Branch: Computer Science and Engineering with specialisation in Internet of Things

STUDY AND EVALUATION SCHEME

FROM

1st TO IVth SEMESTER

MASTER OF ENGINEERING PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING WITH SPECIALISATION IN INTERNET OF THINGS (IoT)

PANJAB UNIVERSITY, CHANDIGARH

(Batch 2020-2022)

Branch: Computer Science and Engineering with specialisation in Internet of Things

Scheme for Master of Engineering in Computer Science and Engineering with Specialisation in Internet of Things

First Semester

Sr.No.	Course No.	Course Title	Hours / Week	Credits	University External Marks	Internal Sessional Marks	Total
1.	CSEI 8101	Advanced Wireless Networks	4	4	50	50	100
2.	CSEI 8102	Sensors and Actuators	4	4	50	50	100
3.	Branch Elective - 1	**Choose one course from the list**	4	4	50	50	100
4.	CSEI 8106 (Industry Core-1)	**Machine Learning** (Common with M.E. in Mechanical Engineeringwith specialisation in Robotics and M.E. in Electronics and Communication Engineering with specialisation in Artificial Intelligence)	3	3	50	50	100
5.	CSEI 8107 (Industry Core-2)	**Fundamentals of IoT**(Common with M.E. in Mechanical Engineering with specialisation in Robotics and M.E. in Electronics and Communication Engineering with specialisation in Artificial Intelligence)	3	3	50	50	100
6.	Audit Course	**Choose one course from the list**	-	-	-	-	-
7.	CSEI 8150	IoT Laboratory-I	4	2	-	100	100
Total			22	20	250	350	600

List of Program Electives– Semester I (SELECT ANY ONE)

CSEI 8103 Logic and Functional Programming
CSEI 8104 Cloud Computing and Virtualization

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CSEI 8105 Programming and Interfacing with Microcontrollers

List of Audit Courses

1. Technical Report Writing
2. Start-up/ Venture Capitalism
3. Digital Pedagogy
4. Stress Management by Yoga

Second Semester

Sr.No.	Course No.	Course Title	Hours / Week	Credits	University External Marks	Internal Sessional Marks	Total
1.	CSEI 8201	Mobile Applications Development	4	4	50	50	100
2.	CSEI 8202	IoT Protocols and Security Issues	4	4	50	50	100
3.	Branch Elective - 2	**Choose one course from the list**	4	4	50	50	100
4.	CSEI 8206 (Industry Core-3)	**Industrial IoT**(Common with M.E. in Mechanical Engineeringwith specialisation in Robotics and M.E. in Electronics and Communication Engineering with specialisation in Artificial Intelligence)	3	3	50	50	100
5.	CSEI 8207 (Industry Core-4)	**Big Data Analytics** (Common with M.E. in Mechanical Engineeringwith specialisation in Robotics and M.E. in Electronics and Communication Engineeringwith specialisation in Artificial Intelligence)	3	3	50	50	100

6.	CSEI 8250	IoT Laboratory - II	4	2	-	100	100
Total			22	20	250	350	600

List of Program Electives– Semester II (SELECT ANY ONE)

CSEI 8203 Beyond IoT – Ubiquitous Sensing and Wireless Sensor Networks
CSEI 8204 Fog/ Edge Computing
CSEI 8205 Energy Harvesting Technologies and Power Management for IoT Devices

Third Semester

Sr. No.	Course No.	Course Title	Hours / Week	Credits	University External Marks	Internal Sessional Marks	Total
1	CSEI 8301	SWAYAM MOOC Course 1*	-	2	-	-	100**
2	CSEI 8302	SWAYAM MOOC Course 2*	-	2	-	-	100**
3	CSEI 8350	Preliminary Thesis Work	20	10	-	100	100
Total			20	14	-	100	300

* The **Curated List of SWAYAM MOOCS to be announced at the Start of Semester by the Department and same will be informed to PU, Chandigarh.**

**** The Total Marks obtained in the Proctored Examination Conducted by SWAYAM / NAT / NPTEL is considered**

Example MOOCs:

S. No.	MOOCs Course Title	Faculty and Institute	Web Link
List of MOOC Courses (Non-technical)			
1.	Managing Intellectual Property in Universities	**Feroze Ali** IIT Madras	https://swayam.gov.in/courses/5474-jan-2019-managing-intellectual-property-at-universities
2.	Innovation, Business Models and Entrepreneurship	**Rajat Agarwal** IIT Roorkee	https://swayam.gov.in/courses/4816-july-2018-innovation-business-models-and-entrepreneurship

List of MOOC Courses (Technical)			
1.	Deep Learning (NPTEL)	Dr.Mitesh M. Khapra, IIT Madras	https://onlinecourses.nptel.ac.in/ noc18_cs41/preview
2.	Designing of IoT Applications	**Dr. Ian Harris** University of California	https://www.coursera.org/learn/raspberry-pi-platform

The Dept. should prepare the list only from the MOOC which conduct proctored examinations like NPTEL. Depending upon the availability of online MOOC courses, students will be intimated one month prior to the commencement of the course.

Fourth Semester

Sr. No.	Course No.	Course Title **	Hours / Week	Credits	University External Marks	Internal Sessional Marks	Total
1	CSEI 8450	Thesis Work	32	16	100	100	200
Total			32	16	100	100	200

**** Candidate shall make a presentation along with a demo of work done in the presence of panel of experts and nominees as per Panjab University, Chandigarh norms.**

Total Credits: 70

Program Outcomes of PG program in CSE (IoT)

At the end of the program, a student is expected to have:

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report / document.

