DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

Evaluation Scheme & Syllabus

For

B.Tech. 4th Year

Computer Science and Engineering

(Internet of Things)

(Effective from the Session: 2023-24)

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

B.TECH 4th Year

COMPUTER SCIENCE AND ENGINEERING (INTERNET OF THINGS)

SEMESTER- VII

Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KHU701/KHU702	HSMC -1/ HSMC-2	3	0	0	30	20	50		100		150	3
2	Departmental Elective-IV	Departmental Elective-IV	3	0	0	30	20	50		100		150	3
3	Departmental Elective-V	Departmental Elective-V	3	0	0	30	20	50		100		150	3
4	KOE07X	Open Elective-II	3	0	0	30	20	50		100		150	3
5	KCS751A	Departmental Elective**	0	0	2				25		25	50	1
6	KCS752	Mini Project or Internship Assessment*	0	0	2				50			50	1
7	KCS753	Project	0	0	8				150			150	4
8		MOOCs (Essential for Hons. Degree)											
		Total	**12**	**0**	**12**							**850**	**18**

*The Mini Project or internship (4 - 6 weeks) conducted during summer break after VI semester and will be assessed during VII semester.

**Department may conduct one Lab of based on either Data Analytics for IOT or Mobile Application Development for IoT.

SEMESTER- VIII

Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KHU801/KHU802	HSMC-1/HSMC-2	3	0	0	30	20	50		100		150	3
2	KOE08X	Open Elective-III	3	0	0	30	20	50		100		150	3
3	KOE09X	Open Elective-IV	3	0	0	30	20	50		100		150	3
4	KCS851	Project	0	0	18				100		300	400	9
5		MOOCs (Essential for Hons. Degree)											
		Total	**9**	**0**	**18**							**850**	**18**

Departmental Elective-IV

1. KOT071 IoT Security
2. KCS072 Natural language processing
3. KAI073 Text Analytics and Natural Language Processing
4. KCS074 Cryptography and Network Security
5. KOT075 Real time Operating System
6. KOT076 Deep Learning
7. KOT077 Data Analytics for IoT

Departmental Elective-V

1. KOT078 Architecting Smart IoT Devices
2. KAI079 Distributed Computing System
3. KOT710 IoT System Architectures
4. KOT711 Operating Systems for IoT
5. KOT712 Mobile Application Development for IoT
6. KCS713 Cloud Computing
7. KCS714 Blockchain Architecture Design

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

B.TECH 4th Year

COMPUTER SCIENCE & ENGINEERING- INTERNET OF THINGS

KOT071	IOT Security	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course , the student will be able to	
CO 1	Identify the Components that forms part of IoT Architectur	
CO 2	Determine the most appropriate IoT Devices and Sensors based on Case Studies	
CO 3	Setup the connections between the Devices and Sensors	
CO 4	Evaluate the appropriate protocol for communication between IoT	
CO 5	Analyse the communication protocols for IoT	

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications. Security Architecture in the Internet of Things, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT. Vulnerabilities, Secrecy and Secret, Key Capacity, Authentication/Authorization for Smart Devices, Transport Encryption, Attack and Fault trees, These cure IoT system implementation lifecycle	**08**
II	Cryptographic primitives and its role in IoT, Encryption and Decryption, Hashes, Digital Signatures, Random number generation, Cipher suites, Key management fundamentals, Cryptographic controls built into IoT messaging and communication protocols, IoT Node Authentication	**08**
III	Identity lifecycle, Authentication credentials, IoT IAM infrastructure, Authorization with Publish/Subscribe schemes, Access control	**09**
IV	Privacy Preservation Data Dissemination, Privacy Preservation for IoT Used in Smart Building, Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles, Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing	**09**
V	Cloud services and IoT, Offerings related to IoT from cloud service providers, Cloud IoT security controls, An enterprise IoT cloud security architecture, New directions in cloud enabled IoT computing	**04**

Text books:

1. IoT Security by Madhusanka Liyanage, An Braeken, Pardeep Kumar, Mika Ylianttila
2.The IoT Hacker's Handbook: A Practical Guide to Hacking the Internet of Things by Aditya Gupta
3.Security challenges and approaches in internet of things , Muthucumaru Maheswaran, Salman Hashmi, and Sridipta Misra ,Springer International Publishing
4. The Internet of Things: Enabling technologies, platforms, and use cases , Anupama C. Raman and Pethuru Raj , CRC Press ,Taylor and Francis Group

