VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

## SCHOOL OF MECHANICAL ENGINEERING

# M.Tech Mechatronics

(M.Tech MMT)

Curriculum

(*2020-2021 admitted students*)

# M.Tech – Mechatronics

## VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

## MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

**World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

**Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.

**Impactful People**: Happy, accountable, caring and effective workforce and students.

**Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.

**Service to Society**: Service to the region and world through knowledge and compassion.

## VISION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

- To be a leader in imparting world-class education in Mechanical Engineering, leading to nurturing of scientists and technologists of the highest caliber who would engage in the sustainable development of the globe.

## MISSION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

- The mission of the school is to create and maintain an environment for Excellence in Instruction, Learning, and Applied Research in the area of Mechanical and allied disciplines so as to equip our students with necessary knowledge and skills for higher education/employment and to meet the social demands.

## M.Tech – Mechatronics

# PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.
2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.
3. Graduates will function in their profession with social awareness and responsibility.
4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.
5. Graduates will be successful in pursuing higher studies in engineering or management.
6. Graduates will pursue career paths in teaching or research.

## M.Tech. –Mechatronics

# PROGRAMME OUTCOMES (POs)

**PO_01:** Having an ability to apply mathematics and science in engineering applications

**PO_02:** Having an ability to design a component or a product applying all the relevant standards and with realistic constraints

**PO_03:** Having an ability to design and conduct experiments, as well as to analyze and interpret data

**PO_04:** Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice

**PO_05:** Having problem solving ability- solving social issues and engineering problems

**PO_06:** Having adaptive thinking and adaptability

**PO_07:** Having a clear understanding of professional and ethical responsibility

**PO_08:** Having a good cognitive load management [discriminate and filter the available data] skills

## M.Tech – Mechatronics

# PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M.Tech. – Mechatronics, graduates will be able to

**PSO_01:** Analyse, design and develop mechatronics systems to solve complex engineering problems by integrating mechanical, electronic and control systems.

**PSO_02:** Adopt a multidisciplinary approach to solve real-world integrated automation in industrial problems

**PSO_03:** Independently carry out research / investigation to solve practical problems and write / present a substantial technical report/document.

# M.Tech. – Mechatronics

## CREDIT STRUCTURE

### Category-wise Credit distribution

| Category | Credits |
|---|---|
| University core (UC) | 27 |
| Programme core (PC) | 19 |
| Programme elective (PE) | 18 |
| University elective (UE) | 06 |
| Total credits | 70 |

# M.Tech. – Mechatronics

# DETAILED CURRICULUM

## UNIVERSITY CORE

| Sl. No. | COURSE CODE | COURSE TITLE | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| 1. | MAT5005 | Advanced Mathematical Methods | 3 | 0 | 0 | 0 | 3 |
| 2. | ENG5001 & ENG5002<br>(or)<br>FRE5001<br>(or)<br>GER5001 | Fundamentals of Communication skills & Professional and Communication Skills<br>Francais Fonctionnel<br>Deutsch fuer Anfänger | 0 0<br>2<br>2 | 0 0<br>0<br>0 | 2 2<br>0<br>0 | 0 0<br>0<br>0 | 1 1<br>2<br>2 |
| 3. | STS5001 & STS5002 | Essentials of Business Etiquette and Problem Solving & Preparing for Industry | 3 3 | 0 0 | 0 0 | 0 0 | 1 1 |
| 4. | SET5001 & SET5002 | SET Projects | - | - | - | - | 4 |
| 5. | MEE6099 | Master's Thesis | - | - | - | - | 16 |

## PROGRAMME CORE

| Sl. No. | COURSE CODE | COURSE TITLE | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| 1. | EEE5023 | Advanced Sensors and Instrumentation | 3 | 0 | 2 | 0 | 4 |
| 2. | MEE5007 | Actuators and Drives | 3 | 0 | 0 | 4 | 4 |
| 3. | MEE5008 | Robot dynamics and Programming | 3 | 0 | 2 | 0 | 4 |
| 4. | MEE5027 | System design and Control | 3 | 0 | 0 | 4 | 4 |
| 5. | EEE5024 | Industrial Controllers | 2 | 0 | 2 | 0 | 3 |

**PROGRAMME ELECTIVES**

| S.No | COURSE CODE | COURSE TITLE | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| 1. | MEE5021 | Manufacturing Automation | 3 | 0 | 2 | 0 | 4 |
| 2. | MEE6043 | Machine Vision Systems | 2 | 0 | 0 | 4 | 3 |
| 3. | MEE6044 | Mobile and Autonomous Robots | 2 | 0 | 0 | 4 | 3 |
| 4. | ECE6057 | MEMS and Microsystems | 2 | 0 | 0 | 4 | 3 |
| 5. | MEE6045 | Fluid Power System Design | 3 | 0 | 2 | 0 | 4 |
| 6. | EEE6018 | Data acquisition and Digital Signal Processing | 3 | 0 | 0 | 4 | 4 |
| 7. | EEE6019 | Advanced Control systems | 3 | 0 | 0 | 4 | 4 |
| 8. | EEE6020 | Embedded systems | 2 | 0 | 0 | 4 | 3 |
| 9. | MEE5009 | Autotronics and Vehicle Intelligence | 3 | 0 | 0 | 4 | 4 |
| 10. | MEE6046 | Intelligent Systems | 3 | 0 | 0 | 4 | 4 |
| 11. | CSE6053 | Wireless Sensor Networks | 3 | 0 | 0 | 0 | 3 |
| 12. | MEE6047 | Virtual Reality and Haptics | 2 | 0 | 0 | 4 | 3 |
| 13. | MEE6048 | Condition Monitoring Techniques | 2 | 0 | 0 | 4 | 3 |
| 14. | MEE6060 | Bio-Mechatronics | 2 | 0 | 0 | 4 | 3 |
| 15. | MEE6058 | Industrial Process Automation | 2 | 0 | 0 | 4 | 3 |
| 16. | MEE6059 | Internet of Things and Smart Manufacturing | 2 | 0 | 0 | 4 | 3 |
| 17. | MEE6049 | Industry/Research Internship | 0 | 0 | 0 | 8 | 2 |

# University Core

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT5005 | ADVANCED MATHEMATICAL METHODS | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 2.0 | | | | |

**Course Objectives(CoB):**

1. To provide the students with sufficient exposure to advanced mathematical methods and tools that are relevant to engineering research.
2. Improving the computational skills of students by giving sufficient knowledge of analytical and numerical techniques useful for solving problems arising in Mechanical Engineering.
3. Imparting the knowledge of real time applications of Autonomous systems, Non-linear systems of ordinary differential equations and partial differential equations.

**Course Outcome(CO):**

1. Distinguish and analyse a variety of tools for solving linear systems and finding eigenvalues of these systems.
2. Derive and use the numerical techniques needed for the solution of a given engineering problems
3. Understand and correlate the analytical and numerical methods
4. Demonstrate their ability to write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models.
5. Demonstrate the understanding of how physical phenomena are modelled by partial differential equations

| Module:1 | Eigenvalue Problems | 5 hours |
|---|---|---|

Standard Eigen value problems–Eigenvalues and Eigenvectors–Gerschgorin Circles theorem–Rutishauser method, Power method, Inverse Power method.

| Module:2 | Iteration Methods | 6 hours |
|---|---|---|

Sturm sequence, Jacobi method, Given's method, Householder method, Deflation, Lanczo's method.

| Module:3 | Calculus of Variations | 9 hours |
|---|---|---|

Euler-Lagrange's equation –Isoperimetric problems, Rayleigh–Ritz method - Galerkin method.

| Module:4 | System of First Order Ordinary Differential Equations | 6 hours |
|---|---|---|

Linear Systems - Homogeneous linear systems with constant coefficients - Autonomous systems - Phase Plane Phenomena - Critical Points - Stability for linear systems.

| Module:5 | Nonlinear systems | 6 hours |
|---|---|---|

Simple critical points of nonlinear systems-Stability by Liapunov's method –

**Non- Linear Mechanics:** Conservative systems.

| Module:6 | Partial Differential Equations | 5 hours |
|---|---|---|

Classification of Second-Order Partial Differential Equations, Significance of characteristic curves, Canonical Form, Sturm–Liouville problems and Eigen function expansions.

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|---|---|---|
| **Module:7** | **Wave equation** | **6 hours** |
| Displacements in a long string – a long string under its weight – a bar with prescribed force on one end – free vibrations of a string. Method of Separation of variables, Solution by method of Laplace transforms | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| Industry Expert Lecture | | |
| **Total Lecture hours:** | | **45 hours** |

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| **Textbook(s)** | |
| 1 | Differential Equations: Theory, Technique and Practice, G.F. Simmons, S. G. Krantz, Tata Mc GrawHill Publishing, 2007. (Topics from Chapters 10, 11) |
| 2 | Elements of Partial differential equations, Ian N. Sneddon, Dover Publications, New York, 2006. (Topics from Chapters 3, 5) |
| 3 | Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International publishers, 7th edition,New Delhi, 2019. (Topics from Chapter 3, 7) |
| 4 | Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2015. (Topics from Chapter 11) |
| 5 | The Calculus of Variations, Bruce van Brunt, Springer, 2004. (Topics from Chapters 2, 4, 5) |
| **Reference Books** | |
| 1 | Differential Equations and Dynamical Systems, Lawrence Perko, 3rd ed., Springer-Verlag, 2001. |
| 2 | An introduction to Ordinary Differential Equations, James C. Robinson, Cambridge University Press, New York, 2008 (4th print). |
| 3 | Elementary Applied Partial Differential Equations, Richard Haberman, Prentice Hall International, 1998. |
| 4 | Numerical Analysis, R. L. Burden and J. D. Faires, 10th Edition, Cengage Learning, India edition, 2015. |

Mode of Evaluation: Continuous Assessment Tests, Final Assessment Test, Digital Assignments, Quizzes.

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| Recommended by Board of Studies | 03-06-2019 | | |
| Approved by Academic Council | No. 55 | Date | 13-06-2019 |

| **Course Code** | **Course Title** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **ENG5001** | **FUNDAMENTALS OF COMMUNICATION SKILLS** | **0** | **0** | **2** | **0** | **1** |
| **Pre-requisite** | Not cleared EPT (English Proficiency Test) | **Syllabus Version** | | | | |
| | | v. 1.0 | | | | |

**Course Objectives (CoB):**

1. To enable learners learn basic communication skills - Listening, Speaking, Reading, and Writing
2. To help learners apply effective communication in social and academic context
3. To make students comprehend complex English language through listening and reading

**Course Outcome (CO):**

1. Ability to communicate effectively in social and academic contexts
2. Develop effective writing skills
3. Demonstrate their understanding the communication Skills

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|---|---|---|
| **Module:1** | **Listening** | **8 hours** |

Understanding Conversation
Listening to Speeches
Listening for Specific Information

| | | |
|---|---|---|
| **Module:2** | **Speaking** | **4 hours** |

Exchanging Information
Describing Activities, Events and Quantity

| | | |
|---|---|---|
| **Module:3** | **Reading** | **6 hours** |

Identifying Information
Inferring Meaning
Interpreting text

| | | |
|---|---|---|
| **Module:4** | **Writing: Sentence** | **8hours** |

Basic Sentence Structure
Connectives
Transformation of Sentences
Synthesis of Sentences

| | | |
|---|---|---|
| **Module:5** | **Writing: Discourse** | **4hours** |

Instructions
Paragraph
Transcoding

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|---|---|
| **Total Lecture hours:** | **30 hours** |

**Textbook(s)**

1. Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Student's Book.* 2013, Cambridge University Press.

**Reference Books**

1. Chris Juzwiak .*Stepping Stones: A guided approach to writing sentences and Paragraphs (Second Edition)*, 2012, Library of Congress.
2. Clifford A Whitcomb & Leslie E Whitcomb, *Effective Interpersonal and Team Communication*

*Skills for Engineers*, 2013, John Wiley & Sons, Inc., Hoboken: New Jersey.

