Course Code: CSE 412	CIE Marks: 60
Course Title: Big Data and IoT	SEE Marks: 40
Credits: 1	

Course Content (from syllabus):

Introduction to Big Data, Small Data and Big Data, How Big Data Comes, Types of Big Data, Big Data Characteristics, Big Data Analytics, Big Data Applications Domains, Hadoop, Hadoop Distributed File Systems, Map Reduce, Yet Another Resource Negotiator, Hadoop Cluster and Ecosystem, Apache Sqoop, Apache Hive, Apache Pig, Introduction to IoT, IoT Protocols, Communication Models in IoT: Request & Response Model, Publish-Subscribe Model(Pub-Sub), Push-Pull Model, Exclusive Pair Model, IoT advantages and Disadvantages, Machine to Machine Communication, Software Defined Networking, Network Function Virtualization, Different Types of IoT Level (Level 1 to Level 6).

Course Description/Rationale:

Big Data is the hot new buzzword in IT circles. The proliferation of digital technologies with digital storage and recording media has created massive amounts of diverse data, which can be used for marketing and many other purposes. The concept of Big Data refers to massive and often unstructured data, on which the processing capabilities of traditional data management tools result to be inadequate. Big Data can take up terabytes and petabytes of storage space in diverse formats including text, video, sound, images, and more.

The course gives an overview of the Big Data phenomenon, focusing then on extracting value from the Big Data using predictive analytics techniques, the main big data tools (Hadoop) focusing on its basic components, the concept of IoT, M2M and IoT communication protocols.

Course Objective

To provide a solid conceptual understanding of the fundamentals of Big Data and IoT.
More specifically,

- To learn the basic concepts of Big Data and IoT.
- To learn the architecture of Hadoop Cluster and Ecosystem.
- To learn distributed data storage and processing systems.
- To learn IoT Levels.
- To learn the concepts of Communication Protocols of IoT.

- To learn Communication Models of IoTs.
- To learn the fundamental tools used in Big Data.

Course Learning Outcome (CLO): (at the end of the course, students will be able to do:)

CLO1	**Interpret** the components, tools, and techniques of Big Data.
CLO2	**Classify** the Hadoop model and identify their differences in implementation.
CLO3	**Explain** how information can be sent via IoT communication protocols and Models.
CLO4	**Determine** the various IoT levels and their applications and Fields in development sectors.

Content of the course:

SL	Course Content (as summary)	Hrs	CLO's
1	Core concepts of big data and big data analytics, including evolution of big data, 5'Vs of big data, life cycle and types of big data analytics.	4	CLO-1
2	Basic components of Hadoop with a special focus on HDFS, MapReduce Approach and can describe the need for YARN including Yarn Components, Architecture and Working flow.	5	CLO-2
3	The services of Hadoop ecosystem components such as Apache Sqoop, Apache Flume, Apache Pig & Hive and can distinguish among their functionalities.	3	CLO-1
4	Concept of IoT, elements, characteristics of an IoT ecosystem, IoT Levels and Templates, the concept of M2M, difference between IoT and M2M, SDN, NFV for IoT, M2M Value Chains, IoT Value Chains and being able to demonstrate various IoT communication protocols.	4	CLO-3, CLO-4

Mapping of Course Learning Outcomes to Program Learning Outcomes

	PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11	PLO-12
CLO-1					✓							
CLO-2		✓										

CLO-3				✓							
CLO-4	✓										

Mapping Course Learning Outcome (CLOs) with the Teaching-Learning and Assessment Strategy:

CLO's	Teaching Learning Strategy [course teacher will decide based on the type of the contents]	Assessment Strategy	Corresponding PLO number	Domain Level/ Learning Taxonomy
CLO-1	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	Class Test/Assignment/ Midterm examination	PLO-5	L2
CLO-2	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	Class Test/Assignment/ Midterm examination	PLO-2	L2, L4
CLO-3	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	Class Test/Assignment/ Final examination	PLO-4	L2, L5
CLO-4	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	Class Test/Assignment/ Final examination	PLO-1	L5

Course Delivery Plan/Lesson Delivery Plan:

Week/Lesson (hour)	Discussion Topic and Book Reference	Student Activities during Online and Onsite [course teacher will decide based on the type of the contents]	Mapping with CLO and PLO	Assessment Plan
Week-1 Lesson 1 [1 Hours]	**Lesson 1:** What is big data How is big data different from traditional data sources? / Small data vs Big data Attributes of big data	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	CLO-1, PLO-5	Class Test,

				Assignment, Midterm
Week-2 Lesson 1 [1 Hours]	Lesson 1: Why big data important Use / Applications of big data Key Computing Resources for Big Data. Why big data analytics	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	CLO-2 PLO-2	Class Test, Assignment, Midterm
Week-3 Lesson 1 [1 Hours]	**Lesson 1:** What is big data analytics Life cycle of big data analytics Types of big data analytics	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.		Class Test, Assignment, Midterm
Week-4 Lesson 1 [1 Hours]	**Lesson 1:** Tools used in big data analytics Big data application domains	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.		Class Test, Assignment, Midterm
Week-5 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Why Hadoop comes (Problems regarding RDBMS and DataWarehouse) What is Hadoop History of Hadoop Examples of commercial distribution company for Hadoop	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	CLO-1 CLO-3 PLO-5 PLO-4	Class Test, Assignment, Midterm
Week-6 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Basic Introduction to Hadoop components Introduction to Masternode, Slavenode & Self healing	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.		Class Test, Assignment, Midterm
Week-7 Lesson 1 & 2 [3 Hours]	**Lesson 1:** What is DFS and HDFS File Block and Replication Rack HDFS Architecture HDFS File Read Operation	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	CLO-1	Class Test, Assignment, Midterm

