Curriculum and Syllabus for M.Tech.

Mechanical Engineering with Specialization in Smart Manufacturing

(From The Academic Year 2021)

Approved by Senate-44

Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram

Chennai-600 127

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Semester 1							
S.No	Course Code	Course Name	Category	L	T	P	C
1	ME5009	Design for Manufacturing Automation	PCC	3	1	0	4
2	ME5010	Manufacturing Systems Engineering	PCC	3	1	0	4
3	ME5011	Design for Additive Manufacturing	DSC	3	1	0	4
4	MA5000	Probability and Statistics	BSC	3	1	0	4
5		Professional Elective Course 1	PEC	3	1	0	4
6	ME5012	Design for Manufacturing Automation Practice	PCC	0	0	3	1.5
7	ME5013	Manufacturing Systems Engineering Practice	PCC	0	0	3	1.5
							23.0

Semester 2							
S.No	Course Code	Course Name	Category	L	T	P	C
1	CS5005	IIoT and Cloud Computing	PCC	3	1	0	4
2	CS5006	Data Science	PCC	3	0	2	4
3		Professional Elective Course 2	PEC	3	1	0	4
4		Professional Elective Course 3	PEC	3	1	0	4
5		Professional Elective Course 4	PEC	3	1	0	4
6	CS5007	IIoT and Cloud Computing Practice	PCC	0	0	3	1.5
7	ME5014	Manufacturing Information Systems Practice	PCC	0	0	3	1.5
							23.0

Semester 3							
S.No	Course Code	Course Name	Category	L	T	P	C
1	ME6000	MT-ME-SM-Project I (May-July) (Summer Internship	PCD	0	0	20	10
2	ME6001	MT-ME-SM-Project II (Aug-Nov)	PCD	0	0	32	16
							26.0

Semester 4							
S.No	Course Code	Course Name	Category	L	T	P	C
1	ME6002	MT-ME-SM-Project III (Dec-April)	PCD	0	0	32	16
							16.0

1. Professional Elective Course is an elective course offered or prescribed by the parent department.
2. 3 Months internship is mandatory, however, the curriculum offers the flexibility to carry out 3-12 Months internship with the approval of the parent department.
3. In line with the guidelines approved by the Senate (Senate 46-07), an M.Tech student can earn a maximum of 6 credits from NPTEL Courses. For all successfully completed NPTEL Courses, the letter grade “H” (Pass) will be awarded and credits of such courses will not be accounted for CGPA calculation.

Semester wise Credit Distribution

Category	Semester					
	S1	S2	S3	S4	Total	%
Professional Core Course (PCC)	11	11	0	0	22	25.0
Design Course (DSC)	4	0	0	0	4	4.5
Basic Science Course (BSC)	4	0	0	0	4	4.5
Professional Elective Course (PEC)	4	12	0	0	16	18
Professional Career Development (PCD)	0	0	26	16	42	48
Total	23	23	26	16	88	100
	23	46	72	88		

