AC:

Item No:

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Internet of Thing

Second Year with Effect from AY 2021-22

Third Year with Effect from AY 2022-23

Final Year with Effect from AY 2023-24

(REV- 2019 'C' Scheme) from Academic Year 2020 – 21

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC:

Item No:

UNIVERSITY OF MUMBAI

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year Engineering (Internet of Thing)**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ **/ U.G./** ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ **/ Semester** (Strike out which is not applicable)
8	Status	~~**New**~~ **/** Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
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University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface by Board of Studies Team

It is our honor and a privilege to present the Rev-2019 'C' scheme syllabus of the Bachelor of Engineering in the Internet of Thing - IoT(effective from the year 2021-22). AICTE has introduced IoT as one of the nine emerging technology and hence many colleges affiliated with the University of Mumbai has started four years UG program for IoT. As part of the policy decision from the University end, the Board of IT got an opportunity to work on designing the syllabus for this new branch. As the Internet of Things is comparatively a young branch among other emerging engineering disciplines in the University of Mumbai, and hence while designing the syllabus promotion of an interdisciplinary approach has been considered.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students and increased Industry Institute Interactions. Industries' views are considered as stakeholders while the design of the syllabus. As per Industry views only 16 % of graduates are directly employable. One of the reasons is a syllabus that is not in line with the latest emerging technologies. Our team of faculties has tried to include all the latest emerging technologies in the Internet of Thing syllabus. Also the first time we are giving skill-based labs and Mini-project to students from the third semester onwards, which will help students to work on the latest Internet of Thing technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be mastered in one of the Internet of Thing domain. The syllabus is peer-reviewed by experts from reputed industries and as per their suggestions, it covers future emerging trends in Internet of Thing technology and research opportunities available due to these trends. .

We would like to thank senior faculties of IT, Computer and Electronics Department, of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of Emerging Areas of Internet of Thing.

Program Specific Outcome for graduate Program in Internet of Thing

1. Apply Core Internet of Thing knowledge to develop stable and secure Internet of Thing Application.
2. Identify, Design, Internet of Thing infrastructures for an enterprise using concepts and best Practices in the area Internet of Thing Domain.
3. Ability to work in multidisciplinary projects and make it Internet of Thing enabled Applications.

Board of Studies in Information Technology - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
Dr. Vaishali D. Khairnar (Member)
Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
Dr. Vaibhav Narwade (Member)
Dr. GV Choudhary (Member)

Ad-hoc Board Information Technology
University of Mumbai

Curriculum Equivalence

TE-Internet of Thing, TE-Cyber Security and TE-Computer Science and Engineering (Internet of Thing and Cyber Security including Blockchain) Sem-V all subjects are equivalent to TE-Computer Engineering Sem-V subjects.

Sr. No.	Sem	Name of Subject	Equivalence Subject	Equivalence Subject Code	Branch
1	VI	IoT Architecture and Protocols	IoT Architecture and Protocols	IoTC601 IoTCSBCC602	TE-Internet of Thing, TE-Computer Science and Engineering(nternet of Thing and Cyber Security including Blockchain)
2	VI	IoT Architecture and Protocols Lab	IoT Architecture and Protocols Lab	IoTL601 IoTCSBCL602	TE-Internet of Thing, TE-Computer Science and Engineering(nternet of Thing and Cyber Security including Blockchain)
3	VI	Web X.0	Web X.0	IoTC604 CSC604 IoTCSBCC604	TE-Internet of Thing, TE-Cyber Security, TE-Computer Science and Engineering(nternet of Thing and Cyber Security including Blockchain)
4	VI	Web Lab	Web Lab	IoTL604 CSL604 IoTCSBCL604	TE-Internet of Thing, TE-Cyber Security, TE-Computer Science and Engineering(nternet of Thing and Cyber Security including Blockchain)
5	VI	Enterprise Network Design	Enterprise Network Design	IoTDLO6011 CSDLO6011 IoTCSBCDLO6011	TE-Internet of Thing, TE-Cyber Security, TE-Computer Science and Engineering(nternet of Thing and Cyber Security including Blockchain)
6	VI	Blockchain Technology	Blockchain Technology	IoTDLO6012 CSDLO6012 IoTCSBCC603	TE-Internet of Thing, TE-Cyber Security, TE-Computer Science and Engineering(nternet of Thing and Cyber Security including Blockchain)

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Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Third Year Internet of Thing

Semester V & VI

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
IoTC601	IoT Architecture and Protocols	3	--	3	--	3
IoTC602	RFID and Microcontrollers	3	--	3		3
IoTC603	Wireless Sensor Technologies	3	--	3	--	3
IoTC604	Web X.0	3	--	3	--	3
IoTDLO601x	**Department Level Optional Course -2**	3	--	3	--	3
IoTL601	IoT Architecture and Protocols Lab	--	2	--	1	1
IoTL602	RFID and Microcontrollers Lab	--	2	--	1	1
IoTL603	Wireless Sensor Technologies Lab	--	2	--	1	1
IoTL604	Web Lab	--	2	--	1	1
IoTL605	Embedded Mobile Application Development Lab (SBL)	--	4	--	2	2
IoTM601	Mini Project :2B IoT & Mobile App Based.	--	4$	--	2	2
	Total	**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. &oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
IoTC601	IoT Architecture and Protocols	20	20	20	80	3	--	--	100
IoTC602	RFID and Microcontrollers	20	20	20	80	3	--	--	100
IoTC603	Wireless Sensor Technologies	20	20	20	80	3	--	--	100
IoTC604	Web X.0	20	20	20	80	3	--	--	100
IoTDLO601x	**Department Level Optional Course -2**	20	20	20	80	3	--	--	100
IoTL601	IoT Architecture and Protocols Lab	--	--	--	--	--	25	25	50

IoTL602	RFID and Microcontrollers Lab	--	--	--	--	--	25	--	25
IoTL603	Wireless Sensor Technologies Lab	--	--	--	--	--	25	-	25
IoTL604	Web Lab						25	25	50
IoTL605	Embedded Mobile Application Development Lab (SBL)	--	--	--	--	--	50	25	75
IoTM601	Mini Project :2B IoT & Mobile App Based.	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**175**	**100**	**775**

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

IoTDLO601X	**Department Optional Course – 2**
IoTDLO6011	Enterprise Network Design
IoTDLO6012	Blockchain Technology
IoTDLO6013	Interfacing Programming with IoT Gateway & Middleware Technologies
IoTDLO6014	Cloud Computing & Services

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
IoTC601	IoT Architecture and Protocols	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
IoTC601	IoT Architecture and Protocols	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand IoT Characteristics and Conceptual Framework.
2	To comprehend network architecture and design of IoT
3	To understand smart objects in IoT.
4	To correlate the connection of smart objects and IoT access technologies.
5	To explore network layer and application layer protocols for IoT.
6	To explore IoT security aspect.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the IoT Characteristics and Conceptual Framework.	L1,L2
2	Differentiate between the levels of the IoT architectures.	L1,L2
3	Interpret sensor network and its components.	L1,L2

4	Analyze the IoT access technologies.	L1,L2,L3,L4
5	Illustrate various protocols at network layer and application layer for IoT.	L1,L2,L3
6	Analyze and evaluate security issues in IoT and risk analysis structure.	L1,L2,L3,L4

Prerequisite:

