

UNIT - I

➤ Chapter 1 : The Internet of Things : An Overview	1-1 to 1-13
✓ Syllabus Topic : The “Internet: of “Things” 1-1	1-1
1.1 The Internet of Things : An Overview 1-1	1-1
✓ Syllabus Topic : Enchanted Objects 1-4	1-4
1.2 Enhanced Objects 1-4	1-4
1.2.1 Smart Physical Objects 1-5	1-5
1.2.2 Smart Virtual Objects 1-6	1-6
✓ Syllabus Topic : Who is Making the Internet of Things..... 1-7	1-7
1.3 Making of IoT 1-7	1-7
1.3.1 IoT Definition – A Different Overview 1-7	1-7
1.3.2 IoT – A Simple Case of Future 1-8	1-8
✓ Syllabus Topic : The Flavors of The Internet of Things..... 1-10	1-10
1.3.3 Flavors of The Internet of Things 1-10	1-10
✓ Syllabus Topic : The Technology of Internet of Things..... 1-11	1-11
1.3.4 The Technology of Internet of Things 1-11	1-11
• Chapter Ends..... 1-13	1-13
➤ Chapter 2 : Design Principles for Connected Devices	2-1 to 2-21
2.1 Design Principals of IoT 2-1	2-1
✓ Syllabus Topic : Calm Technology 2-4	2-4
2.2 Calm Technology or Calm Design..... 2-4	2-4
✓ Syllabus Topic : Ambient Technology 2-4	2-4
2.3 The Ambient Intelligence Technology 2-4	2-4
✓ Syllabus Topic : Magic as Metaphor 2-5	2-5
2.4 Five Metaphors for the Internet of Things 2-5	2-5
✓ Syllabus Topic : Privacy and Keeping Secrets 2-8	2-8
2.5 Privacy and Keeping Secrets 2-8	2-8
2.6 The Evolution of Privacy and Trust..... 2-9	2-9
✓ Syllabus Topic : Whose Data is it Anyway ? 2-10	2-10
2.7 The Deluge of Data (Whose data is it anyway?)..... 2-10	2-10
2.7.1 The Responsibility for Data Privacy 2-11	2-11
✓ Syllabus Topic : Web Thinking for Connected Devices 2-11	2-11
2.8 Web Thinking for Connected Devices..... 2-11	2-11



2.8.1	What is this Web of Things?.....	2-11
2.9	A Uniform Technology.....	2-12
2.10	Web of Things Scenario: Connected Hotel.....	2-13
✓	Syllabus Topic : Small Pieces, Loosely JOINED.....	2-14
2.11	Small and Loosely Joined in IOT.....	2-14
✓	Syllabus Topic : First Class Citizen on the Internet.....	2-15
2.12	First Class Citizen on the Internet.....	2-15
✓	Syllabus Topic : Graceful Degradation.....	2-16
2.12.1	Graceful Degradation in IoT.....	2-16
✓	Syllabus Topic : Affordances.....	2-17
2.13	Role of Affordances in Digital Transformation and Internet of Things.....	2-17
2.13.1	Affordance in DT/IoT.....	2-18
2.13.2	Causes of Poor Affordances.....	2-19
2.13.3	Avoiding Poor Affordances.....	2-20
•	Chapter Ends.....	2-21

▶ Chapter 3 : Internet Principles**3-1 to 3-52**

3.1	The Seven Principles of the Internet of Things (IoT).....	3-1
✓	Syllabus Topic : Internet Communications : An Overview.....	3-4
3.2	Internet Communications.....	3-4
✓	Syllabus Topic : IP, TCP, The IP Protocol Suite(TCP/IP).....	3-12
3.3	Overview of TCP/IP.....	3-12
✓	Syllabus Topic : UDP.....	3-15
3.4	UDP- User Datagram Protocol.....	3-15
3.5	TCP- Transmission Management Protocol.....	3-15
3.5.1	TCP and UDP Headers.....	3-16
✓	Syllabus Topic : TCP and UDP ports.....	3-17
3.5.2	TCP and UDP ports.....	3-17
3.6	Multipath TCP Deployments.....	3-20
3.7	Smartphones.....	3-21
3.7.1	End-to-end Multipath TCP.....	3-21
3.7.2	Multipath TCP through SOCKS Proxies.....	3-23
✓	Syllabus Topic : IP Addresses.....	3-26
3.8	The Internet of Things & IP Address Needs.....	3-26
✓	Syllabus Topic: DNS.....	3-28
3.9	Securing DNS.....	3-28



