VIT®

Vellore Institute of Technology

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

## SCHOOL OF MECHANICAL ENGINEERING

# M. Tech Manufacturing Engineering

## (M.Tech MMF)

Curriculum

(*2020-2021 admitted students*)

## 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 impactful 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 highest caliber who would engage in 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 Manufacturing Engineering

## 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.

# PROGRAMME OUTCOMES (POs)

PO_1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO_2: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO_3: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems

PO_4: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO_5: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO_6: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO_7: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO_8: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

# PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech. (Manufacturing Engineering) programme, graduates will be able to

PSO_01: Prepare process plan, simulate manufacturing processes and establish production systems for the physical realisation of components and products

PSO_02: Conduct experimental investigations and incorporate latest technologies for improving manufacturing processes

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

# M. Tech Manufacturing Engineering

## CREDIT STRUCTURE

### Category-wise Credit distribution

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

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# M. Tech Manufacturing Engineering

# DETAILED CURRICULUM

## University Core

| S. No. | Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| 1. | MAT 5005 | Advanced Mathematical Methods | 3 | 0 | 0 | 0 | 3 |
| 2. | MEE6099 | Master's Thesis | - | - | - | - | 16 |
| 3. | SET5001 | SET Project | - | - | - | - | 2 |
| 4. | SET5002 | SET Project | - | - | - | - | 2 |
| 5. | EFL5097 | English and Foreign Language | 0 | 0 | 0 | 0 | 2 |
| Basket<br>ENG5001 - Fundamentals of Communication Skills - LO<br>ENG5002 - Professional and Communication Skills - LO<br>FRE5001 - Francais fonctionnel - TH<br>GER5001 - Deutsch fuer Anfaenger - TH | | | | | | | |
| 6. | STS6777 | Soft Skills M.Tech. | 0 | 0 | 0 | 0 | 2 |
| Basket<br>STS5001 - Essentials of Business Etiquettes - SS<br>STS5001 - Essentials of Business Etiquette and Problem Solving - SS<br>STS5002 - Preparing for Industry - SS<br>STS5102 - Programming and Problem Solving Skills - SS | | | | | | | |

## Programme Core

| S. No. | Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| **1.** | MEE5001 | Finite Element Methods in Manufacturing | 3 | 0 | 2 | 0 | 4 |
| **2.** | MEE5002 | Computer Integrated Manufacturing | 2 | 0 | 0 | 4 | 3 |
| **3.** | MEE5003 | Advanced Materials and Characterization | 3 | 0 | 0 | 0 | 3 |
| **4.** | MEE5004 | Modern Machining Processes | 2 | 0 | 0 | 4 | 3 |
| **5.** | MEE5005 | Quality and Reliability Engineering | 3 | 0 | 0 | 0 | 3 |
| **6.** | MEE5025 | Mechatronics & Automation | 2 | 0 | 2 | 0 | 3 |

**Programme Elective**

| S. No. | Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| 1. | MEE6001 | Metrology and Non-destructive Testing | 2 | 0 | 0 | 4 | 3 |
| 2. | MEE6002 | Optimization Techniques | 2 | 2 | 0 | 4 | 4 |
| 3. | MEE6003 | Micro and Nano Manufacturing | 3 | 0 | 0 | 0 | 3 |
| 4. | MEE6004 | Casting and Welding Technology | 3 | 0 | 2 | 0 | 4 |
| 5. | MEE6005 | Virtual Manufacturing | 3 | 0 | 0 | 0 | 3 |
| 6. | MEE6006 | Theory of Metal Forming | 2 | 0 | 0 | 4 | 3 |
| 7. | MEE6007 | Sustainable Manufacturing | 3 | 0 | 0 | 0 | 3 |
| 8. | MEE6008 | Supply Chain and Logistics Management | 3 | 0 | 0 | 0 | 3 |
| 9. | MEE6009 | Manufacturing System Simulation | 2 | 0 | 2 | 0 | 3 |
| 10. | MEE6010 | Maintenance Engineering | 3 | 0 | 0 | 0 | 3 |
| 11. | MEE6011 | Manufacturing Information Systems | 2 | 0 | 0 | 4 | 3 |
| 12. | MEE6012 | Design and Analysis of Experiments | 2 | 2 | 0 | 4 | 4 |
| 13. | MEE6013 | Advanced Tool Engineering | 3 | 0 | 0 | 4 | 4 |
| 14. | MEE6014 | Laser Material Processing | 2 | 0 | 0 | 4 | 3 |
| 15. | MEE6015 | Additive Manufacturing Technology | 2 | 0 | 0 | 4 | 3 |
| 16. | MEE6052 | Industrial Surface Engineering | 2 | 0 | 0 | 4 | 3 |

| Course code | Advanced Mathematical Methods | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT5005 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | 2.0 | | | | |

**Course Objectives :**

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. | | |
| | | |
| **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** |

| | |
|---|---|
| **Text Book(s)** | |
| 1 | Differential Equations: Theory, Technique and Practice, G.F. Simmons, S. G. Krantz, Tata McGrawHill 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. | | | |
| Mode of evaluation: | | | |
| Recommended by Board of Studies | 03-06-2019 | | |
| Approved by Academic Council | No. 55 | Date | 13-06-2019 |

| Course code | Science, Engineering and Technology Project– I | L | T | P | J | C |
|---|---|---|---|---|---|---|
| SET5001 | | - | - | - | - | 2 |
| Pre-requisite | | Syllabus Version | | | | |
| | | 1.10 | | | | |

**Course Objectives:**

The Objectives of the course are:

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

**Expected Course Outcome:**

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

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

| Course code | Science, Engineering and Technology Project– II | L | T | P | J | C |
|---|---|---|---|---|---|---|
| SET5002 | | - | - | - | - | 2 |
| Pre-requisite | SET I | Syllabus version | | | | |
| | | 1.10 | | | | |

**Course Objectives:**

The Objectives of the course are:

1. SET project may be of theoretical analysis, modeling& simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these.
2. The SET project is intended to give each student the fundamental research concept. The projects will explore innovations in technology, systems and business strategy.
3. It improves the research culture and gives confidence for the student to practice and write individual research article in the form of national and international conferences and journal papers.
4. A consciousness of the ethical aspects of research and development work needed for societal improvement
5. SET project is carried along with other academic courses in the institute as a part of academic curriculum

**Expected Course Outcome:**

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.

**Student Assessment :** Mid reviews & SET International Conference Presentation (Oral or Poster)

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

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

**Course Objectives:**

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.

**Expected Course Outcome:**

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

**Contents**

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

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

| Course code | Fundamentals of Communication Skills | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ENG5001 | | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | Not cleared EPT (English Proficiency Test) | Syllabus version | | | | |
| | | v. 1.0 | | | | |

**Course Objectives:**

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

**Expected Course Outcome:**

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

| 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 | 8 hours |
|---|---|---|

Basic Sentence Structure
Connectives
Transformation of Sentences
Synthesis of Sentences

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

Instructions
Paragraph
Transcoding

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

**Text Book(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. |
| | Authors, book title, year of publication, edition number, press, place |

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 as 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 in to 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 FAQ's 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

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

| Course code | Professional and Communication Skills | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ENG5002 | | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | ENG5001 | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

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

**Expected Course Outcome:**

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><br>Activity: SWOT Analysis | | |
| **Module:2** | **Interpersonal Interaction** | **2 hours** |
| Interpersonal Communication with the team leader and colleagues at the workplace<br><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><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><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><br>Activity: Case Analysis of a Challenging Scenario | | |

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

| | | |
|---|---|---|
| **Text Book(s)** | | |
| 1 | BhatnagarNitin and MamtaBhatnagar, *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** | **32 hours** |
| Mode of evaluation: : Online Quizzes, Presentation, Role play, Group Discussions, Assignments, Mini Project | | |

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

s

| Course code | Deutsch fürAnfänger | L | T | P | J | C |
|---|---|---|---|---|---|---|
| GER5001 | | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v.1 | | | | |

**Course Objectives:**

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.

**Expected Course Outcome:**

1. To create the basics of German language in their day to day life.
2. To understand the conjugation of different forms of regular/irregular verbs.
3. To understand the rule to identify the gender of the Nouns and apply articles appropriately.
4. To apply the German language skill in writing corresponding letters, E-Mails etc.
5. To create the talent of translating passages from English-German and vice versa and To frame simple dialogues based on given situations.

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

| Course code | FRANCAIS FONCTIONNEL | L | T | P | J | C |
|---|---|---|---|---|---|---|
| FRE5001 | | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v.1 | | | | |

**Course Objectives:**

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.

**Expected Course Outcome:**

1. To remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. To create communicative skill 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 | 10.06.2016 | | |
| Approved by Academic Council | 41 | Date | 17.06.2016 |

| Course code | Essentials of Business Etiquette and problem solving | L | T | P | J | C |
|---|---|---|---|---|---|---|
| STS5001 | | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

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

**Expected Course Outcome:**

The students will be able to

1. Be proficient in solving quantitative aptitude and verbal ability questions of various examinations effortlessly
2. To communicate the message to the target audience clearly
3. Enabling students to use relevant aptitude and appropriate language to express themselves

| 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)

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 09/06/2017 | | |
| Approved by Academic Council | 45 | Date | 15.06.2017 |

| **Course code** | **Preparing for Industry** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **STS5002** | | **0** | **0** | **0** | **0** | **2** |
| **Pre-requisite** | **None** | **Syllabus version** | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

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

**Expected Course Outcome:**

1. Simplify, evaluate, analyze and use functions and expressions to simulate real situations to be industry ready.
2. Interact confidently and use decision making models effectively
3. Be proficient in solving quantitative aptitude and verbal ability questions of various examinations effortlessly

| | | |
|---|---|---|
| **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 Brain storming 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

| | | |
|---|---|---|
| **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** | | |

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)

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 09/06/2017 | | |
| Approved by Academic Council | 45 | Date | 15-06-2017 |

| **Course code** | **Finite Element Methods in Manufacturing** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **MEE5001** | | **3** | **0** | **2** | **0** | **4** |
| **Pre-requisite** | **NIL** | **Syllabus version** | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To teach the mathematical and physical principles underlying the Finite Element Method (FEM)
2. To introduce the concepts of FEM and to apply in the field of Manufacturing Engineering.