PO3: An ability to demonstrate mastery over the emerging area of Internet of Things and allied specialization of the program.

PO4: An ability to build and operationalize an IoT end-to-end system.

PO5: An ability to solve a real world problem in the area of Internet of Things and Cloud based Solutions.

Title	ADVANCED WIRELESS NETWORKS	Credits	04

Branch: Computer Science and Engineering with specialisation in Internet of Things

Code	**CSEI 8101**	**Semester:** I[st]	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	N
Pre-requisites	Computer Networks, Fundamentals of Wireless Communication		**Contact Hours**	45
			Time	4 Hours
Objectives	The objective of this course is to impart comprehensive knowledge of the wireless networks needed for design and implementation of a typical IoT system. The course also aims at developing necessary skills required for efficient network infrastructure of an IoT.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

UNIT I **Wireless networks:** Introduction to wireless networks, Wired Vs. Wireless networks, Cellular networks, Wireless ad-hoc networks, Wireless mesh networks, Wireless sensor networks	11
UNIT II **Mobile ad-hoc networks:** Introduction to MANETs, MAC protocols for MANETs, Basic routing protocols for MANETs (AODV, DSR, DSDV, etc.), Securing ad-hoc networks **Vehicular Networks:** Introduction to VANETs, Infrastructure-less vehicular networks, Intelligent transportation system, Routing in Vehicular Adhoc Networks	12

SECTION-B

UNIT III **Delay-tolerant networks:** Introduction to DTNs, Routing protocols for DTNs (Epidemic, PROPHET, Spray-and-Wait, CBR, etc.), Cooperations in DTNs	11
UNIT IV **Wireless body area networks**: Introduction to WBAN, Positioning of WBANs, WBAN specific protocols, Routing protocols for WBANs	11

Suggested Books	1. Guide to Wireless Ad hoc Networks by S. Misra, I. Woungang and S. C. Misra, Computer Communications and Networks Series. 2. Opportunistic Mobile Networks: Advances and Applications, By S. Misra, B. K. Saha, S. Pal 3. Wireless Sensor andMobile Ad hoc Networks: Vehicular and Space applications by BenhaddouDriss, AI-Fuqaha Ala 4. Ad Hoc Wireless Networks: Architectures and Protocols by Siva Ram Murthy C and Manoj B S, Prentice Hall, 2004.
COURSE	After the completion of this course, the students will be able to:

OUTCOMES	1. Understand various concepts of wireless networks. 2. Apply Wireless Networks Principles in IoT. 3. Evaluate various protocols designed for wireless networks. 4. Analyze the application of Communication Systems in IoT.

Title	**SENSORS & ACTUATORS**		**Credits**	04
Code	**CSEI 8102**	**Semester:** Ist	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	N
Pre-requisites	Knowledge of various Electronic Components		**Contact Hours**	45
			Time	4 Hours
Objectives	The objective of this course is to impart comprehensive knowledge of the wireless networks needed for design and implementation of a typical IoT system. The course also aims at developing necessary skills required for efficient network infrastructure of an IoT.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

UNIT – I: Sensors and Transducers Principles, Classification, Parameters, Characteristics, and Characterization of sensors. Types of sensors- Capacitive Sensors, Electrostatic Transducer, Force/Stress Sensors using Quartz Resonators, Ultrasonic Sensors. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges. Inductive Sensors- Sensitivity and Linearity of the Sensor. Sensor selection and its calibration techniques.	11
UNIT – II: Signal condition and Data acquisition Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers. Data Acquisition Systems and Conversion: Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.	10

SECTION-B

UNIT- III: Thermal Sensors, Radiation Sensors and Smart Sensors	12

Thermal Sensor, Principle & types of Thermal sensors, Applications of thermal sensors. Radiation sensors, principle & types of Photosensistors /Photo detectors– X-ray and Nuclear Radiation Sensors. Fibre Optic Sensors. Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, the Automation. Sensors Applications: On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring. Case study: Environmental monitoring sensors, Health monitoring sensors, Industrial sensors.		
UNIT – IV: Actuators Pneumatic and Hydraulic Actuation Systems- Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves, Cylinders, Servo and proportional control valves, Process control valves, Rotary actuators, Mechanical Actuation Systems Types of motion, Kinematic chains, Cams, Gears, Ratchet and pawl, Belt and chain drives, Bearings, Mechanical aspects of motor selection, Electrical Actuation Systems, Electrical systems, Mechanical switches, Solid-state switches, Solenoids, D.C. Motors, A.C. Motors, Stepper motors.		12
Suggested Books	1. D. Patranabis, "Sensors and Transducers", PHI Learning Private Limited. 2. W. Bolton, "Mechatronics", Pearson Education Limited. **3.** Transducers & Instrumentation, Rangan Mani Sharma.	
COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Explain fundamental concepts of sensors and actuators and their applications. 2. Analyse various premises, approaches, procedures and results related to sensors and actuators. 3. Create analytical design and development solutions for sensors and actuators. 4. Conduct experiments and measurements in laboratory and on real components, sensors and actuators. 5. Interpret the acquired data and measured results.	

Title	**MACHINE LEARNING**		**Credits**	03
Code	**CSEI 8106**	**Semester:** Ist	**L T P**	3 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	N
Pre-requisites	Basics of Probability, Linear Algebra and Calculus		**Contact Hours**	45
			Time	3 Hours
Objectives	This course will serve as a comprehensive introduction to various topics in machine learning.The objective is to familiarize the audience with some basic learning algorithms			

	and techniques and their applications, as well as general questions related to analyzing and handling large data sets. At the end of the course the students should be able to design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate and interpret the results of the algorithms.
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.

