भारतीय सूचना प्रौद्योगिकी अभिकल्पना एवं विनिर्माण संस्थान , कर्नूल

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY DESIGN AND MANUFACTURING KURNOOL

Jagannathagattu, Kurnool – 518007, Andhra Pradesh, INDIA
(An Institute of National Importance under the Ministry of Education, Govt. of India)

M. Tech. Programme in
Smart Manufacturing
(With effective from the A.Y. 2020-21)

Scheme, Syllabi and Regulations

DEPARTMENT OF MECHANICAL ENGINEERING
INDIAN INSTITUTE OF INFORMATION TECHNOLOGY DESIGN AND MANUFACTURING KURNOOL
KURNOOL-518007, ANDHRA PRADESH, INDIA.
July, 2020

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY DESIGN AND MANUFACTURING KURNOOL
Jagannathagattu, Kurnool-518007, Andhra Pradesh
(An Institute of National Importance under the Ministry of Education, Govt. of India)

Institute Vision

To become a leading institute of higher learning in Information Technology enabled design & manufacturing to create technologies and technologists befitting the industries globally.

Institute Mission

To become a center of excellence pioneering in education, research & development, and leaders in design & manufacturing.

Department Vision

To build an academic and research eco system with the innovation mindset and global perspectives to cater the needs of the society in the discipline of Mechanical Engineering with prime focus in the fields of design and manufacturing.

Department Mission

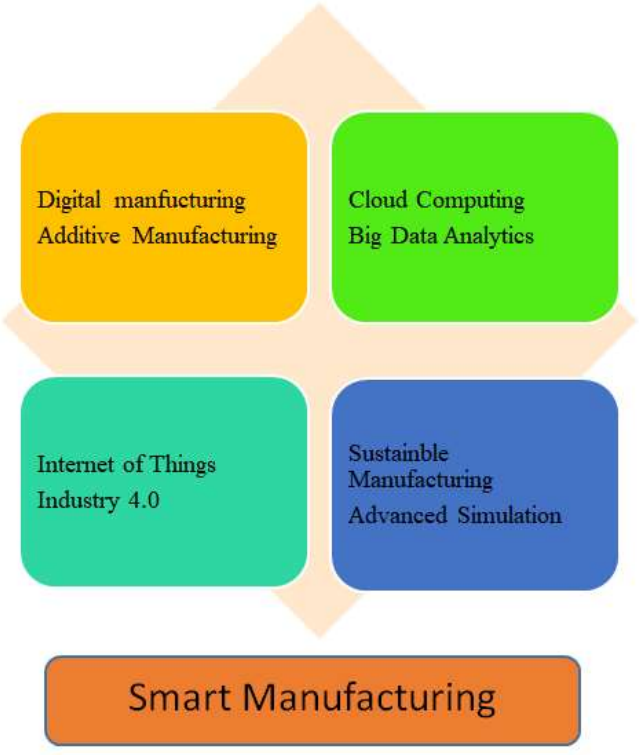
To enable the graduates with technically sound and state-of-the-art curriculum leading to entrepreneurial spirit and carrying out cutting edge research in collaboration with industry and research organizations.

M. Tech. in Smart Manufacturing

- A New Post Graduate Program for Next Generation Industries

The department of Mechanical Engineering, IIITDM Kurnool has been rolling out a new post graduate program from **July 2020**, namely **M. Tech.** in **Smart Manufacturing**. The objectives of the program are to train workforce catering to needs of 21st century manufacturing industries which are increasingly becoming smart and connected. The curriculum for the program has been carefully crafted by conducting many brainstorming sessions with Industry and Academic leaders in Manufacturing. The courses for the program are interdisciplinary in nature. Smart Manufacturing is an amalgamation of Information technology, Networks, Data Science, Sensors for adaptive control and managing the manufacturing enterprises.

M. Tech. in Smart Manufacturing will adopt a faceted approach to manufacturing education by giving equal importance to basic sciences & engineering courses. Students will be trained in fundamental manufacturing processes, manufacturing systems, systems engineering, IT, Networks and basic shop floor communications. Experiential learning approach will be followed and students will be gaining hands-on experience in many spheres of technology related to smart manufacturing. Students will also undergo a comprehensive project work for a duration of one year and will be exposed to real world problems of the present day industry.



About Smart Manufacturing

Smart manufacturing is a broad category of manufacturing with the goal of optimizing concept generation, production, and product transaction. While manufacturing can be defined as the multi-phase process of creating a product out of raw materials, smart manufacturing is a subset that employs computer control and high levels of adaptability.

Smart manufacturing aims to take advantage of advanced information and manufacturing technologies to enable flexibility in physical processes to address a dynamic and global market. There is increased workforce training for such flexibility and use of the technology rather than specific tasks as is customary in traditional manufacturing.

The 21st century manufacturing facilities have ushered a new wave of manufacturing with an amalgamation of technologies from advanced robotics to fully integrated production systems. With smart manufacturing or Industry 4.0, manufacturers are moving towards a new level of interconnected and intelligent manufacturing system which incorporates the latest advances in sensors, robotics, big data, and controllers.
To keep pace with the evolution of these "smart factories', it requires highly skilled and nimble engineers to manage the increasing complexity and shorter mind-to market product cycles. The goal of this program is to train future manufacturing engineers with basic knowledge on IT in addition to the strong problem-solving skills that are imparted in today's programs. Students will be trained in manufacturing processes, manufacturing systems, systems engineering, IT, Networks and basic shop floor communications. Experiential learning approach will be followed and students will be gaining hands-on experience in many spheres of technology related to smart manufacturing.

Curriculum and Syllabus

Department of Mechanical Engineering

Scheme for M. Tech. in **Smart Manufacturing**

Semester I						
S. No.	**Course Code**	**Course Name**	**Category**	**I**	**P**	**C**
1	ME501T	Introduction to Smart Manufacturing	PEC	3	0	3
2	ME502T	Applied AI for Manufacturing	BSC	3	0	3
3	ME503T	Mechatronic Product Design	BSC	0	3	2
4	ME504T	Advanced Manufacturing Processes	PEC	3	0	3
5	ME502P	Applied AI for Manufacturing Practice	PEC	0	3	2
6	ME503P	Mechatronic Product Design Practice	PEC	3	0	3
7	ME504P	Advanced Manufacturing Practice	PEC	0	3	2
8	ME51XT	Elective-I	PEC	3	0	3
9	ME551P	Seminar	PCD	0	3	2
Total				15	12	23
Semester II						
S. No.	**Course Code**	**Course Name**	**Category**	**I**	**P**	**C**
1	ME505T	Industrial IoT and Cloud Computing	PEC	3	0	3
2	ME506T	Modelling and Simulation of Manufacturing Systems	PEC	3	0	3
3	ME507T	Micro and Nano Manufacturing Technology	PEC	3	0	3
4	ME505P	Industrial IoT and Cloud Computing Practice	PEC	0	3	2
5	ME506P	Manufacturing Simulation Practice	PEC	0	3	2
6	ME52XT	Elective-II	PEC	3	0	3
7	ME52XT	Elective-III	PEC	3	0	3
8	ME552P	Comprehensive Viva-Voce	PEC	0	3	2
Total				15	9	21
Semester III						
1	ME653P	Dissertation Work-I	PCD	0	25	10
Total				0	25	10
Semester IV						
1	ME654P	Dissertation Work-II	PCD	0	25	20
Total				0	25	20

LIST OF ELECTIVES

Semester: I (Elective – I)

S. No.	Course Code	Course Name	Category	I	P	C
1	ME511T	Information Systems in Manufacturing	PEC	3	0	3
2	ME512T	Inspection and Testing in Manufacturing	PEC	3	0	3
3	ME513T	Lasers in Manufacturing	PEC	3	0	3
4	ME514T	Advanced Engineering Mathematics	PEC	3	0	3
5	ME515T	Applied Operations Research	PEC	3	0	3
6	ME516T	Design and Analysis of Experiments	PEC	3	0	3
7	ME517T	Computational Tools for Engineers	PEC	3	0	3

Semester: II (Elective – II and III)

S. No.	Course Code	Course Name	Category	I	P	C
1	ME521T	Digital Manufacturing	PEC	3	0	3
2	ME522T	Smart Materials and Structures	PEC	3	0	3
3	ME523T	Product Design and Development	PEC	3	0	3
4	ME524T	Design for Manufacturing and Assembly	PEC	3	0	3
5	ME525T	Additive Manufacturing	PEC	3	0	3
6	ME526T	Soft Computing Techniques	PEC	3	0	3
7	ME527T	Big Data Analytics	PEC	3	0	3
8	ME528T	Operations and Supply Chain Management	PEC	3	0	3
9	ME529T	Total Quality Management	PEC	3	0	3

Syllabi for the courses

Course Title	Course Code	Structure (I-P-C)		
Introduction to Smart Manufacturing	ME501T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand the capability of smart manufacturing with respect to global context.
CO2	Analyze the fundamental concepts data analysis.
CO3	Interpret the role of sensors in smart manufacturing
CO4	Analyze the feasibility and application of statistical quality control approaches with respect to smart manufacturing.
CO5	Analyze the difference between conventional, legacy manufacturing and Smart Manufacturing Processes

Syllabus:

1. **Introduction to Smart Manufacturing**: Global trends bringing major changes to society, products, and the manufacturing process. Demand Driven and Integrated Supply Chains. Dynamically Optimized Manufacturing Enterprises, Real Time, Sustainable Resource Management.
2. **Data Analytics and SPC**: A Visualization Approach: Convergence of manufacturing expertise and data science expertise in the field of smart manufacturing. Modeling to Make Sense Of Data.
3. **Sensors**: Role of sensors in smart manufacturing; Sensors and the types of data that sensors produce.
4. **Industrial Data Models for Industry 4.0**,
5. **Modelling and Simulation Technologies for Manufacturing**.
6. **Control Of Manufacturing Processes**: Manufacturing process control, role of feedback, process modeling, and monitoring, actual versus predicted dynamics. Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Mass Customization, Smart Machine Tools, Robotics and Automation; Statistical Quality Control:, Statistical control charts, Regression analysis, Analysis of variance.
7. **Advanced Technologies**: IoT for Manufacturing, Machine Vision, Augmented Reality, Digital Twins Technologies, AI and ML for Manufacturing
8. **Case Studies and Current trends in Smart Manufacturing and Industry 4.0**

Text Book(s):

1. Luo, ZongWei, Smart Manufacturing Innovation and Transformation: Interconnection and Intelligence: Interconnection and Intelligence, IGI Global, 2014.
2. R. C. Gupta, Statistical Quality Control, 8th edition, Khanna Publishers, 2008, ISBN: 8174091114.