Course Name	Design for Manufacturing Automation	Course Code	ME5009			
Offered by Department	Mechanical Engineering	Structure (LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senae-44			
Learning Objectives	To provide knowledge and exposure in integrated design practices of mechatronic systems in manufacturing automation					
Learning Outcomes	At the end of the course student will be able to: • Understand the basic concepts of mechatronic systems in manufacturing automation • Design of automation systems using various mechatronic elements • Understand the application of SCADA, DCS, PLC, HMI in manufacturing automation • Demonstrate integration of various systems and standards in manufacturing automation					
Course Contents	**Introduction**: Manufacturing Automation – evolution, Review of mechatronics systems, Fundamentals of digital electronics, microprocessors, control systems, and applications. Panel design-switch gears and accessories, panel protection, cable harness assembly and busbar selection. ***(8 L + 2 T)*** **Design of Mechatronics System:** Mechatronics elements –sensors and actuators, ball screws, solenoids, linear actuators and controllers in manufacturing applications. Motion control-variable frequency drive, remote and local operation, Design of drive control panels, Communication interface, Design and simulation of mechatronic systems. ***(10 L + 3 T)*** **PLC & HMI:** Fundamentals of PLC and programming languages, Design of alarm and interlocks; Networking of PLC, PLC protection. Introduction of HMI-I/O's, Programming instructions and interface, GUI in HMI. ***(8 L + 2 T)*** **Computer based Industrial Automation:** Direct digital control, distributed control system, SCADA for manufacturing industries, RTUs, Automation networking, Industrial standard communication protocols, Real time testing and runtime application. Communication among HMI, PLC, SCADA, Fault diagnostics / troubleshooting. ***(10 L + 3 T)*** **Industrial Practices and Case Studies**: Integration of robotic system, vision system, fluid power systems in manufacturing; Case studies on manufacturing automation and design; Safety considerations, National/International standards. ***(8 L+ 2 T)***					
Essential Reading	1. W. Bolton, Mechatronics, Pearson education Ltd. 7th edition, 2018 2. J. Edward Carryer, M. Ohline and T. Kenny, Introduction to Mechatronic Design, Prentice Hall, 2nd edition, 2011 3. F. Lamb, Advanced PLC Hardware & Programming, Automation Consulting, LLC, 2019.					
Supplementary Reading	1. D. G. Alciatore and M. B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill, 4th edition, 2014 2. K. wang, Y. Wang, J. O. Strandhagen, Advanced Manufacturing and Automation VIII, Springer, 1st Edition, 2019. 3. R Mehra, V. Vij, PLCs & SCADA - Theory and Practice, Laxmi Publications, 2nd edition 2017. 4. John W. Webb and Ronald A. Reis, Programmable Logic Controllers: Principles and Applications, Prentice Hall Inc., 5th Edition, 2003					

Course Name	Manufacturing Systems Engineering	Course Code	ME5010			
Offered by Department	Mechanical Engineering	Structure (LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	• To gain a basic understanding of manufacturing systems and its management, including types of systems, current theories of manufacturing management, including lean thinking, JIT and demand driven manufacturing. • To develop an understanding of the performance measurement of manufacturing systems through metrics and key performance indicators. • To analyse manufacturing systems in terms of material flow and storage, information flow using event simulation and Queueing Models					
Learning Outcomes	• Students will recognize manufacturing systems, including job shops, flow lines, assembly lines, work cells. • Students will have a basic understanding of performance measurement and management in modern day manufacturing systems. • Students will have a basic understanding of current manufacturing control theories, such as lean thinking, agile, responsive systems and JIT. • Students will be able to develop a simulation model to analyse manufacturing systems to improve performance of assembly lines and job shops.					
Course Contents (with approximate breakup of hours for lecture/tutorial/ practice)	**Introduction to Manufacturing Systems**: overview, and components of manufacturing systems. Classification of manufacturing industries ***(L 6+T 2)*** **Types of manufacturing Systems**: single station cells, Manual Assembly lines, Automated Production lines, Automated Assembly systems, Group technology and cellular manufacturing, Flexible manufacturing cells and systems, Toyota Production System. ***(L 21+T 7)*** **Factory Layouts:** Types of layouts, systematic layout planning and Design ***(L 3 + T 1)*** **Production Scheduling**: Scheduling process, priority dispatch rules, Flow shop and Job Shop Scheduling ***(L 3 + T 1)*** **Inventory Control:** Inventory control policies, Material Requirements Planning ***(L 3 + T 2)*** **Queuing models**: Notation of queues, Key elements, performance measures, The M/M/1 and M/M/m queue, Queueing Networks ***(L 3 + T 1)*** **Simulation of Manufacturing systems**: Monte Carlo simulation, System and Environment, **Discrete event Simulation *(L 3 + T 1)*** **Intelligent Manufacturing Systems:** Introduction to Industry 4.0, Digital twins and The role of Artificial Intelligence in the factory of the future ***(L 3)***					
Essential Reading	1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing. 3rd edition, Pearson Education, 2015. ISBN: 978-9332549814. 2. Manufacturing Systems Engineering. Katsundo Hitomi, Taylor and Francis, Second Edition					
Supplementary Reading	1. W. J. Hopp, M. L. Spearman, Factory Physics, 3rd edition, Waveland Press, 2011 2. R. Askin and C. Standridge, Modelling and Analysis of Manufacturing Systems, 1st edition, John Wiley, 1992. ISBN: 978-0-471-51418-3 3. S. B. Gershwin, Manufacturing Systems Engineering, 1st edition, Prentice Hall PTR, 1993, ISBN: 9780135606087					

