04082022/V3

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY

## BELAGAVI

# Scheme of Teaching and Examinations

**M.Tech. in Mechanical Engineering**

**(Specialization in ……..)**

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**I SEMESTER (Core Courses related to main Engineering Stream)**

| Sl. No | Course Type | Course Code | Course Title | Teaching Hours per Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical/Seminar | Tutorial/SDA | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | L | P | T/SDA | | | | | |
| 1 | PCC | MME101 | Waste to Energy | 3 | 0 | 0 | 03 | 50 | 50 | 100 | 3 |
| 2 | PCC | MME102 | Mechatronics for Industrial Application | 3 | 0 | 1 | 03 | 50 | 50 | 100 | 3 |
| 3 | IPCC | MME103(IPCC) | Introduction to AI and ML | 3 | 2 | 0 | 05 | 50 | 50 | 100 | 4 |
| 4 | PCC | MME114 | **Professional Elective 1** | 3 | 0 | 0 | 03 | 50 | 50 | 100 | 3 |
| 5 | PCC | MME115 | **Professional Elective 2** | 3 | 0 | 0 | 03 | 50 | 50 | 100 | 3 |
| 6 | PCCL | MMEL106 | Engineering Computational Tools Laboratory | 0 | 2 | 2 | 03 | 50 | 50 | 100 | 2 |
| 9 | NCMC | MRMI107 | Research Methodology and IPR (**Online**) | Online courses (online.vtu.ac.in) | | | | | | | PP |
| | | | | | | | | **300** | **300** | **600** | **18** |

| **Professional Elective 1** | | **Professional Elective 2** | |
|---|---|---|---|
| MME114A | Material Selection in Machine Design | MME115A | Smart Mobility |
| MME114B | Advance Fluid Mechanics | MME115B | Industrial Robots |
| MME114C | Additive Manufacturing Techniques | MME115C | Design of Experiments |
| MME114D | Vibration and Condition Monitoring | MME115D | Theory of Metal Cutting and forming |

Note: **BSC**-Basic Science Courses, **PCC**: Professional core. **IPCC**-Integrated Professional Core Courses, **PCC(PB):** Professional Core Courses (Project Based), **PCCL**-Professional Core Course lab **,NCMC**- None Credit Mandatory Course,**L-** Lecture**, P-**Practical**, T/SDA-**Tutorial **/** Skill Development Activities(Hours are for Interaction between faculty and students) **MRMI107**- Research Methodology and IPR (**Online**) for the students who have **not studied** this course in the Undergraduate level. This course is not counted for vertical progression; Students have to qualify for the award of the master's degree.

**M**- Master program **xx** – **ME** for Mechanical Engineering Stream, **CV** for Civil Engineering Stream, **EE** – Electrical & Electronics Engineering Stream, **EC-** Electronics and Communication Engineering Stream, **CS**- Computer Science and Engineering **BA**- Business Administration **AR**- Architecture- etc.

**BSC: Basic Science Courses:** Courses like Mathematics/ Science are the prerequisite courses that the concerned engineering stream board of Studies will decide. **PCC: Professional Core Course:** Courses related to the stream of engineering, which will have both CIE and SEE components, students have to qualify in the course for the award of the degree. **Integrated Professional Core Course (IPCC)**: Refers to a Professional Theory Core Course Integrated with practicals of the same course. The IPCC's theory part shall be evaluated by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. **Project Based Learning Course (PCC(PB):** Project Based Learning course is a professional core Course only Students have to complete a project out of learning from the course and SEE will be viva voce on project work. **PCCL: Professional Core Course Laboratory:** A Practical course who's CIE will be evaluated by the class teacher and SEE will be evaluated by the two examiners.

**Skill development activities: Under Skill development activities** in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in the modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s are to be involved either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities that will enhance their skills. The prepared report shall be evaluated

for CIE marks.

**MRMI107-Research Methodology and IPR-** None Credit Mandatory Course (NCMC) if students have not studied this course in their undergraduate program then he /she has to take this course at **http://online.vtu.ac.in** and to qualify for this course is compulsory before completion of the minimum duration of the program (Two years), however, this course will not be considered for vertical progression.

**Semester- I**

| Waste to Energy | | | |
|---|---|---|---|
| Course Code | **MME101** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3-0-0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- Differentiate and characterize different waste
- Recognize the various waste to energy conversion processes
- Explain various biochemical conversion processes.
- Explain various thermo-chemical conversion processes.
- Explain various biomass process to energy conversion.

**Module-1(8 Hours)**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

**Module-2(8 Hours)**

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

**Module-3(8 Hours)**

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

**Module-4(8 Hours)**

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

**Module-5 (8 Hours)**

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

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

**Suggested Learning Resources:**

**Books**

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

**Web links and Video Lectures (e-Resources):**

- VTUe- Shikshana Program
- VTU EDUSAT Program

**Skill Development Activities Suggested**

- Quizzes
- Assignments
- Seminars
- Industrial Visit

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Differentiate and characterize different waste | L2 |
| CO2 | Recognize the various waste to energy conversion processes | L2 |
| CO3 | Explain various biochemical conversion processes. | L2 |
| CO4 | Explain various thermo chemical conversion processes. | L2 |
| CO5 | Explain various biomass process to energy conversion. | L2 |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| 1 | An ability to independently carry out research /investigation and development work to solve practical problems | PO1 |
| 2 | An ability to write and present a substantial technical report/document | PO2 |
| 3 | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. | PO3 |

**Mapping of COS and POs**

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

**Semester- I**

| Mechatronics for Industrial Applications | | | |
|---|---|---|---|
| Course Code | **MME102** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:1 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- Understand the design process and integrated design issues in Mechatronics system
- Understand system models and its components
- Acquire the knowledge of Mechatronics in mobility
- Apply the concept of Mechatronics in manufacturing
- Apply the concept of Mechatronics in construction and bio mimics robot

**Module-1(8 Hours)**

**Introduction to Mechatronics: Mechatronics system architecture**: Sensors, signal conditioners, PLC/embedded controllers, pneumatic, hydraulic and electric actuators. **Introduction to Real Time Mechatronics system:** Flexible Manufacturing systems, Computer Integrated Machines. **Sensors**: Proximity and position sensors, velocity sensors, Motion sensors, Acceleration sensors, Pressure sensors, Torque Sensors. **Signal Conditioners:** Need of isolators, filters, amplifiers, fluid and optical amplifiers, Data converters in
Mechatronic system.

**Module-2(8 Hours)**

**Basic Mechatronics System: Basic System Models:** Introduction, Mechanical system building blocks-Translational and Rotational system building up a mechanical system model, Electrical system building blocks-Building up model. **System Models:** Introduction, rotational translational systems, Electromechanical systems. **CNC Machines:** General configuration, advantages, Part programming of CNC machines, G codes and M codes, small application programs, CNC based drilling machine.

**Module-3(8 Hours)**

**Mechatronics in Mobility:** Need of mechatronics in automobiles. modelling and simulation antilock braking system – power steering – adaptive cruise control – active suspension system – case studies in vehicle communication - Hybrid EV- electronic ignition – engine control system – tyre pressure monitoring system - Ornithopter – Intelligent cockpit electronics – Digital flyby wire systems- longitudinal and later control design – surveillance drone –Navigation – Robotic arm in International Space station- Magnetic levitation system

**Module-4(8 Hours)**

**Mechatronics in Manufacturing:** Computed aided metrology –monitoring and control in manufacturing process - case studies in additive manufacturing - case studies in advanced machining-case studies in automated production line - AGV - simultaneous localization and mapping (SLAM) -virtual manufacturing - internet controlled manufacturing - SMART FACTORY, ASRS, mobile manipulator.