References & Web Resources:

1. Fei Tao, Meng Zhang, A.Y.C. Nee, Digital Twin Driven Smart Manufacturing, Academic Press, 2019.

Course Title	Course Code	Structure (I-P-C)		
Applied AI for Manufacturing	ME502T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand the capability of AI for production planning and decision making.
CO2	Analyze the fundamental concepts of manufacturing scheduling.
CO3	Examine the role of robot control system in manufacturing.
CO4	Explain the role of agent and multi-agents in the manufacturing
CO5	Compare the current technology advancements and trends for Manufacturing

Syllabus:

1. Application of Machine Learning to Industrial Planning and Decision Making, Special Purpose Resource Design in Planning to Make More Efficient Plans;
2. Geometric Reasoning Using a Feature Algebra, Backward Assembly Planning Symmetry Groups in Solid Model-Based Assembly Planning,
3. An Expert System Approach for Economic Evaluation of Machining Operation Planning, Interactive Problem Solving for Production Planning,
4. An Abstraction-Based Search and Learning Approach for Effective Scheduling, ADDYMS: Architecture for Distributed Dynamic Manufacturing Scheduling, An Architecture for Real Time Distributed Scheduling, Exploiting Local Flexibility During Execution of Pre-computed Schedules
5. An Architecture for Integrating Enterprise Automation; An Intelligent Agent Framework for Enterprise Integration; Teamwork Among Intelligent Agents: Framework and Case Study in Robotic Service
6. Symbolic Representation and Planning for Robot Control Systems in Manufacturing; Integrated Software System for Intelligent Manufacturing; Enterprise Management Network Architecture: A Tool for Manufacturing Enterprise Integration; Design and Manufacturing: Integration through Quality
7. Introduction to Digital Twin and Cyber Physical Manufacturing Systems.

Text Book(s):

1. A. Fazel Famili (Editor), Dana S. Nau (Editor), Steven H. Kim (Editor); Artificial Intelligence Applications in Manufacturing, AAAI Press.

References & Web Resources:

1. Ellen Friedman, Ted Dunning, AI and Analytics in Production; O'Reilly Media, Inc., 2018 (ISBN: 9781492044116)
2. Çağlayan Arkan, The Future Computed: AI and Manufacturing; Global Lead, Manufacturing and Resources Industry, Microsoft, 2019.

Course Title	Course Code	Structure (I-P-C)		
MECHATRONICS PRODUCT DESIGN	ME503T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand the amalgamation of Mechatronic systems for design and practical requirements
CO2	Understand the basic concepts of the main sensors used in electromechanical systems
CO3	Understand the fundamental concepts of mechanical power transmission components, and pneumatic and hydraulic actuators
CO4	Use the common analog and digital interfaces between sensors/actuators and the systems under control using open source microcontrollers
CO5	Understand the integration of mechanisms, sensors, actuators, interfaces and software in the design of Mechatronic systems

Syllabus:

1. Introduction to Mechatronic Systems, Need for Mechatronic, Emerging area of Mechatronic, Classification of Mechatronics, Measurement Systems - Control Systems.
2. Introduction to Sensors and Transducers, Performance Terminology, Potentiometers, LVDT , Capacitance sensors, Strain gauges, Eddy current sensor, Hall effect sensor, Temperature sensors, Light sensors, Selection of sensors, Signal processing.
3. Pneumatic and hydraulic actuators: Basics of fluid flow, control valves, cylinders and rotary actuators for pneumatics and hydraulics.
4. Introduction to Actuators, Actuators types : Mechanical, Electrical, Fluid Power, Piezoelectric, Magnetostrictive, Shape memory alloy, applications, selection of actuators.
5. Signal conditioning, Amplification, filtering, multiplexing, and telemetry. Data acquisition with A/D, D/A and Digital I/O.
6. Microcontrollers: Introduction to use of open source hardware (Arduino & Raspberry Pi); shields/modules for GPS, GPRS/GSM, Bluetooth, RFID, and Xbee, integration with wireless networks, databases and web pages; web and mobile phone apps.
7. Basic closed-loop control: open-loop, on-off, PID control, Mechatronic systems integration, rapid prototyping of mechanical and electrical systems.

Text Book(s):

1. J. Edward Carryer, et al., Introduction to Mechatronic Design, Prentice Hall, 1st edition, 2010, ISBN: 978-8131788257.

References & Web Resources:

1. W. Bolton, Mechatronics, Pearson India, 4th edition, 2010, ISBN: 978-8131732533.
2. D. G. Alciatore and M. B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill, 4th edition, 2014, ISBN: 978-9339204365.

Course Title	Course Code	Structure (I-P-C)		
ADVANCED MANUFACTURING PROCESSES	ME504T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	To classify non-traditional machining processes and describe mechanical energy based nontraditional machining processes.
CO2	To differentiate chemical and electro chemical energy based processes.
CO3	To describe thermo-electric energy based processes
CO4	To explain nano finishing processes
CO5	To introduce hybrid non-traditional machining processes and differentiate hybrid nontraditional machining processes.

Syllabus:

1. Introduction to mechanical energy based processes, Need for non-traditional machining processes, Classification of non-traditional machining processes, Applications, advantages and limitations of non-traditional machining processes, Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.
2. Introduction to chemical and electro chemical energy based processes, Principles, equipment, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical de-burring
3. Thermal Material Removal Processes, Principles, equipment, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.
4. Nano Finishing Processes, Principles, equipment, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.
5. Hybrid Non-Traditional Machining Process, Introduction, Various hybrid non-traditional machining processes, their working principles, equipment, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.

Text Book(s):

1. Advanced manufacturing processes, Hassan Abdel, Gabad El Hoffy, McGraw Hill.
2. V.K.Jain, Advance Machining Processes, Allied Publisher Bombay.
3. Ghosh and Mallik, Manufacturing Science, EWP Private Ltd.
4. Pandey P.C., Shan H.S., Modern machining processes, Tata McGraw-Hill Education.

References & Web Resources:

1. Weller E.J., Nontraditional machining processes, Society of Manufacturing Engineers, Publications.
2. The Science and Engineering of Micro-fabrication, Stephen P. Campbell, and Oxford University press.

Course Title	Course Code	Structure (I-P-C)		
INDUSTRIAL IoT AND CLOUD COMPUTING	ME505T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understanding the Internet of Things and its applications in Industry
CO2	Understanding the Cloud Computing
CO3	Understand the existing IoT and Cloud architectures
CO4	Design an IoT system with cloud infrastructure
CO5	Implement a prototype of the IoT/cloud system design

Syllabus:

1. Introduction, Physical design of IoT, Logical design of IoT, IoT enabling technologies, Domain specific IoTs
2. IoT design methodology, logical design
3. IoT physical devices (such as Raspberry Pi, pcDuino, Beagle bone black, Cubie board)
4. Introduction to cloud computing: cloud models, cloud service examples, cloud based services and applications
5. Virtualization, load balancing, scalability, deployment, replication, monitoring, SDN, network function virtualization, MapReduce, identity and access management, SLAs. Cloud service and platforms: Commercial clouds (such as Amazon elastic compute cloud, Google Compute engine, Windows Azure), Storage services, database services, application services, content delivery services, analytics services, Open source private clouds.
6. Architectures to integrate IoT modules with Cloud
7. Case studies: Industrial automation, Cloud for IoT

Text Book(s):

1. A. Bahga and V. Madisetti, Internet of Things, A hands-on approach, CreateSpace Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515.
2. A. Bahga and V. Madisetti, Cloud Computing, A hands-on approach, CreateSpace Independent Publishing Platform, 1st edition, 2013, ISBN: 978-1494435141

References & Web Resources:

1. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580.
2. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 1st edition, 2013, ISBN: 978-0133387520.

Course Title	Course Code	Structure (I-P-C)		
MODELLING AND SIMULATION OF MANUFACTURING SYSTEMS	ME506T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Design and evaluate a given manufacturing system using simulation.
CO2	Generate random numbers and variants to execute a simulation model.
CO3	Evaluate queuing networks and markov chains in the context of manufacturing
CO4	Learn to simulate models matching real life scenarios and obtain superior result
CO5	Develop capabilities of taking up simulation and design projects.

Syllabus:

1. Introduction, Systems, modeling, general systems theory, concept of simulation, simulation as a decision making tool, types of simulation.
2. Introduction to Random numbers, Methods of generating random numbers, Pseudo random numbers and random variates, discrete and continuous random probability distributions, tests for random numbers.
3. Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Geometric distribution with examples, Normal, Exponential distribution with examples
4. Design of Simulation, Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation, validation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system
5. Case studies in simulation, Development of simulation models for queuing systems, production systems, inventory systems, Industrial scheduling problems.

Text Book(s):

1. Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, and P. Shahabudeen, Discrete Event System Simulation, PHI, New Delhi, 2008.
2. Kalechman, M., “Practical MATLAB® basics for engineers”, CRC press, Taylor and Francis group, First Indian reprint, 2012.
3. Shannon, R.E. “systems simulation – The art and Science”, Prentice Hall, 1975.
4. Schriber, T.J., “simulation using GPSS”, John Wiley, 1991.
5. Law, A.M. and Kelton, W.D., "Simulation Modeling and Analysis", McGraw Hill, 2000.

References & Web Resources:

1. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, Tata McGraw Hill, New Delhi, 2006.
2. N. Viswanadham and Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007.

Course Title	Course Code	Structure (I-P-C)		
Micro and Nano Manufacturing Technology	ME507T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Model the material removal in various micro manufacturing processes.
CO2	Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials.
CO3	Select the best process out of the available various advanced manufacturing processes for the given job assignment.
CO4	Understand requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.
CO5	Illustrate the appropriate finishing method for achieving nanofinishing

Syllabus:

1. **Introduction**: Introduction to the Course & Classification of Micro manufacturing Processes. Challenges in Meso-, Micro-, and Nano manufacturing.
2. **Introduction to Traditional and Advanced Micromachining Processes**: Microturning, Micromilling, Microgrinding, Biomachining, Micro- and Nano-manufacturing by Focused Ion Beam, Electric discharge micromachining, Electrochemical micromachining, Abrasive water jet micromachining.
3. **Microcasting and Micromolding**: Microcasting, Micromolding – A soft Lithography Technique.
4. **Microforming**: Introduction to Microforming, Micro- and Nanostructured Surface Development by Nano Plastic Forming and Roller imprinting, Microextrusion, Microbending with Laser.
5. **Microjoining**: Introduction to microjoining, Laser Microwelding, Electron Beams Microwelding and Applications. Fabrication of Microelectronic Devices.
6. **Nanofinishing**: Magnetorheological and Allied Finishing Processes and their theoretical analysis, Theoretical Analysis of Abrasive Flow Finishing, An Integrated Wafer Surface Evolution Model for Chemical Mechanical Planarization (CMP).