KCS072	Natural Language Processing	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course , the student will be able :	
CO 1	To learn the fundamentals of natural language processing	K_1 , K_2
CO 2	To understand the use of CFG and PCFG in NLP	K_1 , K_2
CO 3	To understand the role of semantics of sentences and pragmatic	K_2
CO 4	To Introduce Speech Production And Related Parameters Of Speech.	K_1 , K_2
CO 5	To Show The Computation And Use Of Techniques Such As Short Time Fourier Transform, Linear Predictive Coefficients And Other Coefficients In The Analysis Of Speech.	K_3, K_4
	DETAILED SYLLABUS	**3-0-0**

Unit	Topic	Proposed Lecture
I	**INTRODUCTION:** Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance **WORD LEVEL ANALYSIS :** Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.	**08**
II	**SYNTACTIC ANALYSIS:** Context Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.	**08**
III	SEMANTICS AND PRAGMATICS: Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.	**08**
IV	**BASIC CONCEPTS of Speech Processing :** Speech Fundamentals: Articulatory Phonetics – Production And Classification Of Speech Sounds; Acoustic Phonetics – Acoustics Of Speech Production; Review Of Digital Signal Processing Concepts; Short-Time Fourier Transform, Filter-Bank And LPC Methods.	**08**
V	**SPEECH-ANALYSIS**: Features, Feature Extraction And Pattern Comparison Techniques: Speech Distortion Measures– Mathematical And Perceptual – Log–Spectral Distance, Cepstral Distances,	

	Weighted Cepstral Distances And Filtering, Likelihood Distortions, Spectral Distortion Using A Warped Frequency Scale, LPC, PLP And MFCC Coefficients, Time Alignment And Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths. **SPEECH MODELING** : Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-Estimation, Implementation Issues.	**08**

Text books:

1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
3. Lawrence Rabiner And Biing-Hwang Juang, "Fundamentals Of Speech Recognition", Pearson Education, 2003.
4. Daniel Jurafsky And James H Martin, "Speech And Language Processing – An Introduction To Natural Language Processing, Computational Linguistics, And Speech Recognition", Pearson Education, 2002.
5. Frederick Jelinek, "Statistical Methods Of Speech Recognition", MIT Press, 1997.
6. 1. Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.
7. Richard M Reese, —Natural Language Processing with Java, OReilly Media, 2015.
8. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
9. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.

KAI073	Text Analytics and Natural Language Processing	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to understand		
CO 1	To understand the fundamentals of text analytics and natural language processing	K2
CO 2	To learn understand the use of Natural Language Processing	K2, K3
CO 3	To understand the role of semantics of sentences and pragmatic	K3 , K4
CO 4	To Introduce Speech Production And Related Parameters Of Speech.	K2 , K3
CO 5	To Show The Computation And Use Of Techniques Such As Short Time Fourier Transform, Linear Predictive Coefficients And Other Coefficients In The Analysis Of Speech.	K2 , K4

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	Introduction to natural language processing (NLP) and text analytics. Linguistics Essentials. Foundations of text processing: tokenization, stemming, stopwords, lemmatization, part-of-speech tagging, syntactic parsing.	**08**
II	WORD LEVEL ANALYSIS : Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.	**08**
III	SEMANTICS AND PRAGMATICS: Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.	**08**
IV	**BASIC CONCEPTS of Speech Processing :** Speech Fundamentals: Articulatory Phonetics – Production And Classification Of Speech Sounds; Acoustic Phonetics – Acoustics Of Speech Production; Review Of Digital Signal Processing Concepts; Short-Time Fourier Transform, Filter-Bank And LPC Methods.	**08**
V	**SPEECH-ANALYSIS**: Features, Feature Extraction And Pattern Comparison Techniques: Speech Distortion Measures– Mathematical And Perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances And Filtering, Likelihood Distortions, Spectral Distortion Using A Warped Frequency Scale, LPC, PLP And MFCC Coefficients, Time Alignment And Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths. **SPEECH MODELING** : Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-Estimation, Implementation Issues.	**08**

Text books:

1. Daniel Jurafsky, James H. Martin―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, ―Natural Language Processing with Python, First Edition,

OReilly Media, 2009.