**Module-5(8 Hours)**

**Mechatronics in others Application:** Surgical Robot - Skeletal muscles servo mechanism – Analysis of force in orthopedic implants – sensory assisted exoskeletons – lower and upper limb exoskeleton- Rehabilitation, wheelchairs for mobility assistance - Haptics- online patience monitoring - Applications in sports and exercise. Intelligent safety elements in buildings - robotics in construction – IoT assisted home automation- Bio Mimics.

**Assessment Details (both CIE and SEE)**

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**Continuous Internal Evaluation:**

3. Two Unit Tests each of **25 Marks**
4. Two assignments each of **25 Marks** or**one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources: Books**

1. William Bolton, "Mechatronics: Electronic Control Systems In Mechanical and Electrical Engineering", 7th edition, Pearson. 2023,
2. Robort H Bishop, "Mechatronics an Introduction", Taylor and Francis, 2nd edition, 2003.
3. Annalisa Melilla, Donato Di Paola and Grazia Cicirelli, "Mechatronic Systems, Applications", InTech publisher, 2010.
4. Devdasshetty, Richard A. Kolkm, "Mechatronics System Design", PWS Publishing company, 2nd edition, 2010.
5. M. D. Singh, J. G. Joshi, "Mechatronics", Prentice Hall of India Private limited, 2006.
6. William B. Ribbens, Norman P. Mansour, "Understanding Automotive Electronics", 8th edition, Elsevier Science, 2017.

**Web links and Video Lectures (e-Resources):**

- Mechatronics, IIT Roorkee, Prof. Pushparaj Mani Pathak ( https://nptel.ac.in/courses/112107298)
- Mechatronics and Manufacturing Automation, IIT Guwahati. Dr. Shrikrishna N. Joshi (https://nptel.ac.in/courses/112103174)
- Design of Mechatronic Systems By Prof. Prasanna Gandhi | IIT Bombay
- https://www.youtube.com/watch?v=PgJoBkzikwI&pp=ygUcbWVjaGF0cm9uaWNzIGZvciBhdXRvbW9iaWxlIA%3D%3D
- https://www.youtube.com/watch?v=Bly955ALvA&pp=ygUkbWVjaGF0cm9uaWNzIGZvciByb2JvdGljcyBpbmR1c3RyaWVz
- https://www.youtube.com/watch?v=v-3TmN4HhLc&list=PLwdnzlV3ogoW31clPN6Dn6c8Ia-n36vXk
- Sensors Modeling & Simulation Lab – Virtual Lab
- Basics of Pneumatic Components -Virtual Lab

**Skill Development Activities Suggested**

- Design Microcontroller based robot arm to pick and place material from one place to another place.
- Design Microcontroller based AVCS for speed control of car.
- Design a model to demonstrate the use of any one velocity sensor.
- Design the use of any one motion sensor using simulation.
- Design the use of any one mechanical actuator using simulation.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Define and explain design process | L1 |
| CO2 | Explain Mechatronics systems and models | L1 |
| CO3 | Build a mechatronics system for mobility applications | L2 |
| CO4 | Apply the concept of Mechatronics in manufacturing | L2 |
| CO5 | Apply the concept of Mechatronics in construction and bio mimics robot | L3 |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| 1 | An ability to independently carry out research /investigation and development work to solve practical problems | PO1 |
| 2 | An ability to write and present a substantial technical report/document | PO2 |
| 3 | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. | PO3 |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 |
|---|---|---|---|
| **CO1** | **1** | **1** | **2** |
| **CO2** | **2** | **2** | **1** |
| **CO3** | **1** | **2** | **1** |
| **CO4** | **1** | **2** | **1** |
| **CO5** | **2** | **1** | **2** |

| INTRODUCTION TO AI AND ML | | | |
|---|---|---|---|
| Course Code | MME103 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:2:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Theory + 10-12 lab | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |

**Course Learning Objectives**

CLO1. Understands the basics of AI, history of AI and its foundations, basic principles of AI for problem solving.

CLO2. Explore the basics of Machine Learning & Machine Learning process, understanding data

CLO3. Understand the Working of Artificial Neural Networks.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. 8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1(8 Hours)

**Introduction:** What is AI, The foundation of Artificial Intelligence, The history of Artificial Intelligence, Intelligent Agents: Agents and Environments, Good Behaviour: The concept of rationality, the nature of Environments, the structure of Agents.

Module-2(8 Hours)

**Problem solving by searching:** Problem solving agents, Example problems, Searching for solutions, Uniformed search strategies, Informed search strategies, Heuristic functions

Module 3(8 Hours)

**Introduction to machine learning:** Need for Machine Learning, Machine Learning Explained, and Machine Learning in relation to other fields, Types of Machine Learning. Challenges of Machine Learning, Machine Learning process, Machine Learning applications.

Module-4(8 Hours)

**Understanding Data**: What is data, types of data, Big data analytics and types of analytics, Big data analytics framework, Descriptive statistics, univariate data analysis and visualizationBivariate and Multivariate data, Multivariate statistics, Essential mathematics for Multivariatedata, Overview hypothesis, Feature engineering and dimensionality reduction techniques.

**Similarity-based learning:** Introduction to Similarity or instance based learning, Nearest-neighbourlearning, weighted k- Nearest - Neighbor algorithm.

Module-5(8 Hours)

**Artificial Neural Network:** Introduction, Biological neurons, Artificial neurons, Perceptron and learning theory, types of Artificial neural Network, learning in multilayer Perceptron, Radial basis function neural network.,

**Course Outcomes**:

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

CO 1. Design intelligent agents for solving simple gaming problems.
CO 2. Have a good understanding of machine leaning in relation to other fields and fundamental issues and Challenges of machine learning
CO 3. Understand data and applying machine learning algorithms to predict the outputs.
CO 4. Model the neuron and Neural Network, and to analyze ANN learning and its applications.

PRACTICAL COMPONENT OF IPCC
Course objectives:

- Implement and evaluate AI and ML algorithms in Python programming language.
- To analyze big data using machine learning techniques

| Sl.No. | Experiments |
|---|---|
| 1 | Implement AI Search algorithm. |
| 2 | Implementation of find-S Algorithm in Machine Learning. |
| 3 | For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples. |
| 4 | Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem. |
| 5 | Visualize data using basic plotting techniques in Python. |
| 6 | Implementation of perceptron model for logical gates. |
| 7 | Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets. |
| 8 | |

**Laboratory Outcomes:** The student should be able to:

- Implement and demonstrate AI and ML algorithms.
- Evaluate different algorithms.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**CIE for the theory component of IPCC**

1. Two Tests each of **25 Marks**

2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

**CIE for the practical component of IPCC**

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the**

**test** conducted at the end of the semester.

- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for **10 marks**. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test at the end /after completion of all the experimentsshall be conducted for **50 marks** and scaled down to **05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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**SEE for IPCC**

Theory SEE will be conducted by the University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component**).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

**Suggested Learning Resources:**

1. Stuart Russel, Peter Norvig: "Artificial Intelligence-A Modern approach", 3rd Edition, Pearson Education, 2015.
2. S Sridhar, M Vijayalakshmi: "Machine Learning", Oxford, 2021.
3. Elaine Rich, Kevin Knight: "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709.