1. Python programming
2. C programing language
3. Computer Networks

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	ports, Timers ,Programming of controller , How to use IDE to write code of microcontroller, TCP-IP protocol stack	**02**	
I	Introduction to IoT	1.1 Introduction to IoT- Defining IoT, Characteristics of IoT, Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Basics of networking Communication protocol, wireless sensor networks. 1.2 Convergence of IT and OT , IoT Challenges, IoT protocol vs Web Protocol stack **Self-learning Topics:** Hardware and software development tools for - *A*rduino, NodeMCU, ESP32, Raspberry Pi pico	**04**	CO1
II	IoT Network Architecture and Design	**2.1 Drivers Behind New Network Architectures** : Scale,Security,Constrained Devices and Networks ,Data,Legacy Device Support **2.2 Architecture :** The IoT World Forum (IoTWF) Standardized Architecture :Layer 1-7, IT and OT Responsibilities in the IoT Reference Model,Additional IoT Reference Models, A Simplified IoT Architecture, The Core IoT Functional Stack ::Layer 1-3 , Analytics Versus Control Applications , Data Versus Network Analytics Data Analytics Versus Business Benefits , Smart Services, **2.3 IoT Data Management and Compute Stack** :Fog Computing , Edge Computing ,The Hierarchy of Edge, Fog, and Cloud	**06**	CO2
III	Smart Objects IoT	**3.1 Sensors, Actuators, and Smart Objects , Sensors , Actuators, 3.2 Micro-Electro-Mechanical Systems (MEMS)** Smart Objects: A Definition , Trends in Smart Objects, **3.3 Sensor Networks** , Wireless Sensor Networks (WSNs) , Communication Protocols for WSN,RFID ,NFC **Self-learning Topics:** RFID in Libraries	**04**	CO3
IV	Connecting Smart Objects	**4.1 Communications Criteria** : Range , Frequency Bands , Power Consumption , Topology , Constrained Devices , Constrained-Node Networks , Data Rate and Throughput , Latency and Determinism , Overhead and Payload , **4.2 IoT Access Technologies** :	**08**	CO4

		Standardization and Alliances , Physical Layer , MAC Layer , Topology ,Security and Conclusion of IEEE 802.15.4 , IEEE 802.15.4g and 802.15.4e ,IEEE 1901.2a ,IEEE 802.11ah , LoRaWAN, and NB-IoT and Other LTE Variations , LTE Cat 0 , LTE-M, NB-IoT **Self-learning Topics:** case studies		
V	IoT Network Layer and Application protocols	5.1 The Business Case for IP , The Key Advantages of Internet Protocol ,Adoption or Adaptation of the Internet Protocol ,The Need for Optimization ,Constrained Nodes , Constrained Networks IP Versions , Optimizing IP for IoT , 5.2 From 6LoWPAN to 6Lo, Header Compression, Fragmentation , Mesh Addressing ,Mesh-Under Versus Mesh-Over Routing , 6Lo Working Group , 6TiSCH , RPL , Objective Function Rank, RPL Headers ,Metrics , Authentication and Encryption on Constrained Nodes , ACE , DICE, Profiles and Compliances, Internet Protocol for Smart Objects Alliance ,Wi-SUN Alliance, Thread, IPv6 Ready Logo 5.3 The Transport Layer , IoT Application Transport Methods,Generic Web-Based Protocols , 5.4 IoT Application Layer Protocols , CoAP, MQTT, AMQP **Self-learning Topics:** case studies	**08**	CO5
VI	Securing IoT	6.1 **A Brief History of OT Security** Common Challenges in OT Security : Erosion of Network Architecture,Pervasive Legacy Systems,Insecure Operational Protocols like Modbus, DNP3 ,ICCP ,OPC , (IEC) Protocols,Device Insecurity **6.2 Security Knowledge:** IT and OT Security Practices and Systems Vary, The Purdue Model for Control Hierarchy, OT Network Characteristics Impacting Security, Security Priorities: CIA, Security Focus 6.3 **Formal Risk Analysis Structures**: OCTAVE and FAIR, FAIRThe Phased Application of Security in an Operational Environment , Secured Network Infrastructure and Assets, Deploying Dedicated Security Appliances, Higher-Order Policy Convergence and Network Monitoring **Self-learning Topics:** OWASP IoT Top 10 attacks ,X.509, SSL & TSL basics	**06**	CO6

Text Books:

1. Arsheep Bahga (Author), Vijay Madisetti, Internet Of Things: A Hands-On Approach Paperback, Universities Press, Reprint 2020
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO.

References:

1. Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases by , CRC Press.
2. Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.
3. Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Packt Publications, Reprint 2018.
4. Amita Kapoor, "Hands on Artificial intelligence for IoT", 1st Edition, Packt Publishing, 2019.
5. Sheng-Lung Peng, Souvik Pal, Lianfen Huang Editors: Principles of Internet of Things (IoT)Ecosystem:Insight Paradigm, Springer

Online References:

1. https://owasp.org/www-project-internet-of-things/
2. NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/

3. NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, https://onlinecourses.nptel.ac.in/noc21_ee85/preview

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
IoTC602	RFID and Microcontrollers	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
IoTC602	RFID and Microcontrollers	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn Basic knowledge of radio frequency identification technology.
2	To Learn and analyze technical problems related to RFID technology.
3	To conceptualize the basics of organizational and architectural issues of a Microcontroller.
4	To learn programming techniques used in Microcontrollers.
5	To emphasis on design of interfacing techniques of Microcontroller.
6	To understand the fundamentals of real time communication protocols.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Demonstrate the concepts of RFID systems, the operation of each component of the RFID system.	L1, L2
2.	Analyze the different RFID technology.	L3
3.	Describe the architecture of 8051 microcontroller.	L1,L2
4.	Implement assembly language programming for 8051 microcontroller.	L1,L2
5.	Analyze and design interfacing of peripheral devices with 8051 microcontroller.	L2,L3
6.	Examine different communication protocols required in embedded devices.	L1,L2

Prerequisite: Digital Logic & Computer Architecture, Microprocessor

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of Computer Architecture and Microprocessor	**02**	
I	RFID Technology	Principle of RFID, components of RFID system: RFID tag, Reader, RFID architecture, RFID issues. **Self-learning Topics:** RFID middleware, concepts and technology: RFID, transponder.	**05**	CO1
II	RFID Applications	Introduction, RFID applications: logistics and supply chain, production, monitoring and maintenance, product safety, quality and information, access control and tracking and tracing of individuals, payment, loyalty, household etc . Hardware, Hardware issues, Collision resolution protocol: pure aloha, slotted aloha, frame slotted aloha, tree protocols, tree splitting algorithms, binary search algorithms, bitwise arbitration protocols. Main query tree protocols. **Self-learning Topics:** Near field Communication, Key study of Fast tag.	**08**	CO2
III	The Microcontroller Architecture	Introduction to 8051 Microcontroller, Architecture, Pin configuration, Memory organization, Input /Output Ports, Counter and Timers, Serial communication, Interrupts. **Self-learning Topics:** Darlington Pair (Current Amplifier ULN28803 IC), ARM 7 and ARM 9 architecture and Multi Core Processor.	**06**	CO3
IV	Assembly Language Programming of 8051	Instruction set, Addressing modes, Development tools, Assembler Directives, Programming based on Arithmetic & Logical operations, I/O parallel and serial ports, Timers & Counters, and ISR. **Self-learning Topics:** Programming of 8051 in 'C'.	**08**	CO4
V	Microcontroller Applications	Interfacing matrix keyboard and Seven segments LED display, LCD Interfacing, ADC Interfacing, DC motor interfacing. **Self-learning Topics:** NAND flash, NOR flash, eMMC, PMIC (Power Management IC), RAM Configuration.	**05**	CO5
VI	Communication Protocols and Interfaces	UART, I2C, SPI, RS232, RS485 Protocol, CAN Bus Interface, Capacitive Touch. **Self-learning Topics:** Modbus, Multi master I2C, and Daisy Chaining of SPI.	**05**	CO6

Text Books:

1. Internet of Things connecting objects to the web, by Hakima Chaouchi, Wiley.
2. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006.
3. C. Kenneth J. Ayala and D. V. Gadre, "The 8051 Microcontroller & Embedded system using assembly & 'C' ", Cengage Learning, Edition 2010.