Text Book(s):

1. Micromanufacturing, V. K. Jain (Ed.), CRC press, 2012.
2. Micromanufacturing& Nanotechnology, N. P. Mahalik, Springer.

References & Web Resources:

1. Microfacbrication & Nanomanufacturing, Mark J. Jackson, CRC press.
2. Introduction to Micromachining, V. K. Jain (Ed.), Narosa publisher, 2010.

Course Title	Course Code	Structure (I-P-C)		
Applied AI for Manufacturing Practice	ME502P	0	3	2

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Realize application of Machine Learning to Industrial Planning and Decision Making
CO2	Develop a practical understanding of effective scheduling.
CO3	Integrated Software System for Intelligent Manufacturing.
CO4	Planning for Robot Control Systems in Manufacturing.
CO5	Importance of Modelling & Simulation of the process

Syllabus:

These Laboratory classes aims at:

1. Understanding the phenomena involved
2. Study of influencing parameters
3. Develop setup, instrumentation, equation, product, etc.
4. Modelling & Simulation of the process
5. Simple project
6. Creation of concept
7. Application to real problem
8. Assignments suggested by the instructor.

Text Book(s):

1. A. Fazel Famili (Editor), Dana S. Nau (Editor), Steven H. Kim (Editor); Artificial Intelligence Applications in Manufacturing, AAAI Press.

References & Web Resources:

1. Ellen Friedman, Ted Dunning, AI and Analytics in Production; O'Reilly Media, Inc., 2018 (ISBN: 9781492044116)
2. Çağlayan Arkan, The Future Computed: AI and Manufacturing; Global Lead, Manufacturing and Resources Industry, Microsoft, 2019.

Course Title	Course Code	Structure (I-P-C)		
MECHATRONICS PRODUCT DESIGN PRACTICE	ME503P	0	3	2

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand the basic concepts of the main sensors used in electromechanical systems
CO2	Understand basics of open source hardware/software, Mechaphonics, and mobile/web apps
CO3	Design, modeling and analysis of basic electrical, hydraulic and pneumatic systems.
CO4	Hands-on laboratory experiments and team projects involving the above concepts.
CO5	Developing a model constituting of electro-mechanical systems.

Syllabus:

These Laboratory classes aims at designing a model by students in the area of:

1. Arduino microcontroller I/O and interfacing
2. Basic sensors interfacing with Arduino
3. GPS and data logging with Arduino
4. Networking with Arduino: GSM and Bluetooth
5. Raspberry Pi microcomputer I/O and interfacing

The model should consist of the above modules, addressing a real time problem.

Text Book(s):

1. J. Edward Carryer, et al., Introduction to Mechatronic Design, Prentice Hall, 1st edition, 2010, ISBN: 978-8131788257.

References & Web Resources:

1. W. Bolton, Mechatronics, Pearson India, 4th edition, 2010, ISBN: 978-8131732533.
2. D. G. Alciatore and M. B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill, 4th edition, 2014, ISBN: 978-9339204365.

Course Title	Course Code	Structure (I-P-C)		
ADVANCED MANUFACTURING PRACTICE	ME504P	0	3	2

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Realize products using advanced manufacturing processes
CO2	Develop a practical understanding of advanced manufacturing processes and capabilities of each.
CO3	Identify and rectify defects in parts and manufacturing processes related problems.
CO4	Analyze data from experiments performed and reach conclusions.
CO5	Create a model (hybrid process) to enhance the techniques of non-traditional manufacturing.

Syllabus:

These Laboratory classes aims at:

1. Understanding the phenomena involved
2. Study of influencing parameters
3. Develop setup, instrumentation, equation, product, etc.
4. Modeling& Simulation of the process
5. Simple project
6. Creation of concept
7. Application to real problem

Assignments suggested by the instructor.

Text Book(s):

1. Advanced manufacturing processes, Hassan Abdel, Gabad El Hoffy, McGraw Hill.
2. V.K.Jain, Advance Machining Processes, Allied Publisher Bombay.
3. Ghosh and Mallik, Manufacturing Science, EWP Private Ltd.
4. Pandey P.C., Shan H.S., Modern machining processes, Tata McGraw-Hill Education.

References & Web Resources:

1. Advanced manufacturing processes, Hassan Abdel, Gabad El Hoffy, McGraw Hill.
2. V.K.Jain, Advance Machining Processes, Allied Publisher Bombay.
3. Ghosh and Mallik, Manufacturing Science, EWP Private Ltd.
4. Pandey P.C., Shan H.S., Modern machining processes, Tata McGraw-Hill Education.

Course Title	Course Code	Structure (I-P-C)		
Industrial IoT and Cloud Computing Practice	ME505P	0	3	2

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understanding the Internet of Things and its applications in Industry
CO2	Understanding the Cloud Computing
CO3	Understand the existing IoT and Cloud architectures
CO4	Design an IoT system with cloud infrastructure
CO5	Implement a prototype of the IoT/cloud system design

Syllabus:

These Laboratory classes aims at:

1. Understanding the phenomena involved
2. Study of influencing parameters
3. Develop setup, instrumentation, equation, product, etc.
4. Modeling & Simulation of the process
5. Simple project
6. Creation of concept
7. Application to real problem
8. Assignments suggested by the instructor.

Practice: (practice exercises can be mini projects)

Using IoT devices small systems like classroom automation, smart parking, environment monitoring can be designed and implemented also, Hadoop cluster can be setup and studied. Cloud computing with IoT for healthcare and industrial automation can be studied

References & Web Resources:

1. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580.
2. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 1st edition, 2013, ISBN: 978-0133387520.

Course Title	Course Code	Structure (I-P-C)		
MANUFACTURING SIMULATION PRACTICE	ME506P	0	3	2

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Design and evaluate a given manufacturing system using simulation.
CO2	Generate random numbers and variants to execute a simulation model.
CO3	To understand the importance and advantages of applying simulation techniques for solving various problems on discrete event systems in manufacturing domain.
CO4	To understand the applications of random probability distributions in real time environments
CO5	Train students to solve discrete event problems through hand simulation and to develop simulation models using Extend simulation software.

Syllabus:

Simulation software, Study and selection of simulation languages, Use of simulation software such as GPSS, Extend, Mat lab, Simulink, LabVIEW etc., for simulation of following models

1. Warehouse concept : Module 1 - Unloading, loading and depart
   Module 2 - Chain of events occurring in the warehouse
2. Fasteners in assembly of planes/automobile parts (Module based on Simio)
3. Medical Centre problem (Outpatient, emergency, and inward monitoring
   - The model should be a virtual environment and used the insights to identify and remove bottlenecks, reduce patient and surgeon travel distance, ensure the use of operating rooms during staff peak hours, and reduce patient turnover.
4. Reduction of wastage in industries/agriculture sector/and industry bodies.
   - Ascertain the "optimum" number of transport vehicles it needs to transport materials to its processing mills while lowering costs.
   - Identify how it can increase the mills' capacity.
   - Identify and remove production bottlenecks and "improve the flow of (sic) product."

Text Book(s):

1. Shannon, R.E. Systems simulation – The art and Science, Prentice Hall, 1975.
2. Schriber, T.J., Simulation using GPSS, John Wiley, 1991.
3. Law, A.M. and Kelton, W.D., Simulation Modeling and Analysis, McGraw Hill, 2000.

References & Web Resources:

1. Manufacturing Systems Modeling and Analysis, Guy L Curry and Richard M Feldman, 2011, Springer.
2. Manufacturing Systems Design and Analysis, B Wu, 1992, Springer.
3. Model Design and Simulation Analysis, Syng Yup Ohn and Sung Do Chi, 2015, Springer.

Course Title	Course Code	Structure (I-P-C)		
INFORMATION SYSTEMS IN MANUFACTURING	ME511T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand/implement computer models of common engineering information types.
CO2	Understand the importance and be able to critically discuss the role of management information systems for design, engineering and manufacturing.
CO3	Discuss and evaluate engineering data management issues across the extended enterprise.
CO4	Demonstrate an appreciation of the complex relationship between information systems and organization.
CO5	Understanding Information Systems in Smart Manufacturing

Syllabus:

1. Manufacturing organizations, management, and the networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and Behavioral approach.
2. Organizations, management, and the networked enterprise: Information systems in global business today, Global e-business: Use of information systems in manufacturing functions, information system, organizations, and strategy, ethical and social issue in information systems
3. Information Technology Infrastructure: IT Infrastructure and Emerging Technologies, Foundations of Business Intelligence: Databases and Information Management, Telecommunications, the Internet, and Wireless Technology, Securing Information Systems, shop floor communications.
4. Key System Applications: Achieving Operational Excellence and Customer Intimacy: Enterprise Applications, E-Commerce: Digital Markets, Digital Goods, Managing Knowledge and Collaboration, Enhancing Decision Making.
5. Smart manufacturing and connected enterprise, ISA 95, Functional and physical sub-divisions, Global connected supply chain, mass customization, customer co-creation. Case studies of information systems for key manufacturing functions: Life cycle, supply chain, enterprise, quality, maintenance, materials, energy and sustainability information systems.

Text Book(s):

1. K. Laudon and J. Laudon, Management Information Systems, 14th edition, Pearson Higher Education, 2016, ISBN: 9780136093688.
2. F. Cecelja, Manufacturing Information and Data Systems, 1st edition, Butterworth Heinemann, 2002, ISBN: 9781857180312.

References & Web Resources:

1. T. O. Boucher and A. Yalçin, Design of Industrial Information Systems, 1st edition, Elsevier, 2006, ISBN: 9780123704924.
2. K. E. Kurbel, Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies, 1st edition, Springer, 2013, ISBN: 9783662509869.
3. R. Zurawski, Integration Technologies for Industrial Automated Systems, 1st edition, CRC Press, 2006, ISBN: 9780849392627.