✓	Syllabus Topic : Static IP address assignment and Dynamic IP Address assignment.....	3-28
3.9.1	Static IP address assignment and Dynamic IP Address assignment	3-28
✓	Syllabus Topic : IPv6	3-35
3.10	IPv6 for IoT	3-35
✓	Syllabus Topic : MAC Addresses.....	3-37
3.10.1	MAC Addresses.....	3-37
✓	Syllabus Topic : HTTP ports.....	3-38
3.11	HTTP	3-38
✓	Syllabus Topic : Application Layer Protocols.....	3-38
3.12	Application Layer Protocols	3-38
3.13	MQTT Protocol Architecture.....	3-40
3.14	MQTT-SN Protocol Architecture	3-46
✓	Syllabus Topic : Other Common Ports.....	3-46
3.14.1	Other Common Ports	3-46
✓	Syllabus Topic : HTTPS : Encrypted HTTP	3-48
3.15	HTTPS : Encrypted HTTP.....	3-48
3.16	SSL or TLS	3-49
3.16.1	How Does SSL/TLS Actually Work?.....	3-49
3.16.2	OpenSSL.....	3-49
✓	Syllabus Topic : Other Application Layer Protocols.....	3-50
3.16.3	Other Application Layer Protocols	3-50
	• Chapter Ends.....	3-52

UNIT - II

➤ Chapter 4 : Thinking About Prototyping		4-1 to 4-26
4.1	Design Thinking - Prototype Stage.....	4-1
4.1.1	Primary Guidelines for Prototyping.....	4-1
4.1.2	Final Prototype.....	4-3
✓	Syllabus Topic : Sketching	4-3
4.2	Sketching	4-3
4.2.1	Benefits of Sketching and Prototyping	4-3
4.2.2	Prototyping Steps.....	4-4
✓	Syllabus Topic : Familiarity, Cost vs. ease of Prototyping.....	4-6
4.3	Familiarity, Cost vs. ease of Prototyping	4-6



✓	Syllabus Topic : Prototype and Production	4-9
4.4	Prototype and Production.....	4-9
4.4.1	Prototype.....	4-9
4.4.2	Production.....	4-10
✓	Syllabus Topic : Changing Embedded Platforms	4-10
4.5	Changing Embedded Platforms	4-10
✓	Syllabus Topic : Physical Prototypes and Mass Personalization	4-11
4.6	Physical Prototypes and Mass Personalization	4-11
✓	Syllabus Topic : Climbing into Cloud	4-14
4.6	Climbing into Cloud	4-14
4.6.1	Accelerate Business Agility and Decision Making with IOT Data.....	4-14
4.6.2	Enhance your IOT solution with Location Intelligence	4-14
✓	Syllabus Topic : Open Source Vs. Closed Source	4-17
4.7	Open Source Vs. Closed Source	4-17
✓	Syllabus Topic : Why Closed? Why Open?	4-18
4.7.1	What's the Difference between Open Source and Closed Source Software? Let's Explain....	4-18
✓	Syllabus Topic : Mixing Open and Closed Source	4-19
4.7.2	Which Type of Software Should You Use for Business Purposes?.....	4-19
4.7.3	Where Does Open Source Fit in Your Business?	4-20
✓	Syllabus Topic : Tapping into the Community	4-23
✓	Syllabus Topic : Closed Source for Mass Market Projects	4-23
4.8	Closed Source for Mass Market Projects	4-23
4.8.1	Prototyping Embedded Devices.....	4-24
4.8.2	Business Benefits.....	4-24
	• Chapter Ends.....	4-26