**Expected Course Outcome:**

1. Solve differential equations using various weighted residual methods and use them for finite element analysis
2. Perform structural analysis of using 1 D and 2 D elements
3. Perform thermal analysis using 1 D and 2 D elements
4. Model various nonlinearities to perform nonlinear finite element analysis
5. Model and simulate manufacturing processes such as welding, casting, metal forming and metal cutting
6. Perform finite element analysis on real life components and for simulating manufacturing processes using commercial package

| **Module:1** | **Mathematical basis for FEM** | **6 hours** |
|---|---|---|

General field problems in engineering-Discrete and continuous models characteristics – Variational formulation of boundary value problems–Minimum potential energy principle - The method of weighted residuals-Solution of large system of equations - Choleski decomposition-Gaussian elimination procedures.

| **Module:2** | **General theory of FEM** | **5 hours** |
|---|---|---|

General theory of FEM–Procedure for FEM - Discretization of domain - Selection of interpolation polynomials–Convergence requirements- Shape functions for simplex elements.

| **Module:3** | **Applications of FEM in structural analysis** | **8 hours** |
|---|---|---|

Element characteristic matrices and vectors for elasticity problem - Assembly of element characteristics matrices–Incorporation of boundary conditions - Solution of the equations-Post processing –Solving problems in structural mechanics using bar, truss and beam elements.

| **Module:4** | **Applications of FEM in solid mechanics** | **6 hours** |
|---|---|---|

Plane stress, plane strain and axisymmetric stress analysis using constant strain trainable and rectangular element - Natural coordinate systems and numerical integration.

| **Module:5** | **Applications of FEM in Heat transfer** | **6 hours** |
|---|---|---|

Formulation of element equation for heat transfer considering conduction and convection loss - One dimensional, two dimensional and axisymmetric steady start heat transfer analysis using simplex elements – Introduction to transient heat transfer analysis.

| **Module:6** | **Basic concepts of nonlinear FEM** | **6 hours** |
|---|---|---|

Nonlinear problems – Analysis of material nonlinearity - Analysis of geometric nonlinearity – combined material and geometric nonlinearity – nonlinear contact conditions.

| **Module:7** | **Applications of FEA in casting and weldment solidification,** | **6 hours** |
|---|---|---|

| | | |
|---|---|---|
| | **Metal Forming and Machining** | |
| FE analysis of casting and Weldments solidification – special considerations, latent heat incorporation - Case studies from published papers.<br>FE analysis of metal forming and metal cutting, chip separation criteria, incorporation of strain rate dependency- Case studies from published papers. | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | J. N. Reddy. (2005), An Introduction to Finite Element Method McGraw Hill, International Student Edition |
| **Reference Books** | |
| 1. | J. Paulo Davim, (2011), Finite Element Method in Manufacturing Processes, Wiley |
| 2. | R. W. Lewis, PerumalNithiarasu, KankanhalliSeetharamu,(2004), Fundamentals of the Finite Element Method for Heat and Fluid Flow, John Wiley & Sons Ltd. |
| 3. | Prakash Mahadeo Dixit, Uday S. Dixit, (2008) Modeling of Metal Forming and Machining Processes: By Finite Element and Soft Computing Methods, Springer-Verlag Ltd. |
| 4. | Reddy. J.N., (2014), An Introduction to Nonlinear Finite Element Analysis: with applications to heat transfer, fluid mechanics, and solid mechanics, OUP Oxford; 2 edition |

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

**List of Challenging Experiments (Indicative)**

Lab course is to introduce the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics. To train the students in analysis software to perform various analysis like static, thermal, fatigue, Harmonic and transient analysis on components and structures. Software used to demonstrate the FEM is ANSYS.

| | | |
|---|---|---|
| 1. | Finite Element Analysis of structural problem. | 5 hours |
| 2. | Finite Element Analysis of Heat transfer problems | 5 hours |
| 3. | Finite Element Analysis of fluid flow problems | 5hours |
| 4. | Finite Element Analysis of nonlinear continuum mechanics problems | 5hours |
| 5. | Dynamic and normal Mode Dynamic Analysis using FEA Technique. | 5 hours |
| 6. | Finite element analysis of contact analysis | 5 hours |
| | **Total Laboratory Hours** | **30 hours** |

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|---|---|---|---|
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Computer Integrated Manufacturing | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5002 | | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. Develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.
2. Develop an understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality.
3. Obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc, as they apply to factory management and factory floor operations.

**Expected Course Outcome:**

1. Understand the effect of manufacturing automation strategies and derive production metrics.
2. Analyze automated flow lines and assembly systems, and balance the line
3. Design automated material handling and storage systems for a typical production system
4. Design a manufacturing cell and cellular manufacturing system.
5. Develop CAPP systems for rotational and prismatic parts

| Module:1 | Concept of CIM | 4 hours |
|---|---|---|

Manufacturing and its types – Definition of CIM, Elements of CIM, Benefits of CIM, Needs of CIM: Hardware and software. Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Product Life-Cycle Management (PLM), Collaborative Product Development.

| Module:2 | CIM Technology and Systems: | 4 hours |
|---|---|---|

Design for Manufacturability (DFM): Component Design, Design for Assembly. Computer-Aided Process Planning: Variant and Generative Process Planning, Material Requirements Planning (MRP), Manufacturing Resource Planning (MRP -II), Cellular Manufacturing, Programmable Logic Controllers, Flexible Manufacturing Systems: Physical Components of an FMS, FMS benefits and limitations of FMS.

| Module:3 | Computer Aided Planning and Control | 4 hours |
|---|---|---|

Production planning and control-cost planning and control-inventory management-Material requirements planning - (ERP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology automated data collection system.

| Module:4 | Computer Monitoring | 4 hours |
|---|---|---|

Types of production monitoring systems-structure model of manufacturing process-process control & strategies direct digital control-supervisory computer control-computer in QC – contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.

| Module:5 | Intelligent Systems in Manufacturing | 4 hours |
|---|---|---|

| | | |
|---|---|---|
| Current Developments and Future Prospects-Artificial intelligence techniques and the components of an intelligent manufacturing system. key artificial intelligence technologies (fuzzy logic, artificial neural networks, expert systems and genetic algorithms), | | |
| | | |
| **Module:6** | **Application of Computer Integrated Manufacturing (CIM) systems** | **4 hours** |
| CIM in automotive industry, Contributing Factors on CIM Application, Group technology applications for computer-integrated manufacturing, Computer-aided Tooling Design for Manufacturing Processes | | |
| | | |
| **Module:7** | **Cloud-based design and manufacturing** | **4 hours** |
| Evolution of design and manufacturing systems, Characteristics and requirements for cloud-based design and manufacturing systems, Cloud-based design and manufacturing example scenario, Cloud-Based Desktop Factory. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |
| **Text Book(s)** | | |
| 1. | MikellGroover, (2016), Automation, Production Systems and Computer-Integrated Manufacturing, 4th. Ed., ISBN # 0-13-349961-8, Pearson, New Jersey | |
| **Reference Books** | | |
| 1. | T.C. Chang, R. Wysk and H.P. Wang, (2009), Computer aided Manufacturing, Third Edition, Pearson Education | |
| | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | |
| **List of Challenging Experiments (Indicative)** | | |
| # Group project with a team size of 2 or 3<br>## Assessment will based on three reviews<br>### Down to earth industrial problems shall be given<br><br>1. A project scheduling approach to production and material requirement planning in Manufacturing-to-Order environments.<br>2. On-Line Simulation for Shop Floor Control in Manufacturing Execution System<br>3. Productivity Improvement through Computer Integrated Manufacturing.<br>4. Group Technology (GT) and Lean Production: A Conceptual Model for Enhancing Productivity.<br>5. A methodology for forming machine cells in a computer integrated manufacturing environment using group technology.<br>6. Cloud-Based Design, Engineering Analysis, and Manufacturing: A Cost-Benefit Analysis<br>7. Feature-based Data Exchange as Service for Cloud Based Design and Manufacturing | | **60 Hrs.** |
| | **Total Laboratory Hours** | **30 hours** |
| Mode of assessment: | | |
| Recommended by Board of Studies | 17-08-2017 | |

| | | | |
|---|---|---|---|
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Advanced Materials and Characterization | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5003 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To provide insight into the various classes of materials, their mechanical behaviour and applications
2. To impart knowledge on various surface modification techniques
3. To enable acquire skills in the use and selection of advanced experimental techniques for characterization of materials and application of these techniques to solving problems in materials science and engineering

**Expected Course Outcome:**

1. Describe the mechanical behaviour of materials, their importance and applications
2. Explain various engineering alloys in terms of specifications, applications, and heat treatment
3. Evaluate the suitability of different types of surface modifications on materials
4. Analyse the processing and applications of different non-metallic materials
5. Demonstrate the acquired skills in analysing the properties and applications of modern materials and alloys
6. Identify methods for use on characterization based on microscopy, microanalysis and diffraction techniques, and surface and spectroscopy analysis
7. Apply advanced lighting, thermal, chemical and imaging techniques for materials characterization particularly of the most widely used thin films, nanomaterials and advanced materials

| Module:1 | Review of Mechanical Behavior of Materials | 7 hours |
|---|---|---|

Plastic de formation in poly phase alloys - Strengthening mechanisms - Griffith's theory of failure modes – Brittle and ductile fractures - Damping properties of materials - fracture toughness - Initiation and propagation of fatigue cracks - Creep mechanisms - Environmental degradation of materials, Selection of materials for various applications.

| Module:2 | Engineering Alloys | 6 hours |
|---|---|---|

Cast iron , steels , alloy steels and stainless steels – an overview of phases and microstructure, types, specifications applications, heat treatment, effect of alloying elements, Aluminum, Magnesium and Titanium wrought and cast alloys used in engineering applications –Types, specifications, applications, heat treatment.

| Module:3 | Surface Modifications of Materials | 6 hours |
|---|---|---|

Mechanical surface treatment and coating - Case hardening and hard facing - thermal spraying – vapour deposition-ion implantation - Diffusion coating - Electroplating and Electrolysis - Conversion coating - Ceramic and organic coatings – Diamond coating, Laser based surface modification.

| | | |
|---|---|---|
| **Module:4** | **Nonmetallic Materials** | **6 hours** |
| Composite materials, ceramics, plastics -Introduction, an overview of processing, their characteristic features, types and applications. | | |
| **Module:5** | **Modern Materials and Alloys** | **6 hours** |
| Super alloys- Refractory metals - Shape memory alloys- Dual phase steels, Micro alloyed, High strength low alloy steel, Transformation induced plasticity (TRIP) steel, Maraging steel Compacted graphite iron and Creep resistant aluminum alloys, SMART materials, Metallic glass – Quasi crystal and Nano crystalline materials, metal foams. | | |
| **Module:6** | **Characterization Techniques - I** | **6 hours** |
| Optical Microscopy, Elements of Image Analysis and Quantitative Metallography X-Ray Diffraction, Intensity of diffracted beam, Indexing of XRD patterns of cubic and non-cubic crystals, precise lattice parameter determination – | | |
| **Module:7** | **Characterization Techniques - II** | **6 hours** |
| Scanning Electron Microscopy, Modes of Operation, Fractography, Chemical Analysis using Energy Dispersive Analysis – Transmission Electron Microscopy Principles, Thin Film and Replication Techniques, Image Contrast, Bright Field and Dark Field Imaging, Selected Area Diffraction and Chemical Analysis – Thermal Analysis Methods | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | W.D. Callister, David G. Rethwisch, (2013) Materials Science and Engineering: An Introduction, 9th ed., Wiley & Sons |

**Reference Books**

| | |
|---|---|
| 1. | William F. Hosford (2010), Mechanical Behavior of Materials, Cambridge University Press |

| | | | |
|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Modern Machining Processes | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5004 | | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To teach the fundamentals and advances in modern machining processes
2. To provide knowledge in applied aspects of modern machining processes viz., high speed machining, non-traditional machining, hybrid machining, advanced finishing and micro-machining

**Expected Course Outcome:**

1. Explain the working principle, process capabilities and applications of various modern machining/finishing processes
2. Analyse the inter-relationship between the process parameters and machining performances such as cutting forces, tool wear, material removal rate and surface finish
3. Discuss the specific characteristics and requirements of high speed machining system
4. Select a suitable modern machining/finishing process for manufacturing of macro/ micro components/features
5. Demonstrate understanding of modern machining process through a hands on project

| Module:1 | Mechanics of machining | 4 hours |
|---|---|---|

Mechanisms of chip formation, shear angle relations, and theoretical determination of cutting forces in machining - Thermal aspects of machining, tool wear and tool life.

| Module:2 | High speed machining | 4 hours |
|---|---|---|

High speed machining (HSM) – Characteristics of HSM – Machine tools requirements for HSM – Cutting tools for HSM – Design of tools for HSM – Tool clamping systems - Applications of HSM – Hard machining

| Module:3 | Unconventional machining processes-I | 4 hours |
|---|---|---|

Water jet machining - Abrasive water jet machining - Ultrasonic machining – working principle, machining system, process variables, parametric analysis, process capabilities and applications -

| Module:4 | Unconventional machining processes-II | 6 hours |
|---|---|---|

Electrochemical machining - Electric discharge machining - Laser beam machining – Electron beam machining - working principle, machining system, process variables, parametric analysis, process capabilities and applications.

| Module:5 | Hybrid machining processes | 3 hours |
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Vibration assisted machining – Electro chemical grinding – Electro chemical honing -Electrical