**Semester- I**

| Materials Selection in Mechanical Design | | | |
|---|---|---|---|
| Course Code | **MME114A** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**
**Students will be able**

1. To develop advanced understanding on the basic concepts and methodology of material selection in mechanical design
2. To understand how to use diverse engineering materials property data to select appropriate materials for structural applications in a variety of engineering contexts.
3. To use engineering materials property data to justify the selection of materials, processes and component geometry against various design goals.

**Module-1**(8 Hours)

**Introduction:** Materials in design, The evolution of engineering materials. Case Study: Vacuum cleaner

**Design Process:** The design process, Types of design, Design tools and materials data, Function, material, shape, and process

**Module-2**(8 Hours)

**Engineering Materials and theirProperties:** The families of engineering materials, The definitions of material properties, Exploring material properties and charts

**Materials Selection:** The selection strategy, Attribute limits and material indices, Selection procedure, Computer-aided selection. **Case Studies:** Materials for springs, heat exchangers, thermal distortion in precision devices, Radomes in Aircrafts.

**Module-3**(8 Hours)

**Processes and Process Selection:** Classifying processes, The processes: shaping, joining, and finishing, Systematic process selection, Computer-aided process selection

**Multiple constraints and objectives:** Selection with multiple constraints, Conflicting objectives, penalty-functions, and exchange constants

**Module-4**(8 Hours)

**Designing Hybrid Materials:** Filling holes in material-property space, The method: A + B + Configuration + Scale. Composites: Hybrids of type 1, Sandwich structures: Hybrids of type 2, Lattices: hybrids of type 3, Segmented structures: Hybrids of type 4

**Case studies: Efficiency of** Natural materials, Designing metal matrix composites, Refrigerator walls, Extreme combinations of thermal and electrical conduction, The mechanical efficiency of natural materials

**Module-5**(8 Hours)

**Materials and the Environment:** The material life cycle, Material and energy-consuming systems, The eco-attributes of materials, Eco-selection

**Materials and Industrial Design**: The requirements pyramid, Product character, Using materials and processes to create product personality.

**Assessment Details (both CIE and SEE)**

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**Continuous Internal Evaluation:**

5. Two Unit Tests each of **25 Marks**
6. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

11. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
12. The question paper will have ten full questions carrying equal marks.
13. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
14. Each full question will have a sub-question covering all the topics under a module.
15. The students will have to answer five full questions, selecting one full question from each module

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**Suggested Learning Resources:**

**Books**

1. Materials Selection in Mechanical Design, Third Edition by Michael F. Ashby
2. A History of Technology (21 volumes), edited by Singer, C., Holmyard, E.J., Hall, A.R., Williams, T.I., and Hollister-Short, G. Oxford University Press (1954–2001)
3. Cross, N. (2000) Engineering Design Methods, 3rd edition, Wiley, Chichester, UK. ISBN 0-471-87250-4. (A durable text describing the design process, with emphasis on developing and evaluating alternative solutions.)
4. ASM Engineered Materials Handbook (2004) ''Testing and characterisation of polymeric materials'', ASM International, Metals Park, OH, USA. (An on-line, subscription-based resource, detailing testing procedures for polymers.)
5. Cottrell, A.H. (1964) Mechanical Properties of Matter, Wiley, New York Library of Congress Number 65-14262. (An inspirational book, clear, full of insights and of simple derivations of the basic equations describing the mechanical behaviour of solids, liquids and gasses.)
6. Dieter, G.E. (1991) Engineering Design, a Materials and Processing Approach, 2nd edition, McGraw-Hill, New York, USA. ISBN 0-07-100829-2. (A well-balanced and respected text focusing on the place of materials and processing in technical design.)
7. Callister, W.D. (2003) Materials Science and Engineering, An Introduction, 6th edition, John Wiley, New York, USA. ISBN 0-471-13576-3.
8. ASM Handbook Series (1971–2004), ''Volume 4: Heat treatment; Volume 5: Surface engineering; Volume 6: Welding, brazing and soldering; Volume 7: Powder metal technologies; Volume 14: Forming and forging; Volume 15: Casting; Volume 16: Machining'', ASM International, Metals Park, OH USA. (A comprehensive set of handbooks on processing, occasionally updated, and now

available on-line at www.asminternational.org/hbk/index.jsp)

**Web links and Video Lectures (e-Resources):**

- 

**Skill Development Activities Suggested**

- 

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| **CO1** | Use materials property charts, to apply engineering and science principles, to make initial judgements about the selection of materials for diverse engineering design contexts. | L3 |
| **CO2** | Apply engineering and science principles to understand a broad range of processes for materials manufacture and their implications for materials and process selection. | L3 |
| **CO3** | Apply engineering and science principles to analyse the mechanics of a materials design problem so as to select materials and geometry to minimise weight, minimise environmental impact, etc. | L3 |
| **CO4** | Analyse complex problems in order to establish when a hybrid material might provide a better design solution than a monolithic engineering material. | L4 |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| **PO1** | An ability to independently carry out research /investigation and development work to solve practical problems | PO1 |
| **PO2** | An ability to write and present a substantial technical report/document | PO2 |
| **PO3** | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. | PO3 |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 |
|---|---|---|---|
| **CO1** | **3** | **2** | **2** |
| **CO2** | **3** | **2** | **2** |
| **CO3** | **3** | **2** | **2** |
| **CO4** | **3** | **2** | **2** |

| Advanced Fluid Mechanics | | | |
|---|---|---|---|
| Course Code | **MME114B** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 50 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 Hr |

**Course Learning objectives:**

- To understand the kinematics of fluids, their governing equations, Mechanics of laminar and turbulent flow, NS Equations.
- Advanced knowledge of boundary layer equation, as well as a fundamental understanding of the drag and lift force.
- Understanding of the fundamental of the Flow across Normal Shock and Oblique Shock and Comparison of isentropic and adiabatic processes.
- Knowledge of several practical applications of the theory covered.

| **Module-1** | |
|---|---|
| **Review of undergraduate Fluid Mechanics:** Introduction: Fluid Statics, Relative Motion of Liquids. Kinematics of Fluids- Review of basics-Velocity potential, Stream function and Vorticity. Fundamental Equations, Applications of Fundamental Equations, Differential Flow analysis-Continuity equation (3D Cartesian, Cylindrical and spherical Coordinates) Navier Stokes equations (3D- Cartesian, coordinates), Energy Equations (3D- Cartesian, coordinates), Elementary in viscid flows; superposition (2D). | |
| **Teaching-Learning Process** | Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home. |

| **Module-2** | |
|---|---|
| **Mechanics of Laminar and Turbulent Flow:** Introduction; Laminar and turbulent flows; viscous flow at different Reynolds number - wake frequency; laminar plane Poiseuille flow; stokes flow; flow through a concentric annulus. structure and origin of turbulent flow - Reynolds, average concept, Reynolds equation of motion; zero equation model for fully turbulent flows and other turbulence models; turbulent flow through pipes; losses in bends, valves etc; analysis of pipe network - Hard cross method. | |
| **Teaching-Learning Process** | Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home. |

| **Module-3** | |
|---|---|
| **Exact and Approximate solutions of N-S Equations:** Introduction; Parallel flow past a sphere; Oseen ‘s approximation; hydrodynamic theory of lubrication; Hele-Shaw Flow.<br>**Boundary layer over a flat plate:** Thickness of boundary layer, displacement and momentum thickness, Prandtl‘s boundary layer equation, Vonkarmann momentum equation – shear stress and drag force, laminar boundary layer, turbulent boundary layer, pressure distribution in the boundary layer, boundary layer separation, drag and lift force – lift on an airfoil. | |
| **Teaching-Learning Process** | Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home. |

| **Module-4** |
|---|

| | |
|---|---|
| **Energy equation**: Energy equation for non-flow and flow processes, adiabatic energy equation, stagnation enthalpy, stagnation temperature, stagnation pressure, stagnation velocity of sound, reference velocities, Bernoulli's equation, effect of Mach number on compressibility.<br>**Isentropic Flow with variable Area:** Comparison of isentropic and adiabatic processes, Mach Number variation, Stagnation and critical states, Area ratio as a function of Mach number, impulse function, Mass flow rate, Flow through nozzles and diffusers | |
| **Teaching-Learning Process** | Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home. |