Course Name	Design for Additive Manufacturing	Course Code	ME5011			
Offered by Department	Mechanical Engineering	Structure (LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	• To understand the design constraints and design capabilities unique to the additive manufacturing processes • To analyse the part design for opportunities in improving its sustainability using computational tools					
Learning Outcomes	• Students will be able understand the complexities in design and modify the existing designs suitable for additive manufacturing. • Students would be able to apply computational tools to optimize the design for reduced cost and material use.					
Course Contents (with approximate breakup of hours for lecture/tutorial/practice)	• Introduction to Additive Manufacturing (AM) processes ***(6 L + 2 T)*** • Process planning for additive manufacturing process ***(8 L + 2 T)*** • Principles of design for manufacturing and assembly (DfMA) ***(4 L + 1 T)*** • Constraint approach to design for additive manufacturing: Guidelines and rules for part building ***(5 L + 1 T)*** • Mass customization, part consolidation, functional integration ***(5 L + 1 T)*** • Computational tools for design optimization: Topology optimization and generative design ***(4 L + 2 T)*** • Hierarchical structures and lattice structures ***(6 L + 1 T)*** • Design for hybrid additive manufacturing ***(2 L + 1 T)*** • Industrial case studies ***(2 L + 1 T)***					
Essential Reading	1. Diegel, Olaf, Axel Nordin, and Damien Motte. A Practical Guide to Design for Additive Manufacturing. Springer Singapore, 2019. 2. Leary, Martin. Design for additive manufacturing. Elsevier, 2019. 3. Page, Tom. Design for additive manufacturing. LAP Lambert Academic Publishing, 2011. 4. Gibson, Ian, David Rosen, Brent Stucker, and Mahyar Khorasani. Additive manufacturing technologies. Vol. 17. New York: Springer, 2014.					
Supplementary Reading	1. Gebhardt, Andreas. "Understanding additive manufacturing." (2011). 2. Chua, Chee Kai, and Kah Fai Leong. 3D Printing and additive manufacturing: Principles and applications of rapid prototyping. 5th Edition, World Scientific Publishing Company, 2017.					

Course Name	Probability and Statistics	Course Code	MA5000			
Offered by Department	SH- Mathematics	Structure(LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	To impart and/or refresh the knowledge of probabilistic and statistical concepts, tools and techniques.					
Learning Outcomes	The student will be comfortable with probabilistic and statistical ideas in engineering applications and will be capable of approaching the issues in a similar spirit wherever necessary.					
Course Contents (with approximate breakup of hours for lecture/tutorial/practice)	• **Introduction to probability** – sample spaces and axioms, counting techniques; conditional probability, independence, and Bayes' theorem. ***(L 9 + T 3)*** • Discrete and continuous random variables, probability and mass density functions of a few standard discrete and continuous distributions: binomial, Poisson, exponential and normal and their relevance in engineering. Joint distributions, marginal distributions. ***(L 9 + T 3)*** • Concepts of mean, variance; Moment generating functions, Markov and Chebychev inequalities; the laws of large numbers and the central limit theorem. ***(L 9 + T 3)*** • Purpose and nature of the sampling, point estimation: method of moments and method of maximum likelihood. Confidence Intervals. Linear regression, correlation, covariance. ***(L 9 + T 3)*** • Formulation and testing of hypotheses: Type I and Type II Errors. Size and power of a test. Criteria for acceptance of hypothesis: t-test, chi-squared test. Goodness of fit tests. ***(L 6 + T 2)***					
Essential Reading	1. D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, 6th edition, Wiley India, 2016. 2. R. A. Johnson, Miller and Freund's Probability and Statistics for Engineers, 8th edition, Pearson, 2015					
Supplementary Reading	1. An Introduction to Probability and Statistics by Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, Wiley, 2nd edition, 2008 2. S. Ross, A First Course in Probability, 9th edition, Pearson 2019					