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| discharge grinding – Electro chemical discharge grinding - Thermal assisted machining. | | |
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| **Module:6** | **Advanced Finishing Processes** | **3 hours** |
| Abrasive flow finishing, Magnetic abrasive finishing, Magneto rheological finishing and chemical mechanical finishing - working principle, machine tool set up, process variables, process performance and applications. | | |
| | | |
| **Module:7** | **Micromachining processes** | **4 hours** |
| Introduction to microfabrication, Diamond micro-machining, ultrasonic micromachining, micro-EDM, micro-ECM laser beam micro-machining, electron beam micromachining and focused ion-beam techniques. | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
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| | **Total Lecture hours:** | **30 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Jain V.K, (2010), Introduction to Micromachining, Narosa Publishers |
| **Reference Books** | |
| 1. | J Paulo Davim (2011), Modern Machining Technology: A Practical Guide, Woodhead Publishing, USA |
| 2. | Hassan Abdel-Gawad El-Hofy (2014), Fundamentals of Machining Processes: Conventional and Nonconventional Processes, CRC Press, Taylor & Francis Group, USA |

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|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | |
| **List of Challenging Experiments (Indicative)** | | |
| 1. | # Group project with a team size of 2 or 3<br>## Assessment will based on three reviews<br>### Down to earth industrial problems shall be given<br>1. Development of analytical model based on the estimation of tool life by varying various process parameters in turning.<br>2. Effect of various cutting fluids on surface roughness in milling of Superalloys<br>3. Numerical modeling of cutting force and temperature in orthogonal cutting using ABAQUS<br>4. Measurement of cutting temperature in various machining process through contact and non-contact methods.<br>5. Ultrasonic machining of ceramics.<br>6. EDM machining of difficult to cut materials.<br>7. Effect of EDM process parameter on surface integrity<br>8. Numerical modeling of crater formation in Electrical Discharge Machining | 60 hours |

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|---|---|---|
| | 9. Surface roughness prediction based on cutting parameters and tool vibrations in turning operations<br>10. Effect MQL parameters on grinding of titanium of alloys | |

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| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Quality and Reliability Engineering | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5005 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. Demonstrate the approaches and techniques to assess and improve process and/or product quality.
2. Develop the understanding of principles and techniques of statistical quality control and their practical uses in product and/or process design and monitoring.
3. Present a problem oriented in depth knowledge, underlying concepts, methods and application of reliability engineering.

**Expected Course Outcome:**

1. Relate the process variability in terms of cost of quality.
2. Demonstrate the ability to design, use, and interpret control charts for monitoring the process quality.
3. Design a sampling plan with OC curve to evaluate the effectiveness for a given inspection process.
4. Apply basic quality improvement and problem solving tools like QFD, FMEA and bench marking.
5. Design basic factorial experiments and Taguchi methods to identify the main effects, interaction effects, and their significance.
6. Acquire the concepts of the reliability to calculate the system reliability based on the given component connection.
7. Apply the quality and reliability concepts to solve real time industry problem.

| Module:1 | Quality Management | 7 hours |
|---|---|---|

Evolution of Quality Control; Quality Control vs. Assurance, Basic stages of Quality Control, Elements of Quality Cost, Elements of Quality costs

| Module:2 | Statistical Process Control (SPC) | 6 hours |
|---|---|---|

Process Capability/Process Control: Process capability (Cp, Cpk, Pp, Ppk), Z scores, Special Causes and Common Causes of Variation, Process control charts for variables: X-R charts. Process control for attributes: p, np, c, u charts, Cusum Charts, Multi-vari charts, Six – Sigma approach

| Module:3 | Acceptance Sampling | 6 hours |
|---|---|---|

Lot by lot sampling-types - probability of acceptance in single, double, multiple sampling techniques- O.C. curves - producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

| Module:4 | Strategic tools and Techniques | 6 hours |
|---|---|---|

Quality Function Deployment, Deming's PDCA Cycle - Poka Yoke, Failure modes & Effects Analysis – Benchmarking - 5S concepts

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| **Module:5** | **Experimental design and Taguchi method** | **6 hours** |
| Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array. | | |
| | | |
| **Module:6** | **Reliability** | **6 hours** |
| Definition – reliability vs quality, reliability function – MTBF, MTTR, availability, bathtub curve – time dependent failure models – distributions – normal, weibull, lognormal – Reliability of system and models – serial, parallel and combined configuration – Markove analysis, load sharing systems, standby systems, covariant models, static models, dynamic models. | | |
| | | |
| **Module:7** | **Hazard models** | **6 hours** |
| Constant hazard model, linearly increasing hazard model, nonlinear hazard model and Weibull distribution, Advantages of Weibull distribution; System reliability models: series system, parallel system, series-parallel system, faulty tree analysis (FTA), Design based on reliability, Redundancy in design. | | |
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| **Module:8** | **Contemporary issues** | **2 hours** |
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| | **Total Lecture hours:** | **45 hours** |

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| **Text Book(s)** | |
| 1. | D.C. Montgomery, John Wiley, (2011), Introduction to Statistical Quality Control, 6th Edition, 2011. |
| **Reference Books** | |
| 1. | Krishnaiah.K, (2014), Applied Statistical Quality Control and Improvement, Prentice Hall of India (PHI) |
| 2. | P. A. Tobias and D. C. Trindade, (2011), Applied Reliability, 3rd Edition, Chapman and Hall/CRC |

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Mechatronics and Automation | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE5025 | | 2 | 0 | 2 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To provide the interdisciplinary knowledge in mechanical, electric, and control subsystems for developing mechatronic components and impart basic concepts of automation.
2. To introduce various sensing, actuating and control elements of a mechatronics system.
3. To provide hands on experience automation using Hydraulics, Pneumatics and PLC.

**Expected Course Outcome:**

1. Select a suitable sensor, actuator and controller for a Mechatronics application
2. Design a hydraulic circuit for a given automaton requirement
3. Design a Pneumatic Circuit for a given Problem
4. Develop programs for CNC machines and robots
5. Design an automation system for simple industrial applications
6. Experimentally perform industrial automation using Hydraulics, Pneumatics and PLC

| Module:1 | Mechatronics and its Elements | 4 hours |
|---|---|---|

Mechatronics in manufacturing, products and design. Review of electronics fundamentals - Mechatronics elements - Sensors, transducers, signal processing devices, relays, contactors, timers and data conversion devices

| Module:2 | Processors and controllers | 4 hours |
|---|---|---|

Microprocessors, microcontrollers, PID controllers and PLCs.

| Module:3 | Drives and mechanisms | 4 hours |
|---|---|---|

Drives: stepper AC/ DC motors and servo drives - Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines and transfer systems.

| Module:4 | Hydraulic systems | 4 hours |
|---|---|---|

Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps - Design of hydraulic circuits.

| Module:5 | Pneumatic Systems | 4 hours |
|---|---|---|

Production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

| Module:6 | CNC technology and Robotics | 4 hours |
|---|---|---|

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|---|---|---|
| CNC machines and part programming - Industrial Robotics basics and programming. | | |
| | | |
| **Module:7** | **Mechatronics in Automation** | **4 hours** |
| Applications of Mechatronics for the automation of industrial processes, such as the use of belt conveyors**,** material handling system, Automated inspections systems | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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| **Text Book(s)** | |
| 1. | Boucher, T. O.,(2012) Computer automation in manufacturing - an Introduction, Chapman and Hall |
| **Reference Books** | |
| 1. | W. Bolton, (2011) Mechatronics: Electronic control systems in mechanical and electrical engineering, Pearson; 5th edition |

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

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | PLC programming for simple industrial control problems with logic, timers and counters, data manipulation and math instructions. | 3 hours |
| 2. | Interfacing digital input and output field devices with PLC hardware. | 3 hours |
| 3. | Interfacing analog field devices with PLC. | 3 hours |
| 4. | Control of conveyor and material handling system using PLC system | 3 hours |
| 5. | Control of AC/DC/Servo motor drives for a motion control application. | 3 hours |
| 6. | PLC control of electro-pneumatic and electro-hydraulic systems. | 3 hours |
| 7. | Development and analysis of fluid power circuits with AUTOMATION STUDIO software | 3 hours |
| 8. | Industrial robot programming for a material handling and processing applications | 3 hours |
| 9. | Development HMI and SCADA system for simple industrial application. | 3 hours |
| 10. | Physical modeling and analysis of mechanical systems with MATLAB\SIMULINK \ SIMSCAPE software. | 3 hours |
| | **Total Laboratory Hours** | **30 hours** |

Mode of assessment:

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| **Course code** | **Metrology and Non-Destructive Testing** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **MEE6001** | | **2** | **0** | **0** | **4** | **3** |
| **Pre-requisite** | **NIL** | **Syllabus version** | | | | |
| | | v. 1.1 | | | | |

| **Course Objectives:** | | |
|---|---|---|
| 1. Introduce the basic principles of various measurement methodologies<br>2. Impart Knowledge on different types of measurement and statistical quality control methods.<br>3. Provide sufficient knowledge on the use and selection of inspection techniques. | | |
| | | |
| **Expected Course Outcome:** | | |
| 1. Carryout linear and angular measurements on mechanical components.<br>2. Identify transducer for sensing various mechanical parameters.<br>3. Design suitable sensing systems for measuring mechanical parameters.<br>4. Statistically analyze variation and design Statist0069cal Quality Control systems.<br>5. Carryout Non Destructive evaluation of components and products. | | |
| | | |
| **Module:1** | **Measurements** | **6 hours** |
| Need of inspection, Principles of measurement, Measuring Standards, Measuring systems and accuracy of measurement, Precision and accuracy, errors in measurement, calibration of measuring instruments. Introduction to limits, fits and tolerances, tolerance limits, deviations, allowance, unilateral and bilateral tolerance system | | |
| | | |
| **Module:2** | **Linear, angular and surface roughness measurements** | **6 hours** |
| Linear and angular measuring instruments, gauges, types of gauges, Limit gauges: GO and NO GO gauges, Slip gauges and Sine bar, significance of comparators in mass production. Different surface texture, factors affecting surface finish, methods of measuring surface finish, numerical evaluation of surface roughness – Ra, Rq and Rz, | | |
| | | |
| **Module:3** | **Vibration, strain, force and torque measurements** | **6 hours** |
| Vibration measurement system - strain gauges, Wheatstone's bridge circuit, strain measurement-axial, bending and torsional, strain gauge selection criteria. Force measurement system, load cells – types of load cells, dynamic force measurement; Torque measurement - static and dynamic torque, slip rings, introduction to torque testing dynamometers | | |
| | | |
| **Module:4** | **Metrology of machine tools, screw threads and gears** | **6 hours** |
| Geometrical alignment tests, performance tests, Machine tool testing – alignment testing of Lathe. Screw thread terminology, types of threads, measurement of effective diameter by two-wire method. Types of gears, spur gear terminology, pitch measurement methods. | | |
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| **Module:5** | **Statistical Quality Control** | **6 hours** |
| Data presentation – Statistical measures and tools – Process capability – Confidence and tolerance limits – Control charts for variables and for fraction defectives | | |
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| **Module:6** | **Inspection Techniques I** | **6 hours** |
| Characteristics of liquid penetrants – Principles of operation of Liquid Penetranttest – Developers – | | |

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| applications- Methods of production of magnetic fields- Principles of operation of magnetic particle test- Applications- Advantages and Limitations. | | |
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| **Module:7** | **Inspection Techniques II** | **7 hours** |
| **Radiography** Sources of ray X-ray production-properties of d and x rays – film characteristics – exposure charts – contrasts – operational characteristics of x ray equipment – applications. **Ultrasonic Techniques:** Production of ultrasonic waves – different types of waves - general characteristics of waves – pulse echo method – A, B, C scans | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Jain R.K., (2015), Engineering Metrology, Khanna Publications, Edition: 21st revised. |
| 2. | Baldevraj, Jayakumar T., Thavasimuthu M. (2008), Practical Non-Destructive Testing, 3rd edition, Narosa Publishers. |
| **Reference Books** | |
| 1. | Bewoor A.K and Kulkarni V.A,(2009), Metrology and measurement", Tata McGraw-Hill |
| 2. | Practical Non-Destructive Testing- Baldevraj, Jayakumar T., Thavasimuthu M., (2008), Narosa Publishers. 3rd edition |
| 3. | Alan S. Morris, Reza Langari, (2013), Measurement and instrumentation – Theory and application" 2nd edition |
| 4. | Paul E. Mix, (2005), Introduction to Non-destructive Testing, John Wiley & sons |

