GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3722320

Semester – II
Subject Name: IoT Application and Communication Protocol

Type of course: Master Of Engineering

Prerequisite: Fundamentals of computer network, wireless sensor network, communication & Internet technology, web technology.

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Sr. No.	Syllabus Content	No. of Hours
1	**Introduction IoT & The Internet of Things Today:** What Is IoT? ,Genesis of IoT, IoT and Digitization , IoT Impact, Connected Roadways & Connected Factory,Smart Connected Buildings ,Smart Creatures , Convergence of IT and OT, IoT Challenges.	2
2	**Identification of IoT Objects and Services:** Structural Aspects of the IoT: Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture. Key IoT Technologies: Device Intelligence, Communication Capabilities, Mobility Support , Device Power, Sensor Technology, RFID Technology, Satellite Technology.	4
2	**IoT Network Architecture and Design:** • Comparing IoT Architectures ,The oneM2M IoT Standardized Architecture, The IoT World Forum (IoTWF) Standardized Architecture, • Layer 1: Physical Devices and Controllers Layer, • Layer 2: Connectivity Layer, • Layer 3: Edge Computing Layer, • Upper Layers: Layers 4–7 ,IT and OT Responsibilities in the IoT Reference Model, Additional IoT Reference Models, A Simplified IoT Architecture, • The Core IoT Functional Stack: ◦ Layer 1: Things: Sensors and Actuators Layer, ◦ Layer 2: Communications Network Layer,Access Network Sublayer: Gateways and Backhaul Sublayer,Network Transport Sublayer,IoT Network Management Sublayer, ◦ Layer 3: Applications and Analytics Layer, Analytics Versus Control Applications, Data Versus Network Analytics, Data Analytics Versus Business Benefits.	8
3	Smart Objects: The “Things” in IoT & Connecting Smart Objects: • Sensors, Actuators, and Smart Objects, Sensors, Actuators, Micro-Electro-Mechanical Systems (MEMS),Smart Objects.	10

	• Smart Objects: A Definition, Trends in Smart Objects, Sensor Networks, Wireless Sensor Networks(WSNs), Communication Protocols for Wireless Sensor Networks. • Communications Criteria & IoT Access Technologies: IEEE 802.15.4 ,IEEE 802.15.4g and 802.15.4e , IEEE 1901.2a ,IEEE 802.11ah, LoRaWAN & NB-IoT and Other LTE Variations: Physical Layer, MAC Layer, Topology, Security & Competitive Technologies.	
4	**IP as the IoT Network Layer:** The Business Case for IP, The Key Advantages of Internet Protocol, Adoption or Adaptation of the Internet Protocol, The Need for Optimization, Optimizing IP for IoT. LoWPAN: Header Compression, Fragmentation, Mesh Addressing, Mesh-Under Versus Mesh-Over Routing.	4
5	**Application Protocols for IoT:** The Transport Layer, IoT Application Transport Methods: Application Layer Protocol Not Present, SCADA, A Little Background on SCADA, Adapting SCADA for IP, Tunneling Legacy SCADA over IP Networks, SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T, Generic Web-Based Protocols, IoT Application Layer Protocols, CoAP, Message Queuing Telemetry Transport (MQTT).	8
6	**Internet of Things Applications Examples:** Overview, Smart Metering/Advanced Metering Infrastructure, e-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking (Following and Monitoring Mobile Objects), Over-The-Air-Passive Surveillance/Ring of Steel, Control Application Examples, Myriad Other Applications.	6

Reference Books

1. IoT Fundamentals, Networking Technologies ,Protocols, and Use Cases for the Internet of Things, David Hanes ,Gonzalo Salgueiro,Patrick Grossetete, Rob Barton, Jerome Henry, Forwarded by Rowan Trollope, Ciscopress.com, Pearson,reprint 2017/2018
2. Building the Internet of Things with IPv6 and MIPv6,The Evolving World of M2M Communications, Daniel Minoli, Willy ,Reprint 2018
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, **"From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",** 1st Edition, Academic Press, 2014.
4. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013, ISBN: 978-87-92982-96-4 (EBook), ISBN: 978-87-92982-73-5 (Print)
5. Vijay Madisetti and Arshdeep Bahga, **"Internet of Things (A Hands-on-Approach)",** 1st Edition, VPT, 2014.
6. Francis daCosta, **"Rethinking the Internet of Things: A Scalable Approach to Connecting Everything",** 1st Edition, Apress Publications, 2013
7. Cuno Pfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493-9357-1

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Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**12**	**16**	**16**	**08**	**08**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Course Outcome:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the fundamentals of IoT from a Application design context	10
CO-2	Determine smart objects and its connect	20
CO-3	Understand the application protocols of IoT and its network and interconnecting aspects and rules	20
CO-4	Use of IoT Devices, Gateways and Data Management in various network layer protocols	15
CO-5	Developing IoT Applications	20
CO-6	Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints	15

List of Experiments:

1. Develop simple Smart Metering Application
2. Develop any simple e-Health using body Area Networks sensors like temperature and pressure.
3. Understand City Automation on Any smart city Simulation Tools.
4. Develop Home Automation small Application.
5. Develop Smart Cards based or payment card based using standard Paypal or any other toolkit.
6. Develop Simple racking Application on (Following and Monitoring Mobile Objects).
7. Develop Over-The-Air-Passive Surveillance application simple example
8. Define and Explain Eclipse IoT Project.
9. List and summarize few Eclipse IoT Projects.
10. Sketch the architecture of IoT Toolkit and explain each entity in brief.
11. Demonstrate a smart object API gateway service reference implementation in IoT toolkit.
12. Write and explain working of an HTTP- to-CoAP semantic mapping proxy in IoT toolkit.
13. Describe gateway-as-a-service deployment in IoT toolkit.
14. Explain application framework and embedded software agents for IoT toolkit.
15. Explain working of Raspberry Pi.
16. Connect Raspberry Pi with your existing system components.

Major Equipment:

Raspberry pi, Arduino, Google Devices and Google App Engine and its toolkits

List of Open Source Software/learning website:

- https://github.com/connectIOT/iottoolkit
- https://www.arduino.cc/
- http://www.zettajs.org/
- Contiki (Open source IoT operating system)
- Arduino (open source IoT project)
- IoT Toolkit (smart object API gateway service reference implementation)