**Module-5**

| | |
|---|---|
| **Flow across Normal Shock and Oblique Shock:** Development of a shock wave, rarefaction wave, governing equations, Prandtl-Meyer relation, Mach number downstream of the shock wave, static pressure ratio, temperature ratio, density ratio, and stagnation pressure ratio across the shock.<br>Oblique shock waves fundamental relations, Prandtl's Equation, Rankine – Hugoniot Equation, Variation of flow parameters, Relations and Tables, Numerical Problems. | |
| **Teaching-Learning Process** | Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home. |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

7. Two Unit Tests each of **25 Marks**
8. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

16. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
17. The question paper will have ten full questions carrying equal marks.
18. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
19. Each full question will have a sub-question covering all the topics under a module.
20. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Textbooks**


1. Foundations of fluid mechanics - S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India, 2000.
2. White F.M., Viscous Fluid Flow, 3rd edition, Tata McGraw Hill Book Company, 2011.
3. S.M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion (SI UNITs), Fifth Edition, New Age International Publishers, New Delhi, 2020.


**Reference Books**


1. Yunus A. Cengel and John M. Cimbala, Introduction to Fluid Mechanics, Second Edition, Tata McGraw-Hill, 2010.
2. Introduction to fluid dynamics - Principles of analysis & design - Stanley Middleman, Wiley, 1997.
3. D. S. Kumar, Fluid Mechanics and Fluid power engineering, S. K. Kataria & sons, 2010.


**Web links and Video Lectures (e-Resources):**

- https://archive.nptel.ac.in/courses/112/105/112105218/
- https://archive.nptel.ac.in/courses/112105269/
- https://archive.nptel.ac.in/courses/112/105/112105287/
- https://archive.nptel.ac.in/courses/112/106/112106311/
- https://archive.nptel.ac.in/courses/103/102/103102211/
- https://archive.nptel.ac.in/courses/112/103/112103290/

**Skill Development Activities Suggested**

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Illustrate the basic concepts fluid flow and their governing equations | |
| CO2 | Analyse the laminar and turbulent flow problems. | |
| CO3 | Demonstrate the concept of boundary layer equations and drag and lift force | |
| CO4 | Distinguish normal and oblique shocks and their governing Equations. | |
| CO5 | Explain thePropagation of sound waves and Comparison of isentropic and adiabatic processes in fluid mechanics. | |

**Mapping of COS and POs**

| POs → COs↓ | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | - | 1 | 1 |
| CO3 | 3 | 2 | 1 | 2 | - | 1 | 1 |
| CO4 | 3 | 2 | 1 | 2 | - | 1 | 1 |
| CO5 | 3 | 2 | 1 | - | - | 1 | 1 |

| Additive Manufacturing Techniques | | | |
|---|---|---|---|
| Course Code | MME114C | CIE Marks | 50 |
| Teaching Hours/Week(L:P:SDA) | 03:00:00 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40Hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**
Develop a comprehensive understanding of fundamental additive manufacturing– alternatively, "three-dimensional (3D) printing" – approaches, including extrusion- based deposition, stereo lithography, powdered – based melting, and inkjet-based deposition. Cultivate a "design -for- additive manufacturing" skill set for combining computer-aided design (CAD) and computer-aided manufacturing (CAM) methodologies to produce successful 3D prints. Fabricate 3D mechanical objects using a variety of 3D printing technologies on campus. Execute a design project that demonstrates how additive manufacturing technologies can overcome critical limitation soft traditional manufacturing processes.

**Module-1**

**Introduction and Basic Principles**: The Generic AM Process and its Benefits. Distinction between AM and CNC Machining. Example of AM Parts and other Related Technologies.

**Development of Additive Manufacturing Technology**: Computer-Aided Design Technology and Other Associated Technologies. The Use of Layers. Metal Systems and Hybrid Systems

| **Teaching-Learning Process** | Chalk and Talk and Power Point Presentation |
|---|---|

**Module-2**

**Generalized Additive Manufacturing Process Chain:** Introduction. Steps in Additive Manufacture, Variations from One AM Machine to Another. Maintenance of Equipment and Materials Handling Issues.

**Vat Photo polymerization Processes:** Introduction, Reaction Rates, Laser Scan Vat Photo-polymerization, Photo polymerization Process Modelling, Vector Scan VP Machines, Scan Patterns. Vector Scan Micro-Vat Photo polymerization. Process Benefits and Drawbacks

| **Teaching-Learning Process** | Chalk and Talk and Power Point Presentation |
|---|---|

**Module-3**

**Extrusion-Based Systems:** Introduction, Basic Principles, Material Loading Liquefaction, Extrusion, Solidification, Positional Control, Bonding, Support Generation Plotting and Path Control. FDM Machine. Types, Materials, Limitations of FDM. Bio-Extrusion and Other Systems
**Material Jetting:** Materials for Material Jetting, Materials for Material Jetting, MJ Process Modelling, Material Jetting Machines, Process Benefits and Drawbacks

| **Teaching-Learning Process** | Chalk and Talk and Power Point Presentation |
|---|---|

**Module-4**

**Design for Additive Manufacturing**: Motivation, Design for Manufacturing and Assembly, AM Unique Capabilities. Shape Complexity. Hierarchical Complexity. Functional Complexity Material Complexity Core DFAM Concepts and Objectives Complex Geometry Integrated Assemblies Customized Geometry Multifunctional Designs Elimination of Conventional DFM Constraints Contents Exploring Design Freedoms Part Consolidation and Redesign Hierarchical Structures Industrial Design Applications.

**Rapid Tooling:** Introduction Direct AM Production of Injection Moulding Inserts EDM Electrodes Investment Casting Other Systems Vacuum Forming Tools Paper Pulp Moulding Tools Formwork for Composite Manufacture Assembly Tools And Metrology Registration Rigs

| Teaching-Learning Process | Chalk and Talk and Power Point Presentation |
|---|---|

**Module-5**

**Applications for Additive**: Manufacture Introduction Historical Developments Value of Physical Models Functional Testing Rapid Tooling The Use of AM to Support Medical Applications Surgical and Diagnostic Aids Prosthetics Development Manufacturing Tissue Engineering and Organ Printing Software Support for Medical Applications

**Limitations of AM**: Limitations of AM for Medical Applications Speed Accuracy Materials Ease of Use Further Development of Medical AM Applications Approvals Insurance Engineering Training Location of the Technology Service Bureaus Aerospace Applications Characteristics Favouring AM Production Manufacture Automotive Applications

| Teaching -Learning Process | Chalk and Talk and Power Point Presentation |
|---|---|

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

9. Two Unit Tests each of **25 Marks**
10. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

21. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
22. The question paper will have ten full questions carrying equal marks.
23. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
24. Each full question will have a sub-question covering all the topics under a module.
25. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. PhamD.T.&DimovS.S"RapidManufacturing"SpringerLondon2011.2.
2. C.P.Paul&A.N.Jinoop,"AdditiveManufacturing:Principles,TechnologiesandApplications",McGrawHill2021.
3. TerryWohlers"Wohler'sReport2000"Wohler'sAssociation2000
4. PaulF.Jacobs:"StereolithographyandotherRP&MTechnologies",SME,NY1996,Springer


