable – solution to difference equation – convolution sum – correlation – Discrete time Fourier series – Discrete time Fourier transform.

**UNIT II: FOURIER AND STRUCTURE REALIZATION 9**

Discrete Fourier transform – properties – Fast Fourier transform – Z-transform – structure realization – Direct form – lattice structure for FIR filter – Lattice structure for IIR Filter.

**UNIT III: FILTERS 9**

Discrete Fourier Transform- properties, magnitude and phase representation Computation of DFT using FFT algorithm - DIT & DIF using radix 2 FFT- Use of FFT algorithms in linear filtering and correlation.

**UNIT IV: MULTISTAGE REPRESENTATION 9**

FIR & IIR filter realization - Direct form I, Direct form II, Linear phase FIR realizations - Parallel & cascade forms. FIR design: Windowing Techniques - Rectangular, Kaiser Windows Analog filter design - Butterworth and Chebyshev approximations- LPF, HPF, BPF, BRF; IIR Filters- digital design using impulse invariant and bilinear transformation warping, pre warping.

**UNIT V: MULTIRESOLUTION ANALYSIS 9**

Short-time Fourier transform – Heisenberg uncertainty principle. Principles of multi-resolution analysis – sub-band coding, the continuous and discrete wavelet transform – properties. Applications of wavelet transform – noise reduction, image compression.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. John G.Proakis, DimitrisG.Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, PHI.
2. S.Salivahanan, A.Vallavaraj and C.Gnanapriya “Digital Signal Processing, TMH, 2000.
3. A.V. Oppenheim and R.W.Schafer, Englewood “Digital Signal Processing”, Prentice-Hall, Inc, 1975.
4. B.Venkatramani&M.Bhaskar, “Digital Signal Processors architecture, programming and applications”, TMH, 2002
5. P. P. Vaidyanathan, “Multirate systems and filter banks”, Prentice Hall Inc. 1993


| **MA3501** | **PROCESS CONTROL LABORATORY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **0** | **0** | **4** | **2** |

**OBJECTIVES**

- To impart practical knowledge on various process control systems applied in process industries.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to experimentally verify the operation of interacting and non-interacting process systems. | A, An |
| CO-02 | Ability to impart practical skill on simulation of response on-off and PID controllers. | A, An |
| CO-03 | Ability to experimentally verify the closed loop response of several process control loops. | A, An |
| CO-04 | Ability to simulate and experiment tuning of controllers. | A, An |
| CO-05 | Ability to study the practical knowledge of complex control systems. | A, An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | L | M | M | S | |
| **CO-02** | S | S | S | M | M | L | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | L | S | M | L | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | L | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**LIST OF EXPERIMENTS:**

1. Operation of interacting and non-interacting systems
2. Responses of different order processes with and without transportation lag
3. Response of on-off controller
4. Response of P+I+D controller
5. Characteristics of control valve with and without positioner
6. Operation of on-off controlled thermal process
7. Closed loop response of flow control loop
8. Closed loop response of level control loop
9. Closed loop response of temperature control loop
10. Closed loop response of pressure control loop
11. Tuning of controllers
12. Study of complex control system (ratio / cascade / feed forward).

**TOTAL: 30 HOURS**

**SEMESTER II**

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1. | EI3504 | Dynamic Control System | 3 | 1 | 0 | 4 |
| 2. | EI3505 | Process Instrument Design | 3 | 0 | 0 | 3 |
| 3. | EI3506 | Applied Industrial Instrumentation | 3 | 0 | 0 | 3 |
| 4. | EI3507 | Industrial Automation | 3 | 0 | 0 | 3 |
| 5. | EIXXX | Department Elective III | 3 | 0 | 0 | 3 |
| 6. | EIXXX | Department Elective IV | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | |
| 7. | EI3572 | Automation Laboratory | 0 | 0 | 4 | 2 |
| **TOTAL** | | | **18** | **0** | **4** | **21** |

| EI3504 | DYNAMIC CONTROL SYSTEM | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**OBJECTIVES**

- To gain knowledge in analysis of linear and non-linear systems of dynamic control

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the fundamentals of physical systems in terms of its linear and nonlinear models. | U |
| CO-02 | Ability to study the description and stability of non-linear system. | U |
| CO-03 | Ability to study the conventional technique of non-linear system analysis. | An |
| CO-04 | Ability to study the analysis of digital control system using state-space formulation. | An |
| CO-05 | Ability to study the formulation and analysis of multi input multi output (MIMO) system | E |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | L | M | M | S | |
| **CO-02** | S | S | S | M | M | L | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | L | S | M | L | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | L | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: PHYSICAL SYSTEMS AND STATE ASSIGNMENT 9**

Systems: Electrical - Mechanical – Hydraulic – Pneumatic – Thermal systems –Modelling of some typical systems like DC Machines - Inverted Pendulum.

**UNIT II: STATE SPACE ANALYSIS 9**

Realisation of State models: – Non-uniqueness - Minimal realization – Balanced realization – Solution of state equations: – State transition matrix and its properties - Properties: Controllability and observability- Stabilisability and detectability – Kaman decomposition.

**UNIT III: MIMO SYSTEMS –FREQUENCY DOMAIN DESCRIPTIONS 9**

Properties of transfer functions – Impulse response matrices – Poles and zeroes of transfer function matrices – Critical frequencies – Resonance – Steady state and dynamic response – Bandwidth- Nyquist plots-Singular value analysis.

**UNIT IV: NON-LINEAR SYSTEMS 9**

Types of non-linearity – Typical examples – Equivalent linearization - Phase plane analysis – Limit cycles – Describing functions- Analysis using Describing functions- Jump resonance.

**UNIT V: STABILITY 9**

Stability concepts – Equilibrium points – BIBO and asymptotic stability – Direct method of Liapunov – Application to non-linear problems – Frequency domain stability criteria – Popov's method and its extensions.

**L: 45 + T: 15, TOTAL: 60 HOURS**

**REFERENCES:**


1. M. Gopal, "Modern Control Engineering", Wiley, 1996.
2. J.S. Bay, "Linear State Space Systems", McGraw-Hill, 1999.
3. Eroni-Umez and Eroni, "System dynamics & Control", Thomson Brooks/ Cole, 1998.
4. K. Ogatta, "Modern Control Engineering", Pearson Education Asia, Low Priced Edition, 1997.
5. G. J. Thaler, "Automatic Control Systems", Jaico publishers, 1993.

6. A. Nagoorkani, “Advanced Control Theory”, RBA publications, 1999

| EI3505 | PROCESS INSTRUMENT DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To gain knowledge in the designing of process instruments.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to design signal conditioning circuits. | U, A |
| CO-02 | Ability to design transmitters and controllers. | U, A |
| CO-03 | Ability to design final control elements. | An |
| CO-04 | Ability to understand the characteristics and design of control valve sizing. | An |
| CO-05 | Ability to learn the design of alarm and annunciation circuits. | A, E |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | L | M | M | S | |
| **CO-02** | S | S | S | M | M | L | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | L | S | M | L | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | L | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: DESIGN OF SIGNAL CONDITIONING CIRCUITS 9**

Design of V/I Converter and I/V Converter- Analog and Digital Filter design – Signal conditioning circuit for pH measurement –Compensation circuit - Signal conditioning circuit for Temperature measurement - Cold Junction Compensation -Thermocouple Linearization.

**UNIT II: DESIGN OF TRANSMITTERS 9**

RTD based Temperature Transmitter – Thermocouple based Temperature Transmitter- Design of Capacitance based Level Transmitter – Air-purge Level Measurement – Design of Smart Flow Transmitters.

**UNIT III: DESIGN OF DATA LOGGER AND PID CONTROLLER 9**

Design of ON / OFF Controller using Linear Integrated Circuits- Electronic PID Controller – Microcontroller Based Digital PID Controller - Micro - controller based Data Logger – Design of PC based Data Acquisition Cards.

**UNIT IV: ORIFICE AND CONTROL VALVE SIZING 9**

Orifice Sizing: - Liquid, Gas and steam services - Control Valves – Valve body:-Commercial valve bodies – Control valve sizing – Liquid, Gas and steam Services –Cavitation and flashing –Selection criteria – Rotameter Design.