➤ Chapter 5 : Prototyping Embedded Devices	5-1 to 5-19
---	--------------------

✓	Syllabus Topic : Electronics, Sensors and Actuators	5-1
5.1	Electronics, Sensors and Actuators.....	5-1
✓	Syllabus Topic : Scaling up the Electronics, System-on-Chips	5-2
5.2	Scaling up the Electronics.....	5-2
✓	Syllabus Topic : Embedded Computing basics	5-3
5.3	Embedded Computing basics.....	5-3
5.3.1	Embedded systems hardware	5-4
5.3.2	Embedded systems software	5-4



✓	Syllabus Topic : Choosing Your Platform	5-5
5.4	Choosing Your Platform	5-5
✓	Syllabus Topic : Developing on the Arduino	5-5
5.5	Developing on the Arduino.....	5-5
5.6	IOT device Characteristics.....	5-6
✓	Syllabus Topic : Some Notes on the Hardware, Openness	5-9
5.6.1	Types of off-the-shelf Hardware for Prototyping your IOT Project and Openness	5-9
✓	Syllabus Topic : Cases and Extension Boards, Microcontrollers	5-10
5.6.2	Cases and Extension Boards	5-10
✓	Syllabus Topic : Arduino	5-11
5.6.3	Arduino Microcontroller Development Board.....	5-11
✓	Syllabus Topic : Raspberry Pi	5-13
5.7	Single Board Computers	5-13
✓	Syllabus Topic : Developing on the Raspberry Pi	5-15
5.7.1	Raspberry Pi 3 Model B Microcontroller Board.....	5-15
✓	Syllabus Topic : Some notes on the Hardware, Openness	5-16
5.8	IOT Hardware Requirements for Deploying your IOT Project and Openness	5-16
5.8.1	Ease of Development	5-17
5.8.2	Data Acquisition, Processing, and Storage Requirements	5-17
5.8.3	Connectivity Requirements.....	5-18
5.8.4	Power Requirements	5-18
5.8.5	Physical Device Design Requirements	5-18
5.8.6	Cost Requirements.....	5-19
	• Chapter Ends.....	5-19

UNIT - III

➤	Chapter 6 : Prototyping the Physical Design	6-1 to 6-17
---	--	--------------------

✓	Syllabus Topic : Preparation	6-1
6.1	Preparation	6-1
✓	Syllabus Topic : Sketch, Iterate, and Explore	6-2
6.2	Sketch, Iterate, and Explore	6-2
✓	Syllabus Topic : Non-digital Methods	6-3
6.3	Non-digital Methods	6-3
✓	Syllabus Topic : Laser Cutting	6-5
6.4	Laser Cutting	6-5



✓	Syllabus Topic : Choosing a Laser Cutter	6-6
6.5	Choosing a Laser Cutter.....	6-6
✓	Syllabus Topic : Software	6-6
6.6	Software.....	6-6
✓	Syllabus Topic : Hinges and Joints	6-8
6.7	Hinges and Joints	6-8
6.7.1	Lattice (or Living) Hinges	6-8
6.7.2	Integrated Elastic Clip	6-8
6.7.3	Bolted Tenon (or T-Slot) Joints	6-9
✓	Syllabus Topic : 3D Printing	6-9
6.8	3D Printing.....	6-9
✓	Syllabus Topic : Types of 3D Printing	6-10
6.8.1	Types of 3D Printing.....	6-10
✓	Syllabus Topic : Software	6-12
6.9	Software	6-12
✓	Syllabus Topic : CNC Milling	6-13
6.10	CNC Milling	6-13
✓	Syllabus Topic : Repurposing/Recycling	6-15
6.11	Repurposing/Recycling.....	6-15
	• Chapter Ends.....	6-17
➤ Chapter 7 : Prototyping Online Components		7-1 to 7-18
✓	Syllabus Topic : Getting Started with an API	7-1
7.1	Getting Started with an API.....	7-1
✓	Syllabus Topic : Mashing Up APIs	7-2
7.2	Mashing up APIS.....	7-2
✓	Syllabus Topic : Scraping	7-2
7.3	Scraping	7-2
✓	Syllabus Topic : Legalities	7-3
7.4	Legalities.....	7-3
✓	Syllabus Topic : Writing a new API	7-3
7.5	Writing a new API	7-3
✓	Syllabus Topic : Clockodillo	7-4
7.6	Clockodillo	7-4