3. Lawrence Rabiner And Biing-Hwang Juang, “Fundamentals Of Speech Recognition”, Pearson Education, 2003.
4. Daniel Jurafsky And James H Martin, “Speech And Language Processing – An Introduction To Natural Language Processing, Computational Linguistics, And Speech Recognition”, Pearson Education, 2002.
5. Frederick Jelinek, “Statistical Methods Of Speech Recognition”, MIT Press, 1997.
6. Breck Baldwin, ―Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.
7. Richard M Reese, ―Natural Language Processing with Java, OReilly Media, 2015.

KCS074	Cryptography & Network Security	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course , the student will be able to understand	
CO 1	Classify the symmetric encryption techniques and Illustrate various Public key cryptographic techniques.	K2 , K3
CO 2	Understand security protocols for protecting data on networks and be able to digitally sign emails and files.	K1 , K2
CO 3	Understand vulnerability assessments and the weakness of using passwords for authentication	K4
CO 4	Be able to perform simple vulnerability assessments and password audits	K3
CO 5	Summarize the intrusion detection and its solutions to overcome the attacks.	K2
	DETAILED SYLLABUS	**3-0-0**

Unit	Topic	Proposed Lecture
I	Introduction to security attacks, services and mechanism, Classical encryption techniques-substitution ciphers and transposition ciphers, cryptanalysis, steganography, Stream and block ciphers. Modern Block Ciphers: Block ciphers principles, Shannon's theory of confusion and diffusion, fiestal structure, Data encryption standard(DES), Strength of DES, Idea of differential cryptanalysis, block cipher modes of operations, Triple DES	**08**
II	Introduction to group, field, finite field of the form GF(p), modular arithmetic, prime and relative prime numbers, Extended Euclidean Algorithm, Advanced Encryption Standard (AES) encryption and decryptionFermat's and Euler's theorem, Primarily testing, Chinese Remainder theorem, Discrete Logarithmic Problem,Principals of public key crypto systems, RSA algorithm, security of RSA	**08**
III	Message Authentication Codes: Authentication requirements, authentication functions, message authentication code, hash functions, birthday attacks, security of hash functions, Secure hash algorithm (SHA) Digital Signatures: Digital Signatures, Elgamal Digital Signature Techniques, Digital signature standards (DSS), proof of digital signature algorithm,	**08**
IV	Key Management and distribution: Symmetric key distribution, Diffie-Hellman Key Exchange, Public key distribution, X.509 Certificates, Public key Infrastructure. Authentication Applications: Kerberos, Electronic mail security: pretty good privacy (PGP), S/MIME.	**08**
V	IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. Introduction to Secure Socket Layer, Secure electronic, transaction (SET) System Security: Introductory idea of Intrusion, Intrusion detection, Viruses and related threats, firewalls	**08**

Text books: 1. William Stallings, "Cryptography and Network Security: Principals and Practice", Pearson Education. 2. Behrouz A. Frouzan: Cryptography and Network Security, Tata McGraw Hill . 3. C K Shyamala, N Harini, Dr. T.R.Padmnabhan Cryptography and Security ,Wiley

4. Bruce Schiener, "Applied Cryptography". John Wiley & Sons

5. Bernard Menezes," Network Security and Cryptography", Cengage Learning.

6. AtulKahate, "Cryptography and Network Security", Tata McGraw Hill

KOT075	Real Time Operating System	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course , the student will be able to understand	
CO 1	Will be able to control access to a computer and the files that may be shared	K1 , K2
CO 2	Demonstrate the knowledge of the components of computers and their respective roles in computing.	K3
CO 3	Ability to recognize and resolve user problems with standard operating environments.	K1 , K2
CO 4	Gain practical knowledge of how programming languages, operating systems, and architectures interact and how to use each effectively.	K3