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| **List of Challenging Experiments (Indicative)** | | | |
| | | **Total Laboratory Hours** | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-1-2017 |

| **Course code** | **Optimization Techniques** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **MEE6002** | | **2** | **2** | **0** | **4** | **4** |
| **Pre-requisite** | **NIL** | **Syllabus version** | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To understand the role of optimization in engineering design and its importance.
2. To introduce the different optimization algorithms in linear as well as non-linear programming problems
3. To introduce the non-traditional optimization algorithms in solving non-linear optimization problems.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Apply basic concepts of mathematics to formulate engineering optimization problems as well as understand and apply necessary and sufficient conditions based on differential calculus, in finding maxima/minima of single and multi-variables functions.
2. Analyze the potential advantage of search methods and gradient based methods and apply for unconstrained non-linear optimization problems covering wide range of applications.
3. Enumerate the differences between direct and indirect optimization methods and apply for solving constrained non-linear optimization problems covering wide range of applications.
4. Understand and apply quadratic and geometric programming approaches to solve quadratic functions and engineering design problems covering wide range of applications.
5. Describe the basics of different evolutionary algorithms and apply existing optimization software packages to solve engineering problems.
6. Enumerate fundamentals of fuzzy logic and neural networks and apply these techniques to solve various problems arising from engineering areas.
7. Demonstrate the potential advantages of clustering techniques and apply to solve various problems covering wide range of applications in marketing, bio-medical and geo-spatial fields, etc.

| **Module:1** | **Classical Optimization Techniques** | **4 hours** |
|---|---|---|

Introduction, engineering applications of optimization-classification of optimization problems-Single variable optimization-Multivariable optimization with no constraints-Multi variable optimization with equality and in equality constraints: Lagrange multipliers method, Kuhn-Tucker conditions

| **Module:2** | **Unconstrained Nonlinear Optimization** | **4 hours** |
|---|---|---|

Direct Search methods: Univariate method, Pattern directions, Hook and Jeeves' method, Powell's method-Indirect search methods: Gradient of a function, Cauchy method, Fletcher-Reeves method.

| **Module:3** | **Constrained Non-linear Optimization:** | **3 hours** |
|---|---|---|

Characteristics of a constrained optimization problem - Direct methods: Cutting plane method, methods of feasible directions – Indirect methods: Interior and exterior penalty function methods

| **Module:4** | **Quadratic & Geometric programming:** | **3 hours** |
|---|---|---|

Quadratic programming: Introduction, necessary conditions, solution using Wolfe's method-Geometric programming: Solution from differential calculus point of view, Solution from arithmetic-geometric inequality point of view.

| **Module:5** | **Genetic algorithms** | **4 hours** |
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Basic concepts- working principle – encoding – different methods – fitness function – reproduction-

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| different methods. Genetic modelling-inheritance- Crossover mutation-convergence of genetic algorithm. | | |
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| **Module:6** | **Fuzzy logic and Artificial Neural Networks** | **6 hours** |
| Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Deffuzzification methods- Fuzzy logic controller(Block Diagram)<br>Basic concepts-Neural network Architectures-Single layer feed forward network-Multilayer feed forward network-Recurrent Networks-Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network-Kohonen Self organizing maps-ART | | |
| | | |
| **Module:7** | **Clustering** | **4 hours** |
| Supervised Learning and Unsupervised Learning techniques, Basic issues in clustering , First conceptual clustering system, Partitioning methods: K-means and Hierarchical Clustering, C-means, fuzzy K-means, Fuzzy C-means, Support vector machine | | |
| | | |
| **Module:8** | **Contemporary Discussions** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

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| **Text Book(s)** | |
| 1. | Singiresu S. Rao,(2009), Engineering Optimization - Theory and Practice, John Wiley & Sons, Inc., 4th edition |
| **Reference Books** | |
| 1. | Kalyanmoy Deb, (2012), Optimization for Engineering Design: Algorithms and Examples, PHI Learning Pvt. Ltd., 2nd edition |
| 2. | Wilhelm Forst, Dieter Hoffmann, (2010), Optimization - Theory and Practice, Springer |
| 3. | Ravindran, G. V. Reklaitis, K. M. Ragsdell,(2006),Engineering Optimization: Methods and Applications, John Wiley & Sons, 2nd edition |
| 4. | S.Rajasekharan, G.A.VijayalakshmiPai,(2003), Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India |
| | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | |
| **Challenging Projects** | |
| 11. | **Guidelines**<br>▪ Generally a team project [Maximum 4 members]<br>▪ Tools and techniques studied in optimization methods are to be applied.<br>▪ Focus on practical real life applications such as aerospace design, civil engineering constructions, manufacturing, production planning and control etc. |

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|---|---|---|
| | ▪ Report in digital format which includes features and assumptions of the model, notation used, mathematical model development, use of appropriate software/computer program for solving the model and sensitivity analysis/parametric analysis<br>Assessment on a continuous basis with a minimum of 3 reviews. | |
| Sample Projects | | 60 hours |
| 1. | Design and optimization of aircraft structure for minimum weight | |
| 2. | Optimal selection of machining conditions in metal cutting processes for minimum production cost | |
| 3. | Design and optimization of material handling equipment such as conveyors, trucks and cranes for minimum cost | |
| 4. | Design and optimization of water reservoir system for maximum storage capacity | |
| 5. | Design and optimization of multi-echelon inventory systems for optimal inventory decisions and shipment policies. | |
| Mode of assessment: | | |
| Recommended by Board of Studies | 17-08-2017 | |
| Approved by Academic Council | 47 | Date 05-10-2017 |

| Course code | Micro and Nano Manufacturing | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6003 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To acquaint the students with the principles, basic machine tools, and developments in the micro/nano manufacturing process and research trends in the area of micro and nano manufacturing process.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Demonstrate the principles of Micro Nano Manufacturing.
2. Apply the process of patterns using on any surface of lithography.
3. Analyze the etching and micro molding processes for the manufacture of patterns in wafers as well as very small plastic parts.
4. Illustrate size effect in micro machining with respect to plastic behavior.
5. Explain the different mechanical micro machining process.
6. Discuss on vapour deposition and laser nano manufacturing techniques.

| Module:1 | General principles of Micro and Nano manufacturing | 6 hours |
|---|---|---|

Substrates, thin film deposition techniques, etching, requirements of mask materials, Typical fabrication process for an integrated circuit – Scanning probe microscopy for Nano manufacturing

| Module:2 | Lithography | 6 hours |
|---|---|---|

X ray lithography – steps – Synchrotron radiation – LIGA process –Methods of resist application

| Module:3 | Etching and Micro moulding process: | 6 hours |
|---|---|---|

Dry etching and plasma etching, characteristics of plasma, effects of etching, Injection molding, Embossing, micro molding tools

| Module:4 | Size effect in micro machining | 6 hours |
|---|---|---|

Plastic behavior in large strain – Shear angle prediction – Mechanism of large plastic flow – Inhomogeneous train

| Module:5 | Mechanical Micro machining | 6 hours |
|---|---|---|

Principle and operation of Micro milling – Micro turning-Chip removal – High speed spindles – Requirements-Micro grinding process

| Module:6 | Vapor deposition techniques | 6 hours |
|---|---|---|

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|---|---|---|
| Principle and operation of Physical vapor deposition – chemical vapor deposition – thin film characteristics- | | |
| | | |
| **Module:7** | **Laser based Nano manufacturing** | **6 hours** |
| Laser fundamentals, sources, optics, Femtosecond Pulsed laser Micro and Nano fabrication – General applications.<br>**Industrial Applications of micro and Nano manufacturing:** MEMS, IC and micro scale features | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Mark J. Jackson, (2010) Micro and Nano fabrication, CRC Press, Taylor & Francis Group |
| **Reference Books** | |
| 1. | Yi Qin,(2010), Micro-Manufacturing Engineering and Technology, Elsevier Publisher, ISBN: 978-0-8155-1545-6 |
| 2. | V.K.Jain, (2013), Micro manufacturing processes, CRC Press, Taylor and Francis Group |
| 3. | MuammerKoc, TrugelOzel, (2011) Micro manufacturing, Design and manufacturing of micro products, Wiley Publishers |

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|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Casting and Welding Technology | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6004 | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To study the metallurgical concepts and applications of casting and welding process.
2. To impart the knowledge of joining different metallic and non- metallic materials.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Model the solidification process of castings.
2. Evaluate the suitability of various casting processes for a product.
3. Analyze the influence of process parameters on the quality of weld.
4. Evaluate the mechanisms of metal transfer through weld simulation.
5. Select appropriate advanced welding techniques for aerospace, nuclear, automobile and naval applications.
6. Evaluate the weldability of metals and alloys and their metallurgical aspects. Design welding and casting systems and quality control of components.
7. Design welding and casting systems and quality control of components.

| Module:1 | Casting Design and Metallurgy | 3 hours |
|---|---|---|

Heat transfer between metal and mold, Design considerations in casting , Solidification Mechanism, Centre-line feeding resistance

| Module:2 | Recent Trends in Casting and Foundry Layout | 5 hours |
|---|---|---|

Review and critical comparison of various established processes; recent developments e.g. flask less molding, hot and cold box molding; ceramic shell molding; V process; continuous casting; squeeze and pressed casting; Nishiyama process; Shaw process; Anitoch process etc.

| Module:3 | Physics of Welding Arc | 7 hours |
|---|---|---|

Welding arc, arc initiation and maintenance, cathode and anode drops, Arc column, Thermionic and non- thermionic cathode, arc characteristics, Characteristics of power sources for various arc welding processes, arc length regulation in mechanized welding processes, cycle and power factor, Static and dynamic characteristics of power sources.

| Module:4 | Welding Process and Modes of Metal Transfer | 6 hours |
|---|---|---|

Mechanism and types of metal transfer in various arc welding processes, factors controlling melting rate in various welding processes, Arc welding processes.

| Module:5 | Recent Trends in Welding | 4 hours |
|---|---|---|

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|---|---|---|
| Surfacing and Hot facing in welding, Friction welding, friction stir welding, diffusion bonding , ultrasonic welding ,electron beam welding ,Laser beam welding , Plasma welding hybrid twin wire active TIG – Tandem, MIG | | |
| | | |
| **Module:6** | **Weldability** | **6 hours** |
| Weldability tests, Varestraint testing, Lehigh Restraint test, Houldcroft test, Implant test, Oblique Y – Groove test ( Tekken Test )- Weld mechanical testing | | |
| | | |
| **Module:7** | **Metallurgy of Welding** | **12 hours** |
| Carbon equivalent, welding of carbon and low alloy steel, Welding of Stainless steel, Welding of Al and its alloys, Welding of Nickel based super alloys, Weld defects and weld failures | | |
| | | |
| **Module:8** | **Contemporary Discussion** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | John K. C, (2015), Metal Casting and Joining PHI Learning, New Delhi |
| 2. | Sindu Kou, Welding Metallurgy (2015), 2nd Edition, Publisher: John Wiley & Sons, Inc, ISBN: 978-0-471-43491-7 |
| **Reference Books** | |
| 1. | Bowditch, W.A., Bowditch M. A., Bowditch, K. E., (2006), Welding Technology Fundamentals, Goodheart -Willcox Pub., 4th Edition |
| 2. | Messler Robert W. Jr., (2004), Principles of welding WILEY-VCHVerlag GmbH & Co. KGaA, Weinheim |
| 3. | O'Brien, (2004), Welding Handbook: Welding Processes, Part 1, Vol. 2, American Welding Society |