✓	Syllabus Topic : Security	7-5
7.7	Security	7-5
✓	Syllabus Topic : Implementing the API	7-7
7.8	Implementing the API.....	7-7
✓	Syllabus Topic : Using Curl to Test	7-9
7.9	Using Curl to Test.....	7-9
✓	Syllabus Topic : Going Further	7-12
7.10	Going Further.....	7-12
7.10.1	API Rate Limiting.....	7-12
7.10.2	OAuth for Authenticating with Other Services.....	7-12
7.11	Designing a Web Application for Humans	7-13
✓	Syllabus Topic : Real-Time Reactions	7-14
7.12	Real-Time Reactions.....	7-14
✓	Syllabus Topic : Polling	7-14
7.13	Polling.....	7-14
✓	Syllabus Topic : Comet	7-15
7.14	Comet.....	7-15
7.14.1	Multipart XMLHttpRequest (MXHR) (Unidirectional)	7-15
7.14.2	HTML5 WebSockets (Bidirectional).....	7-16
✓	Syllabus Topic : Other Protocols	7-16
7.15	Other Protocols	7-16
✓	Syllabus Topic : MQ Telemetry Transport	7-16
7.15.1	MQ Telemetry Transport	7-16
✓	Syllabus Topic : Extensible Messaging and Presence Protocol	7-17
7.15.2	Extensible Messaging and Presence Protocol.....	7-17
✓	Syllabus Topic : Constrained Application Protocol	7-17
7.15.3	Constrained Application Protocol.....	7-17
	• Chapter Ends.....	7-18

UNIT - IV

➤ Chapter 8 : Techniques for Writing Embedded Code	8-1 to 8-11
✓ Syllabus Topic : Memory Management	8-1
8.1 Memory Management.....	8-1
✓ Syllabus Topic : Types of Memory	8-2
8.2 Types of Memory.....	8-2



✓	Syllabus Topic : Making the most of Your RAM	8-4
8.3	Making the most of your RAM.....	8-4
✓	Syllabus Topic : Performance and Battery Life	8-6
8.4	Performance and Battery Life	8-6
✓	Syllabus Topic : Libraries	8-7
8.5	Libraries	8-7
8.6	Debugging.....	8-9
	• Chapter Ends.....	8-11
➤ Chapter 9 : Business Models		9-1 to 9-16
✓	Syllabus Topic : A Short History of Business Models	9-1
9.1	A Short History of Business Models.....	9-1
✓	Syllabus Topic : Space and Time	9-2
9.2	Space and Time.....	9-2
✓	Syllabus Topic : From Craft to Mass Production	9-3
9.3	From Craft to Mass Production.....	9-3
✓	Syllabus Topic : The Long Tail of the Internet	9-4
9.4	The Long Tail of the Internet.....	9-4
✓	Syllabus Topic : Learning from History	9-5
9.5	Learning from History	9-5
✓	Syllabus Topic : The Business Model Canvas	9-5
9.6	The Business Model Canvas.....	9-5
✓	Syllabus Topic : Who is the Business Model for?	9-7
9.7	Who is the Business Model for?	9-7
✓	Syllabus Topic : Models	9-9
9.8	Models	9-9
✓	Syllabus Topic : Make Thing, Sell Thing	9-9
9.9	Make Thing, Sell Thing	9-9
✓	Syllabus Topic : Subscriptions	9-10
9.10	Subscriptions.....	9-10
✓	Syllabus Topic : Customization	9-10
9.11	Customization	9-10
✓	Syllabus Topic : Be a Key Resource	9-11
9.12	Be a Key Resource.....	9-11