SECTION-A	
Supervised Learning, Decision Trees & CART, Linear regression, Gradient Descent.	7
Linear Classification: Logistic regression, Newton Raphson, Perceptron, Multilayer Perceptron, feedforward neural network, Error backpropagation method, Convolution Networks, Support Vector Machines (SVM)	8
Probabilistic Models: Bayes classifier, Naive Bayes classifier, Hidden Markov models (HMMs) for pattern classification	8
SECTION-B	
Design and Analysis of Experiments: Cross validation, Performance measures, CI Estimation, Hypothesis Testing	8
Unsupervised Learning: Criterion functions for clustering, Techniques for clustering -- K-means clustering, Gaussian Mixture Models, Hierarchical clustering, Density based clustering	8
Dimensionality Reduction Techniques: Principal component analysis, Fisher discriminant analysis, Multiple discriminant analysis	6

Suggested Books	1. Machine Learning by Tom Mitchell 2. Introduction to Machine Learning by EthemAlpaydin 3. Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 2013. 4. Pattern Classification, 2nd Ed., Richard Duda, Peter Hart, David Stork, John Wiley & Sons, 2001.
Course Outcomes	At the end of the course, the students will be able to: 1. Understand the fundamental issues and challenges of machine learning. 2. Understand the strengths and weaknesses of many popular machine learning approaches. 3. Interpret the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning. 4. Design and implement various machine learning algorithms in a range of real-world applications.

Title	**FUNDAMENTALS OF IoT**		**Credits**	03
Code	**CSEI 8107**	**Semester:**Ist	**L T P**	3 0 0

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Max. Marks	**External:** 50	**Internal:** 50	**Elective**	N
Pre-requisites	Basics of Sensors, and Machine Level Programming		**Contact Hours**	45
			Time	3 Hours
Objectives	This course focuses on the latest microcontrollers with application development, product design and prototyping. This also focuses on interoperability in IoT along with various IoT Platforms for application development.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

INTRODUCTION Introduction to IoT, Sensing, Actuation, Basics of Networking, Communication Protocols	6
Sensor Networks, Machine to Machine Communications. Understanding of the IoT ecosystem, various layers in building an IoT application and interdependencies	6
INTEROPERABILITY IN IoT Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming	5
Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. Build use cases using Raspberry Pi	5

SECTION-B

SDN FOR IoT Introduction to SDN, SDN for IoT, Data Aggregation, Handling and Analytics	4
Cloud Computing, Sensors, Fog Computing	4
Understanding of the various protocols being used in IoT like MQTT, AMQP, REST API	4
IoT Platforms and Applications Understanding of the IoT platforms like PTC Thingworx and IoT frameworks like MS Azure, Understanding of the usage of these platforms to build applications like Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Case Study: Agriculture, Healthcare, Activity Monitoring.	11

Suggested Books

1. David Etter, "IoT (Internet of Things) Programming: A Simple and Fast Way of Learning IoT," Kindle Edition.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, and David Boyle, "From Machine to Machine to the Internet of Things:

	Introduction to a New Age of Intelligence," Elsevier Science Publishing Co. Inc, 2014. **3.** Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases," 1st Edition, Auerbach Publications, 2017. **4.** Yasuura, H., Kyung C.M., Liu Y., and Lin Y.L., "Smart Sensors at the IoT Frontier," 1st Edition, Springer International Publishing, 2018.
Course Outcomes	At the end of the course, the students will be able to: 1. Understand the various network protocols used in IoT 2. Understand the role of Big Data, Cloud Computing and Data Analytics in a typical IoT system. 3. Design a simple IoT system made up of sensors, wireless network connection, data analytics and display/actuators, and write the necessary control software. 4. Build and test a complete IoT system.

Title	**LOGIC AND FUNCTIONAL PROGRAMMING**		**Credits**	04
Code	**CSEI 8103**	**Semester:** I[st]	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	Y
Pre-requisites	Knowledge of any Programming Language		**Contact Hours**	45
			Time	4 Hours
Objectives	The objective of this course is to offer students a comprehensive knowledge and practical experience in functional and logic programming. The students will get basic information about theoretical basis of both paradigms and its implementation techniques.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

PROPOSITION LOGIC Introduction of logic and Functional Paradigm, Propositional Concepts, Semantic Table, Problem Solving with Semantic Table.	10
NATURAL DEDUCTION AND AXIOMATIC PROPOSITIONAL LOGIC Rules of Natural Deduction, Sequent Calculus, Axiomatic Systems, Meta theorems, Important Properties of AL, Resolution, Resolving Arguments, Introduction to Predicate Logic Objects, Predicates and Quantifiers, Functions, First Order Language, Quantifiers, Scope and Binding, Substitution, An Axiomatic System for First Order Predicate Logic, Soundness and Completeness, Axiomatic Semantic and Programming.	12