Course Title	Course Code	Structure (I-P-C)		
INSPECTION AND TESTING IN MANUFACTURING	ME512T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand the importance of testing and inspections.
CO2	Draw the suitability and purpose of different testing methods.
CO3	Apply the knowledge of various tools and techniques used for testing and inspecting dimensions of components in engineering applications.
CO4	Perform the job of a quality inspector and help the industries in ensuring and producing qualitative products.
CO5	Able to learn the application potential of different methods of inspection and testing in a real life manufacturing system.

Syllabus:

1. **Introduction**: Types and purposes of testing of manufactured components, Precautions in inspections, Accuracy of measurement and important terms;
2. **Destructive Physical Analysis (DPA):** Suitability and purpose; Review of Mechanical testing methods; Tensile Testing (TT); Compression test, Charpy Impact test, Hardness Testing (HT) - Micro and Nano-hardness test, Stress Rupture Testing (SRT); Toughness, Fatigue and Fracture toughness test, Bend test, Creep test, Chemical tests, Macrographs study;
3. **ASTM standard test methods**: Tensile test, Charpy Impact test, Micro-hardness evaluation, Fracture toughness test, Crack growth rate study, Flexural strength of beam; Introduction to NDT, Visual Optical methods, Dye penetrant testing, Methods of application, Developer; Magnetic particle testing, Magnetization methods, Field indicators, Particle application, Inspection; Eddy current testing, Faraday's law, Inductance, Lenz's law, Self and Mutual Inductance, Impedance plane, Inspection system;
4. **Ultrasonic testing**: Basics of ultrasonic waves, Pulse and beam shapes, Ultrasonic transducers, Distance and Area calibration, Weld inspection by UT;
5. **Acoustic emission testing**: Sources of acoustic emission, Source parameters, Kaiser-Felicity theory, Equipment and Data analysis;
6. **Radiography**: X-rays and their properties, X-ray generation, X-ray absorption and atomic scattering; Image formation, Image quality, Digital Radiography, Image interpretation, Radiation Shielding; ASTM standard test method for NTD tests, like Radiographic, Ultrasonic, Electromagnetic (eddy current), X-ray, Acoustic and Tomographic techniques; and Comparison and selection of NDT methods.

Text Book(s):

1. Nondestructive Testing, Louis Cartz, ASM International
2. Nondestructive Evaluation and Quality Control, ASM Handbook, Vol. 17.
3. Non-Destructive Test and Evaluation of Materials By J Prasad, McGraw Hill, 2017
4. Welding Inspection, American Welding Society,3rdEd.,2000
5. The Mechanical Testing of Metals and Alloys By foster, P. Field, Cousens Press , 2007
6. Metals Handbook: Mechanical testing, American Society for Metals, 1978

References & Web Resources:

1. ASTM standards for mechanical test, such as: ASTM E8/E8M (Tension test for metals),
2. ASTM D6110-10 (Charpy impact test), ASTM E9-09 (Compression test), ASTM E139-11 (Creep test)
3. ASTM standards for various non-destructive tests

Course Title	Course Code	Structure (I-P-C)		
LASERS IN MANUFACTURING	ME513T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Identify the lasers based on their functionality for different applications.
CO2	Determine the requirement of laser components in different configurations.
CO3	Differentiate the lasers required for various material processes and manufacturing.
CO4	Illustrate the use of laser in metrological applications
CO5	Understanding the Laser usage in Industrial applications

Syllabus:

1. **Introduction to Lasers:** Introduction to Lasers: Basic principle of laser generation, Stimulated Emission; Properties of laser beam, Industrial, medical and scientific applications of Laser; Basic concept of the Laser System: Gain Medium, Optical Resonator, Pump Source, Laser beam delivery systems;
2. **Characteristics of different industrial lasers:** Introduction and basic fundamentals and characteristics of different industrial lasers: He-Ne, CO2, Nd:YAG, Excimer, Fiber, Diode and Ultra-short pulse lasers; Laser processing fundamentals: Laser beam interaction with metal, semiconductor and insulator; Ultra-short laser pulse interaction; heat flow theory
3. **Laser based material processing:** Laser Material Processing Applications; process characteristics, mode of material removal: Laser Cutting and Drilling; Laser Welding; Laser Surface Modifications; Laser Additive Manufacturing; Laser Metal Forming; Laser shock peening; Laser Etching and Paint Striping; LCVD and LPVD; Laser hybrid machining; Liquid assisted laser machining: applications and advantages;
4. **Industrial and scientific applications of laser:** Overview of Industrial & Scientific Applications of laser: Metrological applications, Holography (Non-destructive Testing), Laser Isotope Separation, Laser fusion; Theoretical modeling of laser material processing; and economics of Laser applications in manufacturing, Laser safety standards and safety procedures.

Text Book(s):

1. Laser Fundamentals by William T. Silfvast, Cambridge University Press, New Delhi, 2nd South Asian Edition, 2004.
2. Principles of Lasers By SveltoOrazio, Springer, 5th Ed. 2010
3. Laser Material Processing By W. M. Steen and J. Mazumder, Springer, 4th Ed. 2010.

References & Web Resources:

1. Laser Materials Processing By Elijah Kannatey–Asibu, Jr, Wiley, 2009
2. Laser Fabrication and Machining of Materials By Narendra B. Dahotre & Sandip P. Harimkar, Springer, 2009.

Course Title	Course Code	Structure (I-P-C)		
Advanced Engineering Mathematics	ME514T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Apply a range of mathematical theorems and methods to solve routine and complex analytic and applied problems;
CO2	Analyze data necessary for the solution of engineering problems; and
CO3	Examine the effectiveness of proposed solutions to identified engineering problems.
CO4	Understand the Vector and Tensor Calculus
CO5	Understand ODEs and their importance in Engineering domains

Syllabus:

1. Linear Algebra: Vector space and its basis; Matrices as coordinate-dependent linear transformation; null and range spaces;
2. Solution of linear algebraic equations: Gauss elimination and Gauss-Jordon methods, LU Decomposition and Cholesky method, Gauss-Seidel / Jacobi iterative methods; Condition number; Minimum norm and least square error solutions; Eigenvalues and eigenvectors of matrices and their properties; Similarity transformation; Jordon canonical form and orthogonal diagonalization; Mises power method for finding eigenvalues/eigenvectors of symmetric matrices. Tensor Algebra and Index Notation.
3. Vector and Tensor Calculus: Curves and surfaces; Gradient, divergence and curl, Line, surface and volume integrals; Gauss (divergence), Stokes and Green's theorems.
4. Topics in Numerical Methods: Solution of a nonlinear algebraic equation and system of equations; Interpolation methods, Regression; Numerical Integration.
5. Ordinary Differential Equations (ODEs): Techniques of the separation of variable and the integrating factor for 1st order ODEs; Solutions of linear, 2nd order ODEs with constant coefficients and Euler-Cauchy ODEs; System of 1st order ODEs; Numerical methods for solving ODEs, Homogeneous, linear, 2nd order ODEs with variable coefficients: power series and Frobenius methods; Sturm-Louville problem; Laplace transform method for non-homogeneous, linear, 2nd order ODEs: discontinuous right-hand sides.

Text Book(s):

1. Advanced Engineering Mathematics by E. Kreyszig, John Wiley and Sons, International 8th Revised Edition, 1999,

References & Web Resources:

1. Applied Mathematical Methods by B. Dasgupta, Pearson Education, 2006.

Course Title	Course Code	Structure (I-P-C)		
APPLIED OPERATIONS RESEARCH	MT515T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Develop linear programming (LP) models for shortest path, maximum flow, minimal spanning tree, critical path, minimum cost flow, and trans-shipment problems.
CO2	Construct linear integer programming models and discuss the solution techniques.
CO3	Set up decision models and use some solution methods for nonlinear optimization problems.
CO4	Capable to understand the mathematical tools that are needed to formulate & solve transportation problems for optimization and assignment programming.
CO5	Able to learn the application potential of heuristic optimization and dynamic programming.

Syllabus:

1. Introduction to management decision making and operations research. Fundamentals of linear programming. Alternative ways of formulating practical linear programming models. Their advantages and disadvantages.
2. Case studies and applications of linear programming. Solution approaches, implications of sensitivity analysis.
3. Transportation and assignment programming. Sensitivity analysis in transportation programming; integer programming formulations and applications.
4. Basics of heuristic optimization.
5. Dynamic programming. Applications of dynamic programming.

Text Book(s):

1. Anderson, Sweeny and Williams, An Introduction to Management Science: Quantitative Approaches to Decision Making,11th Edition.
2. Ackoff, R.L. and Sasini, M. W., Fundamentals of Operations Research, Wiley & Sons, New York.

References & Web Resources:

1. Wagner, H.M., Principle of Operations Research, Prentice Hall, New Jersey.
2. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill.
3. Churchman, C.W.: Introduction to Operations Research John Wiley& Sons New York.

Course Title	Course Code	Structure (I-P-C)		
DESIGN AND ANALYSIS OF EXPERIMENTS	ME516T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Apply the basic concepts of design of experiment in designing a real-life experiment.
CO2	Implement the tests of hypotheses in solving various engineering problems.
CO3	Design and develop various factorial experiments.
CO4	Develop linear regression models for the prediction of parameters.
CO5	Develop RSM based quadratic models and perform analysis of variance test.

Syllabus:

1. Introduction to Designed Experiments: Strategy of experimentation, typical applications, Basic principles and guidelines for designing experiments.
2. Basic statistical concepts: Descriptive Statistics, Sampling and Sampling Distributions, Tests of Hypotheses.
3. Single factor experiments with Fixed Effects: ANOVA, Model Adequacy Tests, and Orthogonal Contrasts.
4. Experiments with Blocking Factors: Randomized Complete and Incomplete Block Designs, Latin Squares Design.
5. Factorial Experiments: 22, 32, and 2k Designs, Blocking and Confounding, and Fractional Factorial Designs.
6. Linear Regression Models: Estimation of Parameters, Tests of Hypothesis, Regression Model Diagnostics.
7. Response Surface Design: Method of Steepest Ascent, Second-Order Response Surface, Experimental Designs, Computer Models, Mixture Experiments, Evolutionary Operations Advanced Design of Experiments: Random Effects Models, Analysis of Covariance, Non-Normal Response, and Taguchi Methods.