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

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Effect of welding parameters in SMAW, GMAW and GTAW processes | 6 hours |
| 2. | Comparison of rutile, basic and cellulosic electrodes in MMAW process | 2 hours |
| 3. | Effect of shielding gases on performance of GMAW process | 2 hours |
| 4. | Effect of welding fluxes in submerged arc welding process | 2 hours |
| 5. | Study of optical profile gas cutting | 2 hours |
| 6. | Visual inspection for weld quality | 2 hours |
| 7. | Dye-penetrant inspection for determining surface defects in welded joints | 2 hours |
| 8. | Magnetic particle inspection for determining surface defects in welded joints | 2 hours |
| 9. | Ultrasonic inspection for assessing sub-surface defects | 2 hours |
| 10. | Radiographic inspection of weld joints | 2 hours |
| 11. | Sand Testing, Green sand moulding , $CO_2$ Moulding, Shell Moulding, Vacuum Moulding, NDT of castings, Design of gating systems, | 6 hours |

| | | |
|---|---|---|
| | Measurement of fluidity, Melting and casting of aluminum alloy castings | |
| | **Total Laboratory Hours** | **30 hours** |
| Mode of assessment: | | |
| Recommended by Board of Studies | 17-08-2017 | |
| Approved by Academic Council | 47 | Date 05-10-2017 |

| Course code | Virtual Manufacturing | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6005 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. An understanding of basic principles, techniques and issues underlying geometric design, digital geometry processing, and the latest virtual prototyping and e-manufacturing solutions in design and manufacturing;
2. A practical awareness of skills required to use virtual prototyping and e-manufacturing solutions to analyse various design and manufacturing activities

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Describe the techniques for product modeling, product visualization, digital mockup and product data management. Elaborate the methods for digital geometry processing
2. Describe the principles of and facilities for virtual reality and its applications in digital mockup and virtual manufacturing
3. Describe the methods and algorithms for collaborative design and design a product assembly by utilizing appropriate collaborative design tools
4. Demonstrate the applications of VM in material processing through simulation.

| Module:1 | Virtual manufacturing | 6 hours |
|---|---|---|

Definitions, scope of Virtual Manufacturing, Methods and tools used in Virtual manufacturing**,** Paradigms of VM: Design-centered VM, Production-centered VM and Control-centered VM. Generic VM Issues - relationships between VM, Virtual Prototyping, the Virtual Enterprise. Role of object oriented technology in VM.

| Module:2 | Product data visualization | 6 hours |
|---|---|---|

Graphics fundamentals, graphics data representation, polygonal based operations, LOD management, lighting and coloring, illumination, and shading. Virtual reality and its applications: computer animation, viewing in 3D, input/output devices, virtual and augmented reality, virtual design, virtual prototyping and virtual manufacturing

| Module:3 | Digital Mock-up Unit (DM) in Virtual Manufacturing | 6 hours |
|---|---|---|

Integrated Product and Process Development in Collaborative Virtual Engineering Environment using CATIA Software. Success Factors for Digital Mock-ups (DMU) in complex Aerospace Product Development

| Module:4 | Manufacturing process simulation | 6 hours |
|---|---|---|

Factory level, Machine level, Component level, Process level. Integrated Simulation Method to

| | | |
|---|---|---|
| Support Virtual Factory Engineering. Application of Virtual Reality Simulation of a Mechanical Assembly Production Line. Case studies using CATIA, SOLIDCAST, PROCAST, OPTICAST simulation software. | | |
| | | |
| **Module:5** | **Dispersed Network Manufacturing** | **6 hours** |
| Virtual factory, enterprise collaborative modeling system, virtual manufacturing (VM) system, Web-based work flow management, collaborative product commerce, applications of multi-agent technology, e-supply chain management and tele-manufacturing | | |
| | | |
| **Module:6** | **Virtual Machining Simulation** | **6 hours** |
| STEP-NC based machining simulation .Advanced process simulation and NC program optimization software-simulate real-world performance of machining operations | | |
| | | |
| **Module:7** | **Practical applications of VM in materials processing** | **7 hours** |
| VM for sheet metal processing, Virtual machining and inspection system (VMIS), Virtual Assembly Tools for Improving Product Design. | | |
| | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Milan Gregor and Stefan Medvecky (2010), Digital Factory – Theory and Practice, Engineering the Future,LaszloDudas (Ed.), ISBN: 978-953-307-210-4 |
| **Reference Books** | |
| 1. | An Introduction to CATIA V6 Release (2012): A Hands-on Tutorial Approach-Publisher: Schroff Development Corp (21 September 2011), ISBN-13: 978-1585036639. |

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|---|---|---|---|
| | | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Theory of Metal Forming | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6006 | | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. Select forming techniques for various applications
2. Calculate the forming limit for various processes

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Demonstrate the application of theory of plasticity to understand concepts of mechanics , stress and temperature distribution and friction in metal forming processes
2. Apply relevant forging load calculations to evaluate the impact on quality of the process
3. Analyse various forces that occur in a rolling process
4. Analyse the extrusion process in terms of in terms of deformation, lubrication and defects
5. Evaluate the wire and tube drawing processes in terms of performance and including the effect of residual stresses
6. Determine the application of various sheet metal forming methods
7. Evaluate the stresses formed when a new component or part is metal formed

| Module:1 | Fundamentals of Metal working | 5 hours |
|---|---|---|

Classification of Forming Process, Mechanics of Metal working, Flow Stress determination, Temperature in Metalworking, Friction and Lubrication, workability Residual Stresses

| Module:2 | Forging | 5 hours |
|---|---|---|

Classification of Forging process, Forging equipment, Forging in plain strain condition, open and closed die forging, Calculation of forging loads in closed-die forging, Forging defects, Powder Metallurgy in forging

| Module:3 | Rolling of Metals | 4 hours |
|---|---|---|

Classification of Rolling, Rolling mills, Hot-Rolling, Cold-Rolling, Rolling of bars and shapes, Forces and Geometrical Relationship in rolling, Problems and defects in rolled products

| Module:4 | Extrusion | 4 hours |
|---|---|---|

Classification, Extrusion equipment's, Deformation, Lubrication and Defects in extrusion process, Analysis of the extrusion process, Hydrostatic extrusion, extrusion of tubing.

| Module:5 | Drawing of Rods, Wires and Tubes | 4 hours |
|---|---|---|

Rod and wire drawing, Analysis of wire drawing, Tube-drawing processes, Analysis of Tube drawing, Residual stresses in Rod, Wire and Tubes

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|---|---|---|
| **Module:6** | **Sheet-Metal forming** | **3 hours** |
| Forming Methods, Shearing and blanking, Bending, Stretch forming, Deep drawing, Forming Limit Criteria, Defects in formed products | | |
| | | |
| **Module:7** | **Advances in Metal Forming** | **3 hours** |
| Explosive forming, Electro hydraulic forming, magnetic pulse forming, super plastic forming, electro forming – fine blanking HERF. | | |
| **Module:8** | | |
| **Module:1** | **Fundamentals of Metal working** | **5 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| **Text Book(s)** | |
|---|---|
| 1. | Helmi A. Youssef, Hassan A. El-Hofy, Mahmoud H. Ahmed, (2011), Manufacturing Technology: Materials, Processes, and Equipment, CRC Press, Taylor & Francis Group |
| 2. | George E Dieter (2014), Mechanical Metallurgy,Third Edition Tata McGraw Hill.Education PVT Ltd |
| **Reference Books** | |
| 1. | Heinz Tschaetsch,(2005), Metal Forming Practise, Springer Berlin Heidelberg New York |
| 2. | B.L.Juneja, (2012), Fundamentals of Metal Forming Processes, New Age International, 2nd Edition |
| 3. | Marciniak,Z., Duncan J.L., Hu S.J., (2006), Mechanics of Sheet Metal Forming‘, Butterworth-Heinemann An Imprint of Elsevier |
| 4. | Hingole, RahulkumarShivajirao. (2015), Advances in Metal Forming Expert System for Metal Forming, Springer Publications. |

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

**Challenging Projects**

**Guidelines**

**Iterative approach:** The project should be done iteratively, using a time-box approach.

**Intermediate presentation:** The project has to have a presentation half-way. This is crucial to guarantee that no bad surprises will appear at the project end. Before the intermediate presentation, one full iteration should be made. The poster that presents the research and the report outline should also be presented.

| | | |
|---|---|---|
| 1. | Deformation Behavior during rolling and swaging | **60 hours** |
| 2. | Recovery, recrystallization and grain growth grain size measurement by Quantitative metallography | |
| 3. | Determination of the tensile properties and strain hardening exponent of different class of materials | |
| 4. | Strain aging and yield point phenomenon | |
| 5. | Effect of work hardening on the tensile properties of metals | |

| | | | | |
|---|---|---|---|---|
| 6. | Incremental forming study | | | |
| 7. | Conventional FLD study for various sheet metals | | | |
| | | | **Total Laboratory Hours** | |
| Mode of assessment: | | | | |
| Recommended by Board of Studies | 17-08-2017 | | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 | |

| Course code | Sustainable Manufacturing | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6007 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To provide students with knowledge of key environmental and sustainability issues relevant to modern manufacturing.
2. To provide a set of tools and skills that may be used to design, analyze, and improve manufacturing processes, products, and business operations.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Identify key requirements and concepts in lean manufacturing.
2. Understand the need for sustainability assessment and their types.
3. Develop sustainability assessment framework model depending on the process under investigation.
4. To Frame Strategic polices and implement sustainability approaches
5. Leverage sustainability concepts in a supply chain.
6. Apply knowledge of lean and other sustainability concepts in a typical sustainable manufacturing setup.

| Module:1 | Need for Sustainable Manufacturing | 6 hours |
|---|---|---|

Introduction to the environmental issues pertaining to the manufacturing sector – pressure to reduce costs – processes that minimize negative environmental impacts – environmental legislation and energy costs – acceptable practice in society – adoption of low carbon technologies – need to reduce the carbon footprint of manufacturing operations.

| Module:2 | Techniques for non-market valuation | 6 hours |
|---|---|---|

Cost and income based approaches, demand estimation methods – expressed and revealed preference, choice modeling – Multi-criteria analysis- Stakeholder analysis – Environmental accounting at sector and national levels

| Module:3 | Sustainability performance evaluators | 6 hours |
|---|---|---|

Frameworks and techniques – environmental management systems – life cycle assessment – strategic and environmental impact assessments – carbon and water foot-printing.

| Module:4 | Strategies and Design Approaches | 6 hours |
|---|---|---|

Concepts of Competitive Strategy and Manufacturing Strategies and development of a strategic improvement programme – Manufacturing strategy in business - success Strategy formation and formulation – Structured strategy formulation – Sustainable manufacturing system design options –

| | | |
|---|---|---|
| Approaches to strategy formulation – Realization of new strategies/system designs | | |
| | | |
| **Module:5** | **Challenges and Opportunities** | **7 hours** |
| Challenges in logistics and supply chain – developing the right supply chain strategy for the products – need to align the supply network around the strategy – Tools that can be used systematically to identify areas for improvement in supply chains – Specific challenges and new thinking in the plan, source and delivering of sub-processes | | |
| | | |
| **Module:6** | **Principles of sustainable operations** | **7 hours** |
| Life cycle assessment Manufacturing and service activities –Influence of product design on operations – Process analysis – Capacity management – Quality management –Inventory management – Just-In-Time systems – Resource efficient design – Consumerism and sustainable well-being. | | |
| | | |
| **Module:7** | **Sustainable manufacturing and practices – Case Studies** | **4 hours** |
| Case Studies on sustainable manufacturing | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Seliger, G,(2012), Sustainable Manufacturing: Shaping Global Value Creation, Springer |
| **Reference Books** | |
| 1. | Dornfeld, David.(2012), Green Manufacturing, Springer-Verlag, New York |
| 2. | Davim, J.P.(2010), Sustainable Manufacturing, John Wiley & Sons. |
| 3. | Gupta, S.M. and Lambert, A.J.D.(2008), Environment Conscious Manufacturing, CRC Press |
| 4. | Douglas C.Montgomery, "Design and Analysis of Experiments", 5th Edition, John Wiley & Sons, 2012. |