3. ArunPatil, Henk Eijkman &Ena Bhattacharya, *New Media Communication Skills for Engineers and IT Professionals*,2012, IGI Global, Hershey PA.
4. Judi Brownell, *Listening: Attitudes, Principles and Skills*, 2016, 5th Edition, Routledge:USA
5. John Langan, Ten Steps to Improving College Reading Skills, 2014, 6th Edition, Townsend Press:USA
6. Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Teacher's Book*. 2013, Cambridge University Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1. | Familiarizing students to adjectives through brainstorming adjectives with all letters of the English alphabet and asking them to add an adjective that starts with the first letter of their name as a prefix. | **2 hours** |
| 2. | Making students identify their peer who lack Pace, Clarity and Volume during presentation and respond using Symbols. | **4 hours** |
| 3. | Using Picture as a tool to enhance learners speaking and writing skills | **2 hours** |
| 4. | Using Music and Songs tools to enhance pronunciation in the target language / Activities through VIT Community Radio | **2 hours** |
| 5. | Making students upload their Self- introduction videos in Vimeo.com | **4 hours** |
| 6. | Brainstorming idiomatic expressions and making them use those into their writings and day to day conversation | **4 hours** |
| 7. | Making students Narrate events by adding more descriptive adjectives and add flavor to their language / Activities through VIT Community Radio | **4 hours** |
| 8 | Identifying the root cause of stage fear in learners and providing remedies to make their presentation better | **4 hours** |
| 9 | Identifying common Spelling & Sentence errors in Letter Writing and other day to day conversations | **2 hours** |
| 10. | Discussing FAQs in interviews with answers so that the learner gets a better insight in to interviews / Activities through VIT Community Radio | **2 hours** |
| | **Total Laboratory Hours** | **32 hours** |

Mode of evaluation: Online Quizzes, Presentation, Role play, Group Discussions, Assignments, Mini Project

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| Recommended by Board of Studies | 22-07-2017 | | |
| Approved by Academic Council | No. 46 | Date | 24-8-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ENG5002 | PROFESSIONAL AND COMMUNICATION SKILLS | 0 | 0 | 2 | 0 | 1 |
| Pre-requisite | ENG5001 | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives (CoB):**

1. To enable students to develop effective Language and Communication Skills
2. To enhance students' Personal and Professional skills
3. To equip the students to create an active digital footprint

**Course Outcome (CO):**

1. Students will be able to apply the acquired skills and excel in a professional environment

| | | |
|---|---|---|
| **Module:1** | **Personal Interaction** | **2hours** |
| Introducing Oneself- one's career goals<br>Activity: SWOT Analysis | | |
| **Module:2** | **Interpersonal Interaction** | **2 hours** |
| Interpersonal Communication with the team leader and colleagues at the workplace<br>Activity: Role Plays/Mime/Skit | | |
| **Module:3** | **Social Interaction** | **2 hours** |
| Use of Social Media, Social Networking, gender challenges<br>Activity: Creating LinkedIn profile, blogs | | |
| **Module:4** | **Résumé Writing** | **4 hours** |
| Identifying job requirement and key skills<br>Activity: Prepare an Electronic Résumé | | |
| **Module:5** | **Interview Skills** | **4 hours** |
| Placement/Job Interview, Group Discussions<br>Activity: Mock Interview and mock group discussion | | |
| **Module:6** | **Report Writing** | **4 hours** |
| Language and Mechanics of Writing<br>Activity: Writing a Report | | |
| **Module:7** | **Study Skills: Note making** | **2hours** |
| Summarizing the report<br>Activity: Abstract, Executive Summary, Synopsis | | |
| **Module:8** | **Interpreting skills** | **2 hours** |
| Interpret data in tables and graphs<br>Activity: Transcoding | | |
| **Module:9** | **Presentation Skills** | **4 hours** |
| Oral Presentation using Digital Tools<br>Activity: Oral presentation on the given topic using appropriate non-verbal cues | | |
| **Module:10** | **Problem Solving Skills** | **4 hours** |
| Problem Solving & Conflict Resolution<br>Activity: Case Analysis of a Challenging Scenario | | |

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| | |
| **Total Lecture hours:** | **30 hours** |

**Textbook(s)**

1. Bhatnagar Nitin and Mamta Bhatnagar, *Communicative English For Engineers And Professionals*, 2010, Dorling Kindersley (India) Pvt. Ltd.

**Reference Books**

1. Jon Kirkman and Christopher Turk, *Effective Writing: Improving Scientific, Technical and Business Communication*, 2015, Routledge
2. Diana Bairaktarova and Michele Eodice, *Creative Ways of Knowing in Engineering*, 2017, Springer International Publishing
3. Clifford A Whitcomb & Leslie E Whitcomb, *Effective Interpersonal and Team Communication Skills for Engineers*, 2013, John Wiley & Sons, Inc., Hoboken: New Jersey.
4. ArunPatil, Henk Eijkman &Ena Bhattacharya, *New Media Communication Skills for Engineers and IT Professionals*,2012, IGI Global, Hershey PA.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | SWOT Analysis – Focus specially on describing two strengths and two weaknesses | **2 hours** |
| 2. | Role Plays/Mime/Skit -- Workplace Situations | **4 hours** |
| 3. | Use of Social Media – Create a LinkedIn Profile and also write a page or two on areas of interest | **2 hours** |
| 4. | Prepare an Electronic Résumé and upload the same in vimeo | **2 hours** |
| 5. | Group discussion on latest topics | **4 hours** |
| 6 | Report Writing – Real-time reports | **2 hours** |
| 7 | Writing an Abstract, Executive Summary on short scientific or research articles | **4 hours** |
| 8 | Transcoding – Interpret the given graph, chart or diagram | **2 hours** |
| 9 | Oral presentation on the given topic using appropriate non-verbal cues | **4 hours** |
| 10 | Problem Solving -- Case Analysis of a Challenging Scenario | **4 hours** |
| | **Total Laboratory Hours** | **30 hours** |

Mode of evaluation: : Online Quizzes, Presentation, Role play, Group Discussions, Assignments, Mini Project

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|---|---|---|---|
| Recommended by Board of Studies | 22-07-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| GER5001 | Deutsch fuer Anfänger | 2 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus version | | | | |
| | | v.1.0 | | | | |

**Course Objectives (CoB):**

The course gives students the necessary background to:

1. Enable students to read and communicate in German in their day-to-day life
2. Become industry-ready
3. Make them understand the usage of grammar in the German Language.

**Course Outcome (CO):**

The students will be able to

1. To greet people, introduce oneself and understand basic expressions in German
2. To acquire basic grammar and skills to use these in a meaning way
3. To attain beginner's level vocabulary
4. To write on a variety of topics with significant precision and in detail
5. To demonstrate good comprehension of written discourse in areas of special interests

| Module:1 | | 3 hours |
|---|---|---|

Einleitung, Begrüssungsformen, Landeskunde, Alphabet, Personalpronomen, Verb Konjugation, Zahlen (1-100), W-fragen, Aussagesätze, Nomen – Singular und Plural

**Lernziel:**

ElementaresVerständnisvon Deutsch, Genus- Artikelwörter

| Module:2 | | 3 hours |
|---|---|---|

Konjugation der Verben (regelmässig /unregelmässig) die Monate, die Wochentage, Hobbys, Berufe, Jahreszeiten, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit Sie

**Lernziel** :

Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw.

| Module:3 | | 4 hours |
|---|---|---|

Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, unbestimmterArtikel), trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlzeiten, Lebensmittel, Getränke

**Lernziel :**

Sätze mit Modalverben, VerwendungvonArtikel, über Länder undSprachensprechen, übereineWohnungbeschreiben.

| Module:4 | | 6 hours |
|---|---|---|

Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch)

**Lernziel :**

| | | |
|---|---|---|
| Grammatik – Wortschatz - Übung | | |
| | | |
| **Module:5** | | **5 hours** |
| Leseverständnis,Mindmapmachen,Korrespondenz- Briefe, Postkarten, E-Mail<br>**Lernziel :**<br>WortschatzbildungundaktiverSprachgebrauch | | |
| **Module:6** | . | **3 hours** |
| **Aufsätze :**<br>MeineUniversität, Das Essen, mein Freund odermeineFreundin, meineFamilie, einFest in Deutschlandusw | | |
| | | |
| **Module:7** | | **4 hours** |
| **Dialoge:**<br>**a)** Gespräche mit Familienmitgliedern, Am Bahnhof,<br>**b)** GesprächebeimEinkaufen ; in einemSupermarkt ; in einerBuchhandlung ;<br>**c)** in einemHotel - an der Rezeption ;einTerminbeimArzt.<br>TreffenimCafe | | |
| | | |
| **Module:8** | | **2 hours** |
| Guest Lectures/Native Speakers / Feinheiten der deutschen Sprache, Basisinformation über die deutschsprachigen Länder | | |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| | |
| **Text Book(s)** | |
| 1. | Studio d A1 Deutsch alsFremdsprache, Hermann Funk, Christina Kuhn, SilkeDemme : 2012 |
| **Reference Books** | |
| 1 | Netzwerk Deutsch alsFremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, 2013 |
| 2 | Lagune ,HartmutAufderstrasse, Jutta Müller, Thomas Storz, 2012. |
| 3 | Deutsche SprachlehrefürAUsländer, Heinz Griesbach, Dora Schulz, 2011 |
| 4 | ThemenAktuell 1, HartmurtAufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010 |
| | www.goethe.de<br>wirtschaftsdeutsch.de<br>hueber.de<br>klett-sprachen.de<br>www.deutschtraning.org |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | |
| | |

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|---|---|---|---|
| Recommended by Board of Studies | 22-07-2017 | | |
| Approved by Academic Council | No: 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| FRE5001 | FRANCAIS FONCTIONNEL | 2 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus Version | | | | |
| | | v.1.0 | | | | |

**Course Objectives (CoB):**

The course gives students the necessary background to:

1. Demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. Achieve proficiency in French culture oriented view point.

**Course Outcome (CO):**

The students will be able to

1. To Identify in French language the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc
2. To communicate effectively in French language via regular / irregular verbs
3. To demonstrate comprehension of the spoken / written language in translating simple sentences
4. To understand and demonstrate the comprehension of some particular new range of unseen written materials
5. To demonstrate a clear understanding of the French culture through the language studied

| | | |
|---|---|---|
| **Module:1** | Saluer, Se présenter, Etablir des contacts | **9 hours** |
| Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes réguliers, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc. | | |
| **Module:2** | **Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.** | **9 hours** |
| La conjugaison des verbes Pronominaux, La Négation, L'interrogation avec *'Est-ce que ou sans Est-ce que'*. | | |
| **Module:3** | **Situer un objet ou un lieu, Poser des questions** | **9 hours** |
| L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, La Nationalité du Pays, L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif/ l'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc., | | |
| **Module:4** | **Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.** | **8 hours** |
| La traduction simple :(français-anglais / anglais –français) | | |
| **Module:5** | **Trouver les questions, Répondre aux questions générales en français.** | **7 hours** |

| | | |
|---|---|---|
| L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés, Exprimez les phrases données au Masculin ou Féminin, Associez les phrases. | | |
| | | |
| **Module:6** | **Comment ecrire un passage** | **9 hours** |
| **Décrivez :**<br>La Famille /La Maison, /L'université /Les Loisirs/ La Vie quotidienne etc. | | |
| | | |
| **Module:7** | **Comment ecrire un dialogue** | **7 hours** |
| **Dialogue:**<br>**d)** Réserver un billet de train<br>**e)** Entre deux amis qui se rencontrent au café<br>**f)** Parmi les membres de la famille<br>**g)** Entre le client et le médecin | | |
| | | |
| **Module:8** | **Invited Talk: Native speakers** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Echo-1, Méthode de français, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010. |
| 2 | Echo-1, Cahier d'exercices, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010. |
| **Reference Books** | |
| 1. | CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2004. |
| 2 | CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2004. |
| 3 | ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries , Hachette livre 2006. |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | |

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 22-07-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| STS5001 | ESSENTIALS OF BUSINESS ETIQUETTE AND PROBLEM SOLVING | 3 | 0 | 0 | 0 | 1 |
| Pre-requisite | None | Syllabus version | | | | |
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**Course Objectives (CoB):**

1 To develop the students' logical thinking skills

2 To learn the strategies of solving quantitative ability problems

**3** To enrich the verbal ability of the students

**4** To enhance critical thinking and innovative skills

**Course Outcome (CO):**

1 Enabling students to use relevant aptitude and appropriate language to express themselves

2 To communicate the message to the target audience clearly

| Module:1 | Business Etiquette: Social and Cultural Etiquette and Writing Company Blogs and Internal Communications and Planning and Writing press release and meeting notes | 9 hours |
|---|---|---|

Value, Manners, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information, Analysis, Determining, selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body – Make it relevant to your audience,

| Module:2 | Study skills – Time management skills | 3 hours |
|---|---|---|

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, working under pressure and adhering to deadlines

| Module:3 | Presentation skills – Preparing presentation and Organizing materials and Maintaining and preparing visual aids and Dealing with questions | 7 hours |
|---|---|---|

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

| Module:4 | Quantitative Ability -L1 – Number properties and Averages and Progressions and Percentages and Ratios | 11 hours |
|---|---|---|

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, Increase & Decrease or successive increase, Types of ratios and proportions

| Module:5 | Reasoning Ability-L1 – Analytical Reasoning | 8 hours |
|---|---|---|

| | | |
|---|---|---|
| | | |
| Data Arrangement (Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzle test, Selection Decision table | | |
| | | |
| **Module:6** | **Verbal Ability-L1 – Vocabulary Building** | **7 hours** |
| Synonyms & Antonyms, One-word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies | | |
| | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Reference Books**

| | |
|---|---|
| 1. | Kerry Patterson, Joseph Grenny, Ron McMillan, AlSwitzler (2001) Crucial Conversations: Tools for Talking When Stakes are High. Bangalore. McGraw-Hill Contemporary |
| 2. | Dale Carnegie, (1936) How to Win Friends and Influence People. New York. Gallery Books |
| 3. | Scott Peck. M (1978) Road Less Travelled. New York City. M. Scott Peck. |
| 4. | FACE (2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications |
| 5. | ETHNUS (2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd. |

**Websites:**

| | |
|---|---|
| 1. | www.chalkstreet.com |
| 2. | www.skillsyouneed.com |
| 3. | www.mindtools.com |
| 4. | www.thebalance.com |
| 5. | **www.eguru.ooo** |

**Mode of Evaluation**: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| STS5002 | PREPARING FOR INDUSTRY | 3 | 0 | 0 | 0 | 1 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1 | | | | |