**Web links and Video Lectures(e-Resources):**

- **https://youtu.be/t7yv4gSnNkE?list=PLwdnzlV3ogoWI8QEu4hsT-n_r8UbWbquy**
- **https://youtu.be/Bwog2XYCmN8**

**Skill Development Activities Suggested**

- **Individual projects on topics covered in class. Students will choose a real life problems related to the discussed topics and implement the solution by using techniques and strategies discussed in the class. For each project, students have to submit a report and present a seminar.**
- **Assignments, Quiz and Industrial Visit on relevant topic of the course.**

**Course outcome(Course Skill Set)**

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

| Sl.No. | Description | Blooms Level |
|---|---|---|

| | | |
|---|---|---|
| CO1 | Explain the importance and growth of Rapid Prototyping Techniques. | L1 |
| CO2 | Differentiate and describe the operation, applications and advantages of Stereo lithography, selective Laser sintering and fused deposition modelling. | L2 |
| CO3 | Analyze solid ground curing and laminated object manufacturing processes and their working. | L3 |
| CO4 | Evaluate different Concept Model less and recommend different tooling requirements for Rapid Prototype | L3 |

**Mapping of COS and POs**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 2 | 1 | 2 | 2 | 3 | 1 |
| **CO3** | 3 | 2 | 1 | 2 | 2 | 2 | 1 |
| **CO4** | 3 | 2 | 1 | 2 | 1 | 2 | 1 |

**1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-":no correlation**

| VIBRATION AND CONDITION MONITORING | | | |
|---|---|---|---|
| Course Code | **MME114D** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hours | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

1. To study the basic concepts of vibration.
2. Tocharacterizethefreeandforcedvibrationsofdampedandundampedsingledegreeoffreedom systems.
3. To understand the transient vibration response of a single degree of freedom system.
4. To study various vibration measuring instruments.
5. To study and characterize the random vibrations.
6. To characterize the continuous systems.
7. To study the basic principles of maintenance and condition monitoring.

**MODULE-1(9Hours)**

**Introduction:** Elements of vibratory system, examples of vibratory motions, simple harmonic motion, degrees of freedom.

**System with One Degree of Freedom:** Equations of motion by Newton's method & Energy method, general solution, frequency response method. Undamped free vibration and damped free vibration.

| | |
|---|---|
| Teaching-Learning Process | Power-pointPresentation,VideodemonstrationorSimulations,ChalkandTalkareusedforProblem Solving, Laboratory Demonstrations and Practical Experiments |

**MODULE-2(9Hours)**

**Forced Vibration of Single Degree of Freedom System:** Undamped forced vibration – harmonic excitation, damped forced vibration – harmonic excitation, rotating and reciprocating unbalance, vibration isolation and transmissibility, system attached to moving support.

**Transient Vibration of Single Degree of Freedom System:** Introduction, Derivation of Convolution Integral – response due to unit impulse, Response due to a General Excitation, Excitations Whose Forms Change at Discrete Times, Transient Motion Due to Base Excitation, Laplace Transform Solutions,Transfer Functions, Numerical Methods, Shock Sp ectrum, Vibration Isolation for Short Duration Pulses.

| | |
|---|---|
| Teaching-Learning Process | Power-pointPresentation,VideodemonstrationorSimulations,ChalkandTalkareusedforProblem Solving, Laboratory Demonstrations and Practical Experiments |

**MODULE-3(7Hours)**

**Vibration Measurements:** Introduction, transducers, vibration measuring instruments – vibrometers and accelerometers, frequency measuring instruments, vibration exciters, signal analysis.

**Random Vibrations:** Introduction, random variables and random processes, probability distribution, mean value and standard deviation, correlation functions of a random process, stationary random process, Gaussian random process, Fourier transforms and response, power spectral density.

| | |
|---|---|
| Teaching-Learning Process | Power-pointPresentation,VideodemonstrationorSimulations,ChalkandTalkareusedforProblem Solving, Laboratory Demonstrations and Practical Experiments |

**MODULE-4(8Hours)**

**Continuous Systems:** Introduction, continuous system – a simple exposition, separation of time and space variables, problems governed by wave equation: longitudinal vibrations of rods & torsional vibration of shaft, lateral vibration of beams.

| | |
|---|---|
| Teaching-Learning Process | Power-pointPresentation,VideodemonstrationorSimulations,ChalkandTalkareusedforProblem Solving,Laboratory Demonstrations and Practical Experiments |

**MODULE-5(7Hours)**

**Condition Monitoring:**

**Principles of Maintenance:** Introduction, reactive maintenance, preventive maintenance, predictive maintenance, bath tub curve, failure modes effect and criticality analysis.

**Vibration Monitoring:** Principles of vibration monitoring, misalignment detection, eccentricity detection, cracked shaft, bowed and bent shaft, unbalanced shaft, looseness, rub, bearing defects, gear fault, faults in fluid machines and rotating machines.

| | |
|---|---|
| Teaching-Learning Process | Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. Francis S. Tse, Ivan E. Morse, Rolland T. Hinkle, "Mechanical Vibrations - Theory and Applications", Allyn and Bacon, Inc., 2004, ISBN-10: 8123908466 / ISBN-13: 978-8123908465.
2. S.GrahamKelly,"MechanicalVibrations–ThoeryandApplications",CengageLearning,2012, ISBN-10: 1-4390-6214-5 / ISBN-13: 978-1-4390-6214-2.
3. AmiyaR.Mohanty,"MachineryConditionMonitoring",CRCPress,2015,ISBN-13:978-1-4665-9305-3.


**Web links and Video Lectures (e-Resources):**

1. NOC: Introduction to Mechanical Vibration, IIT Rookies (https://nptel.ac.in/courses/112107212)
2. Mechanical Vibrations, IIT Guwahati (https://nptel.ac.in/courses/112103112)
3. http://va-coep.vlabs.ac.in/List%20of%20experiments.html

**Skill Development Activities Suggested**

1. Write MATLAB/SCILAB programs to simulate there sponse of single degree of freedom systems under free and forced vibrations.
2. To create mathematical models of single degree of freedom systems in MATLAB Simulink/ SCILAB.

**Course outcome(Course Skill Set)**

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

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| 1 | An ability to independently carry out research/investigation and development work to solve practical problems. | 1 |
| 2 | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. | 3 |
| 3 | Students should be able to design, synthesize and analyse a physical engineering systems using modern tools and techniques. | 4 |
| 4 | Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions. | 5 |

**Mapping of COS and POs**

Note:High -1,Medium–2,andLow–3

**Semester I**

| Smart Mobility | | | |
|---|---|---|---|
| Course Code | **MME115A** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P:S) | 3:0:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

To deliver and discuss the about architecture, power electronics-based drive control systems, battery management systems and grid integration issues of Electric and Hybrid vehicles.

**Module-1**(8 Hours)

**Introduction to Electric Vehicle (EV) & Hybrid Vehicle (HV)**:
Air pollution and global warming, Impact of different transportation technologies on environment and energy supply, A brief history of Electric and Hybrid Vehicles, Basic Architecture of Hybrid Drive Train and Analysis of Series Drive Train, Vehicle Motion and the Dynamic Equations for the Vehicle, Types of HV and EV, Advantages Over Conventional Vehicles, limitations of EV and HV, Impact on Environment of EV and HV technology, Disposal of Battery, Cell and Hazardous Material and their Impact on Environment.