References:

1. RFID and the Internet of Things, by Herve Chabanne, Wiley.
2. Embedded system design A Unified hardware/software Introduction, Frank Vahid, Tony Givargis, Wiely.
3. Embedded System Architecture, Programming and Design, Raj Kamal, McGraw Hill.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
IoTC603	Wireless Sensor Technologies	03	--	--	03	02	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
IoTC603	Wireless Sensor Technologies	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the fundamentals of wireless sensor networks and its application in real time scenarios.
2	To understand the wireless sensor technology and wireless transmission technology.
3	To understand fundamentals of MAC protocols and its design consideration.
4	To understand routing protocols and Transport control protocol for wireless sensor network,
5	To understand the middleware and operating system for wireless sensor network.
6	To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the fundamentals of wireless sensor networks and its application in real time scenarios.	L1,L2
2	Describe and demonstrate wireless sensor technology and wireless transmission technology.	L1,L2
3	Explain the concept and design issues of MAC protocols.	L1,L2
4	Explain and analyse routing protocols and Transport control protocol for wireless sensor network.	L1,L2,L3,L4
5	Explain the middleware and able to distinguish various operating system for wireless sensor network.	L1,L2,L3
6	Compare and analyse the issues pertaining to sensor networks and the	L1,L2,L3,L4

	performance modelling involved in managing a sensor network.	

Prerequisite: Fundamentals of Wireless Communication Technology, Multiple Access Techniques , Wireless LAN, PAN, MAN, WAN.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of Wireless Communication Technology, Multiple Access Techniques , Wireless LAN, PAN, MAN, WAN.	**02**	-
I	Introduction to Wireless Sensor Network	Background or Wireless Sensor Network, history, Network Architecture, challenges, application areas of sensor network, Issues in sensor network architecture and issues in design of sensor network. **Self Learning:** Recent Case studies	**06**	CO1
II	Basics of Wireless Sensor Technology and Wireless Transmission Technology	Introduction, sensor node technology, sensor taxanomy, wireless network operating environment and trends, radio technology primer and wireless technologies **Self Learning:** Modulation Basics	**06**	CO2
III	MAC Protocols	Fundamentals of MAC Protocols, design goals, MAC protocol for WSN, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4. **Self Learning:** Wireless Adhoc Networks	**06**	CO3
IV	Routing Protocols and Transport Control protocol	Introduction,challenges, design issues , classification of routing protocols, routing strategies in Wireless sensor network, Transport Control protocol, performance of transport control protocol, its design issues. **Self Learning:** Network Management for Wireless Sensor Network	**08**	CO4
V	Middleware and OS for Wireless Sensor Network	Introduction, Principles, Architecture, Comparison of existing middleware. Introduction to types of OS for Wireless Sensor Network, types of OS, design issues. **Self Learning:** Recent OSs for Wireless Sensor Network	**07**	CO5

VI	Performance and Traffic management in WSN	Introduction, WSN design issues, Performance modelling of WSN, Case study. **Self Learning:** Design and find performance measures of any case study.	**04**	CO6

Text Books:

1.Fundamentals of Sensor Network Programming: Applications and Technology, S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley Publications.
2. ContikiCooja User Guide.
3. Sensor Technology Handbook, Jon S.Wilson
4. Wireless Sensor Networks-Technology, Protocols and Applications, KazemSohraby, Daniel Minoli and TaiebZnati, Wiley Publications.
5. Sensor Technologies, Healthcare , Wellness and Environmental Applications, Micheal J McGrath and Cliodhna Ni Scanaill
6. Building Wireless Sensor Networks, Robert Faludi, O'Reilly Publications.
7. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education.

Reference Books:

1. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , ArshdeepBahga.
2. A comparative review of wireless sensor network mote technologies, IEEE paper 2009.
3.Adhoc& Sensor Networks Theory and Applications, Carlos de Morais Cordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.
4. Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.
5. William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004

Online Resources:

1. https://nptel.ac.in
2. https://www.intechopen.com/
3. https://www.youtube.com/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
IoTC604	WEB X.0	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
IoTC604	WEB X.0	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the digital evolution of web technology.
2	To learn TypeScript and understand how to use it in web applications.
3	To learn the fundamentals of Node.js.
4	To make Node.js applications using the express framework.
5	To enable the use of AngularJS to create web applications that depend on the Model-View-Controller Architecture.
6	To gain expertise in a leading document-oriented NoSQL database, designed for speed, scalability, and developer agility using MongoDB.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts related to web analytics and semantic web.	L1,L2
2	Understand how TypeScript can help you eliminate bugs in your code and enable	L1,L2

	you to scale your code.	
3	Develop back-end applications using Node.js.	L1,L2,L3
4	Construct web based Node.js applications using Express.	L1,L2,L3
5	Understand AngularJs framework and build dynamic, responsive single-page web applications.	L1,L2,L3
6	Apply MongoDB for frontend and backend connectivity using REST API.	L1,L2,L3

Prerequisite: HTML5, CSS3, JavaScript.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Introduction to HTML5,CSS3, Basics of JavaScript**	**02**	-
I	Introduction to WebX.0	Evolution of WebX.0; **Web Analytics 2.0**: Introduction to Web Analytics, Web Analytics 2.0, Clickstream Analysis, Strategy to choose your web analytics tool, Measuring the success of a website; **Web3.0 and Semantic Web**: Characteristics of Semantic Web, Components of Semantic Web, Semantic Web Stack, N-Triples and Turtle, Ontology, RDF and SPARQL **Self-learning Topics**: Semantic Web Vs AI, SPARQL Vs SQL.	**04**	CO1
II	TypeScript	Overview, TypeScript Internal Architecture, TypeScript Environment Setup, TypeScript Types, variables and operators, Decision Making and loops, TypeScript Functions, TypeScript Classes and Objects, TypeScript Inheritance and Modules **Self-learning Topics**: Javascript Vs TypeScript	**06**	CO2
III	Node.js	Introducing the Node.js-to-Angular Stack (MEAN Stack), Environment setup for Node.js , First app, Asynchronous programming, Callback concept, Event loops, REPL, NPM, Event emitter, Buffers, Streams, Networking module, File system, Web module. **Self-learning Topics:** Node.js with MongoDB.	**07**	CO3

IV	Express	Introduction to Express ,Installing Express,Creating First Express application,The application, request, and response objects,Configuring Routes,Understanding Middleware,cookies, Session, Authentication **Self-learning Topics:** ExpressJs Templates	**06**	CO4
V	Introduction to AngularJS	Overview of AngularJS, Need of AngularJS in real websites, AngularJS modules, AngularJS built-in directives, AngularJS custom directives, AngularJS expressions,AngularJS Data Binding, AngularJS filters, AngularJS controllers, AngularJS scope, AngularJS dependency injection, AngularJS Services, Form Validation, Routing. **Self-learning Topics:** MVC model, DOM model.	**07**	CO5
VI	MongoDB and Building REST API using MongoDB	**MongoDB**: Understanding MongoDB, MongoDB Data Types, Administering User Accounts, Configuring Access Control, Adding the MongoDB Driver to Node.js, Connecting to MongoDB from Node.js, Accessing and Manipulating Databases, Manipulating MongoDB Documents from Node.js, Accessing MongoDB from Node.js, Using Mongoose for Structured Schema and Validation. **REST API**: Examining the rules of REST APIs, Evaluating API patterns, Handling typical CRUD functions (Create, Read, Update, Delete), Using Express and Mongoose to interact with MongoDB, Testing API endpoints. **Self-learning Topics**: MongoDB vs SQL Databases	**07**	CO6

Text & Reference Books:

1.Boris Cherny, "Programming TypeScript- Making Your Javascript Application Scale", O'Reilly Media Inc.
2. Amos Q. Haviv, "MEAN Web Development" , PACKT Publishing
3.Brad Dayley, Brendan Dayley, Caleb Dayley, "Node.js, MongoDB and Angular Web Development:The definitive guide to using the MEAN stack to build web applications", 2nd Edition, Addison-Wesley Professional
5. Adam Bretz and Colin J. Ihrig, "Full Stack JavaScript Development with MEAN", SitePoint.
4. Dr. Deven Shah, "Advanced Internet Programming", StarEdu Solutions.
References:
1. Simon Holmes Clive Harber, "Getting MEAN with Mongo, Express, Angular, and Node", Manning Publications.
2. Yakov Fain and Anton Moiseev, "TypeScript Quickly", Manning Publications.