Text Book(s):

1. Design and Analysis of Experiments, D. C. Montgomery, John Wiley & Sons, Wiley Student Edition, International Student Version, 7th Edition, 2009.
2. Design of Experiments: An Introduction Based on Linear Models, M. Morris, Chapman & Hall/CRC Texts in Statistical Science, First Edition, 2010.

References & Web Resources:

1. Practical Guide to Designed Experiments: A Unified Approach, P. D. Funkenbusch, CRC Press, 2004.
2. The Theory of the Design of Experiments, D. R. Cox and N. Reid, Chapman and Hall/CRC, 200.
3. Design and Analysis of Experiments A. M. Dean and D. Voss, Springer Texts in Statistics, Second Edition, 2001.

Course Title	Course Code	Structure (I-P-C)		
Computational Tools for Engineers	MT517T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Solve systems of linear equations
CO2	Solve nonlinear algebraic equation
CO3	Perform numerical differentiation and integration
CO4	Solve ordinary differential equations numerically
CO5	Solve standard partial differential equations

Syllabus:

1. Numerical Methods in Linear Algebra: Direct and iterative solution techniques for simultaneous linear algebraic equations – Gauss elimination, Gauss-Jordon, LU Decomposition, QR Method, Jacobi and Gauss-Seidel Methods. Eigenvalues and Eigenvectors – Power and inverse power method, householder transformation
2. Solution of nonlinear algebraic equations: Bisection method, fixed-point iteration method, Newton-Raphson, Secant method, solution of system of nonlinear algebraic equations Interpolation: Polynomial interpolation, Lagrange interpolating polynomial, Hermite interpolation, interpolation in 2 and 3 dimensions
3. Numerical Differentiation and Integration Finite difference formula using Taylor series, Differentiation of Lagrange polynomials, Simpson's rule, Gauss-quadrature rule, Romberg method, multiple integrals.
4. Numerical solution of differential equations Ordinary Differential Equations – Euler, Heun's method and Stability criterion, second order and fourth order Runge-Kutta methods, Adams-Bashforth-Moulton method, system of ODEs and nonlinear ODEs
5. Partial Differential Equations – Classification of PDEs, Elliptic equations, Parabolic equations (Transient diffusion equation), Hyperbolic equations (wave equation)

Text Book(s):

1. Steven C. Chapra, Numerical Methods for Engineering, Mc-Graw Hill Education
2. Joe D Hoffman, Numerical Methods for Engineers and Scientists, Second Edition, Marcel Dekker (2001)
3. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge Press
4. J.H. Mathews and K D Fink, Numerical Methods using MATLAB, Pearson Education
5. Parviz Moin, Fundamentals of Engineering Numerical Analysis, Cambridge University Press

References & Web Resources:

1. S. P. Venkateshan, Prasanna Swaminathan, Computational Methods in Engineering, Ane Books
2. Steven C. Chapra, Numerical Methods for Engineering, Mc-Graw Hill Education
3. Joe D Hoffman, Numerical Methods for Engineers and Scientists, Second Edition, Marcel Dekker (2001)
4. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge Press.

Course Title	Course Code	Structure (I-P-C)		
DIGITAL MANUFACTURING	ME521T	3	0	3

Pre-requisite, if any: Nil

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand the application of Geometrical design in Digital Manufacturing
CO2	Analyze the shape digitization 3D object scanning process
CO3	Distinguish the subtractive and additive manufacturing
CO4	Examine the Product life cycle management
CO5	Interpret the trends in the advanced technology application in digital manufacturing

Syllabus:

1. Digital design: Geometrical design of curves, Surfaces and solids, Introduction to computer aided engineering analysis and optimum design. Consideration of manufacturing and assembly aspects in design;
2. Shape digitization: 3D object scanning, Solid reconstruction from point cloud and tessellated data, Downstream applications; Digital manufacturing:
3. Subtractive manufacturing: Basic architecture, Control hardware and software details, Tooling, Sculptured surface machining;
4. Additive Manufacturing: Basics, Hardware details and capabilities of commercial systems, Planning of material addition, Rapid tooling solutions;
5. Computer Aided Process Planning: CAPP and route sheet development, CAPP system, Computer aided plant layout, Computer Aided Production Planning and Control, Algorithms for CAPP;
6. Product Database Management Systems: Types, Management Information System, Manufacturing data preparation, Shop-floor control, automatic identification systems (sensors, trackers), Product life cycle management; and
7. Introduction to Industrial Internet of Things, Industry 4.0.

Text Book(s):

1. Fundamentals of Digital Manufacturing Science, by Z. Zhou, S.Xie, D. Chen, Springer, 2012.

References & Web Resources:

1. Rapid Prototyping: Principles and Applications By C.K. Chua, K.F. Leong, C.S. Lim, John Wiley, 2010.
2. Mastering CAD CAM By Ibrahim Zeid, McGraw Hill, 2005.
3. Automation, production systems, and computer-aided manufacturing By M P Groover, Pearson, 2016.

Course Title	Course Code	Structure (I-P-C)		
SMART MATERIALS AND STRUCTURES	ME522T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand various existing smart materials
CO2	Develop a mathematical model for smart material systems.
CO3	Understand the nature of coupling field behaviour
CO4	List the usage of smart materials for control application
CO5	Analyze vibration control and damping structures using piezoelectric materials

Syllabus:

1. Introduction to Smart Materials systems: Historical Overview of Piezoelectric Materials, Shape Memory Alloys, and Electroactive Polymers. Recent Applications.
2. Modeling Mechanical and Electrical Systems: Fundamental Relationships in Mechanics and Electrostatics, Work and Energy Methods, Basic Mechanical and Electrical Elements, Variational Principles
3. Mathematical Representations of Smart Material Systems: Algebraic and differential Equations for Smart Material Systems, Input–Output Models and Frequency Response, Impedance and Admittance Models.
4. Piezoelectric Materials: Electromechanical Coupling in Piezoelectric Devices – Direct and Converse Effect. Physical Basis for Electromechanical Coupling. Constitutive Equations. Electrostrictive Materials.
5. Shape Memory Alloys: Properties of Thermally Activated Shape Memory Materials, Physical Basis for Shape Memory Properties, Constitutive Modeling, Dynamic Modeling for Electrical Actuation.
6. Electroactive Polymer Materials: Fundamental Properties of Polymers, Dielectric Elastomers, Input–Output Transducer Models.
7. Control applications: Motion control applications, Passive and Semi active Damping, Active Vibration Control.

Text Book(s):

1. Donald J Leo, Engineering Analysis of Smart Materials Systems, John Wiley and Sons, 2007

References & Web Resources:

1. Cady, W. G., Piezoelectricity, Dover Publication
2. Gauenzi, P., Smart Structures, Wiley, 2009

Course Title	Course Code	Structure (I-P-C)		
PRODUCT DESIGN AND DEPVELOPMENT	ME523T	3	0	3

Pre-requisite, if any: Nil

Course Outcomes: At the end of the course, the students will be able to:

CO1	Emphasize on methodologies for various steps of product design such as user study.
CO2	Realize the need/problem identification, competitive benchmarking, and aspects of human factors in product design, creative concept generation, and prototyping/model making and evaluation techniques.
CO3	Understand the importance of DFX in Product design
CO4	Understand usage of TRIZ, Decision matrix
CO5	Understand the importance of aesthetics and ergonomic aspects in design

Syllabus:

1. Design methodology and philosophy- types of designs, design models, concurrent engineering, and product life cycle.
2. Design Teams – Organizations & product Planning. Need Analysis & Scope- mission statement, customer study, Kano diagram-Establishing Product Function- functional decomposition, FAST and SOP, function structure.
3. Product Tear down- reverse engineering. Product Specifications- product design tools, QFD, Computer Aided Design, Robust design, DFX, DFM, DFA, DFMA, DFSS.
4. Design guidelines for metallic and non-metallic products to be manufactured by various processes. Generation and evaluation of concepts – TRIZ, Decision matrix etc.
5. Industrial Design – aesthetics and ergonomic aspects of product design. Value Engineering. Failure mode and effects analysis.

Text Book(s):

1. Eppinger, S, Ulrich, K, Product design and development, McGraw-Hill, (2000).
2. Kevin Otto, Kristin Wood, Product design, Pearson, (2004).

References & Web Resources:

1. George E. Dieter, Engineering Design, McGraw Hill, (2000).
2. David G Ullman, the Mechanical Design Process, McGraw Hill, (2003).

Course Title	Course Code	Structure (I-P-C)		
DESIGN FOR MANUFACTURING AND ASSEMBLY	ME524T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Outline the appropriate design for economical production and select the materials.
CO2	Fabricate basic parts and assemblies using powered and non – powered machine shop equipment in conjunction with mechanical documentation.
CO3	Integrate the knowledge of compliance analysis and interference analysis for assembly and also use visco-elastic and creep in plastics.
CO4	Understand the Design aspects of various machining and fabrication processes
CO5	Understand the importance of considering Quality and Reliability at Design stage.

Syllabus:

1. Introduction - Need Identification and Problem Definition, Concept Generation and Evaluation;
2. Selection of Materials and Shapes - Properties of Engineering Materials, Selection of Materials, Selection of Shapes, Co-selection of Materials and Shapes;
3. Selection of Manufacturing Processes - Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Co-selection of Materials and Processes;
4. Design for Assembly - Review of Assembly Processes, Design for Welding, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment;
5. Design for Additive Manufacturing; Design for 3D Printing;
6. Design for Reliability and Quality - Failure Mode and Effect Analysis, Design for Quality, Design for Reliability, Approach to Robust Design, Design for Optimization; Design for Six Sigma

Text Book(s):

1. Ashby M.F., Materials Selection in Mechanical Design, Butterworth-Heinemann, (2016).
2. Swift K.G., Booker J.D., Process Selection: From Design to Manufacture, Butterworth-Heinemann , (2003)

References & Web Resources:

1. Dieter G.E., Schmidt L.C., Engineering Design, McGraw-Hill higher education, (1991).
2. Bralla J.G., Handbook for Product Design for Manufacture: A practical guide to low cost production, McGraw-Hill, (1986).
3. Ashby M.F., Johnson K., Materials and Design – the art and science of materials selection in product design, Butterworth-Heinemann, (2014).
4. Courtney T.H., Mechanical Behaviour of Materials, McGraw Hill, (2000).