**UNIT V: DESIGN OF ALARM AND ANNUNCIATION CIRCUIT 9**

Alarm and Annunciation circuits using Analog and Digital Circuits – Thyristor Power Controller – Design of Programmable Logic Controller.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. C. D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Prentice Hall, 2006.
2. Control Valve Handbook, 4th Edition, Emerson Process Management, Fisher Controls International, 2005.
3. R.W. Miller, "Flow Measurement Engineering Handbook", Mc-Graw Hill, NewYork 1996


| EI3506 | APPLIED INDUSTRIAL INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To equip the students with relevant knowledge to suit the industrial requirements.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to study about humidity, moisture and pressure measurements. | U |
| CO-02 | Ability to study about mechanical flow meters and their installation. | R |
| CO-03 | Ability to know about various types of level measurements adopted in industry environment. | A |
| CO-04 | Ability to study about various temperature measurements. | An |

| | | |
|---|---|---|
| CO-05 | Ability to study about advanced instruments to provide safety terminologies related to safety instrumentation and hazards. | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | M | S | L | N | M | N | S | S | N | L | N | L | |
| **CO-02** | S | M | L | S | S | S | L | S | L | N | S | S | |
| **CO-03** | M | L | S | M | N | M | L | S | S | M | L | N | |
| **CO-04** | S | M | L | S | S | N | L | S | M | L | M | S | |
| **CO-05** | M | L | M | S | L | S | L | M | L | N | M | N | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: MEASUREMENT OF PRESSURE 9**

Measurement of Pressure: Fluid properties relating to pressure measurement- manometer - Bourdon gauge- diaphragm gauge - bellows gauge- electrical types - vacuum gauge- Mcleod gauge- Pirani gauge - ionization gauge - thermocouple gauge - pressure transducers and pressure transmitters- differential pressure measurement -instrument calibration principles - instrument mounting , IC Pressure sensor.

**UNIT II: MEASUREMENT OF FLOW AND LEVEL 10**

Measurement of Flow: Variable head and variable area type flow meters: Orifice plate, Venturi tube, Dahl tube, Flow nozzle, Pitot tube -Rotameter-positive displacement meter-turbine flow meter- electromagnetic flow meter-mass flow meter - ultrasonic flow meter- solid flow measurement-calibration of flow meters.

Measurement of Level: Displacer and torque tube - bubbler tube - D/P methods - hydrostatic head level measurement - electrical methods: resistance, capacitance type, nucleonic and ultrasonic type level gauges, solid level measurement.

**UNIT III: MEASUREMENT OF TEMPERATURE 8**

Measurement of Temperature: Resistance thermometer, 3-lead and 4-lead arrangement-thermistor-thermocouple types and ranges-cold junction compensation-linearization of thermocouple-radiation pyrometer- optical pyrometers.

**UNIT IV: MEASUREMENT OF FORCE, DENSITY AND HUMIDITY 9**

Measurement of weight, density, and vibration: Load cell method- strain gauge, LVDT, Piezo electric pneumatic and hydraulic load cell- null balance method-conveyer belt weighing for online measurement- Constant volume hydrometer – gamma ray density measurement-vibrating probe liquid densitometer.

**UNIT V: SAFETY INSTRUMENTATION 9**

Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems –Conservation and emergency vents - Flame, fire and smoke detectors - Leak Detectors - Metal Detectors . Introduction to Safety Instrumented Systems – Hazards and Risk – Process Hazards Analysis(PHA) – Safety Life Cycle – Control and Safety Systems - Safety Instrumented Function -Safety Integrity Level (SIL) – Selection, Verification and Validation..

**TOTAL: 45 HOURS**

**REFERENCES:**


1. D. Patranabis, Principles of Industrial Instrumentation, Tata MCGraw Hill, 1998.
2. Donald P. Eckman, Industrial Instrumentation, Wiley Eastern Limited, 1991.
3. John P. Bentely, Principles of Measurement System, Longman Scientific and Technical, 1995
4. Jone's, Instrument Technology, Vol. 1: Mechanical Measurements, English Language Book Society, Fourth Edition, 1985
5. Douglas M. Considine, Editor-in-Chief, Process Instruments and Controls Handbook, Fourth Edition, McGraw-Hill Book Co., 1994
6. Doebelin, E.O., Measurement Systems, McGraw Hill, Fourth edition, Singapore, 1990.
7. R.K. Jain, Mechanical and Industrial measurements, Khanna publishers, Delhi, 1990
8. Paul Gruhn, P.E., CFSE and Harry Cheddie, P.E., "Safety Instrumented Systems: Design, Analysis, and Justification", 2nd Edition, ISA, 2006.


| EI3507 | INDUSTRIAL AUTOMATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To introduce the importance of automation techniques in manufacturing and process industries.
- Study of components used in data acquisition systems interface techniques.
- To expose to various control techniques employed in process automation.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to be familiar with various automation technologies in manufacturing and process industries. | U |
| CO-02 | Ability to design signal conditioning circuits for industrial automation. | U, A |
| CO-03 | Ability to acquire detail knowledge on data acquisition system interface and DCS system. | A |
| CO-04 | Ability to impart the role of PLC in industry automation. | An |
| CO-05 | Ability to identify the difference between SCADA and DCS applied in automation industries. | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | M | S | L | N | M | N | S | S | N | L | N | L | |
| **CO-02** | S | M | L | S | S | S | L | S | L | N | S | S | |
| **CO-03** | M | L | S | M | N | M | L | S | S | M | L | N | |
| **CO-04** | S | M | L | S | S | N | L | S | M | L | M | S | |
| **CO-05** | M | L | M | S | L | S | L | M | L | N | M | N | |

S-Strong, M-Medium,L-Low,N-Not relevant

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

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: Modbus &Profibus.

**UNIT II: AUTOMATION COMPONENTS** **9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**UNIT III: COMPUTER AIDED MEASUREMENT & CONTROL SYSTEMS** **9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, and Computer based data acquisition system, Internet of things (IoT) for plant automation.

**UNIT IV: PROGRAMMABLE LOGIC CONTROLLERS** **9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

**UNIT V: SCADA AND DISTRIBUTED CONTROL SYSTEM** **9**

Automation in Process Industries Introduction to computer based industrial automation- Supervisory control and data acquisition (SCADA) based architectures- SCADA for process industries. Direct Digital Control (DDC), Distributed Control System- Local Control Unit (LCU) architecture, LCU Process Interfacing Issues, Block diagram and Overview of different LCU security design approaches, Networking of DCS- DCS integration with PLC and Computers- Advantages of DCS.

**TOTAL: 45 HOURS**

**REFERENCES:**

1. S. K. Singh, “Industrial Instrumentation”, Tata McGraw Hill, 2nd edition companies, 2003.
2. C D Johnson, “Process Control Instrumentation Technology”, Prentice Hall India, 8th Edition, 2006.
3. E. A. Parr, Newnes, New Delhi, “Industrial Control Handbook”, 3rd Edition, 2000.
4. Gary Dunning, Thomson Delmar, “Programmable Logic Controller”, Cengage Learning, 3rd Edition, 2005.
5. Krishna Kant, “Computer - Based Industrial Control”, 2nd Edition, Prentice Hall, New Delhi, 2011.
6. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2016.
7. Lukas M.P, “Distributed Control Systems”, Van Nostrand Reinhold Co., New York, 1986

| EI3572 | AUTOMATION LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES**

- To teach the importance of monitoring, control and impart skills in automation.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Interpretation of Piping & Instrumentation Diagrams | U |
| CO-02 | Interfacing pilot plants with Industrial Type Distributed Control System | U |
| CO-03 | Programming of Industrial Type Programmable Logic Controller | An |
| CO-04 | Developing control strategies using functional blocks in DCS. | An |
| CO-05 | Design and implementation of advanced control schemes. | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | M | M | M | S | |
| **CO-02** | S | S | S | M | M | M | M | M | M | M | M | M | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-03** | S | M | S | M | M | M | S | M | M | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**LIST OF EXPERIMENTS**

1. Interpretation of P & ID
2. Control of a typical process using multi-loop PID controller.
3. Interfacing data acquisition card with personal computer.
4. Control of thermal process using embedded controller.
5. PC based control of level process.
6. Develop feedback and cascade control strategies using Function Blocks in DCS.
7. On-line monitoring and control of a plant using an industrial type DCS.
8. Simple exercises using the Instruction Set of Programmable Logic Controller.
9. Programmable logic controller exercises for Filling / Draining control operation
10. Programmable logic controller exercises for Reversal of dc motor direction
11. Control of level and flow measurement system using industrial type PLC.
12. Design and implementation of advanced control scheme on the skid mounted pilot plant.

