M. Tech. Smart Manufacturing (SMT)

(According to 34th Senate meeting minutes)

<table>
<tr><td>Course Title</td><td>IIoT and Cloud Computing</td><td>Course No</td><td colspan="3">To be filled by the office</td></tr>
<tr><td>Specialization</td><td>Computer Engineering</td><td>Structure (IPC)</td><td>3</td><td>3</td><td>5</td></tr>
<tr><td>Offered for</td><td>M. Tech. (SMT)</td><td>Status (Core / Elective)</td><td colspan="3">Core</td></tr>
<tr><td>Prerequisite</td><td>----</td><td>To take effect from</td><td colspan="3"></td></tr>
<tr><td>Course Objectives</td><td colspan="5">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.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">At the end of this course, the students are expected to
1. Understand the existing IoT and Cloud architectures
2. Design an IoT system with cloud infrastructure
3. Implement a prototype of the IoT/cloud system design</td></tr>
<tr><td>Contents of the course</td><td colspan="5">Theory:
Introduction, Physical design of IoT, Logical design of IoT, IoT enabling technologies, Domain specific IoTs (8)
IoT design methodology, logical design (8)
IoT physical devices (such as Raspberry Pi, pcDuino, Beaglebone black, Cubieboard) (4)
Introduction to cloud computing: cloud models, cloud service examples, cloud based services & applications (6)
Virtualization, load balancing, scalability, deployment, replication, monitoring, SDN, network function virtualization, MapReduce, identity and access management, SLAs. (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. (4)
case studies: Industrial automation, Cloud for IoT (2)
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</td></tr>
<tr><td>Textbooks</td><td colspan="5">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.</td></tr>
<tr><td>References</td><td colspan="5">1. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cybermanufacturing 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.</td></tr>
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Course Title	Applied Machine to Machine Communication	Course No	To be filled by the office		
Specialization	Electronics / Computer Engineering	Structure (IPC)	1	3	3
Offered for	M. Tech. (SMT)	Status (Core / Elective)	Core		
Prerequisite	----	To take effect from			
Course Objectives	To learn the fundamental principles in Machine to Machine (M2M) Communication.				
Course Outcomes	At the end of the course, the following are expected from the students: 1. Understand the standards, protocols, and algorithms in M2M Communication 2. Implement the M2M Communication protocols in a prototype 3. Design new protocols for different scenarios				
Contents of the course	**Theory:** Introduction to M2M, Description of M2M Market Segments/Applications – Automotive, Smart Telemetry, Surveillance and Security, M2M Industrial Automation. ETSI M2M Services Architecture – Introduction, High-Level System Architecture, Introducing REST Architectural Style for M2M, Applying REST to M2M, Additional Functionalities. ETSI TC M2M Resource-Based M2M Communication and Procedures - Resource Structure, Interface Procedures. M2M over a Telecommunications Network - Mobile or Fixed Networks, Network Optimizations for M2M, 3GPP Standardization of Network Improvements for Machine Type Communications, 6LoWPAN. M2M Terminals and Modules - Access Technology, Physical Form Factors, Hardware Interfaces, Power Interface, USB (Universal Serial Bus) Interface, UART (Universal Asynchronous Receiver/ Transmitter) Interface, Antenna Interface, UICC (Universal Integrated Circuit Card) Interface, GPIO (General-Purpose Input/Output Port) Interface, SPI (Serial Peripheral Interface) Interface, I2C (Inter-Integrated Circuit Bus) Interface, ADC (Analog-to-Digital Converter) Interface, PCM (Pulse Code Modulation) Interface, PWM (Pulse Width Modulation) Interface, Software Interface, AT Commands, SDK Interface **Practice:** The experiments are designed as mini projects that make use of the architecture, services, and interfaces of the various M2M terminals and modules. Mini projects include Telemetry Surveillance E-Health vehicular communication Smart metering LoWPAN based networks				
Textbooks	1. D. Boswarthick, O. Elloumi, and O. Hersent, M2M communications: A systems approach, Wiley, 1st edition, 2012, ISBN: 978-1119994756.				
References	1. J. Holler et al., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 1st edition, 2014, ISBN: 978-0124076846. 2. C. Anton-Haro and M. Dohler, Machine-to-machine (M2M) Communications: Architecture, Performance and Applications, Woodhead Publishing, 1st edition, 2015, ISBN: 978-1782421023.				