Course Title	Course Code	Structure (I-P-C)		
ADDITIVE MANUFACTURING	ME525T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
CO2	Acquire knowledge on process of transforming a concept into the final product in AM technology.
CO3	Elaborate the vat polymerization and material extrusion processes and its applications.
CO4	Acquire knowledge on process and applications of powder bed fusion and direct energy deposition
CO5	Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes.

Syllabus:

1. Overview, Need, Development of Additive Manufacturing (AM) Technology: Rapid Prototyping Rapid Tooling, Rapid Manufacturing, Additive Manufacturing, AM Process Chain Classification Benefits. Applications: Building Printing, Bio Printing Food Printing Electronics. Business Opportunities and Future Directions, Intellectual Property.
2. Design for Additive Manufacturing (DFAM), Concepts and Objectives, AM Unique Capabilities: Part Consolidation, Topology Optimization, Light weight Structure, DFAM for Part Quality Improvement. Data Processing, CAD Model Preparation, Part Orientation and Support Structure Generation, Model Slicing, Tool Path Generation Customized Design and Fabrication for Medical Applications, Case Studies.
3. Vat Polymerization and Material Extrusion, Photo polymerization: Stereolithography, Apparatus (SLA), Materials, Process, Advantages, Limitations, and Applications. Digital Light Processing (DLP), Materials, Process, Advantages, Applications. Extrusion Based System: Fused Deposition Modeling (FDM), Process, Materials, Applications and Limitations.
4. Powder Bed Fusion and Direct Energy Deposition, Powder Bed Fusion: Selective Laser Sintering (SLS): Process, Powder Fusion Mechanism, Process Parameters, Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials, Process, Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS), Process Material Delivery, Process Parameters, Materials, Benefits, Applications
5. Other Additive Manufacturing Processes Binder Jetting: Three Dimensional Printing, Materials Process, Benefits and Limitations. Material Jetting: Multijet Modeling, Materials, Process, Benefits. Sheet Lamination Process: Laminated Object Manufacturing (LOM), Basic Principle Mechanism: Gluing or Adhesive Bonding, Thermal Bonding, Materials, Application and Limitation.

Text Book(s):

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.
2. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.
3. L. Lu, J. Fuh and Y.-S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press, 200I.

References & Web Resources:

1. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition, World Scientific, 2010.

Course Title	Course Code	Structure (I-P-C)		
SOFT COMPUTING TECHNIQUES	ME526T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understanding classical search techniques
CO2	Differentiate and classify traditional and non-traditional optimization methods.
CO3	Formulate an optimization problem to solve complex manufacturing engineering problems.
CO4	Evaluate the importance of parameters in heuristic optimization techniques
CO5	Understanding Fuzzy and Neural networks and their combination

Syllabus:

1. Problem Solving Methods and Tools: Problem Space, Problem solving, State space, Algorithm's performance and complexity, Search Algorithms, Depth first search method, Breadth first search methods their comparison, A*, AO*, Branch and Bound search techniques, p type, Np complete and Np Hard problems.
2. Evolutionary Computing Methods: Principles of Evolutionary Processes and genetics, A history of Evolutionary computation and introduction to evolutionary algorithms, Genetic algorithms, Evolutionary strategy, Evolutionary programming, Genetic programming.
3. Genetic Algorithm and Genetic Programming: Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.
4. Swarm Optimization: Introduction to Swarm intelligence, Ant colony optimization (ACO), Particle swarm optimization (PSO), Artificial Bee colony algorithm (ABC), and Other variants of swarm intelligence algorithms.
5. Advances in Soft Computing Tools: Fuzzy Logic, Theory and applications, Fuzzy Neural networks, Pattern Recognition, Differential Evolution, Data Mining Concepts, Applications of above algorithms in manufacturing engineering problems.
6. Artificial Neural Networks: Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, applications.

Text Book(s):

1. Tettamanzi Andrea, Tomassini and Marco, Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems, Springer, 2001.
2. Elaine Rich, Artificial Intelligence, McGraw Hill, 2/e, 1990.

References & Web Resources:

1. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, John Wiley and Sons, 2001.

Course Title	Course Code	Structure (I-P-C)		
BIG DATA ANALYTICS	ME527T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand what Big Data is and why classical data analysis techniques are no longer adequate.
CO2	Understand how the Big stored and processed to extract knowledge
CO3	Understanding various existing Big data storage methods
CO4	Importance of designing Algorithms that suits to Big Data scale
CO5	Understanding on how the clustering algorithms are implemented

Syllabus:

1. **Theory**:

   Mapreduce abstraction, Google paper, Google systems, GFS, BigTable, Cluster and Data center network, Distributed Storage, Facebook photo storage, Azure storage systems. Data deduplication storage systems, Venti and DDFS, Data preprocessing, predictive techniques, association rules, classification, clustering, supervised v/s unsupervised learning, algorithms, domain specific feature extraction, similarity measures, Shingles and minhashing, locality sensitive hashing, Dimensionality reduction techniques, Clustering in high dimensional space, Web link analysis.

2. **Practice**:

   Initial few exercises using R on association rule mining, classification, clustering wherein various existing algorithms are tested over benchmark datasets – This shall expose students to the basics of AI perspective over databases. Mapreduce abstraction using the IDE framework, Hadoop, Architecture, Data deduplication storage systems, Venti and DDFS, Shingles and minhashing, locality sensitive hashing, Latent Semantic Indexing, case study for dimensionality reduction, Support for distributed / parallel computing in R, case studies of Clustering in high dimensional space, Web link analysis, Pagerank algorithm, survey / simulation.

Text Book(s):

1. A. Rajaraman, J. Leskovec, J. Ullmann, Mining of Massive Data sets, Cambridge University Press, 2011, ISBN: 1107015359.

References & Web Resources:

1. Papers relating to the various topics mentioned in the syllabus on Facebook photostorage, Google storage systems etc. which are available either as conference proceedings / shared by agencies such as Google.
2. www.cs.princeton.edu/courses/archive/spring13/cos598C/index.htm - Princeton University Course Webpage.

Course Title	Course Code	Structure (I-P-C)		
Operations and Supply Chain Management	ME528T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Apply the forecasting techniques in estimating the number of products.
CO2	Use the inventory management techniques to determine the optimum quantity of material.
CO3	Decide the dispatch procedure required for a production processes and other activities.
CO4	Acquaintance to the concepts Supply chain Management
CO5	Become familiar with current supply chain management trends Understand and apply the current supply chain theories, practices and concepts utilizing case problems and problem-based learning situations.

Syllabus:

1. Forecasting: Need for forecasting, Quantitative methods.
2. Facility layout and location: Qualitative aspects, Quantitative models for layout decisions, Product, process xed position, group layout, Location decisions-quantitative models. Capacity and aggregate planning, Capacity measurement, Long-term and short-term strategies, Aggregate planning.
3. Inventory management: Various costs in inventory management and need, Deterministic model sand discounts, Probabilistic inventory management.
4. Scheduling models and applications, Scheduling in MRP system, Sequencing rules and applications, Batch production sequencing and scheduling.
5. Introduction to supply chain: Definition, complexity, key issues, centralized vs. decentralized systems.
6. Value of information and supply chain integration: Bullwhip effect, Push-based, pull based systems. Outsourcing: Make or buy decisions. Transportation decision: Drivers of the decision, Network design decisions, Cross-docking, trans-shipment.
7. Distribution and logistics in supply chains: Direct shipment/intermediate storage policies, Vehicle routing models, Third-party logistics.
8. Information technology in supply chain, Enabling supply chain through IT, ERP vendor platforms, Service oriented architecture (SOA), RFID

Text Book(s):

1. BOWERSOX, Donald J. (2013) Supply chain logistics management. New York : McGraw-Hill.
2. CHOPRA, SunilMeindl, Peter (2013) Supply chain management: strategy, planning, and operation. Boston : Pearson.

References & Web Resources:

1. R.Panneerselvam, Production/Operations Management, Prentice Hall of India Pvt Ltd, 2007.
2. P.Rama Murthy, Production and Operations Management, New Age International, 2nd Edition, 2005.
3. S.N.Chary, Production and Operations Management, TMH, 4th Edition 2010.
4. SamuelEilon, Elements of Production Planning and Control, Universal Publishing Corporation, 2004.
5. Joseph.G.Monks, Operations Management, McGraw-Hill Inc., 3rd revised edition.

Course Title	Course Code	Structure (I-P-C)		
Total Quality Management	ME529T	3	0	3

Pre-requisite, if any:

Course Outcomes: At the end of the course, the students will be able to:

CO1	Know business excellence models and be able assess organization's performance making reference to their criteria;
CO2	Know the principles of total quality management and peculiarities of their implementation
CO3	Be able to use quality management methods analyzing and solving problems of organization;
CO4	Know prerequisites of evolution of total quality management and significance of quality gurus' works to the management of modern organizations.
CO5	Be able to use QFD and DoE for optimization

Syllabus:

1. **Introduction to total quality management:** Total Quality Management, quality management Philosophies, Leadership, Employee involvement and customer value evaluation, Kaizin.
2. **Tools for quality assurance:** Problem Solving and Quality Management: Problem solving fundamentals, Problem identification, Definition, Diagnosis, Alternative Generation and Evaluation, Elementary concepts related to 7 Old and 7 New tools for quality assurance.
3. **Statistical Process Control:** Basic Statistical Concepts, Control of Accuracy and Precision, Process Capability, SPC, Acceptance Sampling, MIL-STD-105D. Quality Management Systems, ISO 9000, Quality Engineering.
4. **QFD and Introduction to DoE:** Quality Function Development (QFD), Introduction to Design of Experiments (DoE), Process Optimization and Robust Product Design, Steps to Six Sigma, Management of Service Quality, Management of Software Quality.

Course will include projects and industry case studies.

Text Book(s):

1. Douglas C. Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons, Inc.

References & Web Resources:

1. Dale, B. (2015). Total quality management. John Wiley & Sons, Ltd.
2. Oakland G. F. Total Quality Management, Oxford, 2003.
3. S. S. Singh, Total quality control essentials by McGraw Hill Inc.93 Singapore.