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	Introduction to Real time systems:-Need for RTOS, Structure of RTOS, Classification of Real time system, Difference between GPOS and RTOS:- Real Time, Issues in real time operating system. Performance measures for real time system:- Properties, traditional performance measures, cost functions, hard deadlines, and Estimating program run times. Introduction to LINUX/ UNIX OS.	**08**
II	Performance metrics and scheduling Algorithms: - Performance Metrics of RTOS, Task Specifications, Task state. Real Time Scheduling algorithms:- Cyclic executive, Rate monotonic, IRIS and Least laxity scheduling, Schedulability Analysis.	**08**
III	Features of Real Time Operating System:- Messages, queues, mailboxes, pipes, timer function events, memory management. Interrupt basic system design using an RT (OS design principles, interrupt routines, task structures and priority.) Current research in RTOS.	**08**
IV	Real Time Databases:-Real time v/s general purpose databases, main memory databases, transaction priorities, transaction aborts. Concurrency control issues:- pessimistic concurrency control and optimistic concurrency control, Disk scheduling algorithms.	**08**
V	Fault Tolerance Techniques:-Causes of failure, Fault types, Fault detection, Fault and error containment. Redundancy:- hardware redundancy, software redundancy, Time redundancy, information redundancy. Data diversity, Integrated failure handling.	**08**

Text books:

1. David E. Simon, "An Embedded Software Primer", Pearson Education Asia Publication, ISBN: 9780201615692
2. C.M. Krishna and Kang G. Shin," Real Time Systems", TMH Publication, ISBN : 9780070701151
3. Raj kamal ," Embedded system: Architecture Programming and Design", TMH Publication, ISBN : 9780070667648
4. Mazidi," PIC Microcontroller and Embedded Systems" , Pearson, ISBN:9788131716755

KOT076	Deep Learning	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course , the student will be able :	
CO 1	To present the mathematical, statistical and computational challenges of building neural networks	K_1 , K_2
CO 2	To study the concepts of deep learning	K_1 , K_2
CO 3	To introduce dimensionality reduction techniques	K_2
CO 4	To enable the students to know deep learning techniques to support real-time applications	K_2 , K_3
CO 5	To examine the case studies of deep learning techniques	K_3, K_6

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	INTRODUCTION : Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression)- Intro to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates	**08**
II	DEEP NETWORKS : History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks-Convolutional Networks- Generative Adversarial Networks (GAN), Semi-supervised Learning	**08**
III	DIMENTIONALITY REDUCTION 9 Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures – AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyperparameter optimization	**08**
IV	OPTIMIZATION AND GENERALIZATION : Optimization in deep learning– Non-convex optimization for deep networks- Stochastic Optimization Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning - Computational & Artificial Neuroscience	**08**
V	CASE STUDY AND APPLICATIONS : Imagenet- Detection-Audio WaveNet-Natural Language Processing Word2Vec - Joint Detection-Bioinformatics- Face Recognition- Scene Understanding- Gathering Image Captions	**08**

Text books:

1. Cosma Rohilla Shalizi, Advanced Data Analysis from an Elementary Point of View, 2015.

2. Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.

3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.

4. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

KOT077	DATA ANALYTICS FOR IOT	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to understand		
CO 1	Understand the fundamentals of IoT Analytics and Challenges	K_2
CO 2	Understand and analyze IoT Devices and Networking Protocols	K_2
CO 3	To Analyze the IoT data to infer the protocol and device characteristics	K_2, K_3
CO 4	Apply IoT Analytics for the Cloud	K_2 ,K_4
CO 5	Understand exploring and visualizing data	K_2
DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**Defining IoT Analytics and Challenges:** Introduction to IoT, applications, IoT architectures, introduction to analytics, IoT analytics challenges	**08**
II	**IoT Devices and Networking Protocols**: IoT devices, Networking basics, IoT networking connectivity protocols, IoT networking data messaging protocols, Analyzing data to infer protocol and device characteristics.	**08**
III	**IoT Analytics for the Cloud:** Introduction to elastic analytics, Decouple key components, Cloud security and analytics, Designing data processing for analytics, Applying big data technology to storage.	**08**
IV	**Exploring IoT Data:** Exploring and visualizing data, Techniques to understand data quality, Basic time series analysis, Statistical analysis.	**08**
V	**Data Science for IoT Analytics:** Introduction to Machine Learning, Feature engineering with IoT data, Validation methods, Understanding the bias–variance tradeoff, Use cases for deep learning with IoT data.	**08**

Text books:

1. Minteer, Andrew, Analytics for the Internet of Things (IoT), Packt Publishing Ltd. July 2017, ISBN 9781787120730.
2. Kai Hwang, Min Chen, Big-Data Analytics for Cloud, IoT and Cognitive Computing, Wiley.
3. Hwaiyu Geng, Internet of Things and Data Analytics Handbook, Wiley.
4. John Soldatos, Building Blocks for IoT Analytics Internet-of-Things Analytics, River Publishers Gerardus Blokdyk.