Online References:

1.https://www.coursera.org
2. https://udemy.com
3. https://www.tutorialspoint.com/meanjs/meanjs_overview.htm

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical / Oral**	**Tutorial**	**Total**
IoTL601	IoT Architecture and Protocols Lab	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				

IoTL601	IoT Architecture and Protocols Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab aims:	
1	To Understand the definition and significance of the Internet of Things.
2	To Discuss the architecture, operation, and business benefits of an IoT solution.
3	To Examine the potential business opportunities that IoT can uncover.
4	To Explore the relationship between IoT, cloud computing, and Data Analytics.
5	To Identify how IoT differs from traditional data collection systems.
6	To Explore the interconnection and integration of the physical world and be able to design & develop IOT applications.

Lab Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Adapt different techniques for data acquisition using various IoT sensors for different applications.	L1,L2,L3
2	Demonstrate the working of actuators based on the collected data.	L1,L2,L3
3	Use different IoT simulators and correlate working of IoT protocols.	L1,L2,L3
4	Adapt different techniques for Integrating IoT services to other third-party Clouds.	L1,L2,L3
5	Execute data analysis and encryption methodologies for deployment of IoT applications.	L1,L2,L3,L4
6	Implement IoT protocols for communication to realize the revolution of internet in mobile devices, cloud and sensor networks.	L1,L2,L3,L4

Prerequisite:

1. Python programming
2. C programing language
3. Computer Networks

Hardware & Software Requirements:

Hardware Requirement:	Software requirement:
PC i3 processor and above. Arduino using Wifi/Raspberry Pi	Contiki, Cooja or any other simulator. AWS/Azure services. Internet Connection

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Experimentation with Microprocessor and Microcontroller , Experimentation with python and c	**02**	
I	Arduino	Introduction to Arduino, Hardware requirements, Software requirements, Arduino Programming Language,	**05**	LO1, LO2

		Arduino Uno Wired & Wireless connectivity, LCD commands, Serial Communication commands. Program for blinking LED using Arduino. Traffic Light pattern using Arduino. ESP8266 WiFi Module		
II	Raspberry Pi	Introduction to Raspberry Pi, Installation of NOOBS and Raspbian on SD card, Libraries on Raspberry Pi, getting static IP address of Raspberry Pi, Interfacing of Relay, DHT11, DC Motor and LCD with Raspberry Pi.	**05**	LO1,LO2
III	Contiki OS	Contiki OS : History of Contiki OS,Applications, Features, ,Communication Components in Contiki OS, Cooja simulator ,Running Cooja Simulator,	**05**	LO3
IV	Cooja Simulator	Using the Contiki OS with the Cooja simulator to program the IoT for broadcasting data from sensors	**03**	LO5,LO6
V	Protocols and Security with Cooja	Understanding of 6LowPAN , COAP and protocol implementation in Cooja . Encryption Decryption techniques for IoT	**03**	LO5,LO6
VI	IoT data to Cloud	Installing the Remote desktop server. Installation of Pi camera, Face recognition, serial peripheral interface using Raspberry Pi. . DHT11 data logger with ThingSpeak/ thingsboard/ AWS/ Azure server .	**03**	LO4,L06

Text & Reference Books:

1. Jake VanderPlas,“ Python Data Science Handbook”, O’Reilly publication
2. Joakim Verona,” Practical DevOps”, PACKT publishing
3. Honbo Zhou,” The internet of things in the cloud”, CRC press, Taylor and Francis group
4. Perry Lea,” Internet of things for architects”, PACKT publishing

Online References:

1. https://spoken-tutorial.org/watch/Arduino/Introduction+to+Arduino/English/
2. https://pythonprogramming.net/introduction-raspberry-pi-tutorials/
3. https://iotbytes.wordpress.com/basic-iot-actuators/
4. http://www.contiki-os.org/
5. https://www.bevywise.com/iot-simulator/
6. https://mqtt.org/

List of Experiments.

1. To study and implement interfacing of different IoT sensors with Raspberry Pi pico/Arduino/ModeMCU.

2. To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper motor)

3. To study and demonstrate Contiki OS for RPL (like Create 2 border router and 10 REST clients, Access border router from other network (Simulator))

4. To study and demonstrate working of 6LoWPAN in Contiki OS (simulator)

5. Write a program on Raspberry Pi to push and retrieve the data from cloud like thingspeak/thingsboard/AWS/ Azure etc

6. To study and implement IoT Data processing using Pandas.

7. Write a program on Arduino / Raspberry Pi subscribe to MQTT broker for temperature data and print it

8. Write a program to create TCP Server on Arduino/Raspberry Pi and respond with humidity data to TCP client when Requested

9. Write a program for ESP8266 DHT11/DHT22 Temperature and Humidity Web Server with Arduino IDE

10. Write a program to Control Your ESP8266 From Anywhere in the World

11. Write a program for Arduino / Raspberry Pi Publishing MQTT Messages to ESP8266

12 Write a program to collect data from sensor encrypt data send it to receiver (server) and decrypt is at receiving end Ardino/Raspberry Pi/ Contiki OS (simulator)

Term Work: Term Work shall consist of at least 10 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
IoTL602	RFID and Microcontrollers Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of 2 Tests				
IoTL602	RFID and Microcontrollers Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab aims:	
1	To understand Basic knowledge of the radio frequency identification technology.
2	Get hands-on experience with Assembly Language Programming.
3	Realize techniques for faster execution of instructions and improve speed of operation and performance of Microcontroller.
4	Learn the techniques of serial communication and Timer/Counter programming of 8051 Microcontroller.
5	Study interfacing of peripheral devices with 8051 Microcontroller.
6	Become familiar with the MSP430F LaunchPad Development Kit.

Lab Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Developed simple application using RFID system.	L1, L2
2	Build a program on a microcontroller using arithmetic & logical instruction set of 8051.	L1,L2, L3
3	Develop the assembly level programming using 8051 Microcontroller loop instruction set.	L1, L2, L3
4	Write the assembly level programming using 8051 Microcontroller for Serial Port and Timer/Counter.	L1, L2,L3
5	Design interfacing of peripheral devices with 8051 Microcontroller.	L6
6	Demonstrate the significant features of the MSP430F LaunchPad development kit.	L1,L2

Prerequisite: Microprocessor

Hardware & Software Requirements:

Hardware Requirement: Arduino Uno, Raspberry Pi, MSP430F, NodeMCU	**Software requirement:** Arduino software (IDE), Python , C , Code Composer Studio

DETAIL SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Developing Application with RFID	1. RFID based Attendance System. 1. RFID based Car Parking System. 2. RFID based library Management System. (any One)	**04**	LO1
II	Arithmetic and Logical Instructions of 8051 Microcontroller	1. Program to add hex numbers in 8051 Assembly language. 2. Program to perform the logical operations in 8051 Assembly language.	**04**	LO2
III	Loop Instructions of 8051 Microcontroller	1. Program to find even & odd numbers from a given list of numbers in 8051 Assembly language. 2. Program to find maximum & minimum numbers from a given list of numbers in 8051 Assembly language. 3. Program to generate N numbers of Fibonacci series in 8051 Assembly language.	**06**	LO3
IV	Serial Port and Timer/Counter Programming of 8051 Microcontroller	1. Implementation of Serial Communication by using 8051 serial ports. 2. Assembly Language Program for use of Timer/Counter for various applications. (any One)	**02**	LO4
V	Interfacing with 8051 Microcontroller	1. Program to interface 8255 PPI with 8051 Microcontroller 2. Program to interface ADC 0808 with 8051 Microcontroller. 3. Program to interface DAC 0808 with 8051 Microcontroller. (any two)	**05**	LO5
VI	MSP430F LaunchPad development kit	1. To study microcontroller MSP430F with Capacitive touch booster 2. To study the MSP430F instruction set: data transfer instructions, arithmetic instructions, logic instructions, and the program control instructions. 3. Program to blink the onboard, RED LED and GREEN LED together using GPIO. (any two)	**05**	LO6

Text Books:

1. Anand Tamboli ,"Build Your Own IoT Platform", 1st Edition, Apress, 2019.
2. M. A. Mazidi, J. G. Mazidi, R. D., McKinlay ,"The 8051 microcontroller & Embedded systems Using Assembly and C", Pearson, 3rd edition.