**Course Objectives (CoB):**

1 To challenge students to explore their problem-solving skills

**2** To develop essential skills to tackle advance quantitative and verbal ability questions

3 To have working knowledge of communicating in English

**Course Outcome (CO):**

**1.** Enabling students to simplify, evaluate, analyze, and use functions and expressions to simulate real situations to be industry ready.

| Module:1 | Interview skills – Types of interview and Techniques to face remote interviews and Mock Interview | 3 hours |
|---|---|---|

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview¸ Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds

| Module:2 | Resume skills – Resume Template and Use of power verbs and Types of resume and Customizing resume | 2 hours |
|---|---|---|

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

| Module:3 | Emotional Intelligence - L1 – Transactional Analysis and Brainstorming and Psychometric Analysis and Rebus Puzzles/Problem Solving | 12 hours |
|---|---|---|

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways

| Module:4 | Quantitative Ability-L3 – Permutation-Combinations and Probability and Geometry and mensuration and Trigonometry and Logarithms and Functions and Quadratic Equations and Set Theory | 14 hours |
|---|---|---|

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram

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|---|---|---|
| **Module:5** | **Reasoning ability-L3 – Logical reasoning and Data Analysis and Interpretation** | **7 hours** |
| Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data Interpretation-Advanced, Interpretation tables, pie charts & bar chats | | |
| | | |
| **Module:6** | **Verbal Ability-L3 – Comprehension and Logic** | **7 hours** |
| Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**References books**

1. Michael Farra and JIST Editors(2011) Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint Paul, Minnesota.Jist Works
2. Daniel FlagePh.D(2003) The Art of Questioning: An Introduction to Critical Thinking. London. Pearson
3. FACE(2016) Aptipedia Aptitude Encyclopedia.Delhi. Wiley publications

**Mode of Evaluation**: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| SET5001 | SCIENCE, ENGINEERING AND TECHNOLOGY PROJECT– I | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus Version | | | | |
| Anti-requisite | None | 1.10 | | | | |

**Course Objectives (CoB):**

1. To provide opportunity to involve in research related to science / engineering
2. To inculcate research culture
3. To enhance the rational and innovative thinking capabilities

**Course Outcome (CO):**

On completion of this course, the student should be able to:

1. Carried out inside the university, in any research area corresponding to their curriculum
2. Publications in the peer reviewed journals / International Conferences will be an added advantage
3. It motivates and encourage research culture in the young minds of graduate engineers
4. Students are made aware of plagiarism checking and they are advised not to exceed more than 12% as per the academic regulations

**Modalities / Requirements**

1. Individual or group projects can be taken up
2. Involve in literature survey in the chosen field
3. Use Science/Engineering principles to solve identified issues
4. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective
5. Submission of scientific report in a specified format (after plagiarism check)

**Student Assessment:** Periodical reviews, oral/poster presentation

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|---|---|---|---|
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| SET 5002 | SCIENCE, ENGINEERING AND TECHNOLOGY PROJECT– II | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus Version | | | | |
| Anti-requisite | None | 1.10 | | | | |

**Course Objectives (CoB):**

1. To provide opportunity to involve in research related to science / engineering
2. To inculcate research culture
3. To enhance the rational and innovative thinking capabilities

**Course Outcome (CO):**

On completion of this course, the student should be able to:

1. Carried out inside the university, in any research area corresponding to their curriculum
2. Publications in the peer reviewed journals / International Conferences will be an added advantage
3. It motivates and encourage research culture in the young minds of graduate engineers
4. Students are made aware of plagiarism checking and they are advised not to exceed more than 12% as per the academic regulations

**Modalities / Requirements**

1. Individual or group projects can be taken up
2. Involve in literature survey in the chosen field
3. Use Science/Engineering principles to solve identified issues
4. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective
5. Submission of scientific report in a specified format (after plagiarism check)

**Student Assessment :** Periodical reviews, oral/poster presentation

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|---|---|---|---|
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6099 | Master's Thesis | 0 | 0 | 0 | 0 | 16 |
| Pre-requisite | As per the academic regulations | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives (CoB):**

1. To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

**Course Outcome (CO):**

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

1. Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work
2. The capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues
3. A consciousness of the ethical aspects of research and development work
4. Publications in the peer reviewed journals / International Conferences will be an added advantage

1. Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for two semesters based on the completion of required number of credits as per the academic regulations.
3. Should be individual work.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

**Mode of Evaluation:** Periodic reviews, Presentation, Final oral viva, Poster submission

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|---|---|---|---|
| Recommended by Board of Studies | 10.06.2016 | | |
| Approved by Academic Council | 41st AC | Date | 17.06.2016 |

# Programme Core

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| EEE5023 | ADVANCED SENSORS AND INSTRUMENTATION | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | None | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Familiarize with sensors used in engineering
2. Understand the signal conditioning circuits

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Understand the input-output configuration, static and dynamic characteristics of typical measurement systems.
2. Apply the transduction principles of typical transducers used in industrial measurement applications related to force, pressure, level, flow, acceleration, torque, temperature, displacement, speed, etc.
3. Demonstrate the principle of operation and applications of opto electronic, magnetic, digital sensors.
4. Demonstrate the recent trends and advances in the measurement systems.
5. Comprehend the role of signal conditioning circuits and data acquisition in measurement systems.
6. Apply the typical sensors suitable for different industrial applications.

| Module:1 | Introduction to Instrumentation systems | 3 hours |
|---|---|---|

Basic elements of instrumentation systems, Input-Output configuration, Error sources – Calibration – standards, static and dynamic characteristics of instruments.

| Module:2 | General Transduction Principles for measurement applications | 5 hours |
|---|---|---|

Transduction principle – Resistive, Capacitive, Inductive, Piezoresistive, Piezoelectric, optical, Photovoltaic, Thermoelectric, Acoustic and Hall effect.

| Module:3 | Construction and operation of typical instruments | 9 hours |
|---|---|---|

General measurement applications - temperature, pressure, vibration, force, acceleration, torque, position, velocity, angular velocity, humidity, tactile, flow and level measurement.

| Module:4 | Advanced sensors technologies and applications | 6 hours |
|---|---|---|

Opto-electronic sensors, Fiber optic sensor, Magnetic sensors, Digital transducers, LASER based instruments, Ultrasonic sensors, Micro sensors, Bio sensors.

| Module:5 | Smart sensor systems and applications | 6 hours |
|---|---|---|

General architecture of a smart sensor – Self calibration – Wireless sensors- energy harvesting

techniques – Web based instrumentation-Applications.

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|---|---|---|
| **Module:6** | **Signal conditioning and Data Acquisition** | **9 hours** |

Operational Amplifiers, Amplifiers, bridges, filters, analog-to digital and digital-to-analog conversion, Elements of data acquisition system, basics of Virtual instrumentation systems, Data logging.

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|---|---|---|
| **Module:7** | **Industrial Applications of sensors and instrumentation systems** | **5 hours** |

Vibration measurement in machine tools, Position measurement of end effectors in robots - Speed measurement of road wheels in Automotive system, Environmental monitoring and biomedical applications- case studies

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|---|---|---|
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **45 hours** |

**List of Experiments (Indicative)**

1. Measurement of speed and displacement using linear and rotary sensors.
2. Force and Torque measurement using strain gauge.
3. Pressure measurement system using sensors.
4. Temperature measurement using RTD and thermocouple.
5. Vibration and acceleration measurements using. Using peizo electric sensor.
6. Study on humidity measurement.
7. Design of complete signal condition circuit for temperature and pressure sensors.
8. Study on data acquisition systems and interfacing sensors with computer.
9. Analysis of dynamic characteristics of sensor signals using DAQ system.
10. Development of data logging using virtual instrument software.

**Text Book(s)**


| | |
|---|---|
| 1. | Bentley JP, Principles of measurement systems, Pearson Publishers., 2012. |
| 2. | Ernest. O. Doebelin, “Measurement System Application & Design”, (2008), McGraw Hill Book co 5th edition, 2008. |


**Reference Books**


| | |
|---|---|
| 1. | D. Patranabis, “Principles of Industrial Instrumentation”, (2010), Tata McGraw-Hill, Third Edition, |
| 2. | John G. Webster, HalitEren, “Measurement, Instrumentation, and Sensors Handbook”, (2014), Second Edition, CRC Press. |
| 3. | D. V. S. Murty, “Transducers and Instrumentation”, (2010), PHI Learning Pvt. Ltd. |
| 4. | H.R. Taylor, “Data Acquisition for Sensor Systems”, (2013), Springer Science & Business |

| | | | |
|---|---|---|---|
| | Media. | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5007 | ACTUATORS AND DRIVES | 3 | 0 | 0 | 4 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | None | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Understand the fundamental concepts of electro-mechanical and fluid power (hydraulics and pneumatics) systems
2. Demonstrate the students with the actuators in the area of hydraulics, pneumatics, electro-mechanical systems and associated equipment's used for the same.
3. Apply the knowledge of several drives for the different actuators and energy conversions etc and they come up with energy saving solutions in industrial systems
4. Understand and apply fundamental concepts to the modeling, analysis, and control of brushed dc motors, stepper motors, brushless dc motors, solenoids, and hydraulic and pneumatic actuators.

**Course Outcome (CO):**

The student should be able to:

1. Identify key concepts, architecture and principles concerning the hydraulics and pneumatics systems
2. Evaluate key concepts and principles concerning modeling, analysis, and control of brushed dc motors, stepper motors, brushless dc motors, and solenoids.
3. Apply the methods of control algorithms, fault detection and diagnosis.
4. Analyze the set of potential mechanisms and control solutions for the process.
5. Create awareness about actuators, drives and control elements for any applications
6. Selection of actuators and its associated drivers for several working conditions
7. Develop knowledge about the architecture and working principles of the most common electrical motor types
8. Choose and use hydraulic, pneumatic, electrical actuators and drives

| Module:1 | Hydraulic Actuators | 7 hours |
|---|---|---|

-Introduction, Classification of actuators, Hydraulic pumps and supply sources, Hydraulic actuators - Linear actuator – Types - Single acting, Double acting special cylinders - tandem, Rodless, Telescopic, mounting details, cushioning mechanism, Rotary actuators, power packs – accumulators.

| Module:2 | Pneumatic Actuators | 7 hours |
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**:** Pneumatic characteristics and applications, Air generation, treatments and distribution,

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|---|---|---|
| Components, Air filter, regulator, lubricator, Pneumatic cylinders, Pneumatic motors, Stroke Speed Regulation of Pneumatic Actuators. | | |
| | | |
| **Module:3** | **Control and Regulation Elements** | **7 hours** |
| Control and regulation Elements – Basics of Direction control valves, flow and pressure control valves - Basic structure of pneumatic and hydraulic systems – Electro pneumatic and Electrohydraulic systems and controls. | | |
| | | |
| **Module:4** | **Electrical DC actuators** | **6 hours** |
| D.C Motor-Working principle, characteristics, classification, Speed control techniques and braking, Applications - Speed, direction and position control using H-bridge under PWM mode. | | |
| | | |
| **Module:5** | **Electrical AC actuators** | **6 hours** |
| AC Motor- Working principle, Speed torque characteristics, Speed control and braking, Single and three phases DC drives – Speed control of three phase induction motor – chopper drives – Need for V/ F drives – Energy saving AC drives Applications. | | |
| | | |
| **Module:6** | **Other Electrical actuators** | **5 hours** |
| Stepper Motor – Drive circuits for speed and position control - Servo motors – Linear motors – Relays- Power convertors | | |
| | | |
| **Module:7** | **Smart Materials Actuators** | **5 hours** |
| - Smart materials and their application for sensing and actuation, Piezoelectric actuator - Linear actuators Hybrid actuators – Applications, shape memory alloys actuator, magnetostrictive actuators, Electrostrictive actuators, Electro - and magnetorheological fluid actuators – Case study. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |
| 1. Development of Steel rod bending machine using hydraulic actuators. | | |
| 2. Implementation of Hydraulic and pneumatic based lift mechanism. | | |
| 3. Fabrication of sheet cutting machine using pneumatic actuators. | | |
| 4. Development of tree climbing mechanism using pneumatic cylinders. | | |
| 5. Development and control of a scissor jack mechanism actuated by a DC motor. | | |
| 6. Designing a control system for a gantry robot driven by stepper motors. | | |
| 7. Development of a micro grippers using piezoelectric actuators. | | |
| 8. Actuation of robotic hand using shape memory alloys. | | |
| **Text Book(s)** | | |
| 1. Antony Esposito, Fluid Power Systems and Control (2013), Prentice-Hall. | | |

| **Reference Books** | | | |
|---|---|---|---|
| 1. | A. K. Gupta, S. K. Arora, Industrial automation and Robotics (2013), University Science Press. | | |
| 2. | W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering (2011), Pearson Education. | | |
| 3. | Andre Veltman, Duco W.J. Pulle, R.W. De Doncker, Fundamentals of Electrical Drives (2007), Springer. | | |
| 4. | D. Patranabis, Principles of Industrial Instrumentation (2010), Tata McGraw-Hill. | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE 5008 | ROBOT DYNAMICS AND PROGRAMMING | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives(CoB):**

The Objectives of the course are to:

1. Introduce the modelling, simulation, and control of spatial multi-degree-of-freedom robotic manipulators.
2. Study the kinematics and dynamics of robotic manipulators.
3. Provide the awareness about the trajectory planning and control of robotic arm.

