SEMESTER 7

SMART MANUFACTURING

Course Code	**PEMRT745**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. This course introduces Smart Manufacturing, encompassing the integration of advanced manufacturing techniques with digital technologies to create intelligent, interconnected systems.
2. Students will learn about the principles, technologies, and applications of SM, preparing them to implement and innovate within the modern manufacturing landscape.

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SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Smart Manufacturing**: Definition and evolution of Smart Manufacturing, Key components and principles, Comparison with traditional manufacturing. **Industry 4.0 and Digital Transformation:** Overview of Industry 4.0, Digitalization in manufacturing, Cyber-Physical Systems (CPS), **Internet of Things (IoT) in Manufacturing:** IoT fundamentals and architecture, IoT devices and sensors.	**9**
2	**Data-Driven Manufacturing: Internet of Things (IoT) in Manufacturing (contd.)** Applications of IoT in manufacturing, **Data Analytics and Big Data in Manufacturing:** Introduction to data analytics, Big Data in manufacturing, Predictive analytics and maintenance, **Artificial Intelligence and Machine Learning:** AI and ML basics, Applications of AI in manufacturing, Case studies of AI-driven manufacturing.	**9**

3	**Advanced Manufacturing Technologies: Robotics and Automation:** Robotics in manufacturing, Autonomous systems and collaborative robots, Automation technologies, **Additive Manufacturing and 3D Printing:** Principles of additive manufacturing, 3D printing technologies, Applications in manufacturing.	**9**
4	**Smart Manufacturing Systems and Integration**: Integration of digital and physical systems, Smart factories and digital twins. Case studies of integrated systems, **Cybersecurity in Smart Manufacturing:** Cybersecurity challenges in manufacturing, Protection strategies and best practices, Case studies of cybersecurity breaches, **Sustainability and Future Trends in Smart Manufacturing:** Sustainable manufacturing practices, Future trends.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

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Criteria for Evaluation (Evaluate and Analyse): 20 marks

A 'Micro-Project' or Detailed presentation of 'Case Study' with a maximum of 3 students related to the application of smart manufacturing in modern industry should be done.
By using following rubrics table, evaluators can systematically assess students' performance on the "Evaluate and Analyse" component based on their understanding, application, critical thinking, and quality of analysis in the context of Smart Manufacturing.

Rubrics Table: (Evaluate and Analyse: 20 Marks)

Criteria	Excellent (5 Marks)	Good (4 Marks)	Satisfactory (3 Marks)	Needs Improvement (2 Marks)	Unsatisfactory (1 Mark)	Marks
1.Understanding of Concepts	Demonstrates a thorough and comprehensive understanding of the concepts related to Smart Manufacturin	Shows a good understanding of the core concepts, with minor gaps in knowledge.	Has a basic understanding of the concepts, but with noticeable gaps.	Demonstrates limited understanding of the concepts.	Shows little to no understanding of the concepts.	

Criteria	Excellent (5 Marks)	Good (4 Marks)	Satisfactory (3 Marks)	Needs Improvement (2 Marks)	Unsatisfactory (1 Mark)	Marks
	g, including IoT, AI, data analytics, and Industry 4.0.					
2.Application of Knowledge	Applies theoretical knowledge effectively to real-world scenarios and case studies, providing insightful analysis and solutions.	Applies knowledge to real-world scenarios with some insightful analysis.	Applies knowledge to real-world scenarios, but the analysis is basic and lacks depth.	Struggles to apply knowledge effectively to real-world scenarios.	Fails to apply knowledge to real-world scenarios.	
3.Critical Thinking and Problem-Solving	Demonstrates strong critical thinking and problem-solving skills, identifying and addressing complex issues in Smart Manufacturing.	Shows good critical thinking and problem-solving skills, but with minor gaps in addressing complex issues.	Demonstrates basic critical thinking and problem-solving skills, but with noticeable gaps.	Shows limited critical thinking and problem-solving skills.	Demonstrates little to no critical thinking or problem-solving skills.	