**TOTAL: 30 HOURS**

**SEMESTER III**

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1. | EIXXX | Department Elective V | 3 | 0 | 0 | 3 |
| 2. | OEC | Open Elective<br>(Industrial Safety / Operation Research) | 3 | 0 | 0 | 3 |
| 3. | | Audit<br>(Disaster Management / English for Research Paper Writing) | 2 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | | |
| 4. | EI35P1 | Project work – Phase I | 0 | 0 | 12 | 6 |
| **TOTAL** | | | **8** | **0** | **12** | **12** |

**SEMESTER IV**

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | EI35P5 | Project work – Phase II | 0 | 0 | 32 | 16 |
| **TOTAL** | | | 0 | 0 | 32 | 16 |

## LIST OF ELECTIVES

| SI. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | EI35A1 | Applied Bio-Medical Instrumentation | 3 | 0 | 0 | 3 |
| 2. | EI35A2 | Piping and Instrumentation Design | 3 | 0 | 0 | 3 |
| 3. | EI35A3 | Robotics and Automation | 3 | 0 | 0 | 3 |
| 4. | EI35A4 | Design of Embedded Systems | 3 | 0 | 0 | 3 |
| 5. | EI35A5 | Micro and Nano Electro Mechanical Systems | 3 | 0 | 0 | 3 |
| 6. | EI35A6 | Modeling and Simulation | 3 | 0 | 0 | 3 |
| 7. | EI35A7 | Bio Medical Signal Processing | 3 | 0 | 0 | 3 |
| 8. | EI35A8 | Internet of Things and Applications | 3 | 0 | 0 | 3 |
| 9. | EI35A9 | Digital Control System | 3 | 0 | 0 | 3 |
| 10. | EI35B1 | Digital Image Processing | 3 | 0 | 0 | 3 |
| 11. | EI35B2 | Intelligent Control Techniques | 3 | 0 | 0 | 3 |
| 12. | EI35B3 | Digital Instrumentation | 3 | 0 | 0 | 3 |
| 13. | EI35B4 | Wireless Sensor Networks | 3 | 0 | 0 | 3 |
| 14. | EI35B5 | Industrial Data Communication | 3 | 0 | 0 | 3 |
| **OPEN ELECTIVES** | | | | | | |
| 15. | GE35A1 | Business Analytics | 3 | 0 | 0 | 3 |
| 16. | GE35A2 | Industrial Safety | 3 | 0 | 0 | 3 |
| 17. | GE35A3 | Operations Research | 3 | 0 | 0 | 3 |
| 18. | GE35A4 | Cost Management of Engineering Projects | 3 | 0 | 0 | 3 |
| 19. | GE35A5 | Composite Materials | 3 | 0 | 0 | 3 |
| 20. | GE35A6 | Waste to Energy | 3 | 0 | 0 | 3 |

## ELECTIVES

| EI35A1 | APPLIED BIOMEDICAL INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

### OBJECTIVES

- To introduce the principles and design issues of biomedical instrumentation

- To understand the nature and complexities of biomedical measurements

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to apply fundamental principles for designing and modelling biomedical systems. | U |
| CO-02 | Ability to use mathematical/computational tools for biomedical image and signal analysis. | U |
| CO-03 | Ability to learn about acquisition of biological signals and their analysis in biomedical measurements. | U |
| CO-04 | Ability to acquire knowledge on biomedical instrumentation and their applications in monitoring and analysis. | An |
| CO-05 | Ability to learn biomedical implants and microsystems and their clinical applications | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | M | M | M | S | |
| **CO-02** | S | S | S | M | M | M | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | M | S | M | M | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INTRODUCTION TO BIOMEDICAL MEASUREMENTS 9**

Physiological systems and measurable variables- Nature and complexities of biomedical measurements - Medical equipment standards - Biocompatibility - Human and Equipment safety – Physiological effects of electricity, Micro and macro shocks, thermal effects.

**UNIT II: ADVANCES IN MODELING AND SIMULATIONS IN BIOMEDICAL INSTRUMENTATION 9**

Modeling and simulation in biomedical instrumentation – Difference in modeling engineering systems and physiological systems – Model based analysis of action potentials – cardiac output – respiratory mechanism - Blood glucose regulation and neuromuscular function.

**UNIT III: BIOMEDICAL SIGNALS AND THEIR ACQUISITIONS 9**

Types and Classification of biological signals –Noise and artifacts and their management - Biopotential electrodes- types and characteristics - Origin, recording schemes and analysis of biomedical signals with typical examples of Electrocardiography(ECG), Electroencephalography(EEG), and Electromyography (EMG) – Processing and transformation of signals-applications of wavelet transforms in signal compression and denoising.

**UNIT IV: INSTRUMENTATION FOR DIAGNOSIS AND MONITORING 9**

Advanced medical imaging techniques and modalities -Instrumentation and applications in monitoring and diagnosis- Computed tomography, Magnetic Resonance Imaging and ultrasound- Algorithms and applications of artificial intelligence in medical image analysis and diagnosis-Telemedicine and its applications in telemonitoring.

**UNIT V: BIOMEDICAL IMPLANTS AND MICROSYSTEMS 9**

Implantable medical devices: Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy - ICCU patient monitoring system - Nano Robots - Robotic surgery – Advanced 3D surgical techniques- Orthopedic prostheses fixation.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. John G. Webster, “Bioinstrumentation”, John Wiley & Sons, 2008.
2. Shayne C. Gad, “Safety Evaluation of Medical Devices”, CRC Press, Second Edition, 2002.
3. Michael C. K. Khoo, “Physiological Control Systems: Analysis, Simulation and Estimation”, IEEE Press, 2000.
4. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley & Sons, Third Edition, 2009.
5. L. Cromwell, Fred J. Weibell and Erich A. Pfeiffer, “Biomedical Instrumentation and Measurements”, Prentice Hall of India, Digitized 2010.
6. P. Strong, “Biophysical Measurements”, Tektronix Digitized 2007.
7. K. Najarian and R. Splinter, “Biomedical Signal and Image Processing”, CRC Press, 2012.
8. John L. Semmlow, “Biosignal and Biomedical Image Processing”, CRC Press, First Edition, 2004.
9. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Prentice Hall, Fourth Edition, 2004


| EI35A2 | PIPING AND INSTRUMENTATION DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- Focuses on engineering drawings typically used in the chemical and process industries by engineers and technologists in the design phase, and by operations and maintenance staff once facilities are up and running.

| Course Outcome | Cognitive Skill |
|---|---|

| | | |
|---|---|---|
| CO-01 | Ability to gain knowledge on fundamentals of piping engineering, pipe hydraulics, piping supports and instrumentation. | U |
| CO-02 | Ability to effectively assess emergency situations and evaluate safety, environmental, and regulatory compliance issues in industries. | U |
| CO-03 | Ability to create accurate drawings and the ability to interpret them. | U |
| CO-04 | Ability to explore knowledge on piping technology and instrumentation on pipelines. | An |
| CO-05 | Ability to focus on critical documentation essential to the safe day-to-day operation in instrumentation. | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | M | M | M | S | |
| **CO-02** | S | S | S | M | M | M | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | M | S | M | M | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: FLOW SHEETS** **9**

Types of flow sheets, Flow sheet Presentation, Flow Sheet Symbols, introduction to process flow diagram (PFD) and piping and instrumentation diagram (P&ID), Synthesis of steady state flow sheet - Flow sheeting software.

**UNIT II: P & ID SYMBOLS** **9**

P & I D objectives, guide rules, Symbols, Line numbering, Line schedule, P & ID development, typical stages of P & I D.

**UNIT III: P & ID FOR DIFFERENT EQUIPMENTS** **9**

P & ID for rotating equipment and static pressure vessels, Process vessels, absorber, evaporator.

**UNIT IV: CONTROL SYSTEM DEVELOPMENT** **9**

Control System for Heater, Heat exchangers, reactors, dryers, Distillation column, Expander, Level, Temperature, Flow and Level process.