**Course Outcome(CO):**

After completing the course, the student will be able to:

1. Discuss the specifications of various types of Industrial Robots.
2. Design appropriate end effectors for various applications.
3. Analyze kinematics of various manipulator configurations
4. Compute required trajectory planning for the given task.
5. Develop appropriate control system for robotic arm.
6. Prepare the program for various robotic applications.

| Module:1 | Introduction to Industrial robot | 5 hours |
|---|---|---|

Brief History of Industrial robotics – Components of robotics system – Types of joints – Workspace and work-cell – Types of robotics configurations – DOF of serial and parallel manipulator – Basic motion of robot manipulator – Tool centre point – Robot end effector: Grippers and Tools.

| Module:2 | Robot Kinematics | 6 hours |
|---|---|---|

Position analysis and finite rotation and translation - Homogeneous matrices – Direct and Inverse kinematics: Two link planner, PUMA 560, Stanford arm, SCARA and Stewart Platform.

| Module:3 | Velocity and statics of robot manipulators | 6 hours |
|---|---|---|

Linear and angular velocity vector and matrix – Forward and inverse velocity kinematics (Jacobian) – Statics and force analysis of robot manipulator – Identifying singularity in work space.

| Module:4 | Dynamics of robots | 6 hours |
|---|---|---|

- Mass and inertia of links - equation of motion – Forward and inverse dynamics of robot manipulator – Lagrangian formulation of motion – Rigid link Recursive Acceleration.

| Module:5 | Trajectory planning | 6 hours |
|---|---|---|

Path planning – trajectory planning – Joint space trajectory planning – Cartesian space trajectory planning – Blending – Continuous trajectory recording (Trajectory following)

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|---|---|---|
| **Module:6** | **Manipulator control** | **6 hours** |
| Time optimal control method – Disturbance rejection – PD and PID control – Computed torque control – Adaptive control – Feedback linearization for under actuated systems. | | |
| | | |
| **Module:7** | **RAPID Language** | **8 hours** |
| RAPID language basic commands-Motion Instructions-Pick and place operation using Industrial robot-manual mode, automatic mode, subroutine command-based programming. Movemaster command language-Introduction, syntax, simple problems. Industrial Applications of robots - Pick and Place – Machine tending – Painting – welding – fettling – Assembly – Service Robot application: Underwater robot –surgical robot – autonomous guided vehicle | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**List of Experiments (Indicative)**

1. Design & Simulation of Four Bar Crank-Rocker, Crank- Crank, and Rocker-Rocker Mechanism using MTAB Sim-mechanics and ADAMS
2. Calculate the DH parameters for the Two link planner using Mat-Lab
3. Solve the inverse kinematic problem for two link planner using Mat-Lab
4. Compute position, velocities and acceleration for given manipulator configuration.
5. Simulation of Robot for Arc Welding applications using Work Space LT [Rectangular and Circular Paths]
6. Measure the Tool centre point for the given tool or gripper
7. Program the Industrial robot to follow the contour surface
8. Program the Industrial robot to draw the given profile in a plain
9. Program the Industrial robot to draw the given profile in an Incline plain
10. Simulate work cell for CNC tending using Rapid Programming
11. Simulate work cell for Pelletizing and De-Pelletizing using Rapid Programming

**Text Book(s)**


| | |
|---|---|
| 1. | Craig, John J., Introduction to Robotics: Mechanics and Control (2005), Prentice Hall Inc. |


**Reference Books**


| | |
|---|---|
| 1. | Mark W.Spong, M. Vidyasagar, Robotics Dynamics and control (2008), Wiley publication. |
| 2. | AshitavaGhosal: Robotics- Fundamental Concepts and Analysis (2014), Oxford University Press. |
| 3. | S.R.Deb, Robotics Technology and Flexible Automation (2010), Tata Mc-Graw Hill. |
| 4. | J.P.Merlet, Parallel Robots (2005), Springer |

| | |
|---|---|
| 5. | S K SAHA: Introduction to Robotics 2nd Edition (2016), McGraw Hill Education. ISBN (13 Digits): 978-93-329-0280-0. ISBN: 93-329-0280-1. |

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5027 | SYSTEM DESIGN AND CONTROL | 3 | 0 | 0 | 4 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Create an awareness about the mechatronics design process
2. Expose the students to system modelling and system identification of mechatronic systems.
3. Create an interest in students for mathematical simulation of the dynamics of systems.
4. Enable students to apply the above in a real time industrial application

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Design of a mechatronic system.
2. Compile the concepts of system and modelling techniques
3. Apply the software for simulating dynamic systems
4. Outline the principles and analysis of basic control systems.
5. Study of optimization methods in physical systems
6. Examine the above for various industrial measurement and control applications

| Module:1 | Introduction to Mechatronics systems: | 6 hours |
|---|---|---|

Introduction to Mechatronics system – Key elements – Mechatronics Design process – Traditional and Mechatronics designs – Model based system design.

| Module:2 | Concepts of system and modelling: | 6 hours |
|---|---|---|

Concept of systems - modelling of systems - model representations - block diagram, transfer function, state space representation - system identification techniques – linearization of nonlinear models.

| Module:3 | Modelling of physical systems | 6 hours |
|---|---|---|

Development of mathematical models: mechanical, electrical, electromechanical, Thermal, Hydraulic and Pneumatic systems.

| Module:4 | Simulation: | 6 hours |
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Simulation-basics – types – hardware in loop simulations – time response parameters - time response of 1$^{st}$ and 2$^{nd}$order systems - simulation of systems in software environment.

| Module:5 | Basic control systems: | 6 hours |
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Basic Elements of Control System – Open loop and Closed loop systems – Characteristics of on-off, P, PI, PD and PID Controllers –Implementation issues of PID Controller – Modified PID Controller – Tuning of controllers.

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| **Module:6** | **Analysis of systems:** | **8 hours** |
| Time domain and frequency domain analysis of the systems using Routh Hurwitz criterion – Root locus – Frequency domain analysis –Gain margin – Phase margin - Bode Plot – Polar Plot – Nyquist stability criterion. | | |
| **Module:7** | **Design optimization** | **5 hours** |
| Optimization – problem formulation - constraints – overview of optimization techniques- optimal design of mechatronics systems.<br>**Case Studies:** Case studies on building mechatronics systems for measurement and control applications. | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **45 hours** |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. Modelling and control of Anti-lock braking system.
2. Modelling, simulation and control of a SCARA robot.
3. Modelling of Stewart platform with actuators.
4. Modelling and design of electromechanical system
5. Modelling, design and fabrication of a quadcopter.
6. Design and development of thermal modeling of boat cabin
7. Design and development of a novel mechatronics system.

**Text Book(s)**

| | |
|---|---|
| 1. | Devdasshetty and Richard A. Kolk, Mechatronics System Design (2012), 2nd edition, Cengage learning India Pvt. Ltd. |

**Reference Books**

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|---|---|
| 1. | W. Bolton, Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering (2010), Pearson Education. |
| 2. | K.Ogata, Modern Control Engineering (2010), Prentice Hall of India Pvt. Ltd. |
| 3. | FaridGolnaraghi, Benjamin C. Kuo, Automatic Control systems (2014), 9th edition, Wiley India Pvt Ltd |
| 4. | Dean C Karnopp, Donald L. Margolis Ronald C. Rosenberg, System dynamics" (2012), John Wiley & Sons. |

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| Recommended by Board of Studies | 17-08-2017 |

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| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| EEE5024 | INDUSTRIAL CONTROLLERS | 2 | 0 | 2 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Outline the functions of various controllers used in industrial automation systems.
2. Learn the architecture, programming of microcontroller and interfacing with field devices.
3. Discuss the architecture and functions of PLC systems and learn PLC programming.

**Course Outcome (CO):**

The student should be able to

1. Compare the architecture and functions of micro-computing systems for industrial applications.
2. Explain the architecture 8051 Microcontroller.
3. Create microcontroller assembly language programs.
4. Outline the interfacing techniques with 8051 microcontrollers
5. Explain the architecture and functions of PLC and program PLC with ladder logic.
6. Outline selection of industrial controllers, communications standards and distributed control systems.

| Module:1 | Introduction to programmable controllers | 3 hours |
|---|---|---|

Overview of controllers for industrial automation – General description of minicomputers, digital signal processors, microprocessors, microcontrollers, Programmable Logic Controller (PLC) and soft PLCs.

| Module:2 | Architecture of Microcontrollers | 4 hours |
|---|---|---|

Overview of the architecture of typical microcontroller. Overview of the architecture of high-end processors.

| Module:3 | Microcontroller programming | 5 hours |
|---|---|---|

Description of instruction sets; Addressing modes; Timers and counters; Assembly language programs with algorithms.

| Module:4 | Interfacing with 8051 | 4 hours |
|---|---|---|

Serial port and interrupt programming, interfacing with keyboards, LEDs, LCDs, ADCs. DACs, memory, sensors, motor drivers, etc.

| Module:5 | Programmable Logic Controllers | 3 hours |
|---|---|---|

Architecture of PLC; Configuring I/O modules; memory, programming devices, program scan; Soft

| | | |
|---|---|---|
| PLCS; Troubleshooting. | | |
| | | |
| **Module:6** | **PLC Programming** | **5 hours** |
| Programming methods; Timers and counters, math instructions, data manipulations and PID control functions. | | |
| | | |
| **Module:7** | **Industrial Communication standards and HMI** | **4 hours** |
| Communication standards; HMI/MMI, overview of supervisory and distributed control systems. Case Studies:Studyofmicrocontroller and PLC control systems for various industrial cases. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |
| | | |
| **Laboratory** | | |

**List of Experiments (Indicative)**

1. Basic Programming of microcontroller.
2. Keypad and display interfacing with microcontroller.
3. PWM duty cycle and motor speed control using microcontroller.
4. Interfacing of sensors with microcontroller.
5. Serial communications using microcontroller.
6. PLC Programming for simple control applications with logic, timers, counters, data manipulation and math instructions.
7. Interfacing input and output field devices with PLC systems.
8. PLC control of electro-pneumatic and electro-hydraulic systems.
9. Control of Bottle filling system using PLC
10. Interfacing Analog field devices with PLC.

**Text Book(s)**


| | |
|---|---|
| 1. | David Calcutt, Frederick Cowan, Hassan Parchizadeh, 8051 Microcontroller: An Applications Based Introduction (2003), Newnes, |
| 2. | Manish K Patel, The 8051 Microcontroller Based Embedded Systems, (2017), Tata McGraw-Hill Publishing Co Ltd. |
| 3. | Frank D Petruzella, Programmable Logic Controllers Paperback (2010), 4th edition, McGraw-Hill Higher Education. |


**Reference Books**


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|---|---|
| 1. | Yu-Cheng Liu, Glenn A. Gibson, Microcomputer Systems: The 8086 / 8088 Family – Architecture, Programming and Design (2007), Second Edition, Prentice Hall of India. |
| 2. | Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, The 8051 Microcontroller and Embedded Systems: Using Assembly and C (2011), Second Edition, Pearson Education. |
| 3. | W. Bolton, Programmable Logic Controller (2015), Elsevier-Newnes publication, 6th edition. |
| 4. | A. K. Gupta, S. K. Arora, Industrial Automation and Robotics (2013), 3rd edition, Lakshmi |

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| | Publications, India. | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

# Programme Electives

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5021 | MANUFACTURING AUTOMATION | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | NIL | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Impart the fundamentals of automation strategy in manufacturing.
2. Prepare computer aided process planning and CNC part programming for engineering components.
3. Critique on manufacturing support systems and outline intelligent and digital manufacturing.

**Course Outcome (CO):**

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

1. Outline the concept of automation and assess the degree of automation
2. Prepare process planning for industrial components for production
3. Outline CNC technology for computer aided manufacturing and prepare the Mobile and Autonomous Robotics CNC codes for part programming.
4. Select the material handling / storage systems and automated inspection systems.
5. Use manufacturing support systems for productivity improvement.
6. Critique on intelligent manufacturing system and digital enterprises.

| Module:1 | Automation | 5 hours |
|---|---|---|

Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems

| Module:2 | Computer Aided Process Planning | 6 hours |
|---|---|---|

Computer Aided process planning, Generative, variant, hybrid CAPP, Material requirement planning (MRP), Manufacturing resource planning (MRP II), production planning and control system, master production schedule, Capacity planning, Shop floor control.

| Module:3 | Computer Aided Manufacturing | 6 hours |
|---|---|---|

Group Technology, Part family, Sensor technologies, Automated inspection and testing, Coordinate measuring machines, Machine vision, Rapid prototyping..

| Module:4 | Automated handling and storage system | 7 hours |
|---|---|---|

Automated material handling systems – AGV, Transfer mechanism - Buffer storage – Analysis of transfer lines, Robots in material handling, Automated storage and Retrieval Systems (AS/RS) – carousel storage – Automatic data capture – bar code technology, Automated assembly systems.

| Module:5 | Automated Control structures in Manufacturing systems | 7 hours |
|---|---|---|

Automated inspection and testing, Sensor technologies, Coordinate measuring machines, Machine

vision, Group Technology, Part family, Programmable controllers.