KOT078	Architecting Smart IoT Devices	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able :		
CO 1	Understand how the IoT is different from traditional systems.	K_1 , K_2
CO 2	Demonstrate the revolution of internet in mobile and cloud.	K_1 , K_2
CO 3	Explore various tools and programming paradigms for IoT applications	K_2
CO 4	Develop an IoT prototype for real time scenario.	K_2 , K_3
CO 5	Understand the building blocks of IoT and security aspects.	K_3

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	INTRODUCTION: From Nature to Nature Computing , Philosophy , Three Branches: A Brief Design Principles of IoT: Design principles of connected devices, data acquiring organizing and analytics in IoT, system architecture of loT.	**08**
II	Prototyping the Embedded Devices for IoT: System hardware and prototyping, sensors and actuators for IoT, Radio module and wireless sensor network, gateways internet and web, software components	**08**
III	Embedded Programming for IoT: Programming connected devices, C and python for IoT, Case study: Temperature controller, Smart irrigation system.	**08**
IV	Embedded RTOS: Program structure and real time, multitasking and scheduling, RTOS services, signals, semaphores, Nucleus SE, application timers, interrupts in nucleus ES, Nucleus SE initialization and starn1p.	**08**
V	**Tools for IoT:** Introduction, chef puppet, NETCONF - YANG case studies. **loT physical Devices:** Basic building blocks of an IoT device and endpoints, family of ploT devices, pcDuino, Beagle bone black, cubie board, domain specific IoTs	**08**

Text books:

1. Raj Kamal, Internet of Things, Architecture and Design Principles, lst edition, McGraw Hill Education, May 2017.

2. Arsheep Baga and Vijay Madisetti, Internet of Things: A Hands-On Approach, 1st Edition, Universities press, 2015.

3. David Etter, IoT (Internet of Things Programming: A simple and fast way of Learning IoT, Kindle edition 2016.

4. Fei HU, Security and Privacy in Internet of Things (loTs): Models, Algorithms, and Implementations, 1st Edition, CRC Press, 2016. 3. Colin Walls, Embe

KAI079	Distributed Computing System	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able :		
CO 1	Define the characterization of Distributed Systems, Theoretical Foundation for Distributed System and Concepts in Message Passing Systems.	K1 , K2
CO 2	Explain the Distributed Mutual Exclusion and Distributed Deadlock Detection.	K3
CO 3	Apply the Agreement Protocols and Distributed Resource Management.	K4
CO 4	Analyze the Failure Recovery in Distributed Systems and Fault Tolerance.	K2
CO 5	Evaluate the Transactions and Concurrency Control, Distributed Transactions and Replication	K1

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**Characterization of Distributed Systems**: Introduction, Examples of distributed Systems, Resource sharing and the Web Challenges. Architectural models, Fundamental Models. Theoretical Foundation for Distributed System: Limitation of Distributed system, absence of global clock, shared memory, Logical clocks ,Lamport's & vectors logical clocks. Concepts in Message Passing Systems: causal order, total order, total causal order, Techniques for Message Ordering, Causal ordering of messages, global state, termination detection.	**08**
II	**Distributed Mutual Exclusion:** Classification of distributed mutual exclusion, requirement of mutual exclusion theorem, Token based and non token based algorithms, performance metric for distributed mutual exclusion algorithms. Distributed Deadlock Detection: system model, resource Vs communication deadlocks, deadlock prevention, avoidance, detection & resolution, centralized dead lock detection, distributed dead lock detection, path pushing algorithms, edge chasing algorithms.	**08**
III	**Agreement Protocols:** Introduction, System models, classification of Agreement Problem, Byzantine agreement problem, Consensus problem, Interactive consistency Problem, Solution to Byzantine Agreement problem, Application of Agreement problem, Atomic Commit in Distributed Database system. Distributed Resource Management: Issues in distributed File Systems, Mechanism for building distributed file systems, Design issues in Distributed Shared Memory, Algorithm for Implementation of Distributed Shared Memory.	**08**
IV	Failure Recovery in Distributed Systems: Concepts in Backward and Forward recovery, Recovery in Concurrent systems, Obtaining consistent Checkpoints, Recovery in Distributed Database Systems. Fault Tolerance: Issues in Fault Tolerance, Commit Protocols, Voting protocols, Dynamic voting protocols	**08**
V	**Transactions and Concurrency Control**: Transactions, Nested transactions, Locks, Optimistic Concurrency control, Timestamp ordering, Comparison of methods for concurrency control. Distributed Transactions: Flat and nested distributed transactions, Atomic Commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery. Replication: System model and group communication, Fault - tolerant services, highly available services, Transactions with replicated data.	**08**