**UNIT V: APPLICATIONS OF P & ID** **9**

Applications of P & ID in design stage - Construction stage - Commissioning stage - Operating stage - Revamping stage - Applications of P & ID in HAZOPS and Risk analysis.

**TOTAL = 45 HOURS**

**REFERENCES:**


1. Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol.-I Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K. D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, Inc., New York, 1991.
3. Anil Kumar, "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill publishing Company Limited, New Delhi - 1981.
4. A. N. Westerberg, et al., "Process Flow sheeting", Cambridge University Press, 1979


| EI35A3 | ROBOTICS AND AUTOMATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To introduce the concepts of Robotic system, its components and instrumentation and control related to robotics

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the components and basic terminology of Robotics. | U |
| CO-02 | Ability to model the motion of robots and analyze the workspace and trajectory planning of robots. | U |
| CO-03 | Ability to provide the dynamic modelling of the robot. | U |
| CO-04 | Ability to understand the planning of manipulator trajectories. | An |
| CO-05 | Ability to understand the control of robot manipulators. | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | L | S | S | S | L | S | S | L | S | L | |
| **CO-02** | M | L | M | S | L | M | L | S | N | L | S | N | |
| **CO-03** | M | S | L | N | M | N | S | S | N | L | N | L | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-04** | S | M | L | S | S | S | L | S | L | N | S | S | |
| **CO-05** | M | M | S | S | L | N | L | S | S | L | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

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

Geometric configuration of robots – Manipulators – Drive systems – Internal and external sensors – End effectors – Control systems – Robot programming languages and applications – Introduction to robotic vision.

**UNIT II: ROBOT ARM KINEMATICS** **9**

Direct and inverse kinematics – Rotation matrices – Composite rotation matrices – Euler angle representation – Homogenous transformation – DenavitHattenberg representation and various arm configuration.

**UNIT III: ROBOT ARM DYNAMICS** **9**

Lagrange – Euler formulation, joint velocities – Kinetic energy – Potential energy and motion equations – Generalised D'Alembert equations of motion.

**UNIT IV: PLANNING OF MANIPULATOR TRAJECTORIES** **9**

General consideration on trajectory planning joint interpolation & Cartesian path trajectories.

**UNIT V: CONTROL OF ROBOT MANIPULATORS** **9**

PID control computed, torque technique – Near minimum time control – Variable structure control – Non-linear decoupled feedback control – Resolved motion control and adaptive control.

**TOTAL:45 HOURS**

**REFERENCES:**


1. Fu, K.S. Gonazlez, R.C. and Lee, C.S.G., "Robotics (Control, Sensing, Vision and Intelligence), McGraw-Hill, 1968 (II printing).
2. Wesley, E. Sryda, "Industrial Robots: Computer interfacing and Control" PHI, 1985.
3. Asada and Slotine, "Robot Analysis and Control", John Wiley and Sons, 1986.
4. Philippe Coiffet, "Robot Technology" Vol. II (Modelling and Control), Prentice Hall INC, 1981.
5. Saeed B. Niku, "Introduction to Robotics, Analysis, systems and Applications", Pearson Education, 2002
6. Groover M. P. Mitchell Wesis., "Industrial Robotics Technology Programming and Applications", Tata McGraw-Hill, 1986


| **EI35A4** | **DESIGN OF EMBEDDED SYSTEMS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**OBJECTIVES**

- The objective of this course is to enable the students to understand embedded-system and apply that knowledge to design and develop embedded solutions.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to develop the hardware for embedded system application based on the processors. | U |
| CO-02 | Ability to discuss on different tools needed for of embedded system development. | U |
| CO-03 | Ability to incorporate appropriate interfacing circuits used in embedded systems. | U |
| CO-04 | Ability to explore the skills of software development tools in building real time embedded systems. | An |
| CO-05 | Ability to explore the features of RTOS based embedded system and provide apt solutions for any embedded application | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | L | S | S | S | L | S | S | L | S | L | |
| **CO-02** | M | L | M | S | L | M | L | S | N | L | S | N | |
| **CO-03** | M | S | L | N | M | N | S | S | N | L | N | L | |
| **CO-04** | S | M | L | S | S | S | L | S | L | N | S | S | |
| **CO-05** | M | M | S | S | L | N | L | S | S | L | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INTRODUCTION TO EMBEDDED SYSTEMS** **9**

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA, Memory management methods- memory mapping, cache replacement concept, Timer and Counting devices, Watchdog Timer, Real Time Clock.

**UNIT II: INTERRUPT SERVICE ROUTINES** **9**

Interrupt Service routines – Watch dog timers – Flash memory Basic toolset – Host based debugging – Remote debugging – ROM emulators – logic Analyzer – Caches – Computer optimisation – Statistical profiling.

**UNIT III: RTOS** **9**

Introduction to RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Pre-emptive and non-pre-emptive scheduling, Task communication- shared memory, message passing-, Interprocess Communication – synchronization between

processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance-comparison of commercial RTOS features -RTOS Lite, Full RTOS.

**UNIT IV: DEVELOPMENT TOOLS** **9**

Software Development environment-IDE, assembler, compiler, linker, simulator, debugger, Incircuit emulator, Target Hardware Debugging, need for Hardware-Software Partitioning and Co-Design.

Overview of UML, Scope of UML modeling, Conceptual model of UML, Architectural, UML basic elements.

**UNIT V: EMBEDDED SYSTEM APPLICATION DEVELOPMENT** **9**

Objectives, different Phases &Modeling of the embedded product Development Life Cycle (EDLC), Case studies on Smart card- Adaptive Cruise control in a Car -Mobile Phone software for key inputs.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Rajkamal, 'Embedded system-Architecture, Programming, Design', TMH, 2011.
2. Peckol, "Embedded system Design", John Wiley &Sons, 2010
3. Shibu. K. V, "Introduction to Embedded Systems", Tata McGraw Hill, 2009
4. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson2013
5. Tammy Noergaard,"Embedded System Architecture, A comprehensive Guide for Engineers and Programmers", Elsevier, 2006


| **EI35A5** | **MICRO AND NANO ELECTRO MECHANICAL SYSTEMS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**OBJECTIVES**

- The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques

| **Course Outcome** | | **Cognitive Skill** |
|---|---|---|
| CO-01 | Ability to design, analysis, fabrication and testing the MEMS based components. | U |
| CO-02 | Ability to understand the properties of materials, microstructure and fabrication methods. | U |
| CO-03 | Ability to learn about various micro fabrication processes of MEMS. | R, U |
| CO-04 | Ability to explore characterizing microsensors and actuators through design and modeling. | An |
| CO-05 | Ability to understand the fundamentals of nano fabrication processes and actuation | A, An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | L | M | M | S | |
| **CO-02** | S | S | S | M | M | L | M | M | M | M | M | M | |
| **CO-03** | S | M | S | M | M | L | S | M | L | M | S | S | |
| **CO-04** | M | S | M | S | M | M | M | M | S | M | M | M | |
| **CO-05** | S | M | M | M | M | S | L | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INTRODUCTION TO MEMS 9**

History of MEMS, MEMS and Microsystems, Scaling laws in Miniaturization. Materials for MEMS and Microsystems.

**UNIT II: MICRO FABRICATION PROCESSES 9**

Microsystem - design and fabrication, Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical and Physical Vapor deposition, Deposition by Epitaxy, Etching. Bulk Micro manufacturing, Surface micromachining, LIGA process.

**UNIT III: MICROSENSORS AND ACTUATION 9**

Design of Acoustic wave sensors, resonant sensors, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors, Thermal resistor sensors- Applications- Engineering mechanics behind these microsensors.

**UNIT IV: SEMICONDUCTOR SYNTHESIZATION TECHNIQUES 9**

Semiconductor synthesization techniques, electronic structure and physical processes in semiconductor nanostructures, principles and performance of semiconductor nanostructure based electronic and electro-optical devices.

**UNIT V: NANO FABRICATION PROCESSES AND ACTUATION 9**

Nano-Electromechanical systems - fabrication process- choice of materials, calculations - the performance of different structures - advantages and disadvantages of different approaches, thermal – radiation, magnetic, chemical, and mechanical sensors, Microactuators.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Marc Madou, “Fundamentals of Micro fabrication”, CRC press 1997.
2. Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers, 2001
3. B.H. Bao, “Analysis and design principles of MEMS Devices”, Elsevier, 2005.
4. Tai Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata McGraw Hill, 2002.
5. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006,
6. Verdeyen. J, Laser Electronics, II Edition, Prentice Hall, 1990.