**Module-2**(8 Hours)

**Power Management and Energy Sources of EV and HV:**
Power and Energy management Strategies and its General Architecture of EV and HV, Various Battery Sources, Energy Storage, Battery Based Energy Storage and Simplified Models of Battery, Battery Management Systems (BMS), Fuel Cells, their Characteristics and Simplified Models, Super Capacitor Based Energy Storage, its Analysis and Simplified Models, Flywheels and their Modeling for Energy Storage in HV/BEV, Hybridization of Various Energy Storage Devices, Selection of the Energy Storage Technology.

**Module-3**(8 Hours)

**Power Electronics in EV & HV:**
Introduction, Various Power Electronics Converter Topologies and its Comparisons, Control of convertor operations in EV and HV, battery chargers used in EV & HV, Emerging Power Electronic Devices.
**DC and AC Machines & Drives in EV & HV:**
Various types of Motors, Selection and Size of Motors, Induction Motor Drives and Control Characteristics, Permanent Magnet Motor Drives and Characteristics, Brushed & Brushless DC Motor Drive and Characteristics, Switched Reluctance Motors and Characteristics, IPM Motor Drives and Characteristics, Mechanical and Electrical Connections of Motors.

**Module-4**(8 Hours)

**Components & Design Considerations of EV & HV:**
Design Parameters of Batteries, Ultra-Capacitors and Fuel Cells, Aerodynamic Considerations, Calculation of the Rolling Resistance and the Grade Resistance, Calculation of the Acceleration Force, Total Tractive Effort, Torque Required on the Drive Wheel, Transmission Efficiency, Consideration of Vehicle Mass, Electric Vehicle Chassis & Body Design, General Issues in Design, Specifications and Sizing of Components

**Module-5**(8 Hours)

**Electric and Hybrid Vehicles and Grid Interconnection Issues:**
Introduction to Smart Charging: Grid to Vehicle and Vehicle to Grid, Smart Metering and Ancillary Services, Preliminary Discussion on Vehicle to Vehicle and Vehicle to Personal Communication Systems, Introduction to Battery Charging Stations and Its Installation and Commissioning, Preliminary Discussion on Estimation on Station Capacity and Associated Technical Issues, Different Connectors, Policy Regulations and Standards for EV and HV, BEE Standards, Indian And Global Scenario, Case Studies.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

3. Two Unit Tests each of **25 Marks**
4. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**List of References Books:**

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003.
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication ,2011.
5. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009.

**Web links and Video Lectures (e-Resources):**

1. Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

**Skill Development Activities Suggested**

1. Study and analysis of different topologies used in electrical and hybrid vehicles
2. Simulation and analysis of Induction motor characteristics used for electric vehicle
3. Simulation and analysis of BLDC motor characteristics used for electric motor vehicle
4. Simulation and analysis of Switch Reluctance motor characteristics used for electric motor vehicle
5. Simulation and analysis of IPMSM motor characteristics used for electric motor vehicle

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the architecture and vehicle dynamics of electric and hybrid vehicles | L2 |
| CO2 | Analyze and model the power management systems for electric and hybrid vehicles | L3 |
| CO3 | Devise power electronics-based control strategies for electric and hybrid vehicles | L4 |
| CO4 | Analyze and design various components of electric and hybrid vehicles with environment concern. | L4 |
| CO5 | Investigate and model the issues in mathematical domain related to grid interconnections of electric and hybrid vehicle. | L4 |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| 1 | An ability to independently carry out research /investigation and development work to solve practical problems | PO1 |
| 2 | An ability to write and present a substantial technical report/document | PO2 |
| 3 | Students should be able to demonstrate a degree of mastery over the area as per | PO3 |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 |
|---|---|---|---|
| **CO1** | **2** | **2** | **2** |
| **CO2** | **2** | **2** | **2** |
| **CO3** | **2** | **2** | **2** |
| **CO4** | **2** | **2** | **2** |
| **CO5** | **2** | **2** | **2** |

| INDUSTRIAL ROBOTICS | | | |
|---|---|---|---|
| Course Code | **MME115B** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

1. The goal of the course is to familiarize the students with the concepts and techniques in robotic engineering, manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineering systems.
2. Make the students acquainted with the theoretical aspects of Robotics
3. Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.
4. Make the students to understand the importance of robots in various fields of engineering.

**MODULE-1**

**Introduction: Automation and Robotics** – An over view of Robotics – present and future applications. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees offreedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

08Hrs

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method / PowerPoint Presentation |

**MODULE-2**

**Motion Analysis**: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

08Hrs

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method / PowerPoint Presentation |

**MODULE-3**

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion straight line motion.

08Hrs

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method / PowerPoint Presentation |

**MODULE-4**

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools

08Hrs

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method / PowerPoint Presentation |

**MODULE 5**

Robot Application in Manufacturing: Material Transfer – Material handling, loading and unloading- Processing –spot and continuous arc welding & spray painting – Assembly and Inspection. Robotic Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.

08Hrs

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method / PowerPoint Presentation |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

5. Two Unit Tests each of **25 Marks**
6. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

11. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
12. The question paper will have ten full questions carrying equal marks.
13. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
14. Each full question will have a sub-question covering all the topics under a module.
15. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

**Web links and Video Lectures (e-Resources):**

- VTU e-Shikshana Program
- VTU EDUSAT Program

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Quizzes
- Assignments
- Seminars

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | To understand the basic components of robots. | 5 |
| CO2 | Differentiate types of robots and robot grippers. | 5 |
| CO3 | Model forward and inverse kinematics of robot manipulators. | 4 |
| CO4 | Analyze forces in links and joints of a robot. | 5 |
| CO5 | Programme a robot to perform tasks in industrial applications. | 5 |

**Program Outcome of this course**

| Sl. No. | Description | Pos |
|---|---|---|
| PO1 | To prepare students to meet the industrial requirements at global level competitiveness. | |
| PO2 | To develop the students analytical skills to enable them to understand real world problems and formulate solutions. | |
| PO3 | To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas. | |
| PO4 | To allow students to work in teams through group project works and thus help them Achieve interpersonal and communication skills. | |
| PO5 | To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for Environmental and regard for good professional practices. | |
| PO6 | Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. | |
| PO7 | Function effectively as an individual, and as a member or leader in diverse teams, and in Multidisciplinary settings. | |

**Mapping of COS and Pos**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | **3** | **3** | **3** | **2** | **2** |
| **CO2** | **2** | **2** | **3** | **3** | **3** | **3** | **3** |
| **CO3** | **3** | **2** | **3** | **3** | **3** | **2** | **3** |
| **CO4** | **3** | **3** | **2** | **2** | **2** | **2** | **2** |
| **CO5** | **2** | **2** | **2** | **3** | **3** | **3** | **3** |

| DESIGN OF EXPERIMENTS | | | |
|---|---|---|---|
| Course Code | **MME115C** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40Hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

1. To develop an understanding of experimental methods and major experimental designs and think critically about their proper application.
2. Write hypotheses that can be tested using experiments.
3. Be able to develop different types of experimental designs

**MODULE-1(5 Hours)**

**Introduction**: Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.

| | |
|---|---|
| Teaching-Learning Process | Power-point Presentation, Chalk and Talk are used for Problem Solving, |

**MODULE-2(5 Hours)**

**Basic Statistical Concepts:** Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal Illustration through Numerical examples.