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Criteria	Excellent (5 Marks)	Good (4 Marks)	Satisfactory (3 Marks)	Needs Improvement (2 Marks)	Unsatisfactory (1 Mark)	Marks
4.Quality of Analysis	Provides a comprehensive and in-depth analysis, backed by relevant data and references, demonstrating a strong grasp of the subject matter.	Offers a solid analysis with good use of data and references, though with minor gaps in depth or relevance.	Delivers a basic analysis with some use of data and references, but lacking depth and comprehensiveness.	Provides limited analysis with minimal use of data and references.	Offers little to no analysis, with few or no relevant data or references.	

Total: 20 Marks

Score Range	Performance Level
18-20 Marks	Excellent
14-17 Marks	Good
10-13 Marks	Satisfactory
6-9 Marks	Needs Improvement
0-5 Marks	Unsatisfactory

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End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. • Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of Smart Manufacturing and Industry 4.0.	**K2**
CO2	Explore the key technologies driving Smart Manufacturing, such as IoT, AI, and data analytics.	**K2**
CO3	Learn about the integration of digital and physical systems in manufacturing.	**K2**
CO4	Analyze the impact of Smart Manufacturing on productivity, quality, and sustainability.	**K4**
CO5	Develop skills to design, implement, and manage Smart Manufacturing systems.	**K5**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

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CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	-	-	2	-	-	-	-	-	-	3
CO3	3	-	2	-	2	-	-	-	-	1	-	-
CO4	3	-	-	-		-	3	2	-	-	-	3
CO5	-	-	2	3	2	-	-	-	-	-	1	-

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Smart Manufacturing: Concepts and Methods	Shahrukh A. Irani	CRC Press	1st Edition, 2020
2	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Apress	1st Edition, 2016
3	Big Data in Practice	Bernard Marr	Wiley	1st Edition, 2016
4	Artificial Intelligence: A Guide for Thinking Humans	Melanie Mitchell	Farrar, Straus and Giroux	1st Edition, 2019
5	Robotics and Automation Handbook	Thomas R. Kurfess	CRC Press	1st Edition, 2004

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Additional References:

1. Research papers and articles from journals such as "Journal of Manufacturing Systems" and "International Journal of Advanced Manufacturing Technology."
2. Industry reports and whitepapers from organizations like McKinsey & Company, Deloitte, and PwC.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Smart Manufacturing: An Overview	Rajat Kumar Roy	Tata McGraw-Hill Education	1st Edition, 2020
2	Industry 4.0: A Roadmap for Smart Manufacturing	Alok Kumar Jain	Wiley India	1st Edition, 2019
3	Big Data and Analytics in Manufacturing	Sudipta Roy, P.C. Mandal	Springer India	1st Edition, 2021
4	Artificial Intelligence in Industrial Applications"	Ajit Kumar	PHI Learning Pvt. Ltd.	1st Edition, 2019
5	Robotics and Automation: Principles and Applications	R.K. Mittal, I.J. Nagrath	Tata McGraw-Hill Education	2nd Edition, 2018
6	3D Printing and Additive Manufacturing: Principles and Applications	C.P. Kumar	IK International Publishing House	1st Edition, 2020
7	Cybersecurity in Smart Manufacturing"	Anil Kumar Singh	Wiley India	1st Edition, 2021
8	Sustainable Manufacturing and Operations	Ashok Kumar Sarkar	CRC Press India	1st Edition, 2019

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Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	INTRODUCTION TO INDUSTRY 4.0 AND INDUSTRIAL INTERNET OF THINGS Industry 4.0 https://archive.nptel.ac.in/courses/106/105/106105195/ IoT https://youtu.be/olZ3Iyib_wg CPS https://youtu.be/8wBQMbOntNc
2	AI https://youtu.be/zsE9EH0oJSk https://youtu.be/cTZVK7CK1gs
3	AM https://archive.nptel.ac.in/courses/112/103/112103306/
4	CS: https://youtu.be/KqSqyKwVuA8

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