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|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Supply Chain and Logistics Management | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6008 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To improve the overall organization performance and customer satisfaction by improving product or service delivery to consumer.
2. To fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory and labor.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Foresee the trends and importance of value chain in the operations of logistics and supply chain
2. Apply automation and outsourcing techniques for improving in customer service in logistics and warehouse operations
3. Analyse the impact of relationships and benchmarking on the performance of the supply chain using appropriate metrics
4. Demonstrate the effective use of emerging information technologies in logistics and supply chain management
5. Develop appropriate models in transportation management for decision-making
6. Address the problems of inventory management in a holistic approach using suitable models and strategies

| Module:1 | Supply Chain Management | 6 hours |
|---|---|---|

Introduction and Development- Nature and Concept - Importance of Supply Chain - Value Chain - Components of Supply Chain - The Need for Supply Chain - Understanding the Supply Chain Management - Participants in Supply Chain – Global Applications

| Module:2 | Logistics Management | 6 hours |
|---|---|---|

Origin and Definition – Types of Logistics – Logistics Management – Ware House Management – Automation and Outsourcing - Customer Service and Logistics Management – A Perspective - Concepts in Logistics and Physical Distribution - Distribution and Inventory-3PL and 4PL.

| Module:3 | Logistics and Supply chain relationships | 6 hours |
|---|---|---|

Benchmarking the logistics process and SCM operations –Mapping the supply chain processes – Supplier and distributor benchmarking –setting benchmarking priorities –identifying logistics performance indicators –Channel structure – Economics of distribution –channel relationships – logistics service alliances.

| Module:4 | Information System | 6 hours |
|---|---|---|

| | | |
|---|---|---|
| Introduction-Positioning of information in logistics and supply chain management (L&SCM)-Logistical information system-Operational logistical information system-Integrated information technology solution for L&SCM-Emerging Technologies in L&SCM. | | |
| | | |
| **Module:5** | **Transportation System** | **6 hours** |
| Introduction-Position of transportation in L&SCM-Elements of transportation cost-Modes of transportation-Multi-modal transportation-Containerization-Selection of transportation mode-Transportation decision (Pricing and Rate)-Transportation network (Routing and Scheduling). | | |
| | | |
| **Module:6** | **Inventory Management** | **6 hours** |
| The role of cycle inventory in a supply chain –Managing multi echelon cycle inventory – Estimating cycle inventory – related costs in practice – the role of safety inventory in a supply chain – managing safety inventory in a multi echelon supply chain – the role of information technology in inventory management – estimating and managing safety inventory in practice. | | |
| | | |
| **Module:7** | **Logistics Organization** | **7 hours** |
| Introduction-Evolutionary trends of logistics and supply chain organization-Basic organization principles-Factors influencing organizational structure**.** | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Donald J. Bowersox and David J. Closs, (2006), Logistical Management: The Integrated Supply Chain Process, TMH |

**Reference Books**

| | |
|---|---|
| 1. | Edward J Bradi, John J Coyle (2010), A Logistics Approach to Supply Chain Management, Cengage learning, New Delhi |
| 2. | Chopra, S. and Meindl, P., (2014), Supply Chain Management: Strategy, Planning & Operations, 6th edition, Pearson Education (Singapore) Pvt. Ltd. |
| 3. | Agrawal D K, (2003), Logistics & Supply Chain Management, Macmillan India Ltd. |
| 4. | Simchi-Levi, D. Kaminsky, P. Simchi-Levi, E. and Ravi Shankar (2008), Designing & Managing the Supply Chain: Concepts, Strategies & Case Studies, Third Edition, Tata McGraw-Hill, Third Edition |

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|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Manufacturing System Simulation | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6009 | | 2 | 0 | 2 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |
| Course Objectives: | | | | | | |
| 1. Ability to understand the underlying features of discrete event simulation and how it is applicable | | | | | | |

for analyses and development of manufacturing systems.
2. To understand the concept of simulation and to learn the simulation language.
3. To enable application of simulation to manufacturing systems and to gain hands on experiences from how discrete event simulation is applied based on an industrial needs.

**Expected Course Outcome:**

1. Identify and formulate advance problems and apply
2. Knowledge of mathematics and simulation packages to solve manufacturing problems.
3. Use the techniques, skills, and modern packages, necessary for professional practices.
4. Demonstrate the application of discrete event simulation.
5. Apply the methods and tools for select cases.

| **Module:1** | **Computer modelling and simulation system** | **4 hours** |
|---|---|---|

Introduction to simulation- steps in simulation-nature of computer modelling and simulation- types of models- Monte Carlo simulation, limitation of simulation, areas of application, examples. Components of system-discrete and continuous systems- Examples, Model of a system-variety of modelling approaches.

| **Module:2** | **Random number generation** | 3 **hours** |
|---|---|---|

Properties of random numbers, Random number generation techniques-the mid product method-constant multiplier technique- additive congruential method- linear congruential method, Tests for random numbers: frequency tests- test for autocorrelation.

| **Module:3** | **Random variable generation** | **5 hours** |
|---|---|---|

Random variable generation –inverse transform technique-exponential distribution–uniform distribution-Weibull distribution-triangular distribution. Empirical continuous distribution-generating approximate normal variates- Erlang distribution.

| **Module:4** | **Distribution and evaluation of experiments** | **4 hours** |
|---|---|---|

Discrete uniform distribution- Poisson distribution-geometric distribution- acceptance and rejection technique for Poisson, gamma distribution. Variance reduction techniques- antithetic variables-Validation of simulation models-Verification of simulation models.

| **Module:5** | **Discrete event simulation** | **3 hours** |
|---|---|---|

Concepts in discrete-event simulation- manual simulation using event scheduling, simulation of queuing system, simulation of inventory systems. Simulation of manufacturing and material handling systems.

| **Module:6** | **Simulation Packages** | **4 hours** |
|---|---|---|

Introduction to Simulation packages – simulation using spreadsheet, WITNESS, ARENA, GPSS. Programming for discrete event systems in GPSS.

| | | |
|---|---|---|
| **Module:7** | **Case Studies** | 5 **hours** |
| Modelling and simulation of a packaging line, assembly operations, batch processing, production/Inventory system using ARENA. | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Jerry banks, John S Carson, Barry L Nelson and David M Nicol,(2013), Discrete Event System Simulation, 5th edition, Pearson Education Asia |

**Reference Books**

| | |
|---|---|
| 1. | NarsingDeo, (2006), System Simulation with Digital Computer, Prentice hall of India |
| 2. | Averill M. Law, (2014), Simulation modeling and analysis, 5th edition, McGraw-Hill Education |
| 3. | W. David Kelton, Randall P. Sadowski, Nancy B. Zupick (2014), Simulation with Arena, McGraw-Hill Education, 6th edition |
| 4. | Sheldon M. Ross, (2012), Simulation, Academic Press, 5th Edition |
| 5. | William J. Stewart, (2009), Probability, Markov Chains, Queues, and Simulation: The Mathematical Basis of Performance Modeling, Princeton University Press |
| 6. | Barry L. Nelson (2010), Mathematics, Stochastic Modeling: Analysis and Simulation, Dover Publications |

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

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1. | Study of elements, entities, activities and basic models of a simulation package modeling and simulation. | 3 hours |
| 2. | Throughput analysis of an individual production facility using simulation. | 2 hours |
| 3. | Modelling of a typical manufacturing facility and study its performances. | 2 hours |
| 4. | Breakdown analysis of a production facility with one machine. | 2 hours |
| 5. | Breakdown analysis of a production system having multiple machines. | 2 hours |
| 6. | Study of transport system in a shop floor. | 2 hours |
| 7. | Buffer size design | 2 hours |
| 8. | Identification of bottleneck machine on a given shop floor | 2 hours |
| 9. | Simulation of a Queuing Systems | 2 hours |
| 10. | Simulation of Production Systems | 2 hours |
| 11. | Simulation of Inventory systems | 2 hours |
| 12. | Facility layout study using simulation | 2 hours |
| 13. | Project management using simulation | 3 hours |
| | **Total Laboratory Hours** | **30 hours** |

| | | | |
|---|---|---|---|
| SoftwarePackages : ARENA, QUEST, PROMODEL, FLEXSIM, AUTOMOD, WITNESS | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Maintenance Engineering | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6010 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To enable the student to understand maintenance principles, functions and practices followed in industry
2. To understand basic concepts of maintenance categories like Preventive maintenance, condition monitoring and repair methods for some basic machine elements.
3. To have an introductory idea about maintenance management

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Students will be able to trace out and locate the faulty element within a large machine based on the symptoms observed from the machines.
2. To suggest suitable repair methods, tools and tackles needed for performing the repair process.
3. To decide on the application of condition monitoring parameters of a machine as a preventive maintenance tool, with the final objective of reducing the breakdown situations.
4. To decide on the parts replacement plan on any machine in an economical way.

| Module:1 | Principles and Practices of Maintenance Planning | 6 hours |
|---|---|---|

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability

| Module:2 | Maintenance Policies – Preventive Maintenance | 6 hours |
|---|---|---|

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.

| Module:3 | Condition Monitoring | 6 **hours** |
|---|---|---|

Condition Monitoring – Cost comparison with and without CM – On-load testing and off-load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis

| Module:4 | Failure Analysis And Fault Location Methods | 6 hours |
|---|---|---|

Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

| Module:5 | Maintenance Organization, Economics, Optimization Models | 6 hours |
|---|---|---|

Maintenance organization – Maintenance economics-Introduction to maintenance optimization

| | | |
|---|---|---|
| models: Age replacement, Block replacement models | | |
| | | |
| **Module:6** | **Repair Methods For Basic Machine** | **6 hours** |
| Repair methods for beds, slideways, spindles, gears, lead screws and bearings | | |
| | | |
| **Module:7** | **Repair methods for Material handling equipment** | **6 hours** |
| Repair methods for Material handling equipment, Some examples - Upkeep Of Equipment Maintenance Records | | |
| | | |
| **Module:8** | **Contemporary Discussion** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Donald J. Bowersox and David J. Closs,(2006), Logistical Management: The Integrated Supply Chain Process, TMH |
| **Reference Books** | |
| 1. | Edward J Bradi, John J Coyle: (2010), A Logistics Approach to Supply Chain Management, Cengage learning, New Delhi |
| 2. | Chopra, S. and Meindl, P., (2014), Supply Chain Management: Strategy, Planning & Operations, 6th edition, Pearson Education (Singapore) Pvt. Ltd |
| 3. | Agrawal D K, (2003), Logistics & Supply Chain Management, Macmillan India Ltd |
| 4. | Simchi-Levi, D. Kaminsky, P. Simchi-Levi, E. and Ravi Shankar (2008), Designing & Managing the Supply Chain: Concepts, Strategies & Case Studies,. Third Edition, Tata McGraw-Hill, Third Edition |

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Manufacturing Information Systems | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6011 | | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To provide an importance of databases and its application in manufacturing systems that prepare students for their engineering practice by organization by conversant with order policies, data base terminologies, designing, manufacturing considerations.
2. Define and explain basic terms in the area of manufacturing, as well as structure, design, configuration and practical use of IT systems for manufacturing.
3. To provide specialist knowledge in the area of manufacturing information systems, as an upgrade of the basic knowledge about information systems provided in the core courses.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. To create simple to moderately complex manufacturing information system for manufacturing industry
2. Evaluate critically the role of management information systems for design, engineering and manufacturing
3. Demonstrate an appreciation of the complex relationship between information systems and organization
4. Explain system analysis and design tools
5. Apply decision support systems for various issues.

| Module:1 | Management Information Systems | 4 hours |
|---|---|---|

Need, Purpose and Objectives - Contemporary Approaches to MIS - Information as a strategic resource - Use of information for competitive advantage - MIS as an instrument for the organizational change

| Module:2 | Information, Management and Decision Making | 4 hours |
|---|---|---|