**Hypothesis testing,** Probability plots, choice of sample size. Illustration through Numerical examples.

| | |
|---|---|
| Teaching-Learning Process | Power-point Presentation, Chalk and Talk are used for Problem Solving, |

**MODULE-3(5 Hours)**

**Experimental Design:** Factorial Experiments, factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions,

| | |
|---|---|
| Teaching-Learning Process | Power-point Presentation, Chalk and Talk are used for Problem Solving, |

**MODULE-4(5 Hours)**

**Measures of variability,** Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA.

| | |
|---|---|
| Teaching-Learning Process | Power-point Presentation, Chalk and Talk are used for Problem Solving, |

**MODULE-5(5 Hours)**

Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

| | |
|---|---|
| Teaching-Learning Process | Power-point Presentation, Chalk and Talk are used for Problem Solving, |

**Assessment Details (both CIE and SEE)**

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**Continuous Internal Evaluation:**

7. Two Unit Tests each of **25 Marks**
8. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

16. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
17. The question paper will have ten full questions carrying equal marks.
18. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
19. Each full question will have a sub-question covering all the topics under a module.
20. The students will have to answer five full questions, selecting one full question from each module

- 

**Suggested Learning Resources:**

**Books**

1. Montgomery, D. C. (2019). Design and Analysis of Experiments, 10th Edition, John Wiley & Sons.
2. John Lawson,"Design and Analysis of Experiments with R", 1st Edition, Taylor and Francis, 2014.

**Web links and Video Lectures (e-Resources):**

1. Design and Analysis of Experiments (https://onlinecourses.nptel.ac.in/noc21_mg48/preview)
2. Sotware, JMP: https://www.jmp.com/en_ch/applications/design-of-experiments.html
3. R: https://www.r-project.org/
4. R Studio :https://posit.co/

**Skill Development Activities Suggested**

1. Implement the DoE techniques using R Software:

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Describe the fundamentals of experiments and its uses | 2 |
| CO2 | Apply of statistical models, ANOVA in analysing experimental data | 3 |
| CO3 | Analyse the data and identify the significant factors which influence the results | 3 |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| 1 | An ability to independently carry out research/investigation and development work to solve practical problems. | 1 |
| 2 | An ability to write and present a substantial technical report/document. | 2 |
| 3 | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program. | 3 |
| 4 | Students should be able to design, synthesize and analyses a physical Engineering systems using modern tools and techniques. | 4 |
| 5 | Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions. | 5 |

**Mapping of COs and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **1** | **3** | **1** |
| **CO2** | **3** | **3** | **1** | **3** | **1** |
| **CO3** | **3** | **3** | **1** | **3** | **1** |

Note : High - 1, Medium – 2, and Low – 3

| THEORY OF METAL CUTTING AND FORMING | | | |
|---|---|---|---|
| Course Code | MME115D | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 3 | Exam Hours | 3HRS |

Course objectives: To understand basics of metal cutting and metal forming

To understand various factors of machining

To understand the process of various forming methods

To practically study and practice the machining and forming methods

MODULE-1

**Introduction to metal cutting:** Mechanism of chip formation, Orthogonal & Oblique cutting, types of chips, built-up edge,
Determination of shear plane angle, forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, effect of cutting parameters on tool geometry.
Characteristics of tool materials, types of tool materials – carbon tool steels, high speed steels, cast alloys, cemented carbides, ceramics, diamonds, SIALON, CBN,UCON

Mechanisms of tool wear, Sudden & gradual wear, crater wear, flank wear, tool failure criteria, tool life equations, effect of process parameters on tool life

| Teaching-Learning Process | CHALK & TALK/ PPT |
|---|---|

MODULE-2

**Force measurements**: Reasons for measuring cutting forces, Classification of cutting force dynamometers – mechanical, hydraulic, pneumatic, optical, inductance, piezoelectric, and strain gage type dynamometers.

**Temperature measurements**: Heat sources in metal cutting, temperature in chip formation, temperature distribution, and experimental determination of tool temperatures.

**Advanced Machining** Techniques: cryo machining and high speed machining its defects and remedies. -

| Teaching- Learning Process | .CHALK & TALK/ PPT |
|---|---|

MODULE-3

**Introduction to metal forming**: Effect of temperature on forming process-hot working, cold working. Effect of Metallurgical structure, Effect of speed of deformation work of Plastic deformation, Friction in forming operation. Concept of true stress and true strain, uniaxial, biaxial, triaxial stresses, Vonmoises criteria, tresca criteria, principle stresses concepts of plane stress and plane strain.

-

| Teaching-Learning Process | CHALK & TALK/ PPT |
|---|---|

MODULE-4

Forging : Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging of slabs, discs with respect to sticking, sliding and mixed friction forging defects.

**Rolling**: Classification, forces and geometrical relationships in rolling. Expression for rolling load, roll separating force and rolling defects-5 HRS

| Teaching-Learning Process | CHALK & TALK/ PPT |
|---|---|

MODULE 5

**Extrusion :** Classification, Extrusion equipment, variables in extrusion, Deformation in extrusion, Extrusion defects,

**Drawing**: Principles of Rod and wire drawing, variables in wiredrawing, Residual stresses in rod, wire and tube drawing, Defects in Rod and wire drawing -5 HRS

| | |
|---|---|
| Teaching-Learning Process | CHALK & TALK/ PPT |

**Assessment Details (both CIE and SEE)**

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**Continuous Internal Evaluation:**

9. Two Unit Tests each of **25 Marks**
10. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

21. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
22. The question paper will have ten full questions carrying equal marks.
23. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
24. Each full question will have a sub-question covering all the topics under a module.
25. The students will have to answer five full questions, selecting one full question from each module

Web links and Video Lectures (e-Resources):

VTU e-Shikshana ProgramVTU EDUSAT Program

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

SEMINARS

ASSIGNMENTS

Course outcome (Course Skill Set)

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | UNDERSTAND THE BASICS OF METAL CUTTING AND FORMING | |
| CO2 | UNDERSTAND VARIOUS MACHINING FORCES AND MEASURING INSTRUMENTS | |
| CO3 | UNDERSTAND THE PRACTICAL ASPECTS OF MACHINING AND FORMING | |

Program Outcome of this course

| Sl. No. | Description | POs |
|---|---|---|
| 1. | DEVELOPMENT OF SOLUTIONS | 3 |
| 2 | MODERN TOOL USAGE | 5 |
| 3. | ENGINEER AND SOCIETY | 6 |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 2 | | | | | | | | |
| CO2 | | | | | 3 | | | | | |
| CO3 | | | | | 3 | | | | | |
| CO4 | | | | | | 3 | | | | |

Mapping of COS and POs

| Engineering Computational Tools Laboratory | | | |
|---|---|---|---|
| Course Code | **MMEL106** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | **0:0:2:2** | SEE Marks | 50 |
| Credits | **02** | Exam Hours | 03 |

## Course Objectives:

1. To familiarize students with mathematical tools such as MATLAB for engineering analysis.
2. To introduce finite element analysis (FEA) tools and to educate about 1D/2D/3D structural static and transient thermal analysis techniques using FEA tools.
3. To apply optimization techniques to improve mechanical system performance.
4. To introduce the usage of MATLAB for simulation the control system
5. To demonstrate the usage of the software tools to simulate the manufacturing processes.