Course Name	Design for Manufacturing Automation Practice	Course Code	ME5012			
Offered by Department	Mechanical Engineering	Structure (LTPC)	0	0	3	1.5
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	To provide knowledge and exposure in integrated design practices of mechatronic systems in manufacturing automation					
Learning Outcomes	At the end of the course student will be able to: • Understand the basic concepts of mechatronic systems and implementation in manufacturing automation • Design of automation systems using various mechatronic elements • Understand the application of SCADA, DCS, PLC, HMI in manufacturing automation • Demonstrate integration of various systems in manufacturing automation					
Course Contents	• Design and simulation of mechatronic systems for manufacturing applications using CAD packages. • Programming and simulation of various microcontrollers and logic gates using Proteus software/ Tinker CAD. • Control system simulation in MATLAB-Simulink and LabVIEW. • SCADA, PLC & HMI – Programming, simulation and implementation using RSlogix, CODESYS, Rapid SCADA. • Design and implementation of manufacturing automation systems using Tecnomatix and other automation specific software.					
Essential Reading	1. W. Bolton, Mechatronics, Pearson education Ltd. 7th edition, 2018 2. J. Edward Carryer, M. Ohline and T. Kenny, Introduction to Mechatronic Design, Prentice Hall, 2nd edition, 2011 3. F. Lamb, Advanced PLC Hardware & Programming, Automation Consulting, LLC, 2019.					
Supplementary Reading	1. D. G. Alciatore and M. B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill, 4th edition, 2014 2. K. wang, Y. Wang, J. O. Strandhagen, Advanced Manufacturing and Automation VIII,Springer, 1st Edition, 2019. 3. R Mehra, V. Vij, PLCs & SCADA - Theory and Practice, Laxmi Publications, 2nd edition 2017. 4. John W. Webb and Ronald A. Reis, Programmable Logic Controllers: Principles and Applications, Prentice Hall Inc., 5th Edition, 2003 5. T. Bartely, Industrial Automated Systems: Instrumentation and Motion Control, Cengage learning, 2011					

Course Name	Manufacturing Systems Engineering Practice	Course Code	ME5013			
Offered by Department	Mechanical Engineering	Structure (LTPC)	0	0	3	1.5
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	• To understand the broad applicability of discrete-event process simulation and queueing models in manufacturing systems • To analyse manufacturing systems in terms of material flow and storage, information flow using event simulation and Queing Models					
Learning Outcomes	Students will be able to develop a simulation model to analyse different types of manufacturing systems and to improve performance of assembly lines and job shops.					
Course Contents (with approximate breakup of hours for lecture/tutorial/practice)	• Solving queuing problems using simulation techniques • Modelling different types of manufacturing systems • Study the effect of variability on performance of different manufacturing system • Performance analysis of manufacturing cells • Simulation of KANBAN control system • Simulation of push pull production system • Optimization of layouts design • Solving reactive scheduling problems.					
Essential Reading	1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing. 3rd edition, Pearson Education, 2015. ISBN: 978-9332549814. 2. Manufacturing Systems Engineering. Katsundo Hitomi, Taylor and Francis, Second Edition					
Supplementary Reading	1. W. J. Hopp, M. L. Spearman, Factory Physics, 3rd edition, Waveland Press, 2011 2. R. Askin and C. Standridge, Modelling and Analysis of Manufacturing Systems, 1st edition, John Wiley, 1992. ISBN: 978-0-471-51418-3 3. S. B. Gershwin, Manufacturing Systems Engineering, 1st edition, Prentice Hall PTR, 1993, ISBN: 9780135606087					