Models of Decision Making - Classical, Administrative and Herbert Simon's Models - Attributes of information and its relevance to Decision Making - Types of information

| Module:3 | Information Technology | 4 hours |
|---|---|---|

Definition, IT Capabilities and their organizational impact -Telecommunication and Networks - Types and Topologies of Networks - IT enabled services such as Call Centers, Geographical Information Systems etc

| Module:4 | Data Base Management Systems | 4 hours |
|---|---|---|

Data Warehousing and Data Mining

| | | |
|---|---|---|
| **Module:5** | **Systems Analysis and Design** | 4 **hours** |
| Systems Development Life Cycle - Alternative System Building Approaches - Prototyping - Rapid Development Tools - CASE Tools – Object Oriented Systems (Only introduction to these tools &techniques) | | |
| **Module:6** | **Decision Support Systems** | **4 hours** |
| Group Decision Support Systems - Executive Information Systems - Executive Support Systems - Expert Systems and Knowledge Based Expert Systems - Artificial Intelligence | | |
| **Module:7** | **Management Issues in MIS** | **4 hours** |
| Information Security and Control - Quality Assurance -Ethical and Social Dimensions - Intellectual Property Rights as related to IT Services / IT Products - Managing Global Information Systems | | |
| **Module:8** | **Contemporary Issues and Challenges** | **2 hours** |
| | **Total Lecture hours:** | **30 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Jawadekar, (2013) Management Information Systems, Tata McGraw Hill, 5th Edition |
| **Reference Books** | |
| 1. | Laudon and Laudon,, (2011), Management Information Systems, 12th Edition, Pearson Education Asia |
| 2. | Rajaraman, (2011), Analysis and Design of Information Systems, Prentice Hall, 3rd Edition |
| 3. | Turban and Aronson,(2010), Decision Support Systems and Intelligent Systems, Pearson Education Asia |

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

**Challenging Projects**

**Guidelines**

# Group project with a team size of 2 or 3
## Assessment will based on three reviews
### Down to earth industrial problems shall be given

| **Sample projects** | | |
|---|---|---|
| 1. | Developing a Business Intelligence Solutions for the Health Care industry. | 60 hours |
| 2. | Modelling of manufacturing information system based on complexity science | |
| 3. | Energy information system for textile industries | |
| 4. | Development of an information package for unorganized small scale textile sectors | |
| 5. | Decision support system for energy saving analysis in industries | |

| | | |
|---|---|---|
| 6. | Create a website in nearby showrooms/malls that supported their use and administration of talent resources | |
| 7. | Feasibility studies and proof of concept for new products and services | |
| 8. | Work flow analysis and design, process improvement | |
| 1. | Developing a Business Intelligence Solutions for the Health Care industry. | |

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|---|---|---|---|
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| **Course code** | **Design and Analysis of Experiments** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **MEE6012** | | **2** | **2** | **0** | **4** | **4** |
| **Pre-requisite** | **NIL** | **Syllabus version** | | | | |
| | | v. 1.1 | | | | |
| **Course Objectives:** | | | | | | |

1. To introduce the student to the principles and methods of statistical analysis of experimental designs.
2. To provide knowledge on process/product optimization through statistical concepts.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Identify the Principles and Guidelines of Design of Experiments
2. Analyze the Randomized Block Designs
3. Analyze the Factorial Designs
4. Explain the comparison of classical and Taguchi's approach in Design of Experiments
5. Solve the problems by Regression Analysis
6. Analyze the importance of response Surface Methodology in Design of Experiments

| **Module:1** | **Experiments with a Single Factor** | **4 hours** |
|---|---|---|

Basic Principles and Guidelines of Design of Experiments - Single Factor Experiments – ANOVA - Model Adequacy Checking - Determining Sample Size - Comparing Pairs of Treatment Means- Introduction to DOAE software

| **Module:2** | **Randomized Block Designs** | **4 hours** |
|---|---|---|

Randomized complete block design - Latin square designs - Graeco-Latin square design - Balanced incomplete block designs

| **Module:3** | **Factorial Designs** | **4 hours** |
|---|---|---|

Two levels - $2^k$ factorial designs - Confounding and Blocking in factorial designs

| **Module:4** | **Fractional Factorial Designs** | **4 hours** |
|---|---|---|

The One-Half and One-Quarter Fraction of the $2^k$ Design - General $2^{k-p}$ Fractional Factorial Design – Resolution

| **Module:5** | **Robust Design** | **4 hours** |
|---|---|---|

Comparison of classical and Taguchi's approach - orthogonal designs - S/N ratio - application to Process and Parameter design.

| **Module:6** | **Regression Analysis** | **4 hours** |
|---|---|---|

Introduction - Simple Linear Regression Analysis - Multiple Linear Regression Model - Model Adequacy Checking

| **Module:7** | **Response Surface Methodology** | **4 hours** |
|---|---|---|

Response surface methodology, parameter – optimization - robust parameter design and itsapplication to control of processes with high variability.

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|---|---|---|
| **Module:8** | **Contemporary issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Douglas C. Montgomery, (2017), Design and Analysis of Experiments, John Wiley & Sons, Inc., 9th edition |
| **Reference Books** | |
| 1. | Philip J. Rose, (2000), Taguchi Techniques for quality Engineering, Prentice Hall |
| 2. | Charles R. Hicks, Kenneth V. Turner (1999) Jr., Fundamental concepts in the Design of Experiments, Oxford University Press, $5^{th}$ edition |

**Tutorial**

Douglas C. Montgomery (2016) Response Surface Methodology: Process and Product Optimization using designed experiments: $4^{th}$ edition.

The students will be exposed to deal and solve the practical problems faced in the firms.

| | | |
|---|---|---|
| **Sample Tutorials** | | |
| 1. | Single Factor Experiments | **30 hours** |
| 2. | Randomized complete block design | |
| 3. | Latin square designs | |
| 4. | Graeco-Latin square design | |
| 5. | Balanced incomplete block designs | |
| 6. | $2^k$ factorial designs | |
| 7. | Confounding and Blocking in factorial designs | |
| 8. | Fractional Factorial Designs | |
| 9. | Taguchi's orthogonal designs and S/N ratio | |
| 10. | Multiple linear regression model | |
| 11. | Exercise on robust parameter design | |

**Projects**

To provide the knowledge of the DOE software by solving the real time problems and case studies using

| | | |
|---|---|---|
| **Sample Projects** | | |
| 1. | Randomized design, block design to remove noise factors in an organization. | **60** hours |
| 2. | Factorial Designs and fractional factorial designs in process optimization. | |
| 3. | Regression Analysis to predict the process performance. | |
| 4. | Quadratic equation prediction and surface plot using RSM. | |
| 5. | Case studies using optimization techniques**.** | |

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | |
| Recommended by Board of Studies | 17-08-2017 |

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|---|---|---|---|
| Approved by Academic Council | 47 | Date | 05-10-2019 |

| Course code | Advanced Tool Engineering | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6013 | | 3 | 0 | 0 | 4 | 4 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To teach the students the basic and modern tools available.
2. To enable the students to design tools, dies, jigs and fixtures
3. To teach students to analyse and optimise design of jigs and fixtures
4. To expose students to design of dies for press work and forging

**Expected Course Outcome:**

1. Interpret the tooling drawing, materials and their heat treatment
2. Recommend appropriate jigs and fixtures for various metal forming operations
3. Choose various types of work holding devices for different geometry of work pieces
4. Design of cutting tools for various operations
5. Design of tooling for CNC Machine tools
6. Design of cutting tools, press tool dies, jigs and fixtures for manufacturing various components

| Module:1 | Tool Design | 3 hours |
|---|---|---|

Drafting and Design Techniques in Tooling, Modern Tool making practices, Tooling materials and heat treatment

| Module:2 | Design of Press Tools Dies | 6 hours |
|---|---|---|

Types of Dies –Method of Die operation–Clearance and cutting force calculations-Blanking and Piercing die design – Pilots – Strippers and pressure pads-Presswork materials – Strip layout – Short-run tooling for Piercing.

| Module:3 | Design of Forming Dies | 7 hours |
|---|---|---|

Bending dies – Forging dies – Extrusion dies - Drawing dies - Design and drafting; Casting Dies and Welding dies – Design

| Module:4 | Design of Jigs | 7 hours |
|---|---|---|

Types of drill jigs - design of drill jigs - Drill bushings - Types, methods of construction - Simple designs of Plate, Channel, Boxes, Post, Angle plate, Turnovers and Pot Jigs.

| Module:5 | Design of Fixtures | 7 hours |
|---|---|---|

Design principles - Types of fixtures - Fixtures for machine tools: Lathe, Milling, Boring, Broaching and grinding - Computer aided conceptual fixture design, Assembly fixtures, Modular fixtures.

| | | |
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| **Module:6** | **Design of Cutting tools** | **7 hours** |
| Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters | | |
| **Module:7** | **Tool Design for CNC Machine tools** | **6 hours** |
| Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting | | |
| **Module:8** | **Contemporary Discussion** | **2 hours** |
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Donaldson C., Lecain G.H. and Goold V.C., (2012), Tool Design, 4th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi |
| **Reference Books** | |
| 1. | E.G.Hoffman, (2004), Jig and Fixture Design, Thomson Asia Pte. Ltd, Singapore |
| 2. | Prakash Hiralal Joshi, (2000), Tooling data, Wheeler Publishing |
| 3. | Venkataraman K., (2005), Design of Jigs, Fixtures and Presstools, TMH |
| 4. | Andrew Y C Nee, A. Senthil Kumar and Z J Tao,(2004), An Advanced Treatise on Fixture Design and Planning, World Scientific Publishing Co Pte Ltd. |

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

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Design a piercing tool and perform an economic analysis | **60 hours** |
| 2. | Design a Blanking tool and perform an economic analysis | |
| 3. | Design a Bending die piercing tool and perform stress analysis | |
| 4. | Design a single point cutting tool and determine the damage equivalent stress on the tool body | |
| 5. | Design and fabricate an angular milling fixture | |
| 6. | Design a fixture ( Turning/Milling/Broaching/Grinding) and estimate the forces acting on the clamping points | |
| 7. | Design a cold drawing die for the given dimension of pipe using CAD tools | |
| 8. | Design a welding/Inspection fixture | |

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|---|---|---|---|
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Laser Material Processing | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6014 | | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To enable the student to understand the basics of Laser Technology and its application to advanced material process.
2. To broaden the horizon of students on utilization of laser manufacturing experiments.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Demonstrate the importance of industrial lasers and laser processing.
2. Evaluate laser based joining and surface modification processes.
3. Apply laser based machining and rapid manufacturing techniques for various applications.
4. Explain the use and importance of laser methodology.

| Module:1 | Principles of Industrial Lasers | 6 hours |
|---|---|---|

Principle of laser generation, optical resonators, laser modes- mode selection, line- broadening mechanisms, laser beam modifications and types of industrials lasers.

| Module:2 | Laser processing fundamentals | 6 hours |
|---|---|---|

Laser beam interaction with conducting metals, semiconductors and insulators – Heat flow theory and metallurgical considerations.

| Module:3 | Laser based joining processes | 6 hours |
|---|---|---|

Classification of laser based joining processes, principle of key hole and conduction mode joining, laser welding parameters, pulsed laser welding, and laser welding of different materials, laser brazing and laser selective soldering.

| Module:4 | Laser based surface modification | 6 hours |
|---|---|---|

Laser surface heat treatment, Laser surface melting- Glazing, Laser direct Metal deposition– Laser surface alloying, Laser surface cladding and Hard coatings, Laser physical vapour deposition, laser texturing and laser shock peening

| Module:5 | Laser based machining | 7 hours |
|---|---|---|

Laser instrumentation for cutting and drilling – cut quality and process characteristics – methods of cutting – practical performance – process variations – industrial applications of Laser cutting and drilling

| Module:6 | Laser based rapid manufacturing | 7 hours |
|---|---|---|

Laser metal forming, laser rapid manufacturing of low cost tools, lase rapid manufacturing of porous materials, laser rapid manufacturing of bimetallic components.