**NOTE: THE SOFTWARE MENTIONED HERE ARE REPRESENTATIVE IN NATURE ONLY,HENCE ANY COMMERCIAL OR EQUIVALENT OPEN SOURCE SOFTWARE CAN BE USED (AND IS ENCOURAGED).**

| SL.NO | Experiments |
|---|---|
| 1 | **Lab 1: Introduction to Mathematical tools such as MATLAB for Engineering Analysis**<br><br>**Objective:** Familiarize students with basic mathematical tools such as MATLAB for engineering applications.<br>**Topics Covered:** Basic syntax, variables, operations, plotting data and functions, writing simple functions, and scripts.<br>**Activities:**<br>• Plotting sine and cosine functions. |
| 2 | **Lab 2: Matrix Operations and Linear Algebra using Mathematical tools such as MATLAB**<br><br>**Objective:** Introduce matrix operations and linear algebra concepts using mathematical tools such as MATLAB.<br>**Topics Covered:** Matrix creation and manipulation, solving linear equations, eigenvalues, and eigenvectors.<br>**Activities:** Solve systems of linear equations and compute eigenvalues and eigenvectors of matrices. |
| 3 | **Lab 3: Data Analysis and Visualization**<br><br>**Objective:** Teach students data analysis and visualization techniques using any mathematical tool.<br>**Topics Covered:** Data manipulation and statistical analysis.<br>**Activities:** Import, visualise and analyse dataset. |
| 4 | **Lab 4: Advanced MATLAB for Engineering Simulations**<br><br>**Objective:** Apply advanced MATLAB techniques for engineering simulations.<br>**Topics Covered:** Numerical methods (ODEs, PDEs), simulation of physical systems, optimization techniques.<br>**Activities:** Simulate the motion of a damped harmonic oscillator. |
| 5 | **Lab 5:** 1D, 2D Linear static analysis using any one FEA packages like ANSYS/CAEFEM/NASTRAN/NISA<br><br>**Objective:** Introduce the basics of finite element analysis (FEA).<br>**Topics Covered:** Introduction to FEA concepts, setting up a simple static analysis, interpreting results. |

| | |
|---|---|
| | **Activities:** Perform a static analysis of a simple 2D truss structure. |
| 6 | **Lab 6:** 3D Meshing, Linear static analysis using any one FEA packages like ANSYS/CAEFEM/NASTRAN/NISA<br><br>**Objective:** Introduce the basics of 3D finite element analysis (FEA).<br>**Topics Covered:** Introduction to FEA concepts, setting up a simple static analysis, interpreting results.<br>**Activities:** Perform a static analysis of simple Beams with different loads. |
| 7 | **Lab 8:** Transient Thermal Analysis using any one FEA packages like ANSYS/CAEFEM/NASTRAN/NISA<br><br>**Objective:** Teach thermal analysis using FEA package.<br>**Topics Covered:** Transient thermal analysis\<br>**Activities:** Perform a steady-state thermal analysis of a heat sink. |
| | **DEMONSTRATION EXPERIMENTS ( FOR CIE ) IF ANY** |
| 8 | **Lab 10: Optimization of FEA solution with** FEA packages like ANSYS/CAEFEM/NASTRAN/NISA.<br><br>**Objective:** Apply optimization techniques to improve the solution of the given problem statement<br>**Topics Covered:** Optimisation of the solution using shape optimization, node optimization<br>**Activities:** Analyse the effect to modification in shape or number of nodes on the solution |
| 9 | **Lab 11. Simulation of Open loop Control Systems using simulation software**<br><br>**Objective:** Simulate control systems using MATLAB's Simulink.<br>**Activities:** Design and simulate a PID controller for a DC motor. |
| 10 | **Lab 12:** Simulation of manufacturing processes through software process like casting, forging machining etc. (may use software provided by VTU under CoE in Computer Engineering analysis and Visualization)<br><br>**Objective:** To demonstrate the usage of the software tools to simulate the manufacturing processes<br>**Activities:** Use the software tool for simulating the casting, forging and machining process taking one example for each process. |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

**Continuous Internal Evaluation (CIE):**

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14$^{th}$ week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marks is scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

**Semester End Evaluation (SEE):**

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

**Suggested Learning Resources**

**Books:**


1. Moore, Holly. MATLAB for Engineers. Pearson, 2017.
2. https://www.pearson.com/store/p/matlab-for-engineers/P100000316089
3. Strang, Gilbert. Linear Algebra and Its Applications. Cengage Learning, 2016. https://www.cengage.com/c/linear-algebra-and-its-applications-5e-strang/
4. Gokhale, Nitin S. Practical Finite Element Analysis. Finite to Infinite, 2008. https://www.finite2infinite.com/book/
5. Chopra, Anil K. Dynamics of Structures: Theory and Applications to Earthquake Engineering. Pearson, 2019. https://www.pearson.com/store/p/dynamics-of-structures-theory-and-applications-to-earthquake-engineering/P100000961935
6. Blundell, Michael, and Damian Harty. Multibody Systems Approach to Vehicle Dynamics. Elsevier, 2004. https://www.elsevier.com/books/multibody-systems-approach-to-vehicle-dynamics/blundell/978-0-7506-5414-8
7. Chapra, Steven C., and Raymond P. Canale. Numerical Methods for Engineers. McGraw-Hill, 2015. https://www.mheducation.com/highered/product/numerical-methods-engineers-chapra-canale/M9780073397924.html
8. Kurowski, Paul M. Thermal Analysis with SolidWorks Simulation. SDC Publications, 2017. https://www.sdcpublications.com/thermal-analysis-with-solidworks-simulation-2017/
9. Rao, Singiresu S. Engineering Optimization: Theory and Practice. Wiley, 2019. https://www.wiley.com/en-us/Engineering+Optimization%3A+Theory+and+Practice%2C+4th+Edition-p-9781119736375


**Web Links**

**MATLAB Documentation**
- https://www.mathworks.com/help/matlab/

**Matplotlib Documentation**
- https://matplotlib.org/stable/contents.html

**Pandas Documentation**
- https://pandas.pydata.org/docs/

**Seaborn Documentation**
- https://seaborn.pydata.org/

**MSC Nastran Documentation**
- https://www.mscsoftware.com/product/msc-nastran

**MSC Adams Documentation**
- https://www.mscsoftware.com/product/msc-adams

**MATLAB Linear Algebra**
- https://www.mathworks.com/help/matlab/linear-algebra.html

**Khan Academy Linear Algebra**
- https://www.khanacademy.org/math/linear-algebra

**MATLAB Numerical Methods**
- https://www.mathworks.com/help/matlab/numerical-methods.html

**scikit-learn Documentation**
- https://scikit-learn.org/stable/documentation.html

**MSC Nastran Dynamics Documentation**
- https://www.mscsoftware.com/product/msc-nastran

**MSC Nastran Thermal Analysis**
- https://www.mscsoftware.com/product/msc-nastran

**MATLAB Simulink**
- https://www.mathworks.com/help/simulink/

**MSC Adams Optimization**
- https://www.mscsoftware.com/product/msc-adams

## Course Outcomes (Course Skill Set)

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Apply mathematical tool such as MATLAB for solving engineering problems | L3 |
| CO2 | Use finite element analysis tools for solving static structural problems. | L3 |
| CO3 | Conduct dynamic and thermal analyses using FEA tool. | L3 |
| CO4 | Analyse the effect of shape optimisation and node optimisation on the FEA solution. | L4 |
| CO5 | Perform simulation of the manufacturing process under various conditions. | L3 |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| PO1 | An ability to independently carry out research /investigation and development work to solve practical problems | PO1 |
| PO2 | An ability to write and present a substantial technical report/document | PO2 |
| PO3 | Students should be able to demonstrate a degree of mastery over the area as per thespecialization of the program. | PO3 |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 |
|---|---|---|---|
| CO1 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 3 |

RM (NPTEL)