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| **Module:6** | **Manufacturing support Systems** | **6 hours** |

Flexible manufacturing, Building blocks of FMS, FMS layout, FMS planning and implementation issues, Just-in-Time Manufacturing, lean manufacturing, agile manufacturing, Cellular manufacturing,

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| **Module:7** | **Intelligent Manufacturing Systems** | **6 hours** |

Artificial Intelligence based systems, Knowledge - Based Systems, Expert Systems Technology, Agent Based Technology, Virtual Business, e-Commerce Technologies, Global Manufacturing Networks, Digital enterprise technologies. Introduction to PLM.

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| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **45 hours** |

**List of Experiments(Indicative)**

1. CNC part Programming – Step Turning, taper turning, thread cutting, grooving, linear and circular interpolation through canned cycle programming.
2. CNC part Programming – Mirroring and pocket milling
3. CNC part program generation using 3D model.
4. Develop an automated production system simulation for a casting industry using simulation package.
5. Design an assembly sequence for a bearing assembly unit using assembly simulation package.
6. Simulate and analyze any one material handling system using material flow simulation

**Text Book(s)**


| | |
|---|---|
| 1. | Mikell P. Grover, Automation, Production Systems and Computer Integrated Manufacturing (2016), Fourth Edition, Pearson Education. |


**Reference Books**


| | |
|---|---|
| 1. | P. Radhakrishnan, S. Subramanyan, V. Raju, CAD/CAM/CIM (2011), New age International. |
| 2. | Mikell P. Grover, Enory W. Jr Zimmers, CAD/CAM (2006), Pearson Education. |
| 3. | P. N. Rao, CAD/CAM: Principles and Applications (2010), Tata Mc Graw Hill. |
| 4. | Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aided Manufacturing (2009), Pearson Education. |


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| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6043 | MACHINE VISION SYSTEMS | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Introduce students to the fundamentals of image formation
2. Review image processing techniques for computer vision
3. Understand the shape and region analysis.
4. Develop an appreciation for various issues in the design of computer vision and object recognition systems; and
5. Provide the student with programming experience from implementing computer vision and object recognition applications.

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Demonstrate the image processing and image analysis techniques by a machine vision system.
2. Demonstrate the possibilities and limitations of application of image processing and computer vision.
3. Explain various image enhancement and restoration techniques.
4. Describe colour image processing, image compression, image segmentation and representation.
5. Evaluate the techniques for image enhancement and image restoration.
6. Interpret image segmentation and representation techniques.

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| **Module:1** | **Introduction** | **3 hours** |
| Human Vision - Machine Vision and Computer Vision – HMI | | |
| **Module:2** | **Hardware Components** | **4 hours** |
| MVS camera -Analog, Digital- CID, CCD, CMOS, Camera Calibration - Frame Grabber, Manual & Auto shutter | | |
| **Module:3** | **Lighting System** | **3 hours** |
| Lighting parameters**,** Lighting sources, selection - Lighting Techniques - Type and selection | | |
| **Module:4** | **Image Acquisition** | **4 hours** |
| Digital camera Interfaces, Camera Computer Interfaces, Specifications and selection | | |
| **Module:5** | **Image Processing** | **5 hours** |
| Fundamentals of Digital Image-Filtering technique -Processing of binary and grey scale images-segmentation- thresholding-connectivity-noise reduction-edge detection-region growing and region splitting - binary and gray morphology operations. | | |

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| **Module:6** | **Image Analysis** | **5 hours** |
| Feature extraction-Texture Analysis -Pattern recognition, image resolution-depth and volume, color processing, Template Matching -Decision Making, 3D Machine Vision Techniques | | |
| **Module:7** | **Practical Applications** | **4 hours** |
| Applications of machine vision in Automotive Industries, Manufacturing, Electronics, Printing, Pharmaceutical, Biomedical, Robotics, Agricultural Applications. | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **30 hours** |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

Sample Projects

1. Tool wear measurement using Machine vision
2. Inspection system in production line for checking the level of liquid in bottle
3. Sorting of color pencils
4. Printed Circuit Board Inspection using Template Matching
5. Implementing poka yoke using machine vision system
6. Online inspection using machine vision camera

**Text Book(s)**

1. E. R. Davies, Machine Vision: Theory, Algorithms, Practicalities (2014), Academic Press.

**Reference Books**

1. Alexander Hornberg, Handbook on Machine Vision (2006), Wiley.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing Analysis and machine Vision (2014), Cengage Learning.
3. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing (2009), Pearson.
4. Herbert Freeman, Machine Vision: Algorithms, Architectures and Systems (2012), Academic Press.

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| Recommended by Board of Studies | 17-08-2017 | | |
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| **Course Code** | **Course Title** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **MEE6044** | **MOBILE AND AUTONOMOUS ROBOTS** | **2** | **0** | **0** | **4** | **3** |
| **Pre-requisite** | None | **Syllabus version** | | | | |
| **Anti-requisite** | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Outline the basic concepts of Mobile Robot and its types.
2. Study various types of locomotion and its kinematics behavior.
3. Understand the important of localization and its associated sensor system.
4. Solve various path planning algorithm and task allocation.

**Course Outcome(CO):**

After completing the course, the student will be able to:

1. Predict the various types of autonomous system and its challenges.
2. Identify the types of locomotion and its kinematic constrain.
3. Predict the suitable sensors for localizations in mobile robotics system.
4. Compute path planning with various algorithm and task allocation problem in multi robotic system
5. Discuss various application of service and industrial autonomous robotic system.

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| **Module:1** | **Introduction** | **3 hours** |

Tele-operated Robot – Master and slave - Autonomous Robot - Components of autonomous robotic system – challenges in autonomous robot – redundant manipulator – types of autonomous robotic system.

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| **Module:2** | **Locomotion** | **4 hours** |

Types of locomotion – Key issues in locomotion –Wheeled mobile robot – types of wheel – wheel stability – wheel configurations - biomimetic locomotion

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| **Module:3** | | **4 hours** |

Hilare mobile robot – car-link mobile robot – Degree of mobility- Instantaneous Center of Rotation

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| **Module:4** | **Perception** | **4 hours** |

Dead Reckoning- Heading Sensors- Ground-Based RF Beacons and GPS, Sensors for Map-Based Positioning- Odometry- Active Beacon Navigation Systems- Landmark, Sizing and Torque Calculations.

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| **Module:5** | **Localization** | **4 hours** |

Self-localizations and mapping - Challenges in localizations – IR based localizations – vision-based localizations – Ultrasonic based localizations -Map representation and Map building- Map based localization scheme – other localization systems

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| **Module:6** | **Planning, Navigation and Collaborative Robots** | **5 hours** |

Introduction – Competences for Navigation: Planning and Reacting: Path planning: Road map, Cell decomposition , Potential field – Obstacle avoidance: Bug algorithm – A*algorithm - Vector field histogram – Dynamic window approach - Navigation Architectures

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| **Module:7** | **Multi robots and its application** | **4 hours** |
| Leader based multi robot system – leader less mobile robot system - task allocation – fault tolerance – swarm robotics. Applications - Military mobile robots – Underwater robots – Service robot – Surveillance robots – Nano robots – Case study. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

**Sample projects**

1. Design of a Mobile Robot Navigation System with RFID and Ultrasonic Sensors.
2. Design of an Autonomous Surveillance Robot with Path Tracking Capability.
3. Design of a Remote Controlled Pick and Place Robotic Vehicle.
4. Wireless Surveillance Robot with Motion Detection and Live Video Transmission,
5. Design of a Mobile Controlled Robot via GSM.
6. Design of a Voice Controlled Robotic Vehicle.
7. Design of an Accelerometer Based Robot Motion and Speed Control with Obstacle Detection.
8. PIC Microcontroller Based Auto Tracking Robot.
9. Design of RF Based Speed Control System for Vehicles.
10. Design of a Surface Cleaning Robot.

**Text Book(s)**

1. Roland Siegwart, Illah Reza Nourbakhsh, Davidescaramuzza: Introduction to Autonomous Mobile Robots, (2011). The MIT Press. ISBN: 9780262015356.

**Reference Books**

1. FarbodFahimi, Autonomous Robots Modeling, Path Planning and control, (2009), Springer. ISBN: 9780387095370.
2. Bruno Siciliano, OussamaKhatib, Handbook of Robotics 2ndedition, (2016), Springer. ISBN: 9783319325507.
3. Shuzhi Sam Ge, Autonomous Mobile Robots: Sensing, Control, Decision making and Applications (2006), CRC Press, Taylor and Francis Group.
4. Jitendra R. Rao, Ajith K. Gopal, Mobile Intelligent Autonomous Systems, (2012), CRC Press, Taylor and Francis Group. ISBN: 9781439863008.
5. Krzysztof Kozlowski, Robot Motion and Control, (2012), Springer. ISBN: 9781447123422.

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE6057 | MEMS AND MICROSYSTEMS | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Understanding the concept of MEMS and Microsystems.
2. Analyzing the diverse technological and functional approaches
3. Provide an insight on micro sensors, actuators and micro fluidics

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Demonstrate the micro fabrication techniques
2. Assess whether using a MEMS based solution is the relevant and best approach
3. Select the most suitable manufacturing process, actuators, sensors and strategies for micro fabrication
4. Develop the knowledge on general properties of Microfluidics and physics involved in liquid flow
5. Design & analyze the microfabrication techniques in Bio electromechanical systems and Optical MEMs Fluid structure interaction in Microflow devices

| Module:1 | Introduction to MEMS and micro system design | 4 hours |
|---|---|---|

MEMS and micro system definition, Material Properties, Structural behavior, Fabrication technologies.

| Module:2 | Sensors used in MEMs and microsystems | 4 hours |
|---|---|---|

Different types of sensors used for MEMS and microsystems, sensing methods, signal transduction, feedback systems.

| Module:3 | Micro actuators | 4 hours |
|---|---|---|

Basic principles and working of micro-actuators-Thermal actuators-SMA actuators-Piezo-electric Actuators-Electrostatic actuators-micro grippers-micro motors.

| Module:4 | Micro fluidics | 4 hours |
|---|---|---|

Fluid flow ,micro scale transport, different components of a micro fluidic system

| Module:5 | Design aspects of MEMs and microsystems | 4 hours |
|---|---|---|

Design of micro accelerometers-vibration control of a plate –part of a micro system)-Micro mirror design -Micro dispenser design.

| Module:6 | Bio electro mechanical systems | 4 hours |
|---|---|---|

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|---|---|---|
| Bio-MEMS and micro systems, –examples of micro systems in biology-lab-on-a chip-Diagnostics at the micro scale with examples. | | |
| | | |
| **Module:7** | **Optical MEMs and micro systems** | **4 hours** |
| Micro opto-electronic devices, micro optical switches, micro optical arrays in solar panels | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

**Sample Projects**

1. 3D simulation of micro actuator.
2. Characteristics comparison between piezo resistive and piezo electric actuator.
3. Simulation studies on a micro pump.
4. Experimental study on the sensitivity and selectivity of gas sensing materials/micro accelerometers.
5. Pressure sensor and Accelerometer packaging and characteristics study.
6. Thermocouple packaging methods and its performance characteristics for radiation measurement.

**Text Book(s)**

| | |
|---|---|
| 1. | Stephen D.Senturia, Microsystem Design (2007), Springer Science. |

**Reference Books**

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|---|---|
| 1. | James J. Allen, Micro Electro Mechanical System Design (2005), CRC Press, Taylor & Francis Group. |
| 2. | Jacopo Iannacci, Practical Guide to RF-MEMS (2013), John Wiley & Sons Ltd. |
| 3. | MinhangBao, Analysis and Design Principles of MEMS devices (2005), Elsevier. |
| 4. | Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, (2011), CRC |
| 5. | Tai-Ran Hsui, MEMS & Microsystems: Design, Manufacture and Nano scale Engineering (2008), John Wiley and Sons Ltd. |
| 6. | V. Choudhary, K. Iniewski, MEMS: Fundamental Technology and Applications, CRC Press, (2017). |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6045 | FLUID POWER SYSTEM DESIGN | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Provide comprehensive introduction to fluid power system design including both hydraulics and pneumatics.
2. Acquire the knowledge on the fundamental elements of fluid power and properties of fluid,
3. Understand fluid power and differentiate hydraulic and pneumatic systems for their application in industry

**Course Outcome (CO):**

On completion of this course the students will be able to

1. Understand the fundamental principles and analytical modeling of fluid power components and its symbols, circuits, and systems.
2. Acquire knowledge of the applications of fluid power in various engineering fields.
3. Study the benefits and limitations of fluid power compared with other power transmission technologies and Interface PLC with hydraulic and pneumatic systems.
4. Demonstrate the production of compressed air and its distribution.
5. Understand about hydraulics filters and sealers, types of filter elements,- construction and working of filter in hydraulic unit
6. Understand components of hydraulic systems and its advantages
7. Design and analyze the pneumatic system and its advantages in industrial applications.

| Module:1 | Introduction to Fluid Power | 5 hours |
|---|---|---|

Definition- Hydraulics vs Pneumatics – ISO symbols - Application –Pascal's Law- Transmission and multiplication of force - Basic properties of hydraulic fluids - static head pressure-pressure loss – Power - absolute pressure and Temperature - gas laws- vacuum

| Module:2 | Hydraulic and Pneumatic Power Supply Source | 6 hours |
|---|---|---|