Text books:

1. Singhal&Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill

2. Ramakrishna,Gehrke," Database Management Systems", McGraw Hill

3. Vijay K.Garg Elements of Distributed Compuitng , Wiley

4. Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", Pearson Education 5. Tenanuanbaum, Steen," Distributed Systems", PHI

KOT710	IoT System Architectures	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to understand		
CO 1	Understand IoT applications and IoT Architectures.	K_1 , K_2
CO 2	Learn about IoT devices and event driven analysis	K_2
CO 3	Understand and analyze IIoT	K_2
CO 4	Understand safety and security testing of IoT systems	K_3

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**The IoT Landscape:** What Is IoT? Applications, Architectures, Wireless Networks, Devices, Security and Privacy, Event-Driven Systems. IoT System Architectures: Introduction, Protocols Concepts, IoTOriented Protocols, Databases, Time Bases, Security.	**08**
II	**IoT Devices & Event-Driven System Analysis**: The IoT Device Design Space, Cost of Ownership and Power Consumption, Cost per Transistor and Chip Size, Duty Cycle and Power Consumption, Platform Design. Event-Driven System Analysis: Introduction, Motivating Example, IoT Network Model, Events, Networks, Devices and Hubs, Single-Hub Networks, Multi-hub Networks, Network Models and Physical Networks, IoT Event Analysis, Event Populations, Stochastic Event Populations, Environmental Interaction Modeling, Event Transport and Migration.	**08**
III	Industrial Internet of Things: Introduction, Industry 4.0, Industrial Internet of Things (IIoT), IIoT Architecture, Basic Technologies, Applications and Challenges	**08**
IV	**Security and Safety:** Introduction, Systems Security, Network Security, Generic Application Security, Application Process Security and Safety, Reliable-and-Secure-by-Design IoT Applications, Run-Time Monitoring, The ARMET Approach, Privacy and Dependability.	**08**
V	**Security Testing IoT Systems:** Introduction, Fuzz Testing for Security, White-Box Fuzzing, Black-Box Fuzzing, Fuzzing Industrial Control Network Systems, Fuzzing Modbus, The Modbus Protocol, Modbus/TCP Fuzzer	**08**

Text books:

1.Dimitrios Serpanos, Marilyn Wol, Internet-of-Things (IoT) Systems Architectures, Algorithms, Methodologies, ISBN 978-3-319-69714-7.

2. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.

3. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit 2).

4. "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.

5. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.

KOT711	Operating Systems for IoT	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course, the student will be able to understand	
CO 1	Understanding Free RTOS Techniques of Cube Software Tool.	K1
CO 2	Knowledge on Micro Python Features.	K1
CO 3	Understand and Acquire Knowledge on Micropython Hardware.	K4
CO 4	Apply Basic Data Structures and Functions of Micro Python.	K1, K2
CO 5	Knowledge on Windows 10 For Iot Operating System.	K2

DETAILED SYLLABUS		**3-1-0**
Unit	**Topic**	**Proposed Lecture**
I	**Processes, Tools, Toolchains and Hardware:** Design to Code -A Practical Approach, The Stm32cube Software Tool, The Practical Tool Set, The Stm32 Graphical Tool- Stm32cube Mx Details, The Stm32cubehal, Free RTOS Configuration in A Cube Project, The Stm32cube Cubeide Development Platform.	**08**
II	**Introducing Micropython:** Micropython Features, Micropython Limitations, What Does Micropython Run On?, Experimenting With Python On Your Pc, How Micropython Works, Off And Running With Micropython.	**08**
III	**Micropython Hardware:** Getting Started with Micropython Boards, Micropython-Ready Boards, Networking with The Pyboard, Getting Started with Wipy, Connecting to Your Wifi Network, Micropython-Compatible Boards, Other Boards, Breakout Boards and Add-Ons.	**08**
IV	**How To Program In Micropython:** Basic Concepts, Basic Data Structures, Statements, Modularization; Modules, Functions, And Classes, Learning Python By Example.	**08**
V	**Introducing the Windows 10 Iot Core:** Windows 10 Iot Core Features, Things You'll Need, Getting Started with Windows 10 Iot Core.	**08**