7. W. R. Farhner, "Nanotechnology and Nanoelectronics- Materials, Devices and Measurement Techniques" Springer (2006).

| EI35A6 | MODELLING AND SIMULATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To study the modelling and simulation techniques of chemical processes and to gain skills in using process simulators

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to analyse and model physical and chemical phenomena involved in various processes. | U, An |
| CO-02 | Ability to develop mathematical models for various control processes. | U, S |
| CO-03 | Ability to apply various simulation approaches. | U, A |
| CO-04 | Ability to model simple systems and complex systems. | An |
| CO-05 | Ability to solve engineering problems and to simulate the solution | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | L | S | S | S | L | S | S | L | S | L | |
| **CO-02** | M | L | M | S | L | M | L | S | N | L | S | N | |
| **CO-03** | M | S | L | N | M | N | S | S | N | L | N | L | |
| **CO-04** | S | M | L | S | S | S | L | S | L | N | S | S | |
| **CO-05** | M | M | S | S | L | N | L | S | S | L | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: OVERVIEW OF MATHEMATICAL MODELING 9**

Mathematical Model, classification of model equations, Mathematical model development - Development of mathematical model, Simulation, Nonlinear Differential Equations, Conservation of Mass/Energy/Momentum, Black Box Models.

**UNIT II: SIMPLE SYSTEM MODEL DEVELOPMENT 9**

Settling velocity of spherical particle, Vaporization from a single droplet in quiescent air, Modeling of a surge tank, Modeling of the pH process, Modeling of a long chain polymerization reaction, PDE model for tubular reactor with axial dispersion.

**UNIT III: COMPLEX SYSTEM MODEL DEVELOPMENT 9**

Isothermal CSTR, Linearization of a nonlinear equation, Bioreactor Modeling, Magnetic levitation (unstable systems), Choletts model with input multiplicities, Model for predators and Prey populations, Non-Isothermal continuous stirred tank reactor.

**UNIT IV: NUMERICAL SOLUTIONS OF MODEL EQUATIONS 9**

Newton – Raphson's method for a system of nonlinear algebraic equations; Runge-Kutta Methods of solving numerically IVP ODEs, Numerical solution of nonlinear BVP ODEs, Numerical solution of nonlinear PDE, Least square Curve Fitting ,Variable transformation to get a linear equation.

**UNIT V: STRATEGIES FOR DISTRIBUTED PARAMETER MODELS 9**

Solution strategies for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equations. Finite element and finite volume methods.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Bequette, B.W., "Process Dynamics: Modeling, Analysis and Simulation, Prentice-Hall International", Singapore, 1998.
2. Jana, A.K. "Chemical Process Modeling and Computer simulation", Prentice-Hall-India, New Delhi, 2011,
3. Finlayson, B.A., "Introduction to Chemical Engineering Computing", Wiley Student Edition, Singapore, 2006.
4. M.Chidambaram, "Mathematical Modeling and Simulation for Engineers", Cambridge University Press, New Delhi -2017


| EI35A7 | BIO MEDICAL SIGNAL PROCESSING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To introduce fundamental, theoretical and methodological principles of biosignal processing and analysis.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to provide information to physicians and allows them to make a diagnosis. | R |
| CO-02 | Ability to explore both theoretical and methodological principles of biosignal processing and analysis. | R, U |

| | | |
|---|---|---|
| CO-03 | Ability to estimate parametric models of the measured biosignals for prediction, simulation and diagnostic purposes. | U, A |
| CO-04 | Ability to estimate suitable models of the measured bio signals. | A |
| CO-05 | Ability to use mathematical/computational tools for biomedical image and signal analysis. | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | L | M | M | L | L | M | L | L | L | S | |
| **CO-02** | M | S | M | M | M | L | M | L | M | S | S | M | |
| **CO-03** | M | M | S | S | M | M | L | S | S | M | L | M | |
| **CO-04** | M | M | L | L | S | S | S | M | L | M | M | L | |
| **CO-05** | L | L | M | L | S | L | S | L | L | M | M | L | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INTRODUCTION TO SIGNALS 9**

Sources of Biomedical signals, types of signals – Deterministic, stochastic, fractal and chaotic, auto correlation, cross correlation, auto covariance, DFT, FFT algorithm – Digital filters – Introduction to FIR and IIR filter.

**UNIT II: CLASSICAL SPECTRAL ESTIMATION TECHNIQUES 9**

Periodogram, Blackman – Tukey spectral Estimation applications – Analysis of the biosignal using Periodogram,–Cepstra, power cepstrum, applications of cepstrum analysis – analysis of the biosignal using cepstrum technique.

**UNIT III: ADAPTIVE NOISE CANCELLATION 9**

Introduction, principle of adaptive noise canceling, adaptive Noise cancellation with the LMS and RLS adaptation algorithm - applications.

**UNIT IV: PARAMETRIC MODELING METHODS 9**

Autoregressive methods – Linear Prediction and Autoregressive methods, the autocorrelation (Yule - walker) methods, applications of AR methods AR modeling of seizure EEG, ECG signals and surface EMG. Autoregressive Moving Average (ARMA) method – MLE method, Akaike method, Durbin method, applications – ARMA modeling of somatosensory Evoked Potentials.

**UNIT V: CLUSTERING AND WAVELETTRANSFORM FOR BIOSIGNAL PROCESSING 9**

Clustering methods – hard and fuzzy clustering, applications of Fuzzy clustering to Biomedical signal processing, Wavelet transform – Introduction, Filter bank implementation of discrete wavelet transform, signal Denoising using wavelet transform, wavelet based compression.

**TOTAL:45 HOURS**

**REFERENCES:**


1. M.Akay, "Biomedical Signal Processing", Academic Press, San Diego, 1994.
2. M.Akay, "Nonlinear Biomedical Signal Processing", Fuzzy Logic, Neural Networks and New Algorithms, vol.1, IEEE Press Series on Biomedical Engineering, New York, 2000.
3. Eugene N.Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Sons, First Edition, 2000.


| EI35A8 | INTERNET OF THINGS AND APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To give an overview of the Interconnection and Integration of the Physical World with Cyber Space.
- To provide an insight into Design and Development of IOT application.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to gain knowledge about the principles of Internet. | R |
| CO-02 | Ability to control and monitor all the processes taking place at remote location. | R, U |
| CO-03 | Ability to provide an insight into Design and Development of IOT application. | U, A |
| CO-04 | Ability to realize an IoT application | A |
| CO-05 | Ability to learn the use of IoT in different applications. | An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | L | M | M | L | L | M | L | L | L | S | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-02** | M | S | M | M | M | L | M | L | M | S | S | M | |
| **CO-03** | M | M | S | S | M | M | L | S | S | M | L | M | |
| **CO-04** | M | M | L | L | S | S | S | M | L | M | M | L | |
| **CO-05** | L | L | M | L | S | L | S | L | L | M | M | L | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INTERNET PRINCIPLES 9**

Definition and Characteristics - IoT enabling technologies – Levels of deployment – Domain specific IoTs - SDN and NFV for IoT – ISO/OSI model – MAC address and IP address - Overview of TCP/IP and UDP -Basics of DNS - Classes of IP addresses - Static and dynamic addressing –Salient features of IPV4 – Specifications of IPV6.

**UNIT II: PHYSICAL AND LOGICAL DESIGN METHODOLOGIES 9**

Requirements and Specifications – Device and Component Integration —Physical design using prototyping boards - Sensors and actuators, choice of processor, interfacing and networking - Logical Design – Open source platforms - Techniques for writing embedded code .

**UNIT III: PROTOCOLS AND CLOUDS FOR IOT 9**

Application layer protocols for IoT – MQTT and –Introduction to cloud storage models and communication APIs – Web application framework – Designing a web API – Web services - IoT device management.

**UNIT IV: INDUSTRIAL IOT AND SECURITY 9**

Introduction to the Industrial Internet - Networked Control Systems – Network delay modeling - Architecture and design methodologies for developing IoT application for Networked Control Systems – Example using SCADA system - Software Design Concepts - Middleware IIOT platforms- securing the Industrial Internet- Introduction of Industry 4.0.