3. The 8051 and MSP430 Microcontrollers: Architecture, Programming and Applications, Andhe Pallavi K., Uma Rao, Kindle Edition.

References:

1. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain, Internet of things With Raspberry Pi and Arduino, Boca Raton: CRC Press, Taylor & Francis Group,2020.
2. User's Guide for MSP430FR2433 LaunchPad Development Kit.

Online Reference:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org/

Term Work: Term Work shall consist of at least 10 to 12 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus

		Teaching Scheme Contact Hours		Credit Assigned		Total
Course Code	**Course Name**	**Theory**	**Practical**	**Theory**	**Practical**	
IoTL603	Wireless Sensor Technologies Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical/ Oral		Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
IoTL603	Wireless Sensor Technologies Lab	--	--	--	--	25	25	--	50

Lab Objectives:

Sr No	Lab Objectives
	The Lab experiments aims:
1	Learn various communication technologies, Microcontroller boards and sensors.
2	Design the problem solution as per the requirement analysis done using sensors and wireless technologies.
3	Study the basic concepts of programming/sensors/ emulators.
4	Design and implement the mini project intended solution for project based earning.
5	Build, test and report the mini project successfully.
6	Improve the team building, communication and management skills of the students.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxanomy
	On successful completion, of course, learner/student will be able to:	
1	Differentiate between various wireless communication technologies based on the range of communication, cost, propagation delay, power and throughput.	L1,L2
2	Conduct a literature survey of sensors used in real world wireless applications.	L1,L2
3	Demonstrate the simulation of WSN using the Network Simulators (Contiki/ Tinker CAD/ Cup carbon etc).	L1,L2,L3
4	Demonstrate and build the project successfully by utilizing hardware /software , sensors, controller, coding, emulating and testing.	L1,L2,L3
5	Report and present the findings of the study conducted in the preferred domain.	L1,L2,L3
6	Demonstrate the ability to work in teams and manage the conduct of the research study.	L1,L2,L3

Prerequisite: Computer Networks, Microprocessor Lab.

Hardware & Software requirements:

Hardware Specifications:	**Software Specifications:**
1.Laptop/ PC with minimum 2GB RAM and 500 GB Hard disk drive. 2. Sensors –DHT11/22, PIR, MQ2/MQ3, HC-SR04, Moisture sensor , Image sensor, flow sensor, capacitive RH sensor, proximity detector, Arduino Uno/Mega board, RPi Board 3. Wireless Radio Modules- Bluetooth Module , Mobile Phone with Bluetooth antenna, Zigbee RF module, GSM Module 4. Others-Breadboard, wires, power supplies, USB cables, buzzers, LEDs, LCDs.	1. Windows or Linux Desktop OS Arduino IDE 2.XCTU configuration and test utility software 3. CupCarbon IOT simulator 4. Tinkercad Simulation Software 5. Contiki/Cooja 6. Any OS as per requirement(Emerald, Tiny OS, OSPM, MANTIS,EYES OS) 7. Internet connection

Guidelines: A. Students should perform experiments**.**
DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0I	Prerequisite	Introduction to 8051, Basics of Wireless Communication and Python programming	**02**	
I	Review of Wireless Communication Technologies	Study of various wireless communication technologies like IEEE 802.15.1, IEEE 802.15.4 and IEEE 802.11. Mini Project: Allocation of the groups	**02**	LO1
II	Sensors and their Interfacing	Study of various types of sensors and display devices , DHT11/22,HC-SR04, MFRC 522, PIR, MQ2/MQ3, HC-SR04, Moisture sensor , Image sensor, flow sensor, capacitive RH sensor, proximity detector and demonstration of their interfacing using Arduino/ Raspberry pi. Mini Project: Topic selection	**02**	LO2
III	Wireless Communication tools	Installation and testing the simulation tools (eg.TinkerCad/Cupcarbon/ContikiCooja). Mini Project: Topic validation and finalizing software and Hardware requirement.	**02**	LO3

IV	Implementation of Wireless Technologies	Study of interfacing of Arduino/ Raspberry pi with Wireless Technologies (eg. HC-05, XBee S2C by Digi, ESP controller). Mini Project: Hardware procurement	**02**	LO4
V	Remote Access	Study of interface using Mobile / Web to publish or remotely access the data on the Internet. Mini Project: Study of remote access technologies with respect to the selected project.	**02**	LO4
VI	Mini Project	Implementation of the Mini Project: 1. Design, configure, testing the Mini Project. 2. Report submission as per the guidelines.	**14**	LO4,LO5 ,LO6

B. Mini project

1. Students should carry out hardware based mini-project in a group of three/four students with a subject Incharge/ mini project mentor associated with each group.
2. The group should meet with the concerned faculty during laboratory hours and the progress of work discussed must be documented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirement for their defined mini project problem statement.
5. Design, configure and test their own circuit board.
5. Interface using Mobile/Web to publish or remotely access the data on the Internet.
6. A detailed report is to be prepared as per guidelines.
7. Each group may present their work in various project competitions and paper presentations

B. Documentation of the Mini Project

The Mini Project Report can be made on following lines:
1. Abstract
2. Contents
3. List of figures and tables
4. Chapter-1 (Introduction, Literature survey, Problem definition, Objectives, Proposed Solution, Wireless Technology used)
5. Chapter-2 (System design/Block diagram, Flow chart, Circuit/Interfacing diagram, Hardware and Software requirements, cost estimation)
6. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter-4 (Conclusion)
8. References

Text Books:

1. Fundamentals of Sensor Network Programming: Applications and Technology, S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley Publications.
2. ContikiCooja User Guide.

3. Sensor Technology Handbook, Jon S.Wilson
4. Wireless Sensor Networks-Technology, Protocols and Applications, KazemSohraby, Daniel Minoli and TaiebZnati, Wiley Publications.
5. Sensor Technologies, Healthcare , Wellness and Environmental Applications, Micheal J McGrath and Cliodhna Ni Scanaill
6. Building Wireless Sensor Networks, Robert Faludi, O'Reilly Publications.

Reference Books:

1. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , ArshdeepBahga.
2. A comparative review of wireless sensor network mote technologies, IEEE paper 2009.
3.Adhoc& Sensor Networks Theory and Applications, Carlos de Morais Cordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.

Online References:

Sr. No.	Website/Reference link
1	https://www.digi.com/resources/documentation/digidocs/90001526/tasks/t_download_and_install_xctu.htm
2	https://www.arduino.cc/en/software
3	http://cupcarbon.com/

Term Work:

Term Work shall consist of Mini Project on above guidelines/syllabus. Also Term work must include at least 2 assignments and mini project report.
Term Work Marks: 25 Marks (Total marks) =15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
IoTL604	Web Lab	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
IoTL604	Web Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr No	**Lab Objectives**
1	To familiarize with Open Source Tools for Web Analytics and Semantic Web.
2	To familiarize with Programming in TypeScript for designing Web Applications.
3	To orient students for developing Node.js backend applications.
4	To orient students for developing Express applications.
5	To understand AngularJS Framework for Single Page Web Applications.
6	To use REST API and MongoDB for Frontend and Backend Connectivity.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive Levels of Attainment as per Bloom's Taxonomy**
Upon Completion of the course the learner/student should be able to:		
1	Understand open source tools for web analytics and semantic web apps development and deployment.	L1, L2
2	Understand the basic concepts of TypeScript for designing web applications.	L1, L2, L3
3	Construct back-end applications using Node.js.	L1, L2,L3
4	Construct back end applications using Express.	L1, L2,L3
5	Implement Single Page Applications using AngularJS Framework.	L1, L2, L3