भारतीय सूचना प्रौद्योगिकी अभिकल्पना एवं विनिर्माण संस्थान , कर्नूल
INDIAN INSTITUTE OF INFORMATION TECHNOLOGY
DESIGN AND MANUFACTURING KURNOOL
Jagannathagattu, Kurnool – 518007, Andhra Pradesh, INDIA
(An Institute of National Importance under the Ministry of Education, Govt. of India)

ORDINANCES and REGULATIONS

for

Master of Technology Programme

Effective from the A.Y. 2020-21

(July 2020)

ORDINANCE

O.1 The minimum academic qualification for admission through CCMT to IIITDM Kurnool is 60% or 6.5 CGPA in the appropriate branch of engineering or its equivalent.

a. Candidates who have qualified for the award of the Bachelor's degree in Engineering / Technology from educational Institutions approved by AICTE/UGC/Government and who have a valid GATE (Graduate Aptitude Test in Engineering) score are eligible to apply for admission to the M.Tech programme.

b. Associate Membership holders of the professional bodies for admission into their parent disciplines from the following – (i) The Institution of Engineers (India) (AMIE) (ii) The Indian Institute of Metals (AMIM) (iii) The Institution of Electronics and Tele- communication Engineering (AMIETE) with valid GATE Score can also apply.

O.2 Candidates working and sponsored (with full pay and allowances for 24 months) by industry / government organizations / private and public enterprises recognized by DST and engaged in R & D work/ engineering colleges recognized by AICTE / UGC, possessing at least two years of professional experience as on the last date of receipt of applications at IIITDM, Kurnool, can apply, provided they hold:

1. B.E./ B.Tech. degree from AICTE/UGC recognized Engineering Colleges/university with first class or 60% aggregate marks in all the four years or

2. AMIE and other Associate memberships (listed above) with a valid GATE Score

O.3 Admission to the branch of study shall be as decided during CCMT counselling.

O.4 The exact eligibility criteria for admission to the M.Tech programme shall be as approved by the Senate of the Institute from time to time and announced by the Institute on an annual basis.

O.5 The duration of the M.Tech programme will normally comprise of a total of four semesters, including project work.

O.6 Candidates may be permitted to do their project work in industry and other approved organisations as prescribed in the regulations.

O.7 The award of Half-time Teaching Assistantship (HTTA) to the candidates admitted to the M.Tech programme shall be in accordance with the regulations of the Senate of the Institute.

O.8 The award of the M.Tech degree shall be in accordance with the regulations of the Senate of the Institute

REGULATIONS

R.1.0 ADMISSION

R.1.1 The number of seats in each programme for which admission is to be made in the Institute will be decided by its Senate. Seats are reserved for candidates belonging to the Scheduled Castes, Scheduled Tribes, Other backward classes, Economically weaker sections and physically challenged candidates as per the Government of India orders issued from time to time.

R.1.2 Admission to the M.Tech programme in any year will be based on performance in GATE through a conselling conducted by CCMT.

R.1.3 The students admitted into this programme are required to do a minimum of 8 hours work, such as hanlding theory or laboratory classes, tutorials, Assignments, etc.

R.1.4 Foreign nationals whose applications are received through Indian Council of Cultural Relations, Government of India, are also eligible. Foreign Nationals are also eligible under self-financing scheme for which applications are invited through their embassy.

R.1.5 The eligibility criteria for admission including the minimum GATE score required for admission as full time students with HTTA, will be decided by the Senate.

R.1.6 **T**he conditions for admission to M Tech programmes in IIITDM Kurnool wil be given in the CCMT and Institute websites. However, if at any time the Dean(Academic)/Faculty in-charge(Academic)/ Director finds any of the requirements not fulfilled by the candidate, the Dean(Aacdemic)/ Faculty in-charge(Academic)/ Director may revoke his/her admission to the programme.

R.2.0 STRUCTURE OF THE M.TECH PROGRAMME

R.2.1 The programme of instruction for each stream of specialization will consist of

i. core courses (compulsory)
ii. elective courses
iii. project work

The student may be required to give one or more seminars and undergo industrial / practical training during the programme.

R.2.2 The complete programme will be of 4 semester duration. The academic programmes in each semester may consist of course work and/or project work as specified by the Senate for each specialisation. The total contact hours is normally about 32 hours per week.

R.2.3. Every stream of specialisation in the programme will have a curriculum and syllabi for the courses approved by the Senate. The curriculum is so framed such that the minimum number of credits for successful completion of the M.Tech programme of any stream is not less than 67 and not more than 70.

R.2.4 Credits will be assigned to the courses based on the following general pattern:

i. One credit for each lecture period
ii. Two credits for each laboratory or practical session of three periods
iii. Credits for the seminar, project work and industrial / practical training will be as specified in the curriculum.

R.2.5 A student will have to register for all the core courses listed in the curriculum of his/her selected area of specialisation and successfully complete all of them.

However, the Departmental Post Graduate Committee may grant permission to a student not to register for some of the core courses and substitute them by some other courses depending on the courses successfully completed by the student in the undergraduate programme. This has to be intimated to and approved by the Dean (Academic)/Faculty In-charge(Aacdemic) / Director.

R.2.6 Electives will have to be taken from the courses offered by the Department in that particular semester from among the list of approved courses. However, most of the departments permit selection of electives other than those listed against the Department provided they have relevance to the area of specialisation and subject to the approval of the Faculty Adviser.

R.2.7 In some specialisations students may be permitted to register for a maximum of two B.Tech courses. The concerned departments will identify such courses and get prior approval of the Senate.

R.2.8 The medium of instruction, examination, seminar and project reports will be in English.

R.3.0 Faculty Adviser

R.3.1 To help the students in planning their courses of study and for getting general advice on academic programme, the concerned Department will assign a faculty advisor for each M.Tech programme offered in the department in the beginning of every semester.

R.4.0 Class Committee

R.4.1 Every class of the M.Tech programme will have a Class Committee (CC) consisting of Faculty and students.

R.4.2 The constitution of the Class Committee will be as follows:

i) One professor/Head of the department not associated with teaching the class to be nominated by Director to act as the Chairman of the Class Committee.
ii) All faculty teaching the theory /laboratory courses for that class.
iii) Two students from the respective class; and
iv) Faculty Adviser of the respective class.

R.4.3 The basic responsibilities of the class committee are :

a) to review periodically the progress of the classes and discuss issues faced by students.
b) The type of assessment for the course will be decided by the teacher in consultation with the class committee and will be announced to the students at the beginning of the semester.
c) Each class committee will communicate its recommendations to the Head of the Department and the Dean (Academic)/Faculty In-charge(Academic).
d) The class committee without the student members will also be responsible for the finalisation of the semester results.

R. 4.4 The class committee shall meet at least twice in a semster, once at the beginning of the semester and once before commencment of minor II.

R.5.0 Change of Branch

Change of Programme is not permitted once a student is given admission to M.Tech programme.

R.6.0 Registration Requirement

R.6.1 Except for the First semester, registrarion for the semester will be done during a specified week before starting of that semester. Late registration/enrollment will be permitted with a fine as decided by from time to time up to 2 weeks from the last date specified for regsitration.

R.6.2 The M.Tech students are eligible to take extra courses apart from the courses prescribed in the curriculum, namely, one course in 3rd semester and not more than two courses in 4th semester, subject to a maximum of 9 credits, provided a student has no backlog and should have earned CGPA of 7.0 & above by the end of the previous semester. Students taking extra courses should obtain the prior approval of Dean (Academic)/Faculty In-charge(Academic).

R.6.3 During the final project semester, students are not normally permitted to register for courses. However, students who are short of a few credits required for the degree may be allowed by the Dean (Aacdemic)/Faculty In-charge(Academic) to register for one or two courses along with the project under the specific recommendation from the Head of the department.

In such cases the project duration may have to be extended beyond the normal period suitably. However, the M.Tech HTTA will be paid for a maximum period of 24 months only, as per the existing Government of India rules.

R.6.4 Withdrawal from a course registered is permitted upto two weeks from the date of commencement of the semester. Substitution by another course is not

permitted. Courses withdrawn will have to be taken when they are offered next, if they belong to the list of core courses (Compulsory courses).

R.6.5 In extraordinary circumstances like medical grounds, a student may be permitted by the Dean (Academic)/Faculty Incharge(Academic) to withdraw from a semester completely. Normally a student will be permitted to withdraw from the programme only for a maximum continuous period of two semesters.

R.7.0 MINIMUM REQUIREMENT TO CONTINUE THE PROGRAMME

R.7.1 A student should have earned not less than 10 credits in the first semester, 26 credits by the end of second semester and 36 credits by the end of third semester.

The student will be asked to leave the programme failing to satisfy this requirement.

R.7.2 In addition to the above, to be eligible to continue in the programme the student should have a minimum CGPA of 5.0, calculated according to the formula in R.23.2. However, in calculating the CGPA for eligibility to continue the programme, only courses the student has successfully completed upto the point under consideration will be taken into account. If the CGPA of any student so calculated falls below 5.0, the student will be issued a warning and if he/she does not make good and get a CGPA less than 5.0 in the following semester also then he/she will be asked to leave the programme.

R.8.0 MAXIMUM DURATION OF THE PROGRAMME

R.8.1 A student is ordinarily expected to complete the M.Tech programme in four semesters. However students who do not complete their project work in third/four semesters, are permitted to submit the report in the fifth semester with the prior approval.

Students should complete the course work in not more than 5 semesters and the entire programme in 8 semesters including the project work from the date of admission to the programme.

R.9.0 DISCONTINUATION FROM THE PROGRAMME

R.9.1 Students may be permitted to discontinue the programme and take up a job provided they have completed all the course work. The project work can be done during a later period either in the organisation where they work if it has R and D facility, or in the Institute. Such students should complete the project within six semesters from the date of admission to the programme.

Students desirous of discontinuing their programme at any stage with the intention of completing the project work at a later date should seek and obtain the permission of the Dean(Aacdemic)/Faculty In-charge(Academic)/Director

before doing so.

R.10.0 DISCIPLINE

R.10.1 Every student is required to observe discipline and decorous behaviour both inside and outside the campus and should not indulge in any activity which brings down the prestige of the Institute.

R.10.2 Any act of indiscipline of a student reported to the Dean will be referred to Discipline and Welfare Committee constituted by the Senate from time to time. The Committee will enquire into the charges and recommend suitable punishment if the charges are substantiated. The appropriate committee will consider the recommendation of the Discipline and Welfare Committee and authorize the Dean(Aacdemic)/Faculty in-charge(Academic) to take appropriate action.

R.10.3. **Appeal:** The student may appeal to the Chairman, Senate, whose decision will be final. The Dean(Academic)/Faculty Incharge(Academic) will report the action taken at the next meeting of the Senate.