**UNIT V: CASE STUDIES AND REAL-WORLD APPLICATIONS 9**

Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. ArshdeepBahga and Vijay Madisetti, “Internet of Things A Hands-on Approach”, Universities Press (India), 2015.
2. Alasdair Gilchrist," Industry 4.0: The Industrial Internet of Things”, A press, 2016.
3. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley & Sons, 2014.
4. Beheshti, S. M. R., Benatallah, B., Sakr, S., "Process Analytics Concepts and Techniques for Querying and Analyzing Process Data" Springer International Publishing Switzerland, 2016


| **EI35A9** | **DIGITAL CONTROL SYSTEM** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**OBJECTIVES**

- To gain knowledge in analysis of linear and non-linear digital control systems.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to compute the z-transform of elementary signals and difference equations in linear and non-linear systems. | U |
| CO-02 | Ability to determine the poles of a second-order system based on the system's transient response (both continuous time and discrete time systems). | U, A |
| CO-03 | Ability to understand the conventional technique of non-linear system analysis. | U, An |
| CO-04 | Ability to introduce the optimal controller and optimal estimator including Kalman filter. | E |
| CO-05 | Ability to understand the analysis of digital control system using state-space formulation. | A, An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | M | L | L | L | S | S | S | M | M | M | |
| **CO-02** | L | M | S | M | S | S | M | S | S | M | S | S | |
| **CO-03** | M | M | L | S | S | L | S | M | S | S | S | L | |
| **CO-04** | S | S | M | S | M | S | L | M | M | L | M | S | |
| **CO-05** | L | S | L | L | S | M | L | L | L | M | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

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

Sampling and holding – Sample and hold devices – D/A and A/D conversion – Reconstruction – Z transform – Inverse Z transform – Properties – Pulse transfer function and state variable approach – Review of controllability, observability.

**UNIT II: DESIGN USING TRANSFORM TECHNIQUES** **9**

Methods of discretisation – Comparison –Frequency response methods – Root locus method, Controller design using root locus, Nyquist stability criteria, Bode plot, Lead compensator design using Bode plot, Lag compensator design using Bode plot, Lag-lead compensator design in frequency domain.

**UNIT III: QUANTIZATION EFFECTS AND SAMPLE RATE SELECTION 9**

Analysis of round off error – Parameter round off – Limit cycles and dither – Sampling theorem limit – Time response and smoothness – Sensitivity to parameter variations – Measurement noise and antialising filter – Multirate sampling.

**UNIT IV: DESIGN USING STATE SPACE TECHNIQUES 9**

State space design – Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation- Pole assignment - Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula-State Observers - Optimal control – State estimation in the presence of noise –Kalman filter– Effect of delays..

**UNIT V: COMPUTER BASED CONTROL 9**

Selection of processors – Mechanization of control algorithms – PID control laws – Digital Temperature Control System- Application to temperature control and Control Algorithm– Control of electric drives – Data communication for control-Field buses.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Gopal.M., "Digital Control Engineering ", Wiley Eastern Ltd., 1989.
2. G. F. Franklin, J.David Powell, Michael Workman, "Digital control of Dynamic Systems", 3rd Edition, Addison Wesley, 2000.
3. M. Gopal, 'Digital Control and State Variables Methods', Tata McGraw HILL, 2nd Edition, 2003.
4. Paul Katz, "Digital control using Microprocessors", Prentice Hall, 1981.
5. Chesmond, Wilson, Lepla, "Advanced Control System Technology", Viva – low price edition, 1998


| EI35B1 | DIGITAL IMAGE PROCESSING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To provide knowledge on the fundamentals of image processing to understand various techniques involved in digital image processing

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Fundamentals of image processing and techniques | R, U |
| CO-02 | The implementation of image processing applications using software and hardware. | U |
| CO-03 | Able to provide knowledge on image enhancement, segmentation and image analysis. | A |
| CO-04 | Able to learn the fundamentals and significance of image compression. | An |

| | | |
|---|---|---|
| CO-05 | Able to understand the hardware for image processing applications | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | M | L | L | L | S | S | S | M | M | M | |
| **CO-02** | L | M | S | M | S | S | M | S | S | M | S | S | |
| **CO-03** | M | M | L | S | S | L | S | M | S | S | S | L | |
| **CO-04** | S | S | M | S | M | S | L | M | M | L | M | S | |
| **CO-05** | L | S | L | L | S | M | L | L | L | M | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: FUNDAMENTALS OF IMAGE PROCESSING 9**

Introduction to image processing systems, sampling and quantization, color fundamentals and models, arithmetic, geometric and morphological image operations. Multi-resolution analysis.

**UNIT II: IMAGE ENHANCEMENT 9**

Spatial domain; Gray-level transformations – histogram processing – spatial filtering, smoothing and sharpening. Frequency domain: filtering in frequency domain – DFT, FFT, DCT – smoothing and sharpening filters – Homomorphic filtering.

**UNIT III: IMAGE SEGMENTATION AND FEATURE ANALYSIS 9**

Detection of discontinuities – edge operators – edge linking and boundary detection, thresholding – feature analysis and extraction – region based segmentation – morphological watersheds – shape skeletonization, phase congruency.

**UNIT IV: IMAGE COMPRESSION 9**

Image compression: fundamentals – models – elements of information theory – error free compression – lossy compression – compression standards. Applications of image compression techniques.

**UNIT V: EMBEDDED IMAGE PROCESSING 9**

Introduction to embedded image processing. ASIC vs FPGA - memory requirement, power consumption, parallelism. Design issues in VLSI implementation of Image processing algorithms - interfacing.

**TOTAL:45 HOURS**

**REFERENCES:**

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image processing”, 2nd edition, Pearson education, 2003

2. Anil K. Jain, “Fundamentals of digital image processing”, Pearson education, 2003
3. Milan Sonka, ValclavHalavac and Roger Boyle, “Image processing, analysis and machine vision”, 2nd Edition, Thomson learning, 2001
4. Mark Nixon and Alberto Aguado, “Feature extraction & Image processing for computer vision”, 3rd Edition, Academic press, 2012
5. Donald G. Bailey, “Design for Embedded Image processing on FPGAs” John Wiley and Sons, 2011

| EI35B2 | INTELLIGENT CONTROL TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To expose the concepts of intelligent systems and provide adequate knowledge about neural networks.
- To teach about the concept of fuzziness, genetic algorithm and hybrid techniques

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the intelligent agents and search methods. | R, A |
| CO-02 | Ability to know about neural networks and its application in control. | U, A |
| CO-03 | Ability to apply genetic algorithm for optimisation problems. | U |
| CO-04 | Understand the role of fuzzy logic system | U |
| CO-05 | Ability to design applications. | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | M | L | L | L | S | S | S | M | M | M | |
| **CO-02** | L | M | S | M | S | S | M | S | S | M | S | S | |
| **CO-03** | M | M | L | S | S | L | S | M | S | S | S | L | |
| **CO-04** | S | S | M | S | M | S | L | M | M | L | M | S | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-05** | L | S | L | L | S | M | L | L | L | M | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

**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 Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network, Hopfield network, Self-organizing network and Recurrent network, Neural Network based controller.

**UNIT III: 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.

**UNIT IV: GENETIC ALGORITHM& PARTICLE SWARM** **9**

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters, Solution of typical control problems using genetic algorithm, Particle swarm optimisation – principle and theory.

**UNIT V: APPLICATIONS** **9**

Design of controllers using Neural Networks, Fuzzy Logic and GA for Inverted Pendulum and Heat Exchanger process.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. KOSKO,B. "Neural Networks And Fuzzy Systems", PHI Pvt. Ltd., 1994.
3. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers


| **EI35B3** | **DIGITAL INSTRUMENTATION** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**OBJECTIVES**

- To understand the fundamentals building blocks of a digital instrument
- To learn about the different digital data communication techniques
- To study on bus communication standards and working principles
- To learn graphical programming for instrument building

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the need for data acquisition systems | U |
| CO-02 | Perform computational and measurement activities using digital techniques | U, A |
| CO-03 | Ability to learn the different communication standards | U |
| CO-04 | The make of use of graphical programming languages for instrument building | A |
| CO-05 | To discuss on different case studies. | A, An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | M | L | L | L | S | S | S | M | M | M | |
| **CO-02** | L | M | S | M | S | S | M | S | S | M | S | S | |
| **CO-03** | M | M | L | S | S | L | S | M | S | S | S | L | |
| **CO-04** | S | S | M | S | M | S | L | M | M | L | M | S | |
| **CO-05** | L | S | L | L | S | M | L | L | L | M | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: DATA ACQUISITION SYSTEMS 9**

A/D converter, types and characteristics – Sampling, Errors. Objective – Building blocks of Automation systems -Calibration, Resolution, Data acquisition interface requirements.– Counters – Modes of operation- Frequency, Period, Time interval measurements, Single and Multi-channel Data Acquisition systems-Digital storage Oscilloscope-digital display interface.