Week	Content	Teaching Strategy	CLO/PLO	Assessment Strategy
	HDFS Write Read Operation Rack Awareness		CLO-4 PLO-5 PLO-1	
Week-8 Lesson 1 & 2 [3 Hours]	**Lesson 1:** What is Hadoop MapReduce MapReduce in Nutshell Advantages of MapReduce Hadoop MapReduce Approach with an example Hadoop 1.1	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	CLO-3 CLO-4	
Week-9 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Limitations of Hadoop 1.1 Need for yarn Hadoop 2.0 Hadoop MapReduce Yarn Components Yarn Architecture Yarn Working flow	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	PLO-4 PLO-1	Class Test, Assignment, Final Exam
Week-10 Lesson 1 & 2 [3 Hours]	**Lesson 1:** What is Hadoop Cluster Hadoop Cluster Architecture Size of Hadoop Architecture Single Node and Muti-Node Cluster [Textbook: Chapter-6, Page (175-179)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.		Class Test, Assignment, Final Exam
Week-11 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Communication Protocol in Hadoop Cluster Benefits of Hadoop Cluster Challenges of Hadoop Cluster Hadoop Ecosystem: [Textbook: Chapter-10, Page (264-282)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.		Class Test, Assignment, Final Exam
Week-12	**Lesson 1:** Concept, Apache sqoop,	Brainstorming sessions, Classroom discussion,		Class Test, Assignment,

Lesson 1 & 2 [3 Hours]	Apache flume, Apache pig, Apache hive. [Textbook: Chapter-12, Page (325-334)]	Voice over PPT, Lecture video, Lecture note, Open discussion.		Final Exam
Week-13 Lesson 1 & 2 [3 Hours]	**Lesson 1:** What is IoT and why is it important? Elements of an IoT ecosystem and Characteristics of IoT, Infuence of IOT in 4.0 IR, Sensors, Actuators, Physical Design of IoT Embedded Systems. [Textbook: Chapter-12, Page (334-341)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	CLO-4 PLO-1	Class Test, Assignment, Final Exam
Week-14 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Lesson1:IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies –WSN, Cloud Computing, Home automation, Unified Data Standards –Protocols – IEEE802.15.4– BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer– Security,	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.		Class Test, Assignment, Final Exam
Week-15 Lesson 1 & 2 [3 Hours]	**Lesson 1:** IoT Levels and Templates, Domain Specific IoTs Home automation, Industry applications, Agriculture, Surveillance applications, Other IoT application. IoT applications for industry: Future Factory Concepts,	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.		

	Brown field IoT, Smart Objects, Smart Applications.			
Week-16 Lesson 1 & 2 [3 Hours]	Lesson1:Introduction M2M and IOT, M2M, difference between IoT and M2M, software defined networking (SDN), network function virtualization (NFV) for IoT, basics of IoT system management with NETCONFYANG.A use case example, Differing Characteristics. Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT.	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion.	--	None

Assessment Pattern:

Assessment Task	CO's					Mark (Total=100)
	CO1	**CO2**	**CO3**	**CO4**	**CO5**	
Attendance	--	--	--	--	--	7

Class Test (CT1, CT2, CT3)	--	--	--	--	--	15
Assignment	--	--	--	--	--	5
Presentation	--	--	--	--	--	8
Midterm Examination	12	13	0	0	--	25
Semester Final Examination	5	10	10	15	--	40
Total Mark					--	100

CIE – Breakup (Theory) [60 marks]

Bloom's Criteria	Attendance (07)	Class Test (15)	Assignment (05)	Presentation (08)	Mid Exam (25)
Remember					
Understand		05	02	02	12
Apply		05		03	
Analyze		03	03		13
Evaluate		02			
Create				03	

SEE – Semester End Examination [40 marks] {Theory}

Bloom Criteria	Score for the Test
Remember	
Understand	15
Apply	
Analyze	5
Evaluate	20
Create	

Learning Materials:

Textbook/Recommended Readings:

1. Big Data Science & Analytics: A Hands-on Approach Book by Arshdeep Bahga and Vijay K. Madisetti
2. Internet_of_Things_IoT_Systems_Architectures,_Algorithms,_Methodologies
3. Big-Data Analytics for Cloud, IoT and Cognitive Computing

Reference Books/Supplementary Readings:

1. Internet of things and big data analytics toward next-generation intelligence
2. Handbook of Research on Big Data and the IoT, By Gurjit Kaur and Pradeep Tomar
3. Big Data Analytics for Internet of Things (1st Edition), by Tausifa Jan Saleem (Editor), Mohammad Ahsan Chishti (Editor)