Course Title	Mechatronic Systems Design	Course No	To be filled by the office		
Specialization	Electronics Engineering	Structure (IPC)	3	3	5
Offered for	M. Tech. (SMT)	Status (Core / Elective)	Core		
Prerequisite	----	To take effect from			
Course Objectives	To provide a hands-on introduction to design of mechatronic systems, namely sensors, actuators, interfaces, computer hardware, and control software, and enable understanding of the theory and practice of mechatronic systems integration.				
Course Outcomes	1. Understand the basic concepts of the main sensors used in electromechanical systems 2. Understand the fundamental concepts of mechanical power transmission components, and pneumatic and hydraulic actuators 3. Use the common analog and digital interfaces between sensors/actuators and the systems under control using open source microcontrollers 4. Understand the integration of mechanisms, sensors, actuators, interfaces and software in the design of mechatronic systems. 5. Understand basics of open source hardware/software, Mechaphonics, and mobile/web apps 6. Hands-on laboratory experiments and team projects involving the above concepts.				
Contents of the course	**Theory:** Introduction: Mechatronics, history, applications, and trends (2) Sensors and transducers: Characterization, sensors for position, velocity, proximity, force, pressure, temperature and light (4) Signal conditioning: Amplification, filtering, multiplexing, and telemetry. Data acquisition with A/D, D/A and digital I/O (4) Mechanical components: Types of motion, kinematic chains, cams, gears and other power transmission mechanisms (3) Software development: program structures for embedded systems, software design process, inter-processor communication, microcontrollers and peripherals (5) Pneumatic and hydraulic actuators: Basics of fluid flow, control valves, cylinders and rotary actuators for pneumatics and hydraulics (4) 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. (10) Basic closed-loop control: open-loop, on-off, PID control (3) Mechatronic systems integration, rapid prototyping of mechanical and electrical systems (4) Demonstrations of mechatronic systems in class (3) **Practice:** Arduino microcontroller I/O and interfacing (1) Basic sensors interfacing with Arduino (1) GPS and data logging with Arduino (1) Networking with Arduino: GSM and Bluetooth (2) Raspberry Pi microcomputer I/O and interfacing (1) Mid-semester lab examination (1) Final lab examination (1) Remaining sessions will be devoted to complete mechatronic system design (mobile robot competition), course projects, reviews and presentations.				

Textbooks	1. J. Edward Carryer, et al., Introduction to Mechatronic Design, Prentice Hall, 1st edition, 2010, ISBN: 978-8131788257.
References	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	Information Systems in Manufacturing	Course No	(To be allotted by Office)		
Specialization	Mechanical Engineering	Structure (IPC)	3	0	3
Offered for	M. Tech. (SMT)	Status (Core / Elective)	Core		
Pre-requisite	---	To take effective from			
Objectives	This course is designed to give students an appreciation for the management issues surrounding the development and use of information technology in organizations, with a particular focus on manufacturing applications.				
Course Outcomes	On completion of the course, students should be able to: 1. Understand/implement computer models of common engineering information types. 2. Understand the importance and be able to critically discuss the role of management information systems for design, engineering and manufacturing. 3. Discuss and evaluate engineering data management issues across the extended enterprise. 4. Demonstrate an appreciation of the complex relationship between information systems and organization.				
Contents of the course	Manufacturing organizations, management, and the networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and Behavioral approach. (5) 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 (8) 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. (8) Key System Applications: Achieving Operational Excellence and Customer Intimacy: Enterprise Applications, E-Commerce: Digital Markets, Digital Goods, Managing Knowledge and Collaboration, Enhancing Decision Making. (8) Smart manufacturing and connected enterprise, ISA 95, Functional and physical sub-divisions, Global connected supply chain, mass customization, customer co-creation. (5) Case studies of information systems for key manufacturing functions: Life cycle, supply chain, enterprise, quality, maintenance, materials, energy and sustainability information systems. (10)				
Textbooks	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	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.				

