Course Code	18CSE447T	Course Name	EDGE COMPUTING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	*Understand the concepts of IoT*
CLR-2 :	*Understand the IoT and M2M Communication*
CLR-3 :	*Understand the protocols and standards of IoT*
CLR-4 :	*Understand the Fog computing Architecture and its components*
CLR-5 :	*Understand the integration of Fog and Cloud Computing*
CLR-6 :	*Understand the concepts of IoT*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Apply concepts of IoT*	3	80	70	H	L	H	M	H	H	H	H	H	H	M	H	H	H	H
CLO-2 :	*Apply the M2M protocol in IoT.*	3	85	75	H	L	H	M	H	H	H	H	H	H	M	H	H	H	H
CLO-3 :	*Equip themselves familiar with Fog computing in IoT*	3	75	70	H	L	H	M	H	H	H	H	H	H	M	H	H	H	H
CLO-4 :	*Familiarize with IoT standard and protocols*	3	85	80	H	L	H	M	H	H	H	H	H	H	M	H	H	H	H
CLO-5 :	*Acquaint with Fog and Cloud computing in IoT*	3	85	75	H	L	H	M	H	H	H	H	H	H	M	H	H	H	H
CLO-6 :	*Apply concepts of IoT*	3	80	70	H	L	H	M	H	H	H	H	H	H	M	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to IoT*	*IoT Architecture*	*Fog Computational Model*	*BIG DATA*	*Case Study-1: Edge analytics in Irrigation System*
	SLO-2	*Technologies in IoT*	*Data Acquisition, Data Aggregation and Data Analysis*	*Fog Simulators*	*Data Types in Big data*	*Machine Learning in Edge for automation in Irrigation system*
S-2	SLO-1	*IoT Applications- Smart Home, Wearable, Connected Cars, Industrial IoT*	*IoT Protocols- COAP, MQTT*	*iFogSim*	*Characteristics of BIG DATA*	*Case study 2: Edge analytics for Water Quality Monitoring*
	SLO-2	*Smart Cities, Agriculture, Smart Retail, smart Grid, Healthcare*	*XMPP, AMQP, Low power Lossy Network routing*	*FogTorch*	*Benefits of Big Data*	*Machine Learning in Edge for automation in water quality monitoring*
S-3	SLO-1	*Challenges in IoT- Delivering Value to Customers, Hardware Compatibility Issues, Data Connectivity Issues*	*Communication Methods- Bluetooth, Zigbee Z-wave, 6LowPAN*	*Cisco IoX and Fog Application*	*Big Data Application-*	*Case Study 3: IoT- Edge system for Hydroponics system*
	SLO-2	*Incorrect Data Capture Capabilities, Analytic Challenges, Data Security challenges,*	*Wireless Fidelity*	*Contiki/Cooja*	*Layered Big Data Architecture- Data Ingestion, Data collection, Data Processing Layer*	*Deep Learning in Edge for automation in hydroponics system*
S 4-5	SLO-1 SLO-2	*Introduction to Edge Computing*	*4G*	*NS3*	*Data storage, Data Query and Visualization Layer*	*Case Study 4: IoT-Edge for Smart Energy Management*
S-6,7	SLO-1	*Need for Edge Computing- Improved Performance , Compliance, Data Privacy, And Data Security*	*Sigfox, NeUL*	*Software Defined Multi-Tier Fog Architecture*	*Big Data Implementation- Hortonworks, Cloudera, MAP R*	*Case Study 5: IoT- Edge for water demand forecasting*
	SLO-2	*Reduced Operational Cost*	*LoRaWAN*	*PVFOg simulator*	*Apache Projects for Big Data*	*Demand forecasting at Edge*
S-8,9	SLO-1	*Challenges in Edge/Fog Computing*	*5G*	*System Model analysis*	*Edge Computing for Big Data*	

Learning Resources	1. Ashton Kevin, (2009), "That Internet of Things Thing," RFID Journal, pp. 4986. 2. Maria Rita Palattella et al., (2013), "Standardized protocol stack for the internet of (important) things," IEEE Communications Surveys and Tutorials, 15(3), pp. 1389–1406. 3. D. Airehrour, J. Gutierrez and S. K. Ray, (2016), "Secure routing for internet of things: A survey," Journal of Network and Computer Applications, 66, pp. 198–213. 4. Reem Abdul Rahman and Babar Shah, (2016), "Security analysis of IoT protocols: A focus in CoAP," 2016 3rd MEC International Conference on Big Data and Smart City, ICBDSC 2016, pp. 172–178.. 5. Flavio Bonomi, Rodolfo Milito, Jiang Zhu and Sateesh Addepalli, (2012), "Fog Computing and Its Role in the Internet of Things," Proceedings of the first edition of the MCC workshop on Mobile cloud computing, pp. 13–16. 6. Weisong Shi, Jie Cao, Quan Zhang, Youhuizi Li and Lanyu Xu, (2016), "Edge Computing: Vision and Challenges," IEEE Internet of Things Journal, 3(5), pp. 637–646. 7. M. Mukherjee et al., (2017), "Security and Privacy in Fog Computing: Challenges," IEEE Access, 5, pp. 19293–19304. 