SECTION-B

SEMANTIC TABLEAUX & RESOLUTION IN PREDICATE LOGIC	

Semantic Tableaux, Instantiation Rules, Problem-solving in Predicate Logic, Normal forms, Herbr and Universes and H-interpretation, Resolution, Unification, Resolution as a computing Tool, Nondeterministic Programming, Incomplete Data Structure, Second Order Programming in Prolog, Logic Grammars: Definite Clause Grammar, A Grammar Interpreter.	10
LAZY AND EAGER EVALUATION STRATEGIES Evaluation Strategies, Lazy Evaluation: Evaluation Order and strictness of function, Programming with lazy evaluation, Interactive functional program, Delay of unnecessary Computation, Infinite Data Structure, Eager Evaluation and Reasoning, Recent trends in logical and functional programming, predicate logics and various evaluation strategies.	13
Suggested Books	1. John Kelly, "The Essence of Logic," Pearson Education, 1997. 2. Saroj Kaushik, "Logic and Prolog Programming", New Age International, 2002. 3. David S. Warren, "Programming in Tabled Prolog," Citeseer, 1995 4. W. F. Clocksin and C.S.Mellish, "Programming in Prolog," 4th Edition, Springer, 1994. 5. Ulf Nilsson and Jan Maluszynki, "Logic Programming and Prolog," 2nd Edition, John Wiley & Sons Ltd, 1995.
COURSE OUTCOME	After the completion of this course, the students will be able to: 1. Understand the concepts of the Logic and Functional programming paradigms. 2. Differentiate between functional programming and logic programming. 3. Implement Lazy and Eager Evaluation Strategies. 4. Implement functional and logic programs for nodes in IoT. 5. Apply functional and logic programming for solving a real world problem.

Title	**CLOUD COMPUTING AND VIRTUALIZATION**		**Credits**	04
Code	**CSEI8104**	**Semester:** I st	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	Y
Pre-requisites	Basic Knowledge of Distributed Computing		**Contact Hours**	45
			Time	4 Hours
Objectives	This course will enable students to understand cloud computing concepts and prepares students to be in a position to design cloud based applications for distributed systems.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			
SECTION-A				

Overview of Computing Paradigms Recent Trends in Computing: Distributed Computing, Cluster Computing, Grid Computing, Utility Computing, Cloud Computing Evolution of Cloud Computing: Migrating into a Cloud	5
Cloud Computing Basics Cloud Computing Overview; Characteristics; Applications; Benefits; Limitations; Challenges, SOA;Cloud Computing Service Models: Infrastructure as a Service; Platform as a Service; Software as a Service Cloud Computing Deployment Models: Private Cloud; Public Cloud; Community Cloud; Hybrid Cloud, Major Cloud Service providers	6
Virtualization Concepts Overview of Virtualization Technologies, Types of Virtualization, Benefits of Virtualization, Hypervisors VM Provisioning & Migration: VM Lifecycle, VM Provisioning Process, VM Migration Techniques	6
Scheduling in Cloud Overview of Scheduling problem, Different types of scheduling, Scheduling for independent and dependent tasks, Static vs. Dynamic scheduling, Optimization techniques for scheduling	5
SECTION-B	
Cloud Storage Overview; Storage as a Service, Benefits and Challenges, Storage Area Networks(SANs), Case Study of Amazon S3	5
Cloud Security Infrastructure Security: Network Level Security, Host Level Security and Application Level Security; Data Security: Data Security & Privacy Issues; Identity & Access Management; Legal Issues in Cloud Computing	6
Mobile Cloud Computing Overview of Mobile Cloud Computing, Advantages, Challenges, Using Smartphones with the Cloud, Offloading techniques - their pros and cons, Mobile Cloud Security.	6
SLA Management: Overview of SLA, Types of SLA, SLA Life Cycle, SLA Management Process	4
Case Study of Implementation tools/Simulators	2
Suggested Books	1. RajkumarBuyya, James Broberg, AndrzejGoscinski (Editors): Cloud

	Computing: Principles and Paradigms, Wiley, 2011 2. Barrie Sosinsky: Cloud Computing Bible, Wiley, 2011. 3. Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter: Cloud Computing: A Practical Approach, McGraw Hill, 2010. 4. Judith Hurwitz, Robin Bloor, Marcia Kaufman,Fern Halper: Cloud Computing for Dummies, Wiley, 2010. 5. BorkoFurht, Armando Escalante (Editors): Handbook of Cloud Computing, Springer, 2010.	
Course Outcomes	After the completion of this course, the students will be able to: 1. Learn core concepts of cloud computing paradigm 2. Apply virtualization in the cloud ecosystem 3. Design and Implement scheduling algorithms for cloud 4. Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS 5. Analyse various security issues in the cloud	

Title	**PROGRAMMING AND INTERFACING WITH MICROCONTROLLERS**		**Credits**	04
Code	**CSEI 8105**	**Semester:** Ist	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	Y
Pre-requisites	Knowledge of C Language		**Contact Hours**	45
			Time	4 Hours
Objectives	The objective of this course is to impart in depth theoretical and practical knowledge about programming techniques for various microcontrollers like Arduino, Raspberry Pi and other ARM devices. The course also provides student a hand-on experience to work with various microcontrollers by interfacing it with different devices using different software and hardware platform to obtain advance innovations.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			
SECTION-A				
INTRODUCTION Introduction – History - Creative Coding Platforms - Open Source Platforms – PIC - Arduino, Sketch, Raspberry Pi, Iterative coding methodology – Python Programming - Mobile phones and similar devices - Arm Devices - Getting used to Arduino - Sensor				10