Hydraulic Pump - graphic symbol- pump types -pump flow and pressure- pump drive torque and Power- pump efficiency –air compressor- graphic symbol-compressor types -compressor sizing- vacuum pumps

| Module:3 | Control Elements | 8 hours |
|---|---|---|

Directional control valves - Pressure control valves - Flow control Valves -electronic control components - Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve

| | | |
|---|---|---|
| Analysis and Design, Time delay valve, Proportional and Servo valves. | | |
| | | |
| **Module:4** | **Circuits** | **6 hours** |
| DCV controlling single acting, double acting cylinder - Regenerative circuits, high low circuits, Synchronization circuits, and accumulator sizing. Intensifier circuits, Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits- pressure intensifier circuit-accumulator circuits - AND and OR valve circuit | | |
| | | |
| **Module:5** | **Design of Circuits** | **6 hours** |
| Design and analysis of typical hydraulic and pneumatic circuits - Design method consideration for sequential circuits-intuitive circuit design method-cascade method- sequential logic circuit design using KV method- compound circuit design-step counter design | | |
| | | |
| **Module:6** | **Electro-Hydraulic and Electro-Pneumatic systems** | **7 hours** |
| Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Programmable logic control of hydraulic and pneumatic circuits, PLC ladder diagram for various circuits, motion controllers, Servo systems – fundamentals. Applications in Assembly, Feeding, Metalworking, materials handling and plastic working. | | |
| | | |
| **Module:7** | **Fluid Power System Maintenance** | **5 hours** |
| Introduction, Sealing Devices - Reservoir System - Filters and Strainers - Beta Ratio of Filters - Wear of Moving Parts - Gases in Hydraulic Fluids - Temperature Control – Troubleshooting | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| | | |
| **Laboratory** | | **Total hours: 30** |

**List of Experiments (Indicative)**

1. Single acting and double acting cylinder using DCV
2. Automatic reciprocation of double acting cylinder
3. Controlling the hydraulic rotary actuator using electrical push button switch using meter out circuit
4. Controlling the double acting hydraulic cylinder using electrical push button switch manually
5. Or gate & AND gate operation using single acting cylinder.
6. Simulation of basic pneumatic and hydraulic circuits.
7. Simulation of sequencing circuits.
8. Simulation of Electro-Hydraulic systems.
9. Simulation of Electro-Pneumatic systems.
10. Simulation of PLC based electro pneumatic sequencing circuits

**Text Book(s)**

| | |
|---|---|
| 1. | James L.Johnson, Introduction to Fluid power(2003), Delmar Thomson Learning Inc. |
| **Reference Books** | |
| 1. | James R. Daines, Fluid Power: Hydraulics and Pneumatics (2012), Goodheart-willcox Publishers. |
| 2. | Ahmed Abu Hanieh, Fluid Power Control (2012), Cambridge International Science Publishing Ltd. |
| 3. | Anthony Esposito, Fluid Power with Applications (2010), Pearson Higher Ed. |
| 4. | M GalalRabie, Fluid power engineering (2009), Mc-Graw Hill. |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| EEE6018 | DATA ACQUISITION AND DIGITAL SIGNAL PROCESSING | 3 | 0 | 0 | 4 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

1. To understand the mathematical representations of continuous time, discrete time and digital representations.
2. To analyse Discrete time systems using Z - transform.
3. To design and implement IIR filters and FIR filters
4. To obtain knowledge and ability to use the appropriate tools like digital signal processors to build DSP systems for real time problems.

**Course Outcome (CO):**

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

1. Understand the continuous time, discrete time and digital representations and its limitations.
2. Understand the Z transform and analyze the System response.
3. Design and implement IIR filtering operations with the real time constraints.
4. Design a FIR filter for specific digital signal applications.
5. Understanding the DAQ Hardware and Software requirements and its implementations.
6. Applications of Signal processing techniques to speech signals.
7. Identify the techniques, skills and modern technical tools necessary for engineering practice to design and simulate DSP systems.

| Module:1 | Discrete Systems and Signals | 4 hours |
|---|---|---|

Systems and Signals – classification –continuous and discrete systems – Analog to digital and Digital to analog convertors

| Module:2 | Data Acquisition systems: | 5 hours |
|---|---|---|

Basics of DAQ Hardware and Software –Concepts of Data Acquisition and terminology

| Module:3 | DAQ system Implementation | 6 hours |
|---|---|---|

Installing Hardware, Installing drivers -Configuring the Hardware – addressing the hardware Digital and Analog I/O function – Buffered I/O – Real time Data Acquisition.

| Module:4 | Discretization of signals | 8 hours |
|---|---|---|

Introduction to Digitizing Analog Signals, Z-Transformation- Fast Fourier transform; Aliasing; Quantization noise Thermal noise.

| Module:5 | Filter Design | 9 hours |
|---|---|---|

Multiple band optimal FIR filters – design of filters with simultaneous constraints in time and frequency response – Optimizationmethods for designing IIR filters, comparison of optimum FIR filter.

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|---|---|---|
| **Module:6** | **Signal Processing Hardware** | **6 hours** |
| Multipliers, dividers, different forms of FIRHardware, De-multiplexing and multiplexing, realization of frequencysynthesizer. | | |
| | | |
| **Module:7** | **Applications of DSP** | **5 hours** |
| Speech: Model of speech production, speech analysis – synthesis system analyzers and synthesizers, linear prediction of speech | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. Design and development of Data Acquisition System Project for Conveyor Belt,
2. Design and development of Data Acquisition and Sensor Circuits For object detection
3. Design and development of continuous Measurement and Logging using Data Acquisition,
4. Modelling of Feedback Evaporative Cooler using Data Acquisition,
5. Design and development of PC based Data Acquisition System,
6. Design and development of Wireless Data Acquisition System,
7. Design and Modelling of 16-Channel Data Acquisition System,
8. Modelling android base data acquisition system,
9. Design and development of Microcontroller Based Data Acquisition System for measuring vibration,
10. Design of Automated Data Acquisition for On-Site Control in automation.

**Text Book(s)**

| | |
|---|---|
| 1. | Patrick H. Garrett, Advanced Instrumentation and Computer I/O Design: Defined Accuracy Decision |
| 2. | Control and Process Applications (2013), 2nd edition, Wiley.<br>John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing (2007), 3rd edition Prentice Hall. |

**Reference Books**

| | |
|---|---|
| 1. | John Park and Steve Mackay, Practical Data Acquisition for Instrumentation and Control Systems(2006), Elsevier |
| 2. | S. Gupta and J P Gupta, Data Acquisition and Process Control (1994), Instrument Society of America |
| 3. | Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, Statistical and Adaptive Signal Processing(2005) Artech House, Inc. |
| 4. | S.K.Mitra, Digital Signal Processing (2006), 3rd edition, Tata Mc-graw Hill |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| EEE6019 | ADVANCED CONTROL SYSTEMS | 3 | 0 | 0 | 4 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

1. To review the continuous time control system design with realistic system specifications.

2. To design a digital control system for a continuous system model.

3. To provide knowledge of state variable models and fundamental notions of state feedback design

4. To provide understanding of different control algorithms considering nonlinearities, uncertainties and robustness.

**Course Outcome (CO):**

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

1. Design continuous time control system design with realistic system specifications.
2. Analysis of discrete system response using Z-Transform.
3. Infer controllability/ observability of a system.
4. Design a digital Controller with realistic system specifications.
5. Design the state feedback control law for a time domain specification.
6. Understand control system design for nonlinear systems.
7. Comprehend the basics of optimal control, robust control, predictive control

| Module:1 | Classical Control Systems | 6 hours |
|---|---|---|

Review of feedback systems and design of PID Controllers - Design of controllers using Root Loci and Bode plots – Lead, Lag, Lag-lead and parallel compensators.

| Module:2 | Digital Control Systems | 6 hours |
|---|---|---|

Sampling and holding – Z-transform - Correlation between time response and root locations in S plane and Z plane – Direct design in Z and W plane.

| Module:3 | Digital Controller Design | 6 hours |
|---|---|---|

State space design – Design via pole placement - digital PID controller design

| Module:4 | State Space Analysis | 6 hours |
|---|---|---|

State space representations – conversion from transfer function model – solving time-invariant state equations – Controllability – Observability.

| | | |
|---|---|---|
| **Module:5** | **Control System Design in State Space** | **6 hours** |
| Pole placement controllers in state space - design of servo and regulatory controllers – state observers. | | |
| | | |
| **Module:6** | **Nonlinear and Predictive Control** | **6 hours** |
| Common physical non-linear system, phase plane method - Liapunov's stability criterion - Popov's stability criterion - Model reference and predictive control systems – state estimators – Kalman algorithm. | | |
| | | |
| **Module:7** | **Supervisory Level Systems** | **7 hours** |
| Introduction to Adaptive control, optimal control, robust control, multi-variable control systems.<br>Case studies: Control of motion and other dynamics of mechatronics systems | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. Control of inverted pendulum cart.
2. Control and implementation of adaptive PID controller using microcontroller.
3. Control of ball balancing robot.
4. Force Control of a pneumatic gripper.
5. Development of two-wheel balancing robot.
6. Adaptive cruise control of an automobile.
7. Optimal control of an industrial manufacturing process.
8. Tracking control of missiles.

**Text Book(s)**

| | |
|---|---|
| 1. | K. Ogata, Modern Control Engineering, (2010) Prentice Hall of India Pvt. Ltd., New Delhi. |

**Reference Books**

| | |
|---|---|
| 1. | Gene F. Franklin, J. D. Powell, A E Naeini, Feedback Control of Dynamic Systems, (2008) Pearson India. |
| 2. | K. Ogata, Discrete-Time Control Systems, (2009) Prentice Hall of India Pvt. Ltd., New Delhi. |
| 3. | Alok Sinha, Linear Systems: Optimal and Robust Control, (2007) Taylor & Francis. |
| 4. | Brian D. O. Anderson and John B. Moore, Optimal Control: Linear Quadratic Methods, (2007) Dover Publications |
| 5. | H.K. Khalil, Nonlinear Systems, (2001) Prentice Hall. |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| EEE6020 | EMBEDDED SYSTEMS | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

1. To give an emphasis on the characteristics and hardware architecture of embedded system and real time operating systems.
2. To provide essential knowledge on various steps involved in executing a higher-level language and development of required software.
3. To provide the essential knowledge in the operating systems and design methodologies for embedded system development.

**Course Outcome (CO):**

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

1. Understand the characteristics and concepts of embedded system.
2. Understand the architecture of hardware embedded system
3. Interpret the bus protocols involved in interfacing with memory blocks.
4. Understand the steps of embedded system programming.
5. Compare the concepts of RTOS with general purpose OS.
6. Design hardware components/architecture for embedded system applications.
7. Design a component or a product applying all the relevant standards with realistic constraints in practical case studies.

| Module:1 | Introduction to Embedded Systems | 3 hours |
|---|---|---|

Definition, history and applications of Embedded System - Concept of Real time Systems - Embedded System
Design - Design Process - Quality Attributes.

| Module:2 | Embedded System Architecture | 5 hours |
|---|---|---|

Instruction Set Architecture - CISC and RISC instruction set architecture - Basic Embedded Processor/Microcontroller Architecture - DSP Processors – Harvard Architecture - Memory System Architecture - I/0 Sub-system – Coprocessors and Hardware Accelerators - Processor Performance Enhancement

| Module:3 | Designing Embedded Computing Platform | 5 hours |
|---|---|---|

Bus Protocols – Bus Organization - Memory Devices and their Characteristics –RAM, ROM, UVROM, EEPROM, Flash Memory, DRAM - I/O Devices – Component Interfacing – Memory and I/O device Interfacing

| Module:4 | Programming Embedded Systems | 5 hours |
|---|---|---|

Program Design - Design Patterns for Embedded Systems - Programming Languages - Desired Language
Characteristics - Object Oriented Programming - Use of High-Level Languages - Compiling, Assembling, Linking, Debugging - Program Validation and Testing.

| Module:5 | Operating System | 4 hours |
|---|---|---|

| | | |
|---|---|---|
| Basic Features of an Operating System - Kernel Features - Real-time Kernels - Processes and Threads - Context Switching –Scheduling - Inter-process Communication - Real-time Memory Management. | | |
| | | |
| **Module:6** | **Embedded System Development** | **3 hours** |
| Design Methodologies – Requirement Analysis and Use case Modeling - Static Modeling - Object and Class<br>Structuring - Dynamic Modeling - Architectural Design - Hardware-Software Partitioning - Hardware-software Integration - Fault-tolerance Techniques - Reliability Evaluation Techniques | | |
| | | |
| **Module:7** | Case Studies | **3 hours** |
| Design examples of embedded systems such as Inkjet Printer, Set-top Box, Elevator Control System, Automated Teller Machine (ATM) system. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. Design of Propeller LED Display
2. Design and Display of Dialed Telephone Numbers on Seven Segment Displays
3. Design of Distance Measurement by Ultrasonic Sensor
4. Design and development of Auto Power Supply Control from 4 Different Sources: Solar, Mains, Generator & Inverter to Ensure No Break Power
5. Design and development of Automatic Bell System for Institutions
6. Design and development of Automatic Dialing to Any Telephone Using I2C Protocol on Detecting Burglary
7. Design and development of Secret Code Enabled Secure Communication Using RF Technology
8. Design and development of Security System Using Smartcard Technology
9. Design and development of Security System With User Changeable Password.
10. Design and development of Touch Screen Based Industrial Load Switching

**Text Book(s)**

| | |
|---|---|
| 1. | Wayne Wolf, Computers as Components – Principles of Embedded Computing System Design, (2009),<br>Morgan Kaufmann Publishers. |

**Reference Books**

| | |
|---|---|
| 1. | Ball S.R., Embedded microprocessor Systems – Real World Design, (2002), 3rd Ed, Newness, Elsevier<br>Science |

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|---|---|
| 2. | C.M. Krishna, Kang G. Shin, Real Time systems, (2009), McGraw Hill |
| 3. | Frank Vahid, Tony Givagis, Embedded System Design. (2009), Wiley Edition. |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5009 | AUTOTRONICS AND VEHICLE INTELLIGENCE | 3 | 0 | 0 | 4 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Understand the automotive electronics
2. Introduce the different vehicle systems
3. Study the importance of vehicle intelligence system

**Course Outcome (CO):**

On completion of this course student should be able to:

**11.** Comprehensive fundamental and technical knowledge of sensors and transducers used in auto vehicles and vehicle intelligence.