6	Develop REST web services using MongoDB.	L1, L2, L3

Prerequisite: HTML5,CSS3 and Basics of JavaScript

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Angular IDE, Visual Studio Code, Notepad++, Python Editors, MySQL, XAMPP, MongoDB, JDK

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Web Analytics & Semantic Web	Study **Any 1** tool in each 1. Study web analytics using open source tools like Matomo, Open Web Analytics, AWStats, Countly, Plausible. 2. Study Semantic Web Open Source Tools like Apache TinkerPop, RDFLib, Apache Jena, Protégé, Sesame.	**02**	LO1
II	TypeScript	Perform **Any 2** from the following 1. Small code snippets for programs like Hello World, Calculator using TypeScript. 2. Inheritance example using TypeScript 3. Access Modifiers example using TypeScript 4. Building a Simple Website with TypeScript	**04**	LO2
III	Node.js	Perform **Any 2** from the following 1. Build Hello World App in Node.js 2. Stream and Buffer in Node.js 3. Modules in Node.js(Networking, File system, Web module)	**06**	LO3
IV	Express	Perform **Any 2** from the following 1. Configuring Express Settings and creating Express application using request and response objects.	**04**	LO4

		2. Build Express application by Sending and Receiving Cookies. 3. Create an Express application to implement sessions.		
V	AngularJs	Perform **Any 2** from the following .Create a simple HTML "Hello World" Project using AngularJS Framework and apply ng-controller, ng-model,expression and filters. .Implement a single page web application using AngularJS Framework including Services, Events,Validations (Create functions and add events, add HTML validators, using $valid property of Angular, etc.) .Create an application for like Students Record using AngularJS.	**04**	LO5
VI	MongoDB and Building REST API using MongoDB	Perform **Any 2** from the following 1. Connect MongoDB withNode.js and perform CRUD operations. 2. Build a RESTful API using MongoDB. 3. Build a TypeScript REST API using MongoDB.	**06**	LO6

Text Books:

1. Learning Node.js Development, Andrew Mead, Packt Publishing
2. John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez -Lopez, "Semantic Web Programming", Wiley Publishing, Inc, 1st Edition, 2009.
3. Boris Cherny, "Programming TypeScript- Making Your Javascript Application Scale", O'Reilly Media Inc., 2019 Edition.
4. Adam Bretz and Colin J. Ihrig, "Full Stack JavaScript Development with MEAN", SitePoint Pty. Ltd., 2015 Edition.
5. Brad Dayley, Brendan Dayley, Caleb Dayley, "Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications", 2nd Edition, AddisonWesley Professional, 2018 Edition.

References:

1. Simon Holmes Clive Harber, "Getting MEAN with Mongo, Express, Angular, and Node", Manning Publications, 2019 Edition.
2. Yakov Fain and Anton Moiseev, "TypeScript Quickly", Manning Publications, 2020 Edition.
3. Dr. Deven Shah, "Advanced Internet Programming", StarEdu Solutions, 2019 Edition.
4. Ethan Brown ,Web Development with Node and Express",O'Reilly

Online Reference:

Sr. No.	Website Name
1.	https://www.w3schools.com/nodejs/
2.	https://www.tutorialspoint.com/mongodb/index.htm
3.	https://www.mongodb.com/basics

Term Work: Term Work shall consist of at least 10 to 12 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
IoTL605	Embedded Mobile Application Development Lab (SBL)	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
IoTL605	Embedded Mobile Application Development Lab (SBL)	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab aims:	
1	To get familiar with the basics of Flutter open-source UI software development kit.
2	To get familiar with the basics of Dart programming language.
3	To acquire knowledge and skills for creation of embedded mobile application.
4	To gain ability to develop location aware embedded mobile application.
5	To explore Firebase- a cloud hosted NoSQL database.
6	To make students familiar with testing and publishing of embedded mobile applications.

Lab Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**

On successful completion, of course, learner/student will be able to:		
1	Develop basic embedded mobile application using Dart.	L1,L2,L3
2	Develop basic embedded mobile application using Flutter.	L1,L2,L3
3	Develop advanced embedded mobile application using Dart and Flutter.	L1,L2,L3
4	Developed the feature for embedded mobile application to track the location of object GPS and Google map.	L1,L2,L3,L4
5	Demonstrate database connectivity for cloud hosted database.	L1,L2,L3,L4,L5
6	Demonstrate the ability to test and publish embedded mobile application.	L1,L2,L3,L4,L5,L6

Prerequisite:

1. Python programming
2. C programing language
3. Computer Networks

Hardware & Software Requirements:

Hardware Requirement:	Software requirement:
PC i3 processor and above IoT Sensor and Kit with Wifi/Bluetooth support	JDK 8 and above, Android studio, Flutter SDK, Internet Connection

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Experimentation with Microprocessor and Microcontroller , Experimentation with python and c	**02**	
I	Dart	Introduction to Dart Programming Language Dart Programming – Syntax Dart Functions & Object-Oriented Programming (OOP)	**05**	LO1, LO2
II	Flutter	Introduction to Flutter, installation, creating simple flutter application using android app, architecture application	**05**	LO1,LO2
III	Flutter Widgets and visual effects	Flutter Widgets Fundamentals, Navigation and Routing, Visual, Behavioral, and Motion-Rich Widgets implementing Material Design Guidelines	**05**	LO3
IV	Location-Aware Apps:	Location-Aware Apps: Using GPS and Google Maps	**03**	LO5,LO6
V	Firebase	Environment setup, data, array, write data, read data, queries and filtering data	**03**	LO5,LO6
VI	App Testing & Publishing	Types of Testing, Steps involed in testing , example of testing , Deployment tools.	**03**	LO4,LO5, L06

Text & Reference Books:

1. Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter and Dart 2 by Alessandro Biessek
2. Flutter Projects: A practical, project-based guide to building real-world cross-platform mobile applications and games Paperback – Import, 7 April 2020 by Simone Alessandria

Online References:

1. https://docs.flutter.dev/reference/tutorials
2. https://www.tutorialspoint.com/flutter/index.htm
3. https://flutter.dev/docs/get-started/install

List of Experiments.

Basics of flutter five experiments

1. Introduction to Dart Programming
2. Write a program to explore Widgets, Layouts, Gestures and State Management
3. Writing Android Specific Code
4. Write a program to explore Packages and Database
5. Write a program for Accessing REST API, Internationalization and Deployment of application

Using flutter (cross platform applications) implement any five experiments from given list

1. Using mobile app controlling light
2. GPS coordinate of phone and selfie to mark attendance
3. Read RFID card and detect the object
4. Read NFC card and detect the object
5. Read temperature value in the room using temperature measurement LM_35 sensor and display it in the mobile app in the form of a graph for a day to show temperature changes every after one hr
6. Read temperature value in the room using humidity measurement SY_HS 220 sensor and display it in the mobile app in the form of a graph for a day to show temperature changes every after one hr
7. Install a motion sensor on the door and track movement when door is open send alarm should to raise on phone

Note: Use Flutter for mobile application development and Bluetooth or Wi-Fi for IOT sensors communication

Term Work: Term Work shall consist of at least 10 to 12 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
IoTM601	Mini Project :2B IoT & Mobile App Based.	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
IoTM601	Mini Project :2B IoT & Mobile App Based.	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.

9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.

- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
IoTDLO6011	Enterprise Network Design	04	--		04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
IoTDLO6011	Enterprise Network Design	20	20	20	80	- -	- -	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To be familiarized with the methodologies and approaches of the network design for an enterprise network.
2	To understand the network hierarchy and use modular approach to network design for an enterprise network.
3	To understand the campus design and data center design considerations for designing an enterprise campus.
4	To study Enterprise Edge WAN Technologies and design a WAN using them.
5	Designing an IP addressing plan and selecting a Route protocol for an enterprise network.
6	To design enterprise network for given user requirements in an application.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the customer requirements and Apply a Methodology to design a Network.	L1,L2,L3
2	Structure and Modularize the design for an enterprise network.	L6
3	Design Basic Campus and Data Center for an enterprise network.	L6
4	Design Remote Connectivity for an enterprise network.	L6
5	Design IP Addressing and Select suitable Routing Protocols for an enterprise network.	L6
6	Explain SDN and its functioning.	L4,L5

Pre-requisite: Computer Networks

DETAIL SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Pre-requisite	1. OSI Reference Model and TCP/IP Protocol Suite 2. Routing IP Addresses 3. Internetworking Devices	**02**	
I	Applying a Methodology to Network Design:	The Service Oriented Network Architecture, Network Design Methodology, Identifying Customer requirements, Characterizing the Existing Network and Sites, Using the Top- Down Approach to Network Design, The Design Implementation Process. **Self-Learning Topics:** Study the basic concepts of Top-down network design approach with real time application.	**06**	CO1
II	Structuring and Modularizing the Network:	Network Hierarchy, Using a Modular Approach to Network Design, Services Within Modular Networks, Network Management Protocol: SNMP. **Self-Learning Topics:** Study different type of NMP protocols.	**05**	CO2
III	Designing Basic Campus and Data Center Networks	Campus Design Considerations, Enterprise Campus Design, Enterprise Data Center Design Considerations. **Self-Learning Topics:** Real time case study on Enterprise Data Center.	**06**	CO3

IV	Designing Remote Connectivity	Enterprise Edge WAN Technologies, WAN Transport Technologies, WAN Design, Using WAN Technologies, Enterprise Edge WAN and MAN Considerations, Enterprise Branch and Teleworker Design . **Self-Learning Topics:** Case study on WAN design.	**06**	CO4
V	Designing IP Addressing in the Network and Selecting Routing Protocols	Designing an IP Addressing Plan, Introduction to IPv6, Routing Protocol Features, Routing Protocols for the Enterprise, Routing Protocol Deployment, *Route* Redistribution, Route Filtering, Route Summarization **Self-Learning Topics:** Study of different routing protocols for Enterprise design.	**10**	CO5
VI	Software Defined Network	Understanding SDN and Open Flow : SDN Architecture – SDN Building Blocks, OpenFlow messages – Controller to Switch, Symmetric and Asynchronous messages, Implementing OpenFlow Switch, OpenFlow controllers , POX and NOX. **Self-Learning Topics:** Case study on SDN.	**04**	CO6

Text Books:

1. Authorized Self-Study Guide, Designing for Cisco Internetwork Solutions (DESGN), Second Edition, Cisco Press-Diane Teare.
2. Network Analysis, Architecture, and Design 3rd Edition, Morgan Kaufman, James D.
3. CCDA Cisco official Guide
4. Software Defined Networking with Open Flow : PACKT Publishing Siamak Azodolmolky

References Books:

1. Top-Down Network Design (Networking Technology) 3rd Edition, Priscilla Oppenheimer ,Cisco Press Book
2. Network Planning and Design Guide Paperback – 2000,Shaun Hummel

Online References:

1. www.cisco.com
2. https://buildings.honeywell.com

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
IoTDLO6012	Blockchain Technology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
IoTDLO6012	Blockchain Technology	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To get acquainted with the concept of Distributed ledger system and Blockchain.
2	To learn the concepts of consensus and mining in Blockchain through the Bitcoin network.
3	To understand Ethereum and develop-deploy smart contracts using different tools and frameworks.
4	To understand permissioned Blockchain and explore Hyperledger Fabric.
5	To understand different types of crypto assets.
6	To apply Blockchain for different domains IOT, AI and Cyber Security.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per

		Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concept of Blockchain and Distributed Ledger Technology.	L1,L2
2	Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions	L1,L2,L3
3	Implement smart contracts in Ethereum using different development frameworks.	L1,L2,L3
4	Develop applications in permissioned Hyperledger Fabric network.	L1,L2,L3
5	Interpret different Crypto assets and Crypto currencies	L1,L2,L3
6	Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies.	L4,

Prerequisite: Cryptography and Distributed Systems

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Cryptography and Distributed Systems (prerequisite)**	Hash functions, Public – Private keys, SHA, ECC, Digital signatures, Fundamental concepts of Distributed systems	**02**	—-
I	**Introduction to DLT and Blockchain**	Distributed Ledger Technologies (DLTs) Introduction, Types of Blockchains **Blockchain:** Origin, Phases, Components **Block in a Blockchain**: Structure of a Block, Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Blockchain, Merkle Tree. **Self-learning Topics:** Blockchain Demo	**04**	CO1
II	**Consensus and Mining**	What is Bitcoin and the history of Bitcoin, Bitcoin Transactions, Bitcoin Concepts: keys, addresses and wallets, Bitcoin Transactions, validation of transactions, PoW consensus **Bitcoin Network**: Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering, The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging "Inventory", Simplified Payment Verification (SPV) Nodes, SPV Nodes and Privacy, Transaction Pools, Blockchain Forks **Self-learning Topics:** Study and compare different consensus algorithms like PoA, PoS, pBFT	**08**	CO2
III	**Permissionless Blockchain: Ethereum**	Components, Architecture of Ethereum, Miner and mining node, Ethereum virtual machine, Ether, Gas, Transactions, Accounts, Patricia Merkle Tree, Swarm, Whisper and IPFS, Ethash, End to end transaction in Ethereum, **Smart Contracts**: Smart Contract programming using solidity, Metamask (Ethereum Wallet), Setting up development environment, Use cases of Smart Contract, Smart Contracts: Opportunities and Risk. **Smart Contract Deployment**: Introduction to Truffle, Use of Remix and test networks for deployment **Self-learning Topics:** Smart contract development using Java or Python	**10**	CO3
IV	**Permissioned Blockchain : Hyperledger Fabric**	Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain. **Components**: Certificate Authority, Nodes, Chain codes, Channels, Consensus: Solo, Kafka, RAFT Designing Hyperledger Blockchain	**07**	CO4

		Self-learning Topics: Fundamentals of Hyperledger Composer		
V	**Crypto assets and Cryptocurrencies**	ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, ICO, STO, Different Crypto currencies **Self-learning Topics:** Defi, Metaverse, Types of cryptocurrencies	**04**	CO5
VI	**Blockchain Applications & case studies**	Blockchain in IoT, AI , Cyber Security **Self-learning Topics:** Applications of Blockchain in various domains Education, Energy, Healthcare, real-estate, logistics, supply chain	**04**	CO6

Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press.
4. Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, Ashwani Kumar, BPB publications
5. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication
6. Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond, Chris Burniske & Jack Tatar.

Reference:

1. Mastering Blockchain, Imran Bashir, Packt Publishing 2. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media
2. Blockchain Technology: Concepts and Applications, Kumar Saurabh and Ashutosh Saxena, Wiley.
3. The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them, Antony Lewis.for Ethereum and Blockchain, Ritesh Modi, Packt publication.
4. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media

Online References:

1. NPTEL courses:
    a. Blockchain and its Applications,
    b. Blockchain Architecture Design and Use Cases
2. www.swayam.gov.in/
3. www.coursera.org
4. https://ethereum.org/en/
5. https://www.trufflesuite.com/tutorials
6. https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.h
7. Blockchain demo: https://andersbrownworth.com/blockchain/
8. Blockchain Demo: Public / Private Keys & Signing: https://andersbrownworth.com/blockchain/public-private-keys/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
IoTDLO6013	Interfacing Programming with IOT Gateway & Middleware Technologies	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
IoTDLO6013	Interfacing Programming with IOT Gateway & Middleware Technologies	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	