Text books:

1. Jim Cooling, Real-Time Operating Systems Book 2 - The Practice: Using Stm Cube, Freertos And the Stm32 Discovery Board (Engineering of Real-Time Embedded Systems) Jim Cooling, Isbn-10: 1973409933, Isbn-13: 978-1973409939.
2. Charles Bell, Micropython For the Internet of Things, A Beginner's Guide to Programming with Python on Microcontrollers, Apress, Isbn-13 (Pbk): 978-1-4842-3122-7, Isbn-13 (Electronic): 978-1-4842-3123-4.
3. Charles Bell Windows 10 For the Internet of Things 1st Edition, Apress, Isbn-13 (Pbk): 978-1- 4842-2107-5 Isbn-13, (Electronic): 978-1-4842-2108-2.
4. Gerardus Blokdyk, IOT Operating Systems A Complete Guide, Isbn-10: 0655416471, ISBN13: 978-0655416470.
5. Klaus Elk, Embedded Software for The Iot, De Gruyter, Isbn: 9781547401048.

KOT712	Mobile Application Development for IoT	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to understand		
CO 1	Demonstrate basic concepts, principles and challenges in IoT.	K1,K2
CO 2	Understand significance of IoT programming fundamentals	K2
CO 3	Understand and analyze IoT programming applications.	K2
CO 4	Develops IoT applications using standardized hardware.	K2
CP 5	Discuss concepts of IoT Advance Wireless Interfaces and IoT Production System.	K_2

DETAILED SYLLABUS		**3-1-0**
Unit	**Topic**	**Proposed Lecture**
I	**IoT Product Conceptualization:** IoT Product Development Lifecycle, IoT Product Conceptualizations IoT Programming Fundamentals: Getting Started, IoT Programming setup for LED flashing, Program to display message on screen, Program to read LDR level and display on screen, Android APK to perform read write operation, Particle android APK to control LED intensity, LED switching with HTML interface, Cloud based motion detection, Displaying temperature sensor data on terminal, Publishing sensor values on the cloud, Performing computation on sensor values.	**08**
II	**IoT Programming Applications:** Gas level detection using MQ2 sensor, Blink Android Application for controlling LED from mobile, Integration of Temperature and Gas Sensor with Blynk Mobile Application, Printing real-time Date and Time values on serial terminal, Display temperature value on serial terminal, Display temperature values on 16*2 LCD display Interfacing: Interfacing of Nokia 5110 display, display image on Nokia 5110, Particle Electron displaying battery charging level status, GPS tracking device interface to get coordinates.	**08**
III	**IoT Product Hardware Development:** Product realization, Connection diagram of IoT product, Engineering board development, Product board customization and optimization, Flowchart of IoT warehouse monitoring system, Wireless communication between the multiple kits, Particle cloud IDE.	**08**
IV	**IoT Advance Wireless Interfaces:** Bluetooth communication between master and slave module, Data visualization on ThingSpeak cloud using webhook services, Storing data into google excel sheet and sending the sheets to emails.	**08**
V	**IoT Production System:** IoT Warehouse Monitoring System, IoT Product Packaging, Future of IoT Product Development.	**08**

Text books:

1. IoT Product Development with Programming: Stepwise programming approach with Particle Development board Kindle Edition by Mahesh Jadhav and Tejas Sarang Patil.
2. Kale, Vivek. Parallel Computing Architectures and APIs: IoT Big Data Stream Processing 1st edition, CRC Press, 2019.
3. IoT Product Development with Programming: Stepwise programming approach with Particle Development board Kindle Edition by Mahesh Jadhav and Tejas Sarang Patil.