Characterization: Safety, Basic Electronics (circuit theory, measurements, parts identification) Sensors and Software: Understanding Processing Code Structure, variables and flow control, Interfacing to the Real World.	
SOFTWARE FRAMEWORKS Software: open Frameworks as our IDE (C/C++) - "Arduino" Language (C/C++) - Hardware: Desktop / Laptop / Raspberry Pi - How to approach a programming problem? Representing "reality" with computers. Digital vs. Analog circuits, audio, communication, etc. Analog to Digital Conversion (ADC) - Digital to Analog Conversion (DAC) - Microcontrollers.	12
SECTION-B	
HARDWARE COMMUNICATION Communication – Serial& Parallel - Hardware to Hardware Communication - I2C/IIC (Inter-Integrated Circuit) - SPI (Serial Peripheral Interface) – Serial UART Communication - Introduction to the command line – git/github. Introduction to Programming: A comparative studio between Arduino +open Frameworks - Arduino-compatible Microcontrollers Sensors and Actuators.	10
ADVANCED I/O INTERFACING Advanced I/O – open Frameworks: Live Network feeds (push and pull) - Data persistence (saving data and preferences) - Database interface (MySQL, sqLite, XML, PHP/Web) - Arduino: Wired/Wireless Networking.	13
Suggested Books	1. M.A. Mazidi and J.C. Mazidi, "Microcontroller and Embedded systems using Assembly and C," 2nd Edition, Pearson Education India, 2007. 2. Josha Noble, "Programming Interactivity," 2nd Edition, O'Reilly Media, 2012. 3. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python," 2nd Edition, McGraw-Hill Education, 2015. 4. Kenneth J Ayala, "The 8051 Microcontroller," 3rd Edition, Thomson Delmar Learning, 2004. 5. Scott MacKenzie and Raphael C.W. Phan, "The 8051 Microcontroller," 4th Edition, Pearson education, 2008.
COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Acquire the fundamental knowledge and operation of various microcontrollers. 2. Demonstrate familiarity with common microcontroller subsystems. 3. Describe the roles of microcontrollers in contemporary systems, including common consumer products. 4. Interface and simulate microcontroller based systems to peripheral devices. 5. Design interfaces to external devices connected to the microcontroller. 6. Implement the program by using various software frameworks for interfacing peripheral devices with microcontrollers.

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Title	**MOBILE APPLICATION DEVELOPMENT**		**Credits**	04
Code	**CSEI 8201**	**Semester:** IInd	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	N
Pre-requisites	Knowledge of Java Language		**Contact Hours**	45
			Time	4 Hours
Objectives	The objective of this course is to impart necessary knowledge and skills about emerging technologies and tools required to design and implement feature-rich mobile applications for smartphones and tablets. The student will be able to analyse the technical constraints relative to storage capacity, processing capacity, display screen, communication interfaces, and the user interface, context and profile.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

INTRODUCTION Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User.	10
MORE ON UIs VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal Uis, Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Curriculum of Engineering & Technology PG Courses Model Right, Android Storing and Retrieving Data, Working with a Content Provider.	12

SECTION-B

COMMUNICATIONS VIA NETWORK AND THE WEB State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony, Notifications and Alarms: Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics, Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia.	10
PLATFORMS AND ADDITIONAL ISSUES Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking , Active Transactions, More on Security, Hacking Android, Recent trends in Communication protocols for IoT nodes,	13

mobile computing techniques in IoT, agents based communications in IoT.		
Suggested Books	1. Wei-Meng Lee, "Beginning Android 4 Application Development," John Wiley & Sons, 2012. 2. Deitel, P., Deitel, H. and Deitel, A., "Android: How to Program with an Introduction to Java," 1st Edition, Pearson Prentice Hall, 2012. 3. Meier R, "Professional Android 4 Application Development," John Wiley and Sons, 2012.	
COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Describe and compare different mobile application models and patterns. 2. Design and develop a mobile application prototype. 3. Apply mobile application architectures and patterns to the development of a mobile software application. 4. Apply a mobile development framework to the development of a mobile application. 5. Address the limitations and challenges of working in a mobile environment and thus utilize the opportunities for commercial and/or social benefit.	

Title	**IOT PROTOCOLS AND SECURITY ISSUES**		**Credits**	04	
Code	**CSEI 8202**	**Semester:** IInd	**L T P**	4 0 0	
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	N	
Pre-requisites	Knowledge of Network Security		**Contact Hours**	45	
			Time	4 Hours	
Objectives	The purpose of this course is to provide understanding of the main issues related to security in Internet of Things environment. This covers underlying concepts and foundations of computer security, basic knowledge about security-relevant decisions in designing IoT based infrastructures, techniques to secure complex systems and practical skills in managing an IoT based infrastructures				
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.				
	SECTION-A				
	IoT Reference Model and Architecture IoT Architecture- Introduction, IoT reference Model, Functional View, Deployment and Operational View. Challenges in designing IoT based system with reference to protocols & security, Real-World Design Constraints- Introduction, Technical Design constraints, Security constraint. IoT security model, Security aspects in IoT: confidentiality, integrity, availability, security policies, security mechanisms,				10

	assurance.	
	IoT Communication Protocols IoT communication model, Design Principles for the Connectivity for IoT Devices, PHY/MAC layer: IEEE 802.11, IEEE 802.15, ZigBee, Bluetooth low energy, Wi-Fi. Network layer: IPv4, IPv6, 6LoWPAN. Transport Layer: TCP, UDP. Application layer: HTTP, MQTT, SMQTT, CoAP., Implementation layers for security protocols: IPsec, SSL/TLS.	12
	SECTION-B	
	Securing the Internet of Things Security Requirements in IoT, Layer-by-Layer look at security measures, Attacks Specific to IoT, Authentication/Authorization for Smart Devices Cryptographic primitives and its role in IoT: Encryption and Decryption, Cipher suites, key management fundamentals, cryptographic controls built into IoTmessaging and communication protocols, IoT Node Authentication, Authorization with Publish / Subscribe schemes, access control	12
	Secure IoT application development Solution framework for secure IoT applications- Implementation of Device integration, Data acquisition, Organization and integration and analytics, Device data storage- Unstructured data storage on cloud/local server, Authentication, Preventing unauthorized access of devices **Case Study:** Smart Cities and Smart Homes, Connected Vehicles, Industrial IoT, Agriculture, Activity Monitoring	11
Suggested Books	1. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley 2. Practical Internet of Things Security (Kindle Edition) by Brian Russell, Drew Van Duren	
COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Understand various concepts of IoT Protocols. 2. Apply Protocols Principles in IoT. 3. Evaluate various protocols designed for IoT. 4. Analyze the Security Issues in IoT.	