**12.** Ability to understand, analyze and use various SI and CI Management systems

**13.** Ability to use numerical coding for system modelling and simulation

**14.** Selection of automotive sensors and actuators for a specific application

**15.** Designing a suitable controller for energy management in electric and hybrid vehicles

**16.** Acquire Knowledge on several intelligent vehicle system and safety systems

| Module:1 | Automotive Fundamentals | 6 hours |
|---|---|---|

Engine Components – Drive train – suspension system, ABS, Steering System

| Module:2 | Fuel Supply System | 6 hours |
|---|---|---|

Fuel Injection system - components, electronic fuel injection –Throttle body versus Port Injection - MPFI- CRDI. Fuel Ignition System – Electronic ignition system – operation – types – Battery, magneto ignition systems – Electronic spark timing control

| Module:3 | Automotive Sensors | 6 hours |
|---|---|---|

Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensors – operation, types, characteristics, advantage and their applications

| Module:4 | Engine Management system | 6 hours |
|---|---|---|

On-board diagnostics, Exhaust emission control, Catalytic Converters, New Developments in engine management, adaptive Cruise control

| Module:5 | Control of Electric and hybrid vehicles | 6 hours |
|---|---|---|

Electric Vehicle - batteries electric motor and controller, regenerative braking – Control of hybrid vehicles – CNG electric hybrid vehicle – Hybrid Vehicle case studies

| | | |
|---|---|---|
| **Module:6** | **Automotive Safety Sensor applications** | **6 hours** |
| Automatic Rain sensing/wiper activation system, drowsy-driver sensing system, Active Safety Sensor systems, Passive Sensor Safety system - Side Impact Sensing, front impact sensing system. | | |
| **Module:7** | **Intelligent Vehicle System** | **7 hours** |
| MEMS and Microsystems. Vision based autonomous road vehicles, Object detection, Collision warning and avoidance system – Tyre pressure warning system, security systems, Emergency Electronic braking. Intelligent Vehicle Systems – Unmanned ground vehicles, Vehicle Platooning. | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **45 hours** |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. **1.** Ice Warning circuit
2. **2.** Electronic ignition circuit
3. **3.** Lights on Reminder circuit
4. **4.** Accelerometer circuit.
5. **5.** Design of ABS.
6. **6.** Design of Cruise control system.
7. **7.** Design of Tyre Pressure warning system.
8. **8.** Design of automatic rain sensing system.
9. **9.** Design of seat belt warning system.
10. **10.** Design of Automatic jacking system

**Text Book(s)**

1. William B.Ribben, Understanding Automotive Electronic: An Engineering Perspective (2012), Elsevier Science.

**Reference Books**

1. Tom Denton, Automobile Electrical and Electronic systems (2013), Rouletedge, Taylor & Francis Group.
2. Tom Denton, Automobile Mechanical and Electrical Systems (2011), Taylor & Francis Group
3. Gianfranco Pistoia, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market (2010), Elsevier.
4. Ronald K.Jurgen, Electric and Hybrid-electric vehicles (2011), SAE International.

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| Recommended by Board of Studies | 17-08-2017 | | |
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| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6046 | INTELLIGENT SYSTEMS | 3 | 0 | 0 | 4 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Acquire knowledge about different searching techniques and definitions
2. Study the concept of representing knowledge of ANN architecture, fuzzy logic and genetic algorithm

**Course Outcome (CO):**

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

1. Explain the characteristics of AI systems with different searching techniques and algorithms
2. Design a simple AI system
3. Demonstrate the Genetic algorithms programming
4. Apply Hybrid techniques for Industrial Applications of intelligent systems
5. Evaluate the applications of types of AI algorithms for real time industrial applications

| Module:1 | Fuzzy set theory and fuzzy logic system | 6 hours |
|---|---|---|

Basic concepts in Fuzzy Set theory – Operations of Fuzzy sets – Fuzzy relational equations –Fuzzy inference – Fuzzification – Defuzzification –Decision making logic – Membership functions – Rule base

| Module:2 | Adaptive fuzzy systems | 6 hours |
|---|---|---|

Performance index – Modification of rule base – Modification of member ship functions – simultaneous modification of rule base and membership functions

| Module:3 | Introduction to artificial neural networks | 7 hours |
|---|---|---|

Fundamentals of Neural networks – Neural network architectures – Learning methods– multilayer perceptron's -Back propagation algorithm and its variants – Different types of learning

| Module:4 | Mapping and recurrent networks | 7 hours |
|---|---|---|

Counter propagation –Cognitron and Neocognitron - Hopfield Net- Kohonnen Nets- Grossberg Nets- Adaptive Resonance Theory.

| Module:5 | Genetic algorithms | 6 hours |
|---|---|---|

Introduction to genetic algorithm –initialization, selection, mutation and termination- classification of genetic programming

| Module:6 | Hybrid Techniques | 7 hours |
|---|---|---|

Neuro-fuzzy systems – genetic neuro systems – genetic fuzzysystems. **Probabilistic techniques:** Tree search – Monte-carlo techniques – Radial basis function – Gaussian – Probabilistic neural networks

| Module:7 | Industrial Applications of intelligent systems | 4 hours |
|---|---|---|

| | | |
|---|---|---|
| Application of fuzzy logic, Neural network and Genetic algorithm in Mechatronics application. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

**Sample Projects**

1. Development of Fuzzy logic control for a nonlinear process.
2. Use fuzzy logic for engine performance prediction.
3. Use neuro-fuzzy system for engine fault diagnosis system.
4. Optimization of a machining process using artificial neural network
5. Adaptive control of a manufacturing process using neuro-fuzzy system.
6. Use genetic algorithm for number plate identification.
7. Use fuzzy system for identification of friction parameters in a complex machine.

**Text Book(s)**

| | |
|---|---|
| 1. | Timothy J.Ross, Fuzzy Logic with Engineering Applications (2016), Wiley 4th edition. |

**Reference Books**

| | |
|---|---|
| 1. | David E. Goldberg, Genetic Algorithm in Search Optimization and Machine Learning (2013), Pearson Education. |
| 2. | Rajasekaran, S., VijayalakshmiPai, G.A., Neural networks, Fuzzy logic and Genetic algorithms (2011), Prentice Hall of India. |

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| Course Code | Course Topic | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6047 | VIRTUAL REALITY AND HAPTICS | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Provide an overview of the opportunities and the main issues related to designing and developing VR/AR systems architectures, both in local and in distributed (even web-based) contexts, and to the development of VR/AR applications with a multimodal perspective and approach.
2. Demonstrate the principles and multidisciplinary features of virtual reality.
3. Understand the technology for multimodal user interaction and perception in VR, in particular the visual, audial and haptic interface and behaviour.
4. Demonstrate the VR system framework and development tools.
5. Study the human touch perception and Tactile Proprioception.
6. Discuss the haptic components and virtual models.
7. Analyse the significance of knowledge on haptic and augmented reality.

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Identify, examine, and develop software that reflects fundamental techniques for the design and deployment of VR experiences.
2. Describe how VR systems work using modern technology.
3. Choose, develop, explain, and defend the use of particular designs for VR experiences.
4. Evaluate the benefits and drawbacks of specific VR techniques on the human body.
5. Identify and examine state-of-the-art VR design problems and solutions from the industry and academia.
6. Design and control haptic devices and learn the salient properties of human touch perception that are necessary to be recreated in virtual environments.
7. Demonstrate the use of modeling software that used in the haptic device development.

| Module:1 | Introduction to Virtual reality | 3 hours |
|---|---|---|

Virtual reality concepts – virtual world and real world – Interface to virtual world (inputs and outputs) – Types of interaction – Applications.

| Module:2 | Haptics | 5 hours |
|---|---|---|

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of existing applications.

| Module:3 | Design of Haptic devices | 5 hours |
|---|---|---|

Virtual Reality Input and Virtual Reality Output parameters - Computing Architectures for VR -

| | | |
|---|---|---|
| Haptic assembly architecture - Haptic Interface Design – Kinesthetic devices. | | |
| | | |
| **Module:4** | **Kinematics and dynamics** | **5 hours** |
| Homogeneous Transformation Matrices - Transformation Invariants - Force Computation - Force Smoothing and Mapping | | |
| | | |
| **Module:5** | **Geometric Modeling** | **4 hours** |
| Virtual Object Shape - Object Visual Appearance – Position - Object Hierarchies - Physical Modeling: Collision Detection, Surface Deformation, Haptic Texturing. | | |
| | | |
| **Module:6** | **Virtual Reality Programming** | **3 hours** |
| Human Factors in Virtual Reality, Programming Haptic Virtual Environments, calibration. | | |
| | | |
| **Module:7** | **Teleoperation** | **3 hours** |
| Implementation and Transparency, Traditional Applications and Emerging Applications of VR – Master and slave mechanism | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. Design of Haptic Texture by Multidimensional Scaling.
2. Design and Analysis of rendering for wearable haptics.
3. Modelling and Analysis of Texture Rendering in Tele-Operation Tasks.
4. Design a Haptic perception for an object size.
5. Modelling of various effects of device coupling on haptic performance.
6. Design and development of haptic devices for deaf and blind users.

**Text Book(s)**

1. John vince, Essential Virtual Reality Fast (2012), Springer.

**Reference Books**

1. GrigoreBurdea, Philippe Coiffet, Virtual Reality Technology (2006), 2nd edition. Wiley India.
2. John vince, Virtual Reality Systems (2007), Pearson Education.
3. MatjazMihelj, Jonezpodobnik, Haptics for virtual reality and tele operation (2012), Springer.
4. B. Hannaford, A. M. Okamura, Handbook of Robotics (2008), Springer

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| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6048 | CONDITION MONITORING TECHNIQUES | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB:**

The Objectives of the course are:

1. Understand the basics of various condition monitoring methods
2. Identify the selection of condition monitoring techniques for various applications.
3. Provide a basic understanding with case studies on different fault diagnosis method.

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Demonstrate the basic knowledge about various condition monitoring methods in accordance with the established procedures.
2. Explain the different types of sensor design and its application
3. Assess the signal processing methods and its working principles in time and frequency domain
4. Understand the basic knowledge of surface, subsurface and deeper surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
5. Demonstrate the various types of machine learning algorithms application in condition monitoring methods

| Module:1 | Condition monitoring techniques | 4 hours |
|---|---|---|

Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies.

| Module:2 | Sensors for condition monitoring | 4 hours |
|---|---|---|

Accelerometers, strain gauges, eddy current probes, LVDT for measurement of displacement, velocity and acceleration; Temperature transducers, radiation pyrometers and thermal imaging devices.

| Module:3 | Signal processing | 4 hours |
|---|---|---|

Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions.

| Module:4 | Signal Analysis | 4 hours |
|---|---|---|

Time domain and Frequency domain and Time-frequency domain analysis.

| Module:5 | Failure Analysis and Maintenance | 4 hours |
|---|---|---|

Maintenance Principles, Failure mode analysis - Equipment down time analysis - Breakdown analysis - condition based maintenance.

| | | |
|---|---|---|
| **Module:6** | **Machine Condition monitoring** | **4 hours** |
| Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies. | | |
| | | |
| **Module:7** | **Machine Learning** | **4 hours** |
| Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| **Total Lecture hours:** | | **30 hours** |
| | | |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. Condition monitoring of rotating machine element using accelerometers
2. Fault diagnosis of machine elements like, bearing, gear box, pumps etc.
3. Tool condition monitoring using accelerometers.
4. Fault diagnosis of machine components using machine learning approaches
5. Fault diagnosis of machine components using NDT techniques
6. Condition monitoring through image processing analysis

**Text Book(s)**

| | |
|---|---|
| 1. | EthemAlpaydin, Introduction to Machine Learning (2010), The MIT Press, Cambridge, London. |