8. Jie Cao, Quan Zhang and Weisong Shi, (2018), "Challenges and opportunities in edge computing," SpringerBriefs in Computer Science, pp. 59–70. 9. Martina Marjanovic, Aleksandar Antonic and Ivana Podnar Zarko, (2018), "Edge computing architecture for mobile crowd sensing," IEEE Access, 6, pp. 10662–10674. 10. Hesham El-Sayed et al., (2017), "Edge of Things: The Big Picture on the Integration of Edge, IoT and the Cloud in a Distributed Computing Environment," IEEE Access, 6, pp. 1706–1717 11. Huaqing Zhang, Yong Xiao, Shengrong Bu, Dusit Niyato, F. Richard Yu and Zhu Han, (2017), "Computing Resource Allocation in Three-Tier IoT Fog Networks: A Joint Optimization Approach Combining Stackelberg Game and Matching," IEEE Internet of Things Journal, 4(5), pp. 1204–1215 12. Veeramanikandan M. and Suresh Sankaranarayanan, (2019), "Publish/subscribe based multi-tier edge computational model in Internet of Things for latency reduction," Journal of Parallel and Distributed Computing, 127, pp. 18–27. 13. Ashfaq Farooqui, Kristofer Bengtsson, Petter Falkman and Martin Fabian, (2019), "From factory floor to process models: A data gathering approach to generate, transform, and visualize manufacturing processes," CIRP Journal of Manufacturing Science and Technology, 24, pp. 6–16. 14. Hongbing Wang, Chao Yu, Lei Wang and Qi Yu, (2018), "Effective BigDataspace service selection over trust and heterogeneous QoS preferences," IEEE Transactions on Services Computing, 11(4), pp. 644–657. 15. Pekka Pääkkönen and Daniel Pakkala, (2015), "Reference Architecture and Classification of Technologies, Products and Services for Big Data Systems," Big Data Research, 2(4), pp. 166–186 16. Tom White, (2015), "Hadoop: The Definitive Guide, 4th Edition," O'Reilly Media, Inc., (2015). 17. Team Hortonworks, "Hortonworks," [Online]. Available: https://hortonworks.com/. 18. Cloudera, "Cloudera," [Online]. Available: https://www.cloudera.com/about.html. 19. The Apache Software Foundation, "Apache Ni-Fi," [Online]. Available: https://nifi.apache.org/. 20. The Apache Software Foundation, "Apache Kafka," [Online]. Available: https://kafka.apache.org/. 21. The Apache Software Foundation, "Kafka Use cases," [Online]. Available: https://kafka.apache.org/uses. 22. The Apache Software Foundation, "Apache Storm," [Online]. Available: https://storm.apache.org/. 23. The Apache Software Foundation, "Apache Hive," Apache. [Online]. Available: https://hive.apache.org/. 24. The Apache Software Foundation, "Apache Pig." [Online]. Available: https://pig.apache.org/. 25. Alan Gates and Daniel Dai, (2016),"Programming Pig: Dataflow Scripting with Hadoop," Shroff/O'Reilly. 26. The Apache Software Foundation, "Zookeeper," [Online]. Available: https://zookeeper.apache.org/ 27. Shangguang Wang, Yali Zhao, Jinlinag Xu, Jie Yuan and Ching Hsien Hsu, (2019), "Edge server placement in mobile edge computing," Journal of Parallel and Distributed Computing, 127, pp. 160–168. 28. Yuthika, S, Ekta Dagur, Sourabh Mishra, Rijo Jackson Tom, Veeramanikandan,M and Suresh,S, "Intelligent IoT Based Automated Irrigation System", International Journal of Applied Engineering and Research, Vol.12(18), pp.7306-7320, 2017 29. Soundarya, P, Parthyusha, V, Niharika, A .V, Karthick, T and Suresh,S, "Intelligent IoT Based Water Quality Monitoring System", International Journal of Applied Engineering and Research, Vol.12(16), pp.5447-5454, 2017 30. Manav,M, Sameer,S, Suresh,S, Tom, R J and Veeramanikandan,M, "IoT Based Hydroponics System using Deep Neural Networks", Journal of Computers and Electronics in Agriculture, Vol.155,pp.473-486, 2018, Elsvier Publishing 31. Vignesh, M , Lavanya, V, Abhilasha,K, Gunasekhar,A and Suresh, S, "IoT Based Smart Energy Management System", International Journal of Applied Engineering and Research, Vol.12(16), pp.5455-5462, 2017

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.Madan Lakshmanan	*Dr.Subra Ganesan*	*Dr.S.Suresh*
Senior Scientist	*Professor, Department of Electrical and Computer Engineering*	*Dr.J. Sujithra*
CEERI, CSIR, Chennai (R&D Industry)	*Oakalnd University, USA*	