Title	**INDUSTRIAL IoT**		**Credits**	03
Code	**CSEI 8206**	**Semester:** IInd	**L T P**	3 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	N
Pre-requisites	Fundamentals of IoT		**Contact Hours**	45

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		Time	3 Hours
Objectives	To Introduce the state of art of Industrial IoT with smart machines that performs pervasive sensing distinct from M2M communication. The course is a blend of engineering and business of IoT. It deals with connectivity in industrial networks, building systems to enable delivery of software services networked to the cloud platforms. At the end of the course, the students will be in a position to start an Industrial IoT business.		
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.		
SECTION-A			
Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories			4
Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management			5
Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis. Cybersecurity in Industry 4.0			5
Basics of Industrial IoT: Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems			4
IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture			3
Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking			3
SECTION-B			
Industrial IoT: Big Data Analytics and Software Defined Networks			2
IIoT Analytics - Introduction, Machine Learning and Data Science, and Julia Programming, Data Management with Hadoop			6
Data Center Networks, Security and Fog Computing: Cloud Computing in IIoT			3
Industrial IoT: Security and Fog Computing, Application Domains: Factories and Assembly Line, Food Industry, Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management			6
Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies			4
Suggested Books	**1.** Enterprise IoT Strategies and Best Practice for Connected Products and Services. – Dirk Slama, Frank Puhlmann, Jim Mirrish, Rishi M Bhatnagar **2.** The Internet of Things: Key Applications and Protocols - David Boswarthick **3.** The Silent Intelligence, The Internet of Things. By – Daniel Kellmereit, Daniel Obodovski **4.** "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress)		

	5. "Industrial Internet of Things: CybermanufacturingSystems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)
COURSE OUTCOMES	At the end of the course, the students will be able to: 1. Understand Industry 4.0 Standards and IIOT Architecture. 2. Apply Intelligent algorithms for IIOT based Applications. 3. Analyse the security threats of IIOT. 4. Evaluate various components of Cyber Physical Systems in the context of Industry 4.0

Title	**BIG DATA ANALYTICS**		**Credits**	03
Code	**CSEI 8207**	**Semester:** IInd	**L T P**	3 0 0
Max. Marks	**External :** 50	**Internal:** 50	**Elective**	N
Pre-requisites	Basics knowledge of Python or any Object Oriented Programming Language		**Contact Hours**	45
			Time	3 Hours
Objectives	The objective of this course is to teach the emerging concepts and case studies of Big Data with the real world case studies. In addition, the course focuses towards the coverage of data acquisition, storage, processing, querying and visualization with hands-on-practice using various big data analytics tools.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

BIG DATA CONCEPTS, ARCHITECTURES AND ANALYTICS PATTERNS **Introduction to Big Data:**Definition, various tools for Big Data, Possibilities of Big Data storage using RDBMS, Data Warehousing and Data Marts concept, Types of analytics - Descriptive, Diagnostic, Predictive, Prescriptive, Big Data characteristics - Volume, Velocity, Variety, Veracity, Value, Data analysis flow, Big data examples, applications & case studies.	4
Big Data Architectures & Patterns: MapReduce, Sharding, Bloom Filters, Lambda Architecture, Consistency, Availability & Partition Tolerance (CAP), Consensus in Distributed Systems, Leader Election and Other analytics patterns	5
Python Programming for Big Data Applications: Introduction to Python, Big Data stack setup and examples, Hortonworks Data Platform/Apache Ambari, Amazon EMR, Running Python MapReduce examples on big data stack.	5
BIG DATA ACQUISITION & STORAGE **Data Acquisition:** Apache Flume; Apache Sqoop; Publish - Subscribe Messaging Frameworks; Big Data Collection Systems, Messaging queues, Custom connectors,	4

Implementation examples		
Big Data Storage: HDFS, HBase, Kudu **NoSQL Databases:** Key-value databases, Document databases, Column Family databases, Graph databases		3
Standard ETL Tools: Standard Industry tools.		2
SECTION-B		
BATCH ANALYTICS, REAL-TIME ANALYTICS & INTERACTIVE QUERYING **Batch Data Analysis:**Hadoop & YARN, MapReduce& Pig, Spark core, Batch data analysis examples & case studies		4
Real-time Analysis: Stream processing with Storm, In-memory processing with Spark Streaming, Real-time analysis examples & case studies		3
Interactive Querying: Hive, Spark SQL, Interactive querying examples & case studies		4
BIG DATA VISUALIZATION & APPLICATION DEPLOYMENT **Cloud Computing Platforms:** Amazon Web Services (AWS), Deploying Big Data applications in the cloud		4
Web Frameworks & Serving Databases: Django - Python web framework, Using different serving databases with Django		3
Data Visualization: Building visualizations with Lightning, pyGal&Seaborn		4
Suggested Books	**1.** ArshdeepBahga, Vijay Madisetti, "Big Data Analytics: A Hands-On Approach", VPT Publishers, 2018 **2.** Big Data Black Book, D T editorial service, Dreamtech Press, Wiley India; 1st edition, 2016. **3.** Baesens Bart, "Analytics in A Big Data World - The Essential Guide To Data Science and Its Applications", Wiley, 2014 **4.** RadhaShankarmani, M. Vijayalakshmi, "Big Data Analytics", Wiley, 2016 **5.** Acharya Seema, SubhashiniChellappan, "Big Data and Analytics", Wiley, 2015 **6.** NPTEL Course on “The Joy of Computing using Python” by Dr.SudarshanIyengarhttps://onlinecourses.nptel.ac.in/noc18_cs35/preview **7.** NPTEL Course on “Programming, Data Structures and Algorithms in Python” by Dr.MadhavanMukundhttps://onlinecourses.nptel.ac.in/noc16_cs11/preview **8.** NPTEL Course on “Big Data Computing” by Dr. Rajiv Misrahttps://onlinecourses.nptel.ac.in/noc19_cs33/preview **9.** Dive into Python 3, Mark Pilgrim, http://www.diveintopython3.net	
COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Understand the concepts of Big Data Analytics with real world	

