



**SECOND SEMESTER 2023-2024**  
**COURSE HANDOUT (PART-II)**

**Date: 09/01/2024**

In addition to Part-I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

**Course Code** : ME F426  
**Name of the Course** : Industry 4.0 in Manufacturing  
**Instructor-In-Charge** : Dr. Kundan Kumar Singh

**I. Scope and Objective of the Course**

This course is designed to

- Understand the current industrial revolution 4.0, the pillar and the building blocks for successful implementation of Industry 4.0.
- Understand the basic architecture of IIoT and how IIoT helps in industry 4.0.
- Understand how sensors, automation and data science are transforming individual processes and improving operational performance throughout the manufacturing enterprises.
- Knowledge of mathematical interpretation of data collected via sensors for intelligent manufacturing.
- Understanding of concept of Cyber physical system for achieving the intelligent manufacturing and its role in Industry 4.0.
- Understand the implementation of digital twin in manufacturing environment.

**II. Textbook**

<b>T1</b>	Zhang Y. and Tao F., “Optimization of Manufacturing Systems using the Internet of Things”, 1 <sup>st</sup> Edition, 2017, Academic Press (Elsevier), UK
<b>T2</b>	Sartal, Antonio, Diego Carou, and J. Paulo Davim, eds. Enabling technologies for the successful deployment of Industry 4.0. CRC Press, 2020.
<b>T3</b>	Gilchrist, Alasdair. Industry 4.0: the industrial internet of things. Apress, 2016

**III. Reference Books**

<b>R1</b>	Ibrahim Garbie, “Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessment for Industry 4.0”, Springer, 2016, Switzerland.
<b>R2</b>	Thames L. and Schaefer D. (eds), “Cybersecurity for Industry 4.0: Analysis for Design and Manufacturing”, Springer, 2017, Switzerland.
<b>R3</b>	The Internet of Things: Key Applications and Protocols Olivier Hersent, David B. 2nd Edition, Wiley Publication





<b>R4</b>	Mohanty, Nirode C. Signal processing: signals, filtering, and detection. Springer Science & Business Media, 2012.
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#### IV. Course Contents

Topic	Learning Objectives	Topics to be covered	Number of Lectures	Reference
Introduction	The revolution of Industry 4.0 and application. The basic architecture of Industry 4.0 and how it is different from smart and intelligent manufacturing.	Definition of Industry 4.0 and its application. Different industrial revolutions. Different components/pillars, IIoT, Relationship with smart and intelligent manufacturing.	4	T2-Ch. 2
Cyber physical system (CPS)	Definition of CPS and how it is relevant in manufacturing industry. Different methods for adopting CPS in manufacturing processes. What should be the framework for CPS in Industry 4.0?	CPS definition and its role in industry 4.0. Standardised ideal framework for implementation. Different CPS solutions for factories. Examples through case studies.	4	T3-Ch. 3
Overview of IoT for Industry 4.0	To define and explain IoT, summarize the existing AMSs, and devise ideas for realizing IoT-based manufacturing systems (IoT-MS) based on their investigative applications.	Definition, application, Benefits, IT-OT concept and convergence, IIoT framework, Different technologies used for IIoT, connectivity characteristics, Examples for IIoT applications.	4	T3-Ch.1
Concept of Cloud manufacturing	Basic understanding of cloud manufacturing. Scheduling methods for cloud manufacturing. Cloud manufacturing ecosystem and design. Detailed outline of basic architecture of cloud manufacturing.	Definition and key concepts. Task scheduling methods, CM ecosystem and design, Strategic vision of CM, Architecture of CM, Resource allocation in CM; A mechanism design approach, Case studies.	4	T2-Ch.5 and Class notes
Introduction to Digital-twin for product life-cycle in Industry 4.0	Basic ideas behind digital-twin and how it can help in product life cycle. Relationship with Industry 4.0. How to implement digital-twin in a product. Different modelling techniques for digital-twin.	Concept and application. Concept modelling and digital twin framework. Model abstraction and representation. Application to machine tool system and cutting tool.	5	Class notes





Real-Time and Multisource Manufacturing Information Sensing System	Students will be able to explain RMMISS, a system to sense the real-time manufacturing information comprehensively, and associated vital technologies such as the deployment of multiple sensors, sensor manager, and multisource manufacturing information processing and sharing.	Introduction, Related works, Overall architecture of real-time and multisource RMMISS, Deployment of multi-sensors, Multiple sensors manager, Multisource manufacturing information capturing and sharing, Case study.	3	T1-Ch. 3
Concept of Intelligent manufacturing for industry 4.0	Different signal processing methods for condition monitoring in Industry 4.0. How to detect anomalies in processes for intelligent manufacturing?	Different input signal form and behaviour, System representation; autocorrelation and cross correlation, Concept of analogue and digital signal, Fourier analysis, Fast Fourier transformation, Power spectral density.	9	R4 and Lectures notes
IoT-Enabled Smart Assembly Station	To identify key challenges faced by assembly stations, difficulties encountered during assembly operations, and design smart assembly station by adopting RFID technology.	Introduction, Related works, Overall architecture of IoT-enabled smart assembly station, Real-time status monitoring, Real-time production guiding, Real-time production data sharing, Real-time production re-queuing.	5	T1-Ch. 4 and class notes
Conclusions, Future Works and Case Studies	Examples for application of Industry 4.0 in different industries.	Discussion on successful implementation of IOT in India & Abroad, Stanley Black And Decker - Case Study, GE Case Study, Siemens Case Study.	2	Lecture notes & Research Paper

## V. Evaluation Scheme and Schedule

Component	Duration	Weightage(%)	Date & Time	Nature of Component
Mid Sem. Test	90 Min.	25	14/03 - 2.00 - 3.30PM	Close Book
Quiz	—	15	—	Close Book
Project/case study	—	25	—	Open Book





Comprehension examination	180 Minutes	35	15/05 FN	Close Book
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**VI. Chamber Consultation Hour:** To be announced in the class

**VII. Notices concerning the course:** All notices concerning the course will be displayed on the CMS notice board.

**VIII. Make-up Policy:** Make-up will be permitted only in genuine cases with prior permission.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**NOTE:** The border cases in final grading will be decided based on mainly classroom attendance and attentiveness in the classroom.

**Instructor-In-Charge**  
**ME F426**