| | | |
|---|---|---|
| **Module:7** | **Laser Metrology** | **4 hours** |
| Holography , interferometry and laser scattering | | |
| | | |
| **Module:8** | **Contemporary Discussion** | **3 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | William Steen, JyotirmoyMazumder, Kenneth G. Watkins (2010), Laser Material Processing. Publisher: Springer; (6 September 2010) ISBN-10: 1849960615 ISBN-13: 978-1849960618, 4th edition. |
| 2. | Laser Surface Engineering: Process and Applications, J.R Lawrence and D Waugh Woodhead Publications, 2016 |
| **Reference Books** | |
| 1. | Laser Fundamentals, William T Silfvast, Cambridge University Press 2009 |
| 2. | Laser Additive Manufacturing of High Performance Materials, Dongdong, Springer 2015 |
| 3. | Optical Methods in Engineering Metrology, D C Williams, Springer 2012 |
| 4. | Laser Forming and Welding Processes, BekirSaniVilbarandSohailAkhthar, Springer 2014 |
| 5. | Physical Processes in Laser Material Interaction, M Bertolotti, Springer 2012 |

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| **Course code** | **Additive Manufacturing Technology** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|
| **MEE6015** | | **2** | **0** | **0** | **4** | **3** |
| **Pre-requisite** | **NIL** | **Syllabus version** | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. Learn what Advanced/Additive manufacturing (AM) is and understand why it has become one of the most important technology trends in decades for product Development and innovation.
2. Demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
3. Understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. To demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that is available.
2. To understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.
3. To articulate the various tradeoffs that must be made in selecting advanced/additive manufacturing processes devices and material s to suit particular product requirements.
4. Opportunity to design, engineer and fabricate an actual multi-component object using advanced/additive manufacturing devices and processes (the "project").
5. Demonstrate the latest trends and business opportunities in AM, distributed manufacturing and mass customization

| **Module:1** | **Basics and Principles** | **4 hours** |
|---|---|---|

Basics and Principles of Additive Manufacturing (AM), Additive Manufacturing Processes, Extrusion, Beam Deposition, Jetting, Sheet Lamination, Direct-Write, Photo-polymerization, Sintering, Powder Bed Fusion

| **Module:2** | **Design/Fabrication Processes** | **4 hours** |
|---|---|---|

Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre- & Post-processing, Reverse engineering: digitizing, laser scanning, CT-scanning, point cloud manipulation, data segmentation, surface reconstruction, model further processing.

| **Module:3** | **Materials Science for AM** | **4 hours** |
|---|---|---|

Materials Science for Additive Manufacturing- Polymer and Photo-polymerization, Process& Material Selection, Direct Digital Manufacturing and AM; parts and their uses. Process Monitoring and Control for AM-Defects, Geometry, Composition, Temperature, Phase Transformation.

| **Module:4** | **Design for Additive Manufacturing** | **4 hours** |
|---|---|---|

Design for Additive Manufacturing, Multiple Materials, Hybrids, Functionally Graded Materials, Composite Materials, current and future directions; Process Modeling of AM process- Design optimization through finite-element modeling of AM- Simulation of phase transformations- heating, melting, forming, solidification and finishing and rheological studies of various AM materials.

| | | |
|---|---|---|
| **Module:5** | **Rapid Tooling** | **4 hours** |
| An Automotive Perspective to Rapid Tooling utilizing Rapid Prototyping and Manufacturing, Precision Stratiform Machining, CAD/LAM- integration of CAD with CAM laser cutting, Profile Edge Lamination, Slice Control Machining, Subsequent Casting Operations, Rubber Mold Casting, Plaster/Sand Molding, Spin Casting, prototyping methodology for automotive product development. | | |
| **Module:6** | **Nickel Vapor Deposition** | **4 hours** |
| Nickel Ceramic Composite (NCC) Tooling from RP & Models, NCC Tools Based On Stereolithography Models, Integration of Tool Forming With RP&M, Compression Tooling Nickel Vapor Deposition Technology-Need for NVD, NVD applications, properties of NVD nickel, comparison between NVD and Electroformed nickel tooling, comparison between NVD and Conventional tooling | | |
| **Module:7** | **Applications and Future Directions of AM** | **4 hours** |
| The Express Tool Process- Conformal Cooling Channels, The Express tool Process, Finite-Element Analysis of Express Tool, limitations - Applications of AM: Aerospace, Automotive, Biomedical Applications of AM, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing. | | |
| **Module:8** | **Contemporary Discussion** | **2 hours** |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Ian Gibson, David Rosen, Brent Stucker,(2015), Additive Manufacturing Technologies, Springer Publications |

**Reference Books**

| | |
|---|---|
| 1. | DongdongGu, (2014), Laser Additive Manufacturing of High-Performance Materials, Springer Publ. |
| 2. | Andreas Gebhardt, (2011), Understanding Additive Manufacturing, Hanser Publishers |
| 3. | Hopkinson, Hague, Dickens, (2005), Rapid Manufacturing: An Industrial Revolution for the Digital Age. Wiley |
| 4. | Peter D. Hilton, Paul F. Jacobs, (2000), Rapid Tooling-Technologies and Industrial Applications. Technology Strategies Group, Concord, Massachusetts, Laser Fare—Advanced Technology Group, Warwick, Rhode Island, Copyright © 2000 by Marcel Dekker. |

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

**Project**

# Generally a team project of Five
# Concepts studied in Modules should have been used

| | | |
|---|---|---|
| # Down to earth application and innovative idea should have been attempted | | |
| **Sample Projects** | | |
| 1. | Projects on CAD data generation for 3D printing using various tools including: various scanning and reverse engineering techniques and related software. | **60 hours** |
| 2. | Projects on CAD data processing such as STL file corrections, orientation optimization, and support and tool path generation for economically producing the components with desired properties. | |
| 3. | Design and fabrication of working models for the conceptual testing applications. | |
| 4. | Build complex engineering assemblies of polymeric materials with less process planning. | |
| 5. | Redesign the existing locomotive key-components for weight reduction without effecting the functionality that can be produced only by additive manufacturing. | |
| 6. | Microstructural characterization of the additive manufactured materials. | |
| 7. | Mechanical characterization of the additive manufactured materials. | |

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| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |

| Course code | Industrial Surface Engineering | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MEE6052 | | 2 | 0 | 0 | 4 | 3 |
| Pre-requisite | NIL | Syllabus version | | | | |
| | | v. 1.1 | | | | |

**Course Objectives:**

1. To enable the students understand the basic concepts of surface engineering using both conventional and advanced surface engineering techniques
2. To enhance the students' knowledge with regard to characterize and testing surface engineered materials for different properties
3. To familiarize the students with various surface engineering technique adopted in different industries and how to apply the knowledge for solving industrial problems

**Expected Course Outcome:**

Upon successful completion of the course the students will be able to

1. Demonstrate the role of beams in surface modification
2. Explain surface modification processes
3. Apply surface spray and PVD & CVD coatings for various applications
4. Evaluate various electro formed and hot dip coatings processes
5. Test and characterize the coatings

| Module:1 | Surface Modification – Role of Beams | 3 hours |
|---|---|---|

Physics of the power beams used for surface modification. Plasma/laser/flame Plasma: Classification/dynamical characteristics/plasma parameters/plasma excitation/plasma sources:- Lasers: Basic principles, laser parameters, pulsed and CW lasers - Flame: Diffusion flame/pre-mixed flame; Role of fuel/air ratio

| Module:2 | Surface Modification | 4 hours |
|---|---|---|

Gas phase interaction, surface hardening, nitridation, carburization, carbo-nitridation, heat and mass transfer aspects, thermodynamics and process control, surface passivation by oxidation, evolution temperature and composition profiles, case depth control. Carburization/nitridation reactor design, Plasma nitriding, plasma carburizing, laser nitriding/carburizing, laser cladding/laser shock peening, flame carburizing

| Module:3 | Surface Spray Coatings | 5 hours |
|---|---|---|

Plasma spray/wire arc spray/cold spray/ d-gun Spray/HVOF/SPS: In flight particle dynamics/spray watch/ role of Bond Coat Examples: Alumina/zirconia/composites/WC coatings; Spray coating microstructure/ Design of plasma spray Guns ;Vacuum Plasma spray: UHTC based on carbides/borides

| Module:4 | PVD and CVD coatings | 4 hours |
|---|---|---|

| | | |
|---|---|---|
| PVD COATINGS: Magnetron sputtering/ cathodic arc/ multi-layering/FGM coatings/hardness and oxidation resistance control, Thickness and roughness controlExamples: TiN/CrN/NbN/Cr/ Ti/ CARBON COATING/TiAlN/CrAlN/CrAlO<br>CVD Coatings: Principles of CVD/Thermal CVD/PE CVD. CVD reactor design: Reactor Types, kinetics, mass transfer and residence time optimization. ECR & Microwave CVD.Graphite coatings/DLC/Diamond and graphene CVD/ SiC and TiC coatings | | |
| | | |
| **Module:5** | **Electro-formed Coatings** | **3 hours** |
| Basics of electrodeposition, Hard-chrome and Nickel coatings, Cadmium plating, electro-deposition cell design, control parameters in electrodeposition. Electroless coatings: nickel deposition | | |
| | | |
| **Module:6** | **Hot Dip coatings** | **6 hours** |
| Galvanizing & Aluminizing; Pack cementation process: Boronizing and aluminizing: process modelling and furnace design; Conversion coatings: Chromating and phosphating: Process modelling and design aspects ;Coatings for glass: Solgel coatings and magnetron sputtered AR coatings;Pre-coating operations: Degreasing, de-scaling, sand-blasting, plasma cleaning, degassing-Post-coating operation: Curing/consolidation, stress relieving; Large area industrial coatings: Automation, rototics, zigs and fixtures, batch processing - Codes and standards for coating acceptance: ASTM standards | | |
| | | |
| **Module:7** | **Coating testing and characterization** | **3 hours** |
| Composition and phase analysis, morphology and microstructure, wear and oxidation resistance, galvanic corrosion testing, adhesion test, Standard tests as per ASTM standards | | |
| | | |
| **Module:8** | **Contemporary Discussion** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Advanced Surface coatings, A Mathews, David lickerby, Springer (2012 reprint) |
| **Reference Books** | |
| 1. | Laser Fundamentals, William T Silfvast, Cambridge Univ. Press 2009 reprint. |
| 2. | Laser Surface Engineering: Process and Applications J R Lawrence and D Waugh, Woodhead Publications, 2016. |
| 3. | Thin Films by Chemical Vapour Deposition (Thin Film Science and Technology), Morosance C.E and Sidall G, Book 7, Elsevier, 2016. |
| 4. | Electroplating Engg. Handbook, L.J Durrey, Springer, 2014. |
| 5. | Thermal Spray Fundamentals, P.L Fauchaisad, J V R Hebertein, m I Boulos, springer 2014 |

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar |
| **Project** |
| # Generally a team project of two/three |

| | | |
|---|---|---|
| # Concepts studied in Modules should have been used<br># Down to earth application and innovative idea should have been attempted<br># Assessment on a continuous basis with a min of 3 reviews. | | |
| **Sample Projects** | | |
| 1. | Electroplating for automotive industry to combat corrosion | **60 hours** |
| 2. | Nano-coating using EPD | |
| 3. | Micro-arc oxidation of Mg alloys | |
| 4. | Surface oxidation of SS | |
| 5. | Demonstration of Electro-deposition of Ni/Cu | |
| 6. | Plasma modification of SS surface | |
| 7. | Plasma modification of HAP coating | |
| 8. | Gas phase nitridation of steel | |
| 9. | Surface hardening of Aerospace alloys | |
| 10. | Laser texturing of Aerospace alloys | |
| 11. | Spin coatings on Ti implants | |

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|---|---|---|---|
| Mode of assessment: | | | |
| Recommended by Board of Studies | 17-08-2017 | | |
| Approved by Academic Council | 47 | Date | 05-10-2017 |