	case studies. 2. Acquire, store and process Big Data from various sources. 3. Analyse and visualize Big Data. 4. Apply Big Data Analytics in various domains.	

Title	**BEYOND IOT – UBIQUITOUS SENSING AND WIRELESS SENSOR NETWORKS**		**Credits**	04
Code	**CSEI 8203**	**Semester:** IInd	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	Y
Pre-requisites	Knowledge of Advanced Wireless Networks		**Contact Hours**	45
			Time	4 Hours
Objectives	The objective of this course is to impart comprehensive knowledge of the wireless networks needed for design and implementation of a typical IoT system. The course also aims at developing necessary skills required for efficient network infrastructure of an IoT.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

UNIT I – UBIQUITOUS SENSING **Architecture:** New Devices and Communications, Software Architectures **Wireless Standards & Protocols for Ubiquitous Networks:** Near field communication (NFC), Bluetooth Classic, Bluetooth Low Energy (BLE), WiFi, WiFi Direct **Integrating the Physical and The Virtual Worlds:** Sensing and Actuation, Awareness and Perception **Context Aware Computing:** Introduction, Issues and Challenges, Developing Context Aware Applications, System Architecture	12
UNIT II –INTRODUCTION TO WSN **WSN:** Coverage & Placement, Topology Management in Wireless Sensor Network, Mobile WSNs, Medium Access Control in Wireless Networks, Routing in WSNs, Enabling Technologies for WSNs	10

SECTION-B

UNIT III – ARCHITECTURE OF WSN **Single Node Architecture:** Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments	12

Network Architecture: Sensor Network Scenarios, Optimization Goals, Figures of Merit, Design Principles for WSNs, Service Interfaces of WSNs Gateway Concepts	
UNIT IV – CHALLENGES IN WSN **Data Dissemination and Gathering:** Routing Challenges in WSN, Flooding, Flat Based Routing, SAR, Directed Diffusion. **Hierarchical Routing:** LEACH, PEGASIS , Query Based Routing , Negotiation Based Routing **Geographical Based Routing:** Transport Layer, Protocol Design issues and Performance. Congestion and Flow Control, Security of Wireless Sensor Networks, Hardware Design of Sensor Node, Real Life Deployment of WSN	11

Suggested Books	1. Ubiquitous Computing Fundamentals, John Krumm, CRC Press, 2010 2. Wireless Sensor Networks Technology: Protocols, and Applications, KazemSohraby, Daniel Minoli, TaiebZnati, Wiley 3. Wireless Sensor Networks: From Theory to Applications, Ibrahiem M. M. El Emary, S. Ramakrishnan, 1st Edition, CRC Press. 4. Fundamentals of Wireless Sensor Networks Theory and Practice, WaltenegusDargie, Christian Poellabauer, Wiley.
COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Understand various concepts of ubiquitous sensing 2. Apply Wireless Sensor Networks Principles in IoT 3. Evaluate various protocols designed for WSN 4. Analyze the challenges in routing and data dissemination in WSN

Title	**Fog / Edge Computing**		**Credits**	04
Code	**CSEI 8204**	**Semester:** IInd	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	Y
Pre-requisites	Knowledge of Advanced Wireless Networks		**Contact Hours**	45
			Time	4 Hours
Objectives	This course gives an overview of Fog Computing and its architecture, challenges and applications in different context. The further objectives of this course is to make the student understand the architecture and its components and working of components and its performance, explore Fog on security, multimedia and smart data, and finally model the fog computing scenario.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

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SECTION-A	
INTRODUCTION TO FOG COMPUTING Fog Computing-Definition-Characteristics-Application Scenarios - Issues Fog Computing and Internet of Things-Pros and Cons-Myths of Fog Computing -Need and Reasons for Fog Computing Fog Computing and Edge Computing-IoT, FOG, Cloud- Benefits	10
ARCHITECTURE Working Procedure -Performance Evaluation Components- Software Systems – Architecture-Modelling and Simulation –Challenges FOG PROTOCOLS - Fog Protocol-Fog Kit- Proximity Detection Protocols- DDS/RTPS computing protocols	12
SECTION-B	
MANAGEMENT OF DATA AND SECURITY ANALYSIS Smart Management of Big Data-Smart Data-Structure of Smart Data- Smart Data Life Cycle-System Architecture-Multi-dimensional Payment Plan- Security and Privacy Issues-Multimedia Fog Computing-Architecture Deduplication-Hybrid Secure Deduplication-Security Challenges-Security Requirements	10
CASE STUDY Case Study: Wind Farm - Smart Traffic Light System, Wearable Sensing Devices, Wearable Event Device, Wearable System, Demonstrations, Post Application Example. Event Applications Example	13