**Reference Books**

| | |
|---|---|
| 1. | K. P. Soman, Data mining theory and practice (2006), Prentice-Hall of India. |
| 2. | Amiya RanjanMohanty , Machinery Condition Monitoring: Principles and Practices (2015), CRC Press |
| 3. | Mishra, R.C., Pathak, K., Maintenance Engineering and Management (2012), Prentice Hall of India. |
| 4. | Clarence W. De Silva, Sensors and Actuators: Control System Instrumentation (2007), CRC Press – Taylor and Francis Group. |
| 5. | BoualemBoashash, Time Frequency Signal Analysis and Processing: A Comprehensive Reference (2015), Elsevier. |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| CSE6053 | WIRELESS SENSOR NETWORKS | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Introduce the characteristics, basic concepts and systems issues in Wireless sensor networks
2. Illustrate architecture and protocols in wireless sensor networks
3. Identify the trends and latest development of the technologies in the area
4. Provide a broad coverage of challenges and latest research results related to the design and management of wireless sensor networks

**Course Outcome:**

After successfully completing the course the student should be able to:

1. Design the sensor networks for various application setups.
2. Demonstrate the design space and conduct trade-off analysis between performance and resources.
3. Identify the suitable medium access protocols and radio hardware.
4. Design and analysis of energy efficiency and power control in WSN
5. Explain the Operating system and Sensor Network Platforms And Tools

| Module:1 | Introduction to Wireless Sensor Networks | 6 hours |
|---|---|---|

Introduction, Applications of Wireless Sensor Networks, WSN Standards, IEEE 802.15.4, Zigbee. Network Architectures and Protocol Stack – Network architectures for WSN, classification of WSN, protocol stack for WSN.

| Module:2 | Wireless Transmission Technology and Systems | 6 hours |
|---|---|---|

Radio Technology, Available Wireless Technologies Wireless Sensor Technology Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating Environment

| Module:3 | Medium Access Control Protocols for Wireless Sensor Networks | 7hours |
|---|---|---|

Fundamentals of MAC Protocols, MAC Protocols for WSNs, Contention-Based protocols: Power Aware Multi-Access with Signaling - Data-Gathering MAC, Contention-Free Protocols: Low Energy Adaptive Clustering Hierarchy, B-MAC, S-MAC. Dissemination Protocol for Large Sensor Network.

| Module:4 | Deployment and Configuration | 6 hours |
|---|---|---|

Target tracking, Localization and Positioning, Coverage and Connectivity, Single-hop and Multi-hop Localization, Self-Configuring Localization Systems.

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|---|---|---|
| Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks, Routing protocols: data centric, hierarchical, location based energy efficient routing etc. Querying, Data Dissemination and Gathering. | | |
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| **Module:5** | **Energy Efficiency and Power control** | **6 hours** |
| Need for energy efficiency and power control in WSN, passive power conservation mechanisms, active power conservation mechanisms | | |
| | | |
| **Module:6** | **Operating Systems For Wireless Sensor Networks** | **6 hours** |
| Operating System Design Issues, TinyOS, Contiki – Task management, Protothreads, Memory and IO management. | | |
| | | |
| **Module:7** | **Sensor Network Platforms And Tools** | **6 hours** |
| Sensor Node Hardware – Tmote, Micaz, Programming Challenges, Node-level Software Platforms, Node-level Simulators, State-centric Programming | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

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|---|---|
| 1. | KazemSohraby, Daniel Minoli, TaiebZnati, "Wireless Sensor Networks, Technology, Protocols and Applications", Wiley, 2007 |

**Reference Books**

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|---|---|
| 1. | Holger Karl, Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005 |
| 2. | Jun Zheng, Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", Wiley, 2009. |
| 3. | Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks", Wiley, 2010 |
| 4. | Ibrahiem M. M. El Emary, S. Ramakrishnan, "Wireless Sensor Networks: From Theory to Applications", CRC Press Taylor & Francis Group, 2013 |

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| Recommended by Board of Studies | 17-08-2017 | | |
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| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6060 | BIO-MECHATRONICS | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Learn basic knowledge about Bio mechanics, Bio sensors and actuators, and bio-mechatronics devices.
2. Impart the bio assist devices.
3. Know the different types, bio imaging and processing.
4. Understand about bio mechatronics devices and their functions.

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Demonstrate the basic knowledge about the Biomechanics, Bio sensors and actuators, and bio- mechatronics devices.
2. Acquire the different bio imaging and processing.
3. Analyze the Signal processing with bio sensors and actuators.
4. Analyze modern medical measurement devices.
5. Understand the properties of bio assist devices.
6. Understand modern bio-mechatronics devices and its requirements.

| Module:1 | Biomechanics | 4 hours |
|---|---|---|

Cardiovascular biomechanics, Musculoskeletal and orthopedic biomechanics, human ergonomic, Rehabilitation.

| Module:2 | Bio Sensors and Actuators | 4 hours |
|---|---|---|

Introduction to Biomechatronics, Electrodes - Types, - Measurement of blood pressure - Blood Gas analyzers: pH of blood, Smart actuators for biological applications

| Module:3 | Medical Measurements | 4 hours |
|---|---|---|

Heart rate - Heart sound -Pulmonary function measurements -spirometer -finger-tip oximeter - ESR, GSR measurements

| Module:4 | Signal Processing | 4 hours |
|---|---|---|

Bio-medical signals, Signal acquisition and signal processing-Isolation barriers, Bio-Image processing

| Module:5 | Sensory Assist Devices | 4 hours |
|---|---|---|

Hearing aids – Implants, Optical Prosthetics, VisualNeuroprostheses – Sonar based systems, Respiratory aids, Tactile devices for visually challenged.

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| **Module:6** | **Active and Passive Prosthetic Limbs** | **4 hours** |
| Introduction to prosthetics, Passive Prosthetics – walking dynamics, Knee and foot prosthesis. Active prosthesis - Control of Prosthetic Arms and Hands, Leg Mechanisms, Ankle–Foot Mechanisms, Prosthesis Suspension | | |
| **Module:7** | **Wearable mechatronics devices** | **4 hours** |
| Wearable Artificial Kidney, Wireless capsule endoscope, Wearable Exoskeletal rehabilitation system, Wearable hand rehabilitation, | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **30 hours** |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. Design and development of prosthetic limb
2. Development of wearable devices for measuring finger movement
3. Development of hearing aid equipment's
4. Tactile devices for visually challenged people
5. Image processing of CT & MRI data to be used for engineering applications
6. Design and development of cardiac devices like stent etc.,
7. Design of implants and instrumentation for orthopedic applications

**Text Book(s)**

| | |
|---|---|
| 1. | Graham M. Brooker, "Introduction to Bio-Mechatronics", Sci Tech Publishing, 2012. |

**Reference Books**

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|---|---|
| 1. | Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Bio-Medical Instrumentation and Measurements", II edition, Pearson Education, 2009. |
| 2. | Raymond Tong Kaiyu . "Bio-mechatronics in Medicine and Healthcare" Pan Stanford Publishing, CRC Press, 2011. |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| **Course Code** | **Course Title** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **MEE6058** | **INDUSTRIAL PROCESS AUTOMATION** | **2** | **0** | **0** | **4** | **3** |
| **Pre-requisite** | None | **Syllabus version** | | | | |
| **Anti-requisite** | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Impart knowledge on PLC, Supervisory control and factory automation

**Course Outcome (CO):**

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

1. Explain the Industrial process automation and its strategy
2. Demonstrate the Modes of computer control in automations
3. Design a simple automation system using PLC and SCADA for the industry
4. Explain the Industrial networks for developing the communication Infrastructure
5. Design a HMI for industry automation system
6. Apply automation systems in different industrial processes

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|---|---|---|
| **Module:1** | **Industrial Process Automation** | **4 hours** |
| Need for process automation - generic duties of an automation system**,** Concepts of process automation in automotive, food/beverage, oil/gas and chemical industries. | | |
| **Module:2** | **Automation strategy** | **4 hours** |
| Physical architecture of an automation system- Plant wide control systems, Process control systems- continuous and batch process-feedback control system overview. | | |
| **Module:3** | **Automation system control strategies & DCS** | **4 hours** |
| Modes of computer control, DCS- Introduction, Architecture and components, Controllers and functional features | | |
| **Module:4** | **SCADA** | **4 hours** |
| Introduction, Architecture and components, Controllers and functional features, RTU technology, Interfacing PLC to SCADA/DCS. | | |
| **Module:5** | **Industrial Communication Infrastructure** | **4 hours** |
| Serial communication standards - RS232/422/485 - Modbus. Industrial networks - HART - Device Net - Profibus and Fieldbus communication. | | |
| **Module:6** | **Operator consoles and interfaces** | **4 hours** |
| HMI Basics, Types, Applications of Human Machine Interface - HMI Processing -Interaction styles and general design interaction - strategies interface metaphors and conceptual models HCI and the World Wide Web HCI - security accessibility of user interfaces, evaluation HCI and social computing. | | |
| **Module:7** | **Case Studies** | **4 hours** |
| Case studies on applications of automation systems in different industrial processes. | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |

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| **Total Lecture hours:** | **30 hours** |
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| **Challenging Projects (Indicative)** | **60 [Non-contact hours]** |

1. Automation of bottle filling system using PLC
2. Development of HMI interface with PLC Programming
3. PLC Programming for Elevator control applications
4. Implementation of SCADA for supervisory control of Boiler plant in simulation environment
5. Implementation of DCS for overall control of cement factory in simulation environment
6. Interfacing HMI with internet for controlling a remote process

**Text Book(s)**

| | |
|---|---|
| 1. | B. R. Mehta and Y. J. Reddy, Industrial Process Automation Systems Design and Implementation, Elsevier Inc. 2015. |

**Reference Books**

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|---|---|
| 1. | K.L.Sharma, Overview of Industrial Process Automation, Elsevier, 2011 |
| 2. | Frank Lamb, Industrial Automation: Hands On, McGraw-Hill Professional, 2013 |

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| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6059 | INTERNET OF THINGS AND SMART MANUFACTURING | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| Anti-requisite | | v. 1.10 | | | | |

**Course Objectives (CoB):**

The Objectives of the course are to:

1. Understand our MES environment in the context of the ISA95 standards.
2. Introduces the concepts of Industrial Internet of Things, and Cloud Computing. The students are exposed to the architectures, and various frameworks in IIoT and Cloud Computing
3. Provide an insight into the application of cloud computing in manufacturing, enabling high level integration of product development phases. It gives an idea about different tools and methodologies used for cloud based product management
4. Designed to offer learners an introduction to Industry 4.0 (or the Industrial Internet), its applications in the business world. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.
5. Implement Virtualization.

**Course Outcome (CO):**

On completion of this course student should be able to:

1. Analyze manufacturing operations and determine the lines of responsibility and technical integration between operations and logistics systems.
2. Apply the cloud concepts in a sustainable and global product development.
3. Understand the concept of cloud based distributed environment for collaborative manufacturing.
4. Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.
5. Able to outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world.
6. Implement a prototype of the IoT/cloud system design.
7. Appreciate the smartness in Smart Factories, Smart cities, smart products and smart services industrial controllers

| Module:1 | Introduction | 4 hours |
|---|---|---|
| Concept of Internet of Things (IoT), common definitions, IoT applications, and functional view. | | |

| Module:2 | Internet of Things and Internet Technology | 4 hours |
|---|---|---|
| Cloud Computing, Semantic Technologies, Networking and Communication Technologies. | | |

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|---|---|---|
| **Module:3** | **Contemporary Manufacturing Paradigms** | **4 hours** |
| Concept of Agile, Networked, Reconfigurable and Cloud manufacturing. | | |
| **Module:4** | **IoT Enabled Manufacturing System** | **4 hours** |
| Architecture of IoT-MS, Integration framework of Real-time manufacturing information, Work logic of IoT-MS. | | |
| **Module:5** | **Cloud based Manufacturing Resource configuration** | **4 hours** |
| Concept of cloud manufacturing, Real-time production information perception and capturing, Cloud service selection, Cloud Machine model. | | |
| **Module:6** | **Smart Factory and Smart Manufacturing** | **4 hours** |
| Concepts of Industry 4.0 standard, Real-time information- based scheduling, capacity planning, material planning, Real-time production monitoring techniques with smart sensors, Configuration of smart shop floor, traceability and call back of defective products | | |
| **Module:7** | **Case Studies** | **4 hours** |
| Case studies on applications of IoT in different industrial progressions like virtual visibility maturity model etc. | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **30 hours** |
| **Challenging Projects (Indicative)** | | **60 [Non-contact hours]** |

1. IoT based production and shipment monitoring system
2. Raw materials, In process and finished goods monitoring by IoT
3. Energy Monitoring over IoT
4. IoT based Component Detection/Inspection
5. IoT enabled Production Reporting System
6. IoT based Industry Automation using single board computers (Raspberry Pi).

**Text Book(s)**

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|---|---|
| 1. | Yingfeng Zhang, Fei Tao, Optimization of Manufacturing Systems using the Internet of Things, Academic Press- Technology & Engineering, 2016. |

**Reference Books**

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|---|---|
| 1. | Jiafu Wan, IztokHumar, Daqiang Zhang, Industrial IoT Technologies and Applications, Springer, 17-Aug-2016. |
| 2. | K. Wang, Y. Wang, J.O. Strandhagen, T. Yu, Advanced Manufacturing and Automation V, WIT Press, 2016 |
| 3. | OvidiuVermesan and Peter Friess, Internet of Things – From Research and Innovation to |

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|---|---|---|---|
| | Market Deployment, River Publishers, 2014. | | |
| Recommended by Board of Studies | 17-08-2017 | | |
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