R. 10.4 Ragging of any form is a criminal and non-bailable offence in our country and current State and Central legislations provide for stringent punishment including imprisonment. Once the involvement of a student in ragging is established, the concerned student will be dismissed from the Institution and will not be admitted into any other Institution. Avenues also exist for collective punishment, if individuals cannot be identified in this inhuman act. Every senior student of the Institute along with the parent shall give an undertaking every year in this regard and this should be submitted at the time of enrolment.

R.11.0 ATTENDANCE

R.11.1 Students are expected to have 100% attendance in a course. However, students with minimum 85% in each course, either theory/practice, will only be allowed to appear in the end semester examinations. Students failing to meet the minimum attendance percentage will have to repeat the course when it is offered next.

R.11.2 Details of attendance shortage of students for each course/practice should be sent to the Dean (Academic) / Faculty in-charge (Aacdemic) through the concerned Head of the Department.

R.12.0 LEAVE RULES

R.12.1 All M.Tech students should apply to the Head of the Department for leave,

stating the reasons whenever they are not in a position to attend classes/project work. They will not be eligible for HTTA for the period of absence, if it is unauthorised leave even if they have not fully utilised the eligible leave.

R.12.2 Students are eligible for leave of 30 days in a year which will be regularised @15 days per semester with a provision of carryover from first to second semester and from the third to fourth semester (i.e unutilized leave from the first year cannot be carried over to second year).

The intervening holidays will be treated as part of leave with provision of suffixing and prefixing holidays.

R.13.0 ASSESSMENT PROCEDURE: TESTS AND EXAMINATIONS

R.13.1 For Lecture or / Lecture and Tutorial based subjects, a minimum of two sessional assessments will be made during the semester. The sessional assessment may be in the form of periodical tests, assignments or a combination of both, whichever suits the subject best. The assessment details as decided at the Class Committee will be announced to the students right at the beginning of the semester by the teacher.

R.14.0 END SEMESTER EXAMINATION

R.14.1 There will be one end semester examination of 3 hours duration in each lecture based subject. In case of practice based subjects, a final examination may or may not be conducted. In the case of project, a viva-voce examination will be conducted on the completion of the project work.

R.15.0 PROJECT EVALUATION

R.15.1 Evaluation of Project work will be taken up only after the student completes all the core as well as elective course requirements satisfactorily.

R.16.0 WEIGHTAGE

R.16.1 The following will be the weightages for different subjects.

(a) Lecture or lecture and tutorial based subjects:
Sessional assessment: Minimum of 40%.
End semester examination: Minimum of 40%

(b) Practice based subjects:
Sessional work: 75 to 100%.
Final examination: if held: 25%

R.16.2 The markings for all tests/ tutorial/ assignments (if any), practice work and examinations will be on an absolute basis. The final percentages of marks are

calculated in each subject as per the stipulated weightages.

R.17.0 Make-up Examination

R.17.1 Students who have missed sessional assessments on valid reasons should apply to the Academic section indicating the reasons for the absence and the Faculty Advisor shall consider these requests suitably.

R.17.2 Students who have missed the end semester examinations on valid reasons, should make an application to the Dean (Academic) /Faculty In-charge(Academic) within ten days from the date of the examination missed. Permission to sit for a make-up examination in the subject(s) is given under exceptional circumstances like hospitalisation or accident to the student. A student who misses this make-up examination will not be normally given another make-up examination.

However, in exceptional cases of illness resulting in the students missing a make-up examination, the Dean (Academic) / Faculty In-charge(Academic) in consultation with the Chairman of the Senate may permit the student to appear for a second make-up examination.

R.17.3 For application on medical grounds, students residing in the hostels should produce a Medical Certificate issued by an Institute Medical Officer only.

Students staying outside the campus permanently/temporarily should produce a medical certificates from registered medical practitioners and the same should be forwarded by the parents/guardian for the purpose of make-up examinations.

The Dean (Academic)/ Faculty in-charge(academic) can use his discretion in giving permission to a student to take a make-up examination, recording the reasons for his/her decision.

R.18.0 Subject wise Grading of Students into Categories

R.18.1 Letter Grades

Each student is awarded a final letter grade at the end of the semester in each subject based on his/her semester performance at the end of the semester. The letter grades and the corresponding grade points are as follows.

Grade	Points	
S	10	Grade points
A	9	
B	8	
C	7	
D	6	
E	4	
U	0	Unqualified/Failure
W	0	Failure due to insufficient attendance

I	0	Incomplete (Subsequently to be changed into pass (E to S) or U garde in the same semester)

R.18.2 A student is considered to have completed a subject successfully and earned the credit if he/she secures an overall letter grade other than U or W or I in that subject.

A letter grade U or W in any subject implies failure in that subject. A subject successfully completed cannot be repeated.

R.18.3 Grades are awarded on relative basis.

R.19.0 Method of Awarding Letter Grades

R.19.1 A final meeting of the Class Committee without the student members will be convened within seven days after the last day of the end semester examination.

The letter grades to be awarded to the students for different subjects will be finalised at this meeting.

R.19.2 Two copies of the result sheets for each subject containing the final grade and two copies along with absolute marks and final grade should be submitted by the teacher to the concerned Faculty Advisor for further processing.

After finalisation of the grades at the Class Committee Meeting, one copy with absolute marks and one without the absolute marks but having only the grades will be forwarded by the Class Committee Chairman to the Dean (Academic)/Faculty In-charge(Academic).

One copy with absolute marks, the final grade will be sent to the Head of the Department in which the course is offered.

R.20.0 DECLARATION OF RESULTS

R.20.1 The letter grades awarded to the students in each subject will be anounced in the Institute web site soon after the final Class Committee meeting.

R.20.2 **The W grade once awarded stays in the record of the student and is deleted when he/she completes that subject successfully later.** The grade acquired by him/her will be indicated in the grade card of the appropriate semester with an indication of number of attempts made in that course.

R.20.3 **'U' grade obtained by the student will be deleted in the grade card when he/she completes that subject successfully later. Further, the number of attempts made by the student in that course, will be indicated in the grade card.**

R.21.0 RE-EXAMINATION OF ANSWER PAPERS

R 21.1 As a process of learning by students and also to ensure transparency, the answer scripts after correction of class tests, minor (s), assignments etc., will be shown to the students within two weeks from the date of test/examination. The performance of the students in minors will be discussed in the Class Review Committee.

R.21.2 In order to ensure transparency in the evaluation of scripts of end-semester examination, those answer scripts also shall be shown to the students up to one day before the finalization of grades. Once the Grades are finalized, the student will no longer have any right to verify his/her answer scripts.

R.21.3 The student can appeal to DAAC for any arbitration within 20 days from the date of official publication of results in the Institute Website.

R. 21.4 Disposal of Answer Scripts

Answer scripts related to a course shall be preserved by the faculty for a period of 6 months from the date of anouncement of results. After this period, the same shall be disposed of as scrap by the institute.

R.22.0 COURSE REPETITION

R.22.1 A student securing 'U' or 'W' grade in any core subject has to repeat it compulsorily when offered next.

R.22.2 A student securing 'U' or 'W' grade in any elective subject has to repeat the course when offered next or he/she can register another equivalent elective course in order to get a sucessful grade.

R.23.0 GRADE CARD

R.23.1 The grade card issued at the end of the semester to each student will contain the following:

a. the credits for each course registered for that semester.
b. the letter grade obtained in each course
d. the total number of credits earned by the student upto the end of that semester.
e. the semester grade point average (SGPA) of all the courses taken in that semester.
f. the Cumulative Grade Point Average (CGPA) of all the courses taken form the first semester till the current semester is shown in the final semester grade card.

R.23.2 The Grade Point Average (GPA) will be calculated by the formula.

$$GPA = \frac{\sum_i C_i \times GP}{\sum_i C_i}$$

Where C_i = credit for the course, GP = the grade point obtained for the course and ΣC_i is sum of credits of the courses that are successfully completed in that semester.

For the cumulative Grade Point Average (CGPA), a similar formula is used except that the ΣiCi is the sum of credits in all the courses taken in all the semesters completed upto the point of time, including those in which the student has secured U or W grades.

R. 23.3. No class/division/rank will be awarded to the students at the end of the M.Tech programme.

The formula for conversion of CGPA to percentage is **CGPA×10**.

R.24.0 PROJECT WORK IN INDUSTRY OR OTHER ORGANISATION

R.24.1 Students who desire to do their project work in industries/R&D organizations, may be permitted to carry out their project work in such organisations during the third/final semester.

R.24.2 A departmental committee shall examine the requests from such students, and fix:

i. An internal guide (a faculty member of the institute) along with an area of project work and
ii. External guide (Scientists or Engineer in the Industry).

R.24.3 The above details should be submitted to the Dean (Academic)/ Faculty In-charge (Academic) through the Head of the Department for further processing.

R.24.4 The students who are permitted to do the project work in an industry will have to pay the tuition and other fees to the Institute for the third and fourth semester as well.

R.24.5 Students who do their project work in Industry/R&D Organizations, are permitted to draw stipend only from one source.

R.25.0 HALF-TIME TEACHING ASSISTANTSHIP

R.25.1 Students who are qualified for M.Tech admission through valid GATE score and are admitted as full time students of the Institute, will be eligible for the award of the HTTA notified by the Institute from time to time.

R.25.2 Self-financing foreign nationals are not eligible for HTTA.

R.26.0 ELIGIBILITY FOR THE AWARD OF M.TECH DEGREE

R.26.1 A student shall be declared to be eligible for the award of M.Tech degree if he/she has

(1) Registered and successfully completed all the core courses and the project.

(2) Successfully acquired the minimum number of credits prescribed in the curriculum of the given stream within the stipulated time.

(3) No dues to the Institute, Library and Hostels and

(4) No disciplinary action pending against him/her.

(5) For students visiting Universities abroad under Exchange programme the following will be followed for credit transfer:

The credits / grades obtained from the university where the student has done courses will be indicated in the grade card.

Institute transcripts should only indicate the courses, credits and grades completed at IIITDM and the courses and credits (without grades) done in other Universities in a particular semester.

The CGPA calculation based on credits done at Institute alone is to be considered for award of prizes.

The credits earned at Universities abroad will be considered for calculation of minimum required credits for award of degree

R.26.0 The final award of the Degree must be recommended by the Senate and approved by the Board of Governors of the Institute.

R.27.0 POWER TO MODIFY

Notwithstanding all that has been stated above, the Senate has the right to modify any of the regulations from time to time.