Suggested Books

1. Ivan Stojmenovic, Sheng Wen ," The Fog Computing Paradigm: Scenarios and Security Issues" Proceedings of the 2014 Federated Conference on Computer Science and Information Systems.
2. Fog Computing: Helping the Internet of Things Realize its Potential Amir VahidDastjerdi and RajkumarBuyya, University of Melbourne.
3. Multi-Dimensional payment Plan in Fog Computing with Moral Hazar,YanruZhang,Nguyen H. Tran, DusitNiyato, and Zhu Han,IEEE,2016 .
4. FarhoudHosseinpour, JuhaPlosila,HannuTenhunen,"An Approach for Smart management of Big Data in the Fog ConputingContext",IEEE 8th International Conference on Cloud Computing Technology and Science,2016.
5. Hua-Jun Hong, Jo-Chi Chuang and Cheng-HsinHsu,"Animation Rendering on Multimedia Fog computing Platforms", IEEE 8th Intl. Conference on Cloud Computing Technology and Science,2016.
6. Dongyoung Koo, et al.,"A Hybrid deduplicaton for secure and Efficiet data Outsourcing n Fog Computing", IEEE 8th Intl. Conf. on Cloud Computing Technology and Science,2016.
7. Fog Computing: A Platform for Internet of Things and Analytics, FlavioBonomi, Rodolfo Milito, PreethiNatarajan and Jiang Zhu, Big Data and Internet of Things: A Roadmap for Smart Environments, Studies in Computational Intelligence 546, DOI: 10.1007/978-3-31905029-4_7, © Springer International Publishing Switzerland 2014.
8. Fog Computing and Its Role in the Internet of Things,FlavioBonomi, Rodolfo Milito, Jiang Zhu, SateeshAddepalli, MCC'12, August 17,

2012, Helsinki, Finland. Copyright 2012 ACM 978-1-4503-15197/12/08... $15.00.
9. A Survey of Fog Computing: Concepts, Applications and Issues,Shanhe Yi, Cheng Li, Qun Li, Mobidata'15, June 21, 2015, Hangzhou, China. Copyright c.
10. Security and Privacy Issues of Fog Computing: A Survey,Shanhe Yi, Zhengrui Qin, and Qun Li.
11. IEEE INTERNET OF THINGS JOURNAL, VOL. XX, NO. X, JUNE 2017 1 LoDPD: A Location Difference-based Proximity Detection Protocol for Fog Computing.
13. Fog Protocol and FogKit: A JSON-Based Protocol and Framework for Communication Between Bluetooth-Enabled Wearable Internet of Things Devices Spencer Lewson, by Spencer Lewson 2015.

COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Become familiar with the concepts of Fog. 2. Understand the architecture and its components and working of components and its performance. 3. Explore Fog on security, multimedia and smart data. 4. Model the fog computing scenario.

Title	**ENERGY HARVESTING TECHNOLOGIES AND POWER MANAGEMENT FOR IoT DEVICES**		**Credits**	04
Code	**CSEI 8205**	**Semester:** IInd	**L T P**	4 0 0
Max. Marks	**External:** 50	**Internal:** 50	**Elective**	Y
Pre-requisites	Knowledge of Advanced Wireless Networks		**Contact Hours**	45
			Time	4 Hours
Objectives	The objectives of the course are to learn the techniques in involved in Energy harvesting, to understand the various energy sources and energy harvesting based sensor networks, tolearn about the various Piezoelectric materials and Non-linear techniques, to understand the various Power sources for WSN and to learn about the applications of Energy harvesting systems.			
Note for Examiner	The question paper shall be of subject will be of 50 marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each of Section A and Section B and the candidate is required to attempt at least two questions from each of Section A and Section B.			

SECTION-A

ENERGY HARVESTING SYSTEMS Introduction – Energy sources – energy harvesting based sensor networks – photovoltaic cell technologies – generation of electric power in semiconductor PV cells – types	10
PIEZO-ELECTRIC ENERGY HARVESTING AND ELECTROMECHANICAL	

MODELING Piezoelectric materials – transducers – harvesters – micro generators – strategies for enhancing the performance of energy harvesters. Electromechanical modelling of Lumped parameter model and coupled distributed parameter models and closed-form solutions	12
SECTION-B	
ELECTROMAGNETIC ENERGY HARVESTING AND NON-LINEAR TECHNIQUES Basic principles – micro fabricated coils and magnetic materials – scaling – power maximizations – micro and macro scale implementations. Non-linear techniques – vibration control & steady state cases	10
ENERGY HARVESTING WIRELESS SENSORS Power sources for WSN – Power generation – conversion – examples – case studies. Harvesting microelectronic circuits – power conditioning and losses **SELECTED APPLICATIONS OF ENERGY HARVESTING SYSTEMS** Case studies for Implanted medical devices – Bio-MEMS based applications – harvesting for RF sensors and ID tags – powering wireless SHM sensor nodes	13
Suggested Books	1. Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva VeríssimoPaulino, "CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications", springer. 2. 2. Danick Briand, Eric Yeatman, Shad Roundy ,"Micro Energy Harvesting".
COURSE OUTCOMES	After the completion of this course, the students will be able to: 1. Understand the various energy sources and energy harvesting based sensor networks 2. Learn about the various Piezoelectric materials and Non-linear techniques 3. Understand the various Power sources for WSN 4. Learn about the applications of Energy harvesting systems.

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