KCS713	Cloud Computing	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to understand		
CO 1	Describe architecture and underlying principles of cloud computing.	K_3
CO 2	Explain need, types and tools of Virtualization for cloud.	K_3, K_4
CO 3	Describe Services Oriented Architecture and various types of cloud services.	K_2, K_3
CO 4	Explain Inter cloud resources management cloud storage services and their providers Assess security services and standards for cloud computing.	K_2, K_4
CO 5	Analyze advanced cloud technologies.	K_3, K_6

DETAILED SYLLABUS		**3-1-0**
Unit	**Topic**	**Proposed Lecture**
I	**Introduction To Cloud Computing:** Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning.	**08**
II	**Cloud Enabling Technologies Service Oriented Architecture:** REST and Systems of Systems – Web Services – Publish, Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices –Virtualization Support and Disaster Recovery.	**08**
III	**Cloud Architecture, Services And Storage:** Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds – laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.	**08**
IV	**Resource Management And Security In Cloud:** Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.	**08**
V	**Cloud Technologies And Advancements Hadoop:** MapReduce – Virtual Box — Google App Engine – Programming Environment for Google App Engine — Open Stack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation.	**08**

Text books:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, ―Cloud Computing: Implementation, Management and Security, CRC Press, 2017.
3. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, ―Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009.

KCS714	Block chain Architecture Design	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course , the student will be able to	
CO 1	Describe the basic understanding of Blockchain architecture along with its primitive.	K_1, K_2
CO 2	Explain the requirements for basic protocol along with scalability aspects.	K_2, K_3
CO 3	Design and deploy the consensus process using frontend and backend.	K_3, K_4
CO 4	Apply Blockchain techniques for different use cases like Finance, Trade/Supply and Government activities.	K_4, K_5

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**Introduction to Blockchain**: Digital Money to Distributed Ledgers , Design Primitives: Protocols, Security, Consensus, Permissions, Privacy. Blockchain Architecture and Design: Basic crypto primitives: Hash, Signature,) Hashchain to Blockchain, Basic consensus mechanisms	**08**
II	**Consensus:** Requirements for the consensus protocols, Proof of Work (PoW), Scalability aspects of Blockchain consensus protocols Permissioned Blockchains:Design goals, Consensus protocols for Permissioned Blockchains	**08**
III	**Hyperledger Fabric (A):** Decomposing the consensus process , Hyperledger fabric components, Chaincode Design and Implementation **Hyperledger Fabric (B):** Beyond Chaincode: fabric SDK and Front End (b) Hyperledger composer tool	**08**
IV	**Use case 1 :** Blockchain in Financial Software and Systems (FSS): (i) Settlements, (ii) KYC, (iii) Capital markets, (iv) Insurance **Use case 2:** Blockchain in trade/supply chain: (i) Provenance of goods, visibility, trade/supply chain finance, invoice management discounting, etc	**08**
V	**Use case 3**: Blockchain for Government: (i) Digital identity, land records and other kinds of record keeping between government entities, (ii) public distribution system social welfare systems Blockchain Cryptography, Privacy and Security on Blockchain	**08**

Text books:

1. Mstering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos
2. Blockchain by Melanie Swa, O'Reilly
3. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
4. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits - https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

KCS354/KCS554/KCS752	Mini Project or Internship Assessment	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to understand		
CO 1	Developing a technical artifact requiring new technical skills and effectively utilizing a new software tool to complete a task	K_4 , K_5
CO 2	Writing requirements documentation, Selecting appropriate technologies, identifying and creating appropriate test cases for systems.	K_5 , K_6
CO 3	Demonstrating understanding of professional customs & practices and working with professional standards.	K_4 , K_5
CO 4	Improving problem-solving, critical thinking skills and report writing.	K_4 , K_5
CO 5	Learning professional skills like exercising leadership, behaving professionally, behaving ethically, listening effectively, participating as a member of a team, developing appropriate workplace attitudes.	K_2, K_4

KCS753/ KCS 851	Project	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to understand		
CO 1	Analyze and understand the real life problem and apply their knowledge to get programming solution.	K_4 , K_5
CO 2	Engage in the creative design process through the integration and application of diverse technical knowledge and expertise to meet customer needs and address social issues.	K_4 , K_5
CO 3	Use the various tools and techniques, coding practices for developing real life solution to the problem.	K_5 , K_6
CO 4	Find out the errors in software solutions and establishing the process to design maintainable software applications	K_4 , K_5
CO 5	Write the report about what they are doing in project and learning the team working skills	K_5, K_6