Course Name	IIoT and Cloud Computing	Course Code	CS5005			
Offered by Department	Computer Science & Engineering	Structure (LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	• This course introduces the concepts of Industrial Internet of Things, and cloud computing. • The students are exposed to the architectures, and various frameworks in IIoT and cloud computing.					
Learning Outcomes	At the end of this course, the students are expected to • Understand the existing IoT and Cloud architectures • Design an IoT system with cloud infrastructure • Implement a prototype of the IoT/cloud system design					
Course Contents (with approximate breakup of hours for lecture/tutorial/ practice)	• Introduction, Physical design of IoT, Logical design of IoT, IoT enabling technologies, ➢ Domain specific IoTs***(L 4)*** • IoT design methodology, logical design, Communication APIs, Databases, Networking ***(L 8)*** • IoT physical devices (such as Raspberry Pi, pcDuino, Beaglebone black, Cubie board, Jetson, Google Coral, etc.) ***(L 4)*** • Introduction to cloud computing: cloud models, cloud service examples, cloud based services & applications ***(L 6)*** • Virtualization, load balancing, scalability, deployment, replication, monitoring, SDN, ➢ network function virtualization, Map Reduce, identity and access management, SLAs. ***(L 10)*** • 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. ***(L 6)*** • Case studies: Industrial automation, Cloud for IoT ***(L 4)***					
Essential Reading	1. Bahga and V. Madisetti, Internet of Things, a hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515. 2 Bahga and V. Madisetti, Cloud Computing, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2013, ISBN: 978-1494435141					
Supplementary Reading	1. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: 2. Cybermanufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580. 3. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & 4. Architecture, Prentice Hall, 1st edition, 2013, ISBN: 978-0133387520.					

Course Name	Data Science	Course Code	CS5006			
Offered by Department	Computer Science & Engineering	Structure (LTPC)	3	0	2	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	This course covers the basic concepts of Data Science to help the student to learn, understand and practice data analytics encompassing concepts from descriptive, inferential statistics and predictive techniques and big data concepts.					
Learning Outcomes	• Ability to identify the characteristics of datasets • Ability to select and implement machine learning techniques suitable for the respective application • Ability to solve problems associated with big data characteristics such as high dimensionality • Ability to integrate machine learning libraries and mathematical and statistical tools					
Course Contents (with approximate breakup of hours for lecture/tutorial/practice)	• Introduction to relevant industry applications and analytics – Descriptive Statistics – Data Visualization & Interpretation -Measures of Central Tendency & Dispersion - Basic and advanced plots such as Stem-Leaf Plots, Histograms, Pie charts, Box Plots, Violin Plots etc. – Merits of Demerits & Interpretation ***(L 10)*** • Inferential Statistics – Hypothesis Testing - Tests of Significance – Analysis of Variance - Regression – Linear and Logistic (***L 8)*** • Predictive Analytics – Supervised and Unsupervised – Association Rules, Classification, Clustering, Outlier Analysis, Time Series Modelling ***(L 14)*** • Big Data Characteristics – Map Reduce – Deduplication, Distributed Storage, Implementation using Hadoop / Pyspark platforms (***L 8)*** • **Practice Component:** Concepts from Descriptive Statistics, Inferential and Predictive Analytics would be test driven using platforms such as Python, R etc. ML support in these platforms for rule mining and application, classification & clustering algorithms etc. would also be test driven as part of the practice exercises. Modern technologies for big data handling such as Pyspark – support for Map reduce would also be test driven. Applications relevant to the student's stream of specialization would be explored for exercises / course project as case studies. ***(P 14 sessions – weekly exercises)***					
Essential Reading	1. J Han, M Kamber, Data Mining Concepts & Techniques, Elsevier, 3rd Edition, 2007					
Supplementary Reading	1. Joel Grus, Data Science from Scratch, Orielly, 2ndEdn, 2019 2. Leskovec, Anand Rajaraman, Ullmann, Mining of Massive Data Sets, Cambridge University Press, Open Source free version 3. P Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017					