1	Understand and analyze the basics of Arduino and Raspberry Pi.
2	Define and understand architecture of IoT Gateway and Middleware Technologies.
3	Study of M2M interaction and Arduino based web communication.
4	Describe networking with RESTful API's.
5	Study and analyze various IoT protocols and IoT interactions.
6	Design IoT based applications like automated light controllers, sprinkler controllers.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain and design IoT based interfacing using Arduino and Raspberry Pi.	L1,L2
2	Describe and apply the knowledge of IoT gateway and configuring a self-signed certificate.	L1,L2
3	Apply the design considerations and requirements of IoT middleware.	L1,L2,L3
4	Understand the basics of microservices framework and web socket servers.	L1,L2
5	Understand the various types of IoT interactions and applying the knowledge to design automated controllers.	L1,L2
6	Apply concepts like networking with IoT protocols, applying QOS to messages and design the web-based client.	L1,L2,L3

Prerequisite: Basics of Internet of Things (IoT), Wireless technologies.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of IoT, Objects in IOT, Identifier in the IOT, Technologies in IOT.	**02**	
I	Arduino and Raspberry Pi Basics	Introduction to Arduino, Arduino Uno Wired & Wireless connectivity. Introduction to Raspberry Pi, Installation of NOOBS and Raspbian on SD card, Libraries on Raspberry Pi, getting static IP address of Raspberry Pi, Installing Remote Desktop Server, Pi camera installation- Face recognition using Raspberry Pi and data logger with ThingSpeak server. **Self-learning Topics:** Study of Odroid, UDOO Bolt and Nvidia Jetson. To study ThingSpeak server in detail.	**06**	**CO1**
II	IOT Gateways	Overview and architecture of IOT Gateway, Functions of IOT Gateway, Examples and types of Gateways in IoT. Configuring Gateway and Gateway certificate. User interface- configuring an Agent. Configuring a self-signed certificate. **Self-learning Topics:** Study of different IoT Gateway devices and their features.	**06**	**CO2**
III	IoT Middleware	Middleware architecture, IoT middleware design considerations and requirements. Resource discovery and management. Data management, context awareness, and event management. The service-	**06**	**CO3**

		oriented middleware (SOM). Agent-based middleware. Interfacing with Web services. Introduction to Temboo platform, Tweeting from an Arduino board. Automation with IFTTT, sending push and text message notifications. **Self-learning Topics:** Study of recent IoT middleware protocols like Redhat JBoss, Oracle Fusion Middleware and WSO2 Carbon		
IV	Networking with RESTful APIs and Web Sockets	Introduction to Flask microservices framework, creating a RESTful APIs service with Flask-RESTful. Introduction to PWM, adding a RESTful APIs client web page. Creating a Web Socket Service with Flask-Socket IO. Comparing the RESTful API and Web Socket Servers. **Self-learning Topics:** Study of different REST API's and its design patterns.	**06**	**CO4**
V	Machine to Machine Interaction	Introduction and types of IoT interaction, Cloud M2M with IFTTT, M2M Alarm system, Automated light controller, sprinkler controller. Getting data from a web page, sending data to the cloud. **Self-learning Topics:** Study of applications of Cloud computing using IoT. Case study on deployment of IoT applications on cloud platform.	**07**	**CO5**
VI	Networking with MQTT	Introduction to MQTT with example. Publishing and Subscribing MQTT messages. Applying Quality of Service to messages. Controlling an LED with MQTT. Introduction to Web-based MQTT client. **Self-learning Topics**: Study of MQTT broker services, Python Paho-MQTT Client library. MQTT Callback and init method.	**06**	**CO6**

Text Books:

1. Maneesh Rao, "Internet of things with Raspberry Pi3", First edition, Packt 2018.
2. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, "Internet of things with Raspberry Pi and Arduino", First edition, CRC press, 2019.
3. Adeel Javed, "Building Arduino projects for the Internet of Things", First edition, Apress 2017.

References:

1. Macro Schwartz, "Internet of Things with Arduino Cookbook" First edition, Packt 2016.
2. Delicato Flavia C, "Middleware Solutions for the Internet of Things" Springer Paperback.

Online References:

https://www.coursera.org/learn/raspberry-pi-interface
https:// www.classcentral.com/course/arduino-platform-4206

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
IoTDLO6014	Theory Course	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
IoTDLO6014	Cloud Computing and Services	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Basics of cloud computing and its difference with respect to other types of computing's
2	Understand the meaning and the need for having virtualization.
3	Identify the different types of services offered by cloud.
4	Understand the administration and management of cloud services.

5	Identify the various types of securities that can be applied to the cloud.
6	Understand the current and the emerging trends in cloud computing.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Differentiate between different cloud computing models.	L1,L2,L3
2	Implement the virtualization type as per the needs.	L1,L2,L3
3	Select the required cloud service as per the requirements.	L1,L2
4	Apply management strategies for cloud computing applications.	L1,L2,L3
5	Decide and apply the security measures in cloud computing.	L1,L2,L3
6	Understand current trends and apply their knowledge for the development of the new trends.	L1,L2,L3

Prerequisite: Computer Networks

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	LAN, WAN, MAN, Internetworking and networking devices, Working of OSI model for data transfer. Operating systems.	**02**	--
I	Introduction to Cloud Computing	Need for cloud, Cloud Computing and its components, Types of Cloud: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models, Cloud Computing architecture, Characteristics of cloud, Uses of cloud**,** Advantages and disadvantages of cloud computing. **Self-learning Topics:** Client server architecture and peer to peer configuration, Ubiquitous computing, Utility computing, Grid computing, Edge computing.	**08**	CO1
II	Virtualization	Introduction to virtualization, Need for virtualization, Taxonomy of virtualization, Hypervisor and its types, Paravirtualization, Full virtualization, Implementation levels of virtualization, Virtualization and cloud computing Types of virtualizations - memory, CPU, I/O, OS and server virtualization. Virtualization technology: KVM, XEN, Vmware, HperV, QEMU **Self-learning Topics:** Datacenter virtualization, Storage virtualization, Sensor virtualization. Physical machine to virtual machine conversion	**06**	CO2
III	Cloud Computing services	Primary services with its layered representation, Secondary services such as Security as a Service, Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service, Compliance as a Service, Monitoring as a Service, Communication as a Service, Network as a service. Application as a service, Integration as service, Disaster recovery as a service, Analytics as a service and Backup as a service	**06**	CO3

		Self-learning Topics: Paas ~~Providers,~~ and Saas providers, comparison of all the service providers		
IV	Cloud implementation and Management	Open stack cloud architecture, its features, Components and modes of operations. AAA Model, Cloud API. Disaster management and Capacity planning. SMB: problems of SMB in cloud adoption, Public cloud adoption phases for SMB, Cloud vendors and cloud providers roles and responsibilities **Self-learning Topics:** Cloud service management	**06**	CO4
V	Cloud Security	Host security (Iaas, Paas, Saas), Data security (challenges and types), Application security, Information security, Risk, attacks and vulnerabilities in cloud computing: reasons and types of risk, types of vulnerabilities, solution for risk and vulnerability **Self-learning Topics:** Secured cloud software testing, Legal matters in cloud security	**06**	CO5
VI	Trends in Cloud computing	Mobile cloud computing: Need of Mobile cloud computing, its components, Green cloud computing: its requirements Cloud data center, Media cloud, Application specific cloud, Groupware cloud and Intercloud. **Self-learning Topics:** Applications of mobile cloud computing and green cloud computing, Third party cloud service	**05**	CO6

Text Books:

1. Cloud computing Bible by Barrie Sosinsky
2. Cloud Computing Black book by Kailash jayaswal, jagannath kallakurchi, Donald J Houde, Dr Deven Shah
3) Cloud Computing by Kailash jayaswal, jagannath kallakurchi, Donald J Houde
4) Cloud application architectures by George reese
5) Cloud Computing by Shailendra Singh

References Books:

1. Mastering cloud computing by Rajkumar Bhuyya, Christian Vecchiola, S. thamarai selvi
2. Cloud Computing by Dr Kumar Saurabh

Online References:

1. https://www.tutorialspoint.com/cloud_computing/cloud_computing_security.htm
2. https://aws.amazon.com/
3. https://nptel.ac.in/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

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