**UNIT II: INSTRUMENT COMMUNICATION 9**

Introduction, Modem standards, Data transmission systems- Time Division Multiplexing (TDM) – Digital Modulation Basic requirements of Instrument Bus Communications standards, interrupt and data handshaking , serial bus- basics, Message transfer, - RS-232, USB, RS-422, Ethernet Bus- CAN standards interfaces . HART network, Mod Bus, Fieldbus.

**UNIT III: VIRTUAL INSTRUMENTATION BASICS 9**

Block diagram, role, and Architecture for VI— tool bar, Graphical system design &programming using GUI –Virtual Instrumentation for test, control design-modular

programming-conceptual and programming approaches for creation of panels, icons-Loops-Arrays-clusters-plotting data-structures-strings and File I/O- Instrument Drivers.

**UNIT IV: PROGRAMMABLE INSTRUMENTATION 9**

Peripheral Interfaces systems and instrument communication standards –Data acquisition with processor and with VI – Virtual Instrumentation Software and hardware simulation of I/O communication blocks-peripheral interface – ADC/DAC – Digital I/O – Counter , Timer-servo motor control-PID control.

**UNIT V: CASE STUDIES 9**

VI based process measurements like temperature, pressure and level development system-DSO interface -digital controller for colour video display.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Mathivanan, "PC based Instrumentation Concepts and practice", Prentice-Hall India, 2009
2. JovithaJerome, "Virtual Instrumentation using Labview", PHI, 2010.
3. Jonathan W Valvano, "Embedded Microcomputer systems", Brooks/Cole, Thomson, 2010.
4. Cory L.Clark,"Labview Digital Signal Processing & Digital Communication, TMcH, 2005
5. Lisa K. wells & Jeffrey Travis, Lab VIEW for everyone, Prentice Hall, New Jersey, 1997.
6. H S Kalsi, "Electronic Instrumentation" Second Edition, Tata McGraw-Hill, 2006.
7. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGHill, Newyork, 1997


| EI35B4 | WIRELESS SENSOR NETWORKS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To introduce the technologies and applications of wireless sensor networks.
- To understand the various layers in the WSN protocol stack.
- To learn about the MAC protocols.
- To learn about the Routing protocols
- To familiarize the students with the platforms used in the design of WSN

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to explain common wireless sensor node architectures. | U |
| CO-02 | Ability to carry out simple analysis and planning of WSNs. | An |

| | | |
|---|---|---|
| CO-03 | Ability to demonstrate knowledge of MAC protocols developed for WSN. | U, E |
| CO-04 | Ability to demonstrate knowledge of routing protocols developed for WSN. | A, E |
| CO-05 | Ability to understand and explain mobile data-centric networking principles. | A, An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | M | L | L | L | S | S | S | M | M | M | |
| **CO-02** | L | M | S | M | S | S | M | S | S | M | S | S | |
| **CO-03** | M | M | L | S | S | L | S | M | S | S | S | L | |
| **CO-04** | S | S | M | S | M | S | L | M | M | L | M | S | |
| **CO-05** | L | S | L | L | S | M | L | L | L | M | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

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

Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture – Hardware components, energy consumption of sensor nodes, Network architecture – Sensor network scenarios, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources – Introduction to LRWPAN – Design procedure for WSN development.

**UNIT II: PHYSICAL INTRODUCTION LAYER** **9**

Wireless communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication ,packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, energy usage profile, choice of modulation, power management.

**UNIT III: MAC PROTOCOLS** **9**

Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

**UNIT IV: ROUTING PROTOCOLS** **9**

Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

**UNIT V: WSN DESIGN METHODOLOGY** **9**

Network Simulators and Programming tools for WSN– Programming Challenges – Security Challenges – Implementation Issues – case study on networked control system.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Ivan Stojmenovic, "Handbook of Sensor Networks: Algorithms and Architectures", Wiley, 2005.
2. KazemSohraby, Daniel Minoli and TaiebZnati, "Wireless Sensor Networks Technology, Protocols and Applications", John Wiley, 2007.
3. BhaskarKrishnamachari, "Networking Wireless Sensors", Cambridge University Press, 2011.


| EI35B5 | INDUSTRIAL DATA COMMUNICATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To provide comprehensive knowledge of analog to digital conversion and data acquisition
- To explain pc based instrumentation systems.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to gain fundamental knowledge about various analog to digital conversion methods. | R, U |
| CO-02 | Ability to gain knowledge about data acquisition. | U |
| CO-03 | Ability to gain knowledge in the architecture and interfacing using microprocessors | A |
| CO-04 | Ability to understand source digitization, digital multiplexing and modulation. | An |
| CO-05 | Ability to gain basic knowledge about HART (Highway Addressable Remote Transducer) and field bus technology. | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | L | M | L | L | L | S | S | S | M | M | M | |
| **CO-02** | L | M | S | M | S | S | M | S | S | M | S | S | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-03** | M | M | L | S | S | L | S | M | S | S | S | L | |
| **CO-04** | S | S | M | S | M | S | L | M | M | L | M | S | |
| **CO-05** | L | S | L | L | S | M | L | L | L | M | L | S | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: BASIC BLOCKS** **9**

Overview of A/D converter, types and characteristics-Understanding Data acquisition, A/D and S/H terms-passive support and Active support components-Single and Multi-slope, Low cost A/D conversion techniques, types-Electromechanical A/D converter.

**UNIT II: DATA ACQUISITION SYSTEMS** **9**

Objective - Building blocks of Automation systems – Multi, Single channel Data Acquisition systems, PC based DAS, Data loggers- Sensors based computer data systems.

**UNIT III: INTERFACING AND DATA TRANSMISSION** **9**

Data transmission systems- 8086 Microprocessor based system design - Peripheral Interfaces – Time Division Multiplexing (TDM) – Digital Modulation – Pulse Modulation – Pulse Code Format – Interface systems and standards – Communications.

**UNIT IV: PC BASED INSTRUMENTATION** **9**

Introduction - Evolution of signal Standard - HART Communication protocol -Communication modes - HART networks - control system interface - HART commands -HART field controller implementation - HART and the OSI model - Field bus –Introduction - General field bus architecture - Basic requirements of field bus standard -field bus topology - Interoperability – interchangeability - Instrumentation buses-Mod bus - GPIB - Network buses – Ethernet - TCP/IP protocols.

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

PC based industrial process measurements like flow, temperature, pressure and level – PC based instruments development system.

**TOTAL: 45 HOURS**

**REFERENCES:**


1. Kevin M. Daugherty, “Analog – to – Digital conversion – A Practical Approach”, McGraw Hill International Editions, 1995
2. N. Mathivanan, “Microprocessors, PC Hardware and Interfacing”, Prentice – Hall of India Pvt. Ltd., 2003.
3. Krishna Kant “Computer- based Industrial Control”, Prentice- Hall of India Pvt. Ltd., 1997
4. H S. Kalsi, “Electronic Instrumentation”, Technical Education Series (TES)/TMH, New Delhi.
5. Buchanan., “Computer Busses”, Arnold, London, 2000


## OPEN ELECTIVES

| **GE35A1** | **BUSINESS ANALYTICS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**OBJECTIVES**

- To understand the basic concepts of Business Analytics and other operational techniques.
- To make students understandable about the Regression Analysis, Business analytics, forecasting and decision analysis.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the concepts of Business Analytics. | An |
| CO-02 | Can understand the factors of Trendiness and Regression analysis. | A |
| CO-03 | Students can understand about organization structures of business analytics. | A, An, E |
| CO-04 | One can understand the concepts of Forecasting Techniques. | An, S |
| CO-05 | Can understand the Decision analysis. | A, An |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | M | M | M | M | S | |
| **CO-02** | S | S | S | M | M | N | M | M | M | M | N | M | |
| **CO-03** | S | M | S | M | M | M | S | M | M | M | S | S | |
| **CO-04** | S | S | M | S | M | M | M | M | S | N | M | M | |
| **CO-05** | S | M | M | M | M | S | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: BUSINESS ANALYTICS** **9**

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

**UNIT II: TRENDINESS AND REGRESSION ANALYSIS** **9**

Modeling Relationships and Trends in Data, simple Linear Regression.

Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**UNIT III: ORGANIZATION STRUCTURES OF BUSINESS ANALYTICS 9**

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

**UNIT IV: FORECASTING TECHNIQUES 9**

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.
Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**UNIT V: DECISION ANALYSIS 9**

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making. Recent Trends in: Embedded and collaborative business intelligence, Visual data
Recovery, Data Storytelling and Data journalism.

**TOTAL: 45 HOURS**

**REFERENCES**


1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G.Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.


| GE35A2 | INDUSTRIAL SAFETY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To make students understandable about the Industrial safety, Maintenance and fault tracing.
- To understand the basic Industrial Safety and Fault diagnosis.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the concepts of Industrial Safety. | U, A |
| CO-02 | Can understand the fundamentals of Maintenance Engineering. | A, An |
| CO-03 | Students can understand the ways to prevent from wear and corrosion. | An |

| | | |
|---|---|---|
| CO-04 | One can understand the concepts of fault tracing. | A, An |
| CO-05 | Can understand the functions of periodic and preventive maintenance. | A, An, E |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | S | S | M | M | S | M | M | M | N | M | S | |
| **CO-02** | S | S | S | M | M | M | M | M | M | M | M | M | |
| **CO-03** | S | S | S | M | M | M | S | M | M | S | S | S | |
| **CO-04** | S | S | M | S | M | M | M | M | N | M | M | M | |
| **CO-05** | S | M | M | M | M | S | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INDUSTRIAL SAFETY** **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

**UNIT II: FUNDAMENTALS OF MAINTENANCE ENGINEERING** **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**UNIT III: WEAR AND CORROSION AND THEIR PREVENTION** **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**UNIT IV: FAULT TRACING** **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

**UNIT V: PERIODIC AND PREVENTIVE MAINTENANCE 9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

**TOTAL: 45 HOURS**

**REFERENCES**


1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.


| GE35A3 | OPERATIONS RESEARCH | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To understand the concepts behind Operations Research.
- To make students understandable about the optimization techniques

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the concepts of Optimization Techniques. | A, U |
| CO-02 | Can understand the fundamentals of LPP formulation. | A |
| CO-03 | Students can understand the Non-Linear Programming. | An |
| CO-04 | One can understand the concepts Scheduling and Sequencing. | A, E |
| CO-05 | Can understand the functions of Competitive models | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | S | M | M | S | S | |
| **CO-02** | S | S | S | M | M | S | M | S | M | S | S | M | |
| **CO-03** | S | M | S | S | M | M | S | M | M | N | S | S | |
| **CO-04** | S | S | M | S | M | M | M | M | S | S | S | M | |
| **CO-05** | S | M | M | M | M | S | M | S | S | N | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: OPTIMIZATION TECHNIQUES 9**

Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

**UNIT II: LPP FORMULATION 9**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

**UNIT III: NONLINEAR PROGRAMMING 9**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

**UNIT IV: SCHEDULING AND SEQUENCING 9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

**UNIT V: COMPETITIVE MODELS 9**

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

**TOTAL: 45 HOURS**

**REFERENCES**


1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010


| **GE35A4** | **COST MANAGEMENT OF ENGINEERING PROJECTS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**OBJECTIVES**

- To understand the concepts of Cost management of Engineering Projects
- To make students understandable about the cost concepts in decision making and profit planning.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the strategic cost management. | A |
| CO-02 | Can understand the fundamentals of cost concepts in decision making. | U |
| CO-03 | Students can understand the process involved in project execution. | A, |
| CO-04 | One can understand the concepts of cost behavior and profit planning. | E |
| CO-05 | Can understand the functions of quantitative techniques | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | S | M | M | M | M | S | M | S | M | M | S | S | |
| **CO-02** | S | S | S | M | S | M | M | S | M | S | S | M | |
| **CO-03** | S | M | S | M | M | M | S | M | M | M | S | S | |
| **CO-04** | S | S | M | S | M | M | M | S | S | M | S | M | |
| **CO-05** | S | M | M | M | M | S | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: STRATEGIC COST MANAGEMENT** **9**

Introduction and Overview of the Strategic Cost Management Process.

**UNIT II: COST CONCEPTS IN DECISION MAKING** **9**

Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

**UNIT III: PROJECT** **9**

Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

**UNIT IV: COST BEHAVIOR AND PROFIT PLANNING 9**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

**UNIT V: QUANTITATIVE TECHNIQUES 9**

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

**TOTAL: 45 HOURS**

**REFERENCES**


1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler Publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.


| GE35A5 | COMPOSITE MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To understand the characterization and properties of composite materials
- To make students understandable about the material characteristics, processing and classifications of composite materials.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the functional requirements of composite materials. | U |
| CO-02 | Can understand the properties and applications of reinforcements. | A, An |
| CO-03 | Students can understand the process involved in metal matrix composite fabrication. | U, An, E |
| CO-04 | One can understand the concepts of polymer matrix composites fabrication. | An |
| CO-05 | Can understand the physical characteristics of composite materials | A |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | M | S | M | M | M | S | M | M | M | M | M | S | |
| **CO-02** | M | S | S | M | M | N | M | M | M | N | M | M | |
| **CO-03** | M | S | S | M | M | M | S | M | M | M | S | S | |
| **CO-04** | M | S | M | S | N | M | M | M | S | M | M | M | |
| **CO-05** | M | S | M | M | M | S | M | S | S | M | S | M | |

S-Strong, M-Medium,L-Low,N-Not relevant

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

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**UNIT II: REINFORCEMENTS** **9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

**UNIT III: MANUFACTURING OF METAL MATRIX COMPOSITES** **9**

Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**UNIT IV: MANUFACTURING OF POLYMER MATRIX COMPOSITES** **9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

**UNIT V: STRENGTH** **9**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**TOTAL: 45 HOURS**

**TEXT BOOKS**

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

**REFERENCES**

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

| MA3501 | WASTE TO ENERGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**

- To understand the basic properties of Bio Materials and its process
- To make students understandable about the gasification process, bio materials and its design considerations.

| Course Outcome | | Cognitive Skill |
|---|---|---|
| CO-01 | Ability to understand the process of obtaining Energy from waste substances. | U, An |
| CO-02 | Can understand manufacturing of pyrolytic oils and gases, yields and applications. | A, S |
| CO-03 | Students can understand kinetic consideration in gasifier operation. | U, A |
| CO-04 | One can understand the Design, construction and operation of Bio Mass chamber. | An |
| CO-05 | Can understand the basic Properties of biogas | A, An, E |

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

**Mapping of Course Outcome with Programme Outcome**

| PO / CO | PO-A | PO-B | PO-C | PO-D | PO-E | PO-F | PO-G | PO-H | PO-I | PO-J | PO-K | PO-L | PO-M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-01** | M | M | S | S | M | S | M | S | M | M | S | S | |
| **CO-02** | M | S | S | S | M | M | M | S | M | M | S | S | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-03** | S | M | S | S | M | M | S | S | M | M | N | S | |
| **CO-04** | M | M | S | S | M | M | M | S | S | M | S | N | |
| **CO-05** | M | M | S | S | M | S | M | S | S | M | S | N | |

S-Strong, M-Medium,L-Low,N-Not relevant

**UNIT I: INTRODUCTION TO ENERGY FROM WASTE 9**

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

**UNIT II: BIOMASS PYROLYSIS 9**

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**UNIT III: BIOMASS GASIFICATION 9**

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers –Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**UNIT IV: BIOMASS COMBUSTION 9**

Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**UNIT V: BIOGAS 9**

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**TOTAL: 45 HOURS**

**REFERENCES**


1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.


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