Course Name	IIoT and Cloud Computing Practice	Course Code	CS5007			
Offered by Department	Computer Science & Engineering	Structure (LTPC)	0	0	3	1.5
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	• This course introduces the concepts of Industrial Internet of Things, and cloud computing. • The students are exposed to the architectures, and various frameworks in IIoT and cloud computing.					
Learning Outcomes	At the end of this course, the students are expected to • Understand the existing IoT and Cloud architectures • Design an IoT system with cloud infrastructure • Implement a prototype of the IoT/cloud system design					
Course Contents (with approximate breakup of hours for lecture/tutorial/practice)	• Introduction of Hardware Interfaces – Power, USB, UART, Antenna, UICC, GPIO, SPI, I2C, • ADC, PCM, PWM and Analog Audio, Service, Software Interface • Network Design Router Configuration, Port Forwarding, Gateways Interface, DHCP configuration, VPN, Socket Communications, Network security (NMAP) • Logical Design Communication API MQTT, Co-AP, REST, AMQP, HTTP, XMPP, DDS, Web development framework, Cloud Integration, Fog node and Edge node • Deployment, Lightweight Device Management with lightweight Machine to Machine • Advance Practice: SDN, Dockers Container Class Implementation, OpenStack Platform, Database Management (Relational and Non-Relational) • Implementation of smart applications • Cloud computing with IoT for healthcare and industrial automation can be studied					
Essential Reading	D. Boswarthick, O. Elloumi, and O. Hersent, M2M communications: A systems approach, Wiley, 1st edition, 2012, ISBN: 978-1119994756					
Supplementary Reading	1. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: 2. Cybermanufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580. 3. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & 4. Architecture, Prentice Hall, 1st edition, 2013, ISBN: 978-0133387520.					

Course Name	Manufacturing Information Systems Practice	Course Code	ME5014			
Offered by Department	Mechanical Engineering	Structure (LTPC)	0	0	3	1.5
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	• To study the information systems in different domains of manufacturing • To model information using modelling languages for better interoperability between systems					
Learning Outcomes	• Students will be able understand the role of information systems in collecting, curating and analysing the data from disparate sources of data. • Students would be able to apply information modelling principles to different domain information systems.					
Course Contents (with approximate breakup of hours for lecture/tutorial/practice)	• Reference architecture study for Industry 4.0 (RAMI) • Information systems in Enterprise domain: Hands-on exercises in ERP, MES, HMI and IoT point solutions • Information systems in value chain domain: Supply chain management and logistics information systems, block chain exercises • Information systems in lifecycle domain: Product life cycle management (PLM), Product data management and Life cycle inventory information systems • Metrics and KPI modelling • KPI dash boarding and information exchange between information systems					
Essential Reading	1. Gilchrist, Alasdair. Industry 4.0: The Industrial Internet of Things. United States: Apress, 2016. 2. Hernes, Marcin., Jelonek, Dorota., Rot, Artur. Towards Industry 4.0 -- Current Challenges in Information Systems. Germany: Springer International Publishing, 2020. 3. Kumar, Uday., Pascual, Diego Galar., Daponte, Pasquale. Handbook of Industry 4.0 and SMART Systems. United States: CRC Press, 2019.					