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<tr><td>Course Title</td><td>Analytics & Systems of Big Data</td><td>Course No</td><td colspan="3">(To be allotted by Office)</td></tr>
<tr><td>Specialization</td><td>Computer Engineering</td><td>Structure (IPC)</td><td>3</td><td>3</td><td>5</td></tr>
<tr><td>Offered for</td><td>M. Tech. (SMT), DD (CED)</td><td>Status (Core / Elective)</td><td colspan="3">Core</td></tr>
<tr><td>Pre-requisite</td><td>-----</td><td>To take effective from</td><td colspan="3"></td></tr>
<tr><td>Objectives</td><td colspan="5">The course intends to expose computer engineering students to recent advances in storage and analytics involved with big data.
Topics related to Mapreduce, globally distributed storage systems and analytics such as feature extraction, learning, similarity, etc. are dealt with to expose the students to current trends in data storage & analytic and will be implemented / simulated.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">The course shall equip students with required storage mechanisms / analysis algorithms for data management in distributed & data intensive applications.</td></tr>
<tr><td>Contents of the course</td><td colspan="5">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.
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.</td></tr>
<tr><td>Textbooks</td><td colspan="5">1. A. Rajaraman, J. Leskovec, J. Ullmann, Mining of Massive Data sets, Cambridge University Press, 2011, ISBN: 1107015359.</td></tr>
<tr><td>References</td><td colspan="5">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.</td></tr>
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Course Title	Manufacturing Systems Engineering	Course No	(To be allotted by Office)		
Specialization	Mechanical Engineering	Structure (IPC)	3	3	5
Offered for	M. Tech. (SMT)	Status (Core / Elective)	Core		
Pre-requisite	-----	To take effective from			
Objectives	To analyze manufacturing systems in terms of material flow and storage, information flow, capacities, and times and durations of events.				
Course Outcomes	1. The students will be able to understand the probability, queuing models, optimization, process analysis, and linear and dynamic systems. 2. The students will also be able to carry-out flow planning, bottleneck characterization, use buffer and batch-size tactics, seasonal planning, and analyze dynamic behavior of production systems				
Contents of the course	**Theory:** Overview of Manufacturing systems, Probability: introduction, discrete random variable, continuous random variable. Queuing: single-server queues, queuing networks. (5) Introduction to Factory models, single workstation factory models, processing time variability, Single-Part-Type Systems, Multi-stage single product and multi-product systems, Models of various forms of batching, WIP limiting control strategies, serial limited buffer models. (20) Manual Assembly lines, Automated Production lines, Automated Assembly systems, Group technology and cellular manufacturing, Flexible manufacturing cells and systems, Toyota Production System. (10) Material Requirements Planning, Multi-Stage Control and Reactive Scheduling, Simulation Techniques. (9) **Practice:** Solving queuing problems using simulation techniques, performance analysis of manufacturing cells, optimization of layouts, Solving reactive scheduling problems.				
Textbooks	1. M. P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 4th edition, Pearson Education, 2016, ISBN: 9789332572492. 2. Guy L. Curry and R. M. Feldman, Manufacturing Systems Modeling and Analysis, 1st edition, Butterworth-Heinemann, 2009, ISBN: 978-3-540-88762-1.				
References	1. S. B. Gershwin, Manufacturing Systems Engineering, 1st edition, Prentice Hall PTR, 1993, ISBN: 9780135606087. 2. W. J. Hopp and M. L. Factory Physics, 3rd edition, Waveland Press, 2011, ISBN: 978-1577667391.				