✓	Syllabus Topic : Provide Infrastructure: Sensor Networks	9-11
9.13	Provide Infrastructure : Sensor Networks	9-11
✓	Syllabus Topic : Take a Percentage	9-12
9.14	Take a Percentage	9-12
✓	Syllabus Topic : Funding an Internet of Things Startup	9-12
9.15	Funding an Internet of Things Startup	9-12
✓	Syllabus Topic : Hobby Projects and Open Source	9-13
9.16	Hobby Projects and Open Source	9-13
✓	Syllabus Topic : Venture Capital	9-13
9.17	Venture Capital	9-13
✓	Syllabus Topic : Government Funding	9-14
9.18	Government Funding	9-14
✓	Syllabus Topic : Crowdfunding	9-15
9.19	Crowdfunding	9-15
✓	Syllabus Topic : Lean Startups	9-15
9.20	Lean Startups	9-15
	• Chapter Ends.....	9-16

UNIT - V

➤ Chapter 10 :Moving to Manufacture		10-1 to 10-18
✓	Syllabus Topic : What Are You Producing?	10-1
10.1	What are you Producing?.....	10-1
✓	Syllabus Topic : Designing Kits	10-2
10.2	Designing Kits	10-2
✓	Syllabus Topic : Designing Printed Circuit Boards	10-4
10.3	Designing Printed Circuit Boards	10-4
✓	Syllabus Topic : Software Choices	10-5
10.4	Software Choices	10-5
✓	Syllabus Topic : The Design Process	10-6
10.5	The Design Process.....	10-6
10.5.1	The Schematic	10-7
10.5.2	The Board	10-8



✓	Syllabus Topic : Manufacturing Printed Circuit Boards	10-9
10.6	Manufacturing Printed Circuit Boards.....	10-9
✓	Syllabus Topic : Etching Boards	10-9
10.6.1	Etching Boards.....	10-9
✓	Syllabus Topic : Milling Boards	10-9
10.6.2	Milling Boards	10-9
10.6.3	Third-Party Manufacturing	10-10
✓	Syllabus Topic : Assembly	10-10
10.6.4	Assembly	10-10
✓	Syllabus Topic : Testing	10-11
10.6.5	Testing	10-11
✓	Syllabus Topic : Mass-Producing the Case and Other Fixtures	10-11
10.7	Mass-Producing the Case and Other Fixtures	10-11
10.7.1	Injection Molding of Plastic.....	10-12
✓	Syllabus Topic : Certification	10-13
10.8	Certification	10-13
✓	Syllabus Topic : Costs	10-14
10.9	Costs	10-14
✓	Syllabus Topic : Scaling up Software	10-14
10.10	Scaling up Software	10-14
✓	Syllabus Topic : Deployment	10-15
10.11	Deployment.....	10-15
✓	Syllabus Topic : Correctness and Maintainability	10-15
10.12	Correctness and Maintainability	10-15
✓	Syllabus Topic : Security	10-16
10.13	Security	10-16
✓	Syllabus Topic : Performance	10-17
10.14	Performance	10-17
✓	Syllabus Topic : User Community	10-17
10.15	User Community.....	10-17
	• Chapter Ends.....	10-18

➤ Chapter 11 : Ethics		11-1 to 11-11
✓	Syllabus Topic : Characterizing the Internet of Things	11-1
11.1	Characterizing the Internet of Things	11-1
✓	Syllabus Topic : Privacy	11-2
11.2	Privacy	11-2
✓	Syllabus Topic : Control	11-3
11.3	Control	11-3
✓	Syllabus Topic : Disrupting Control	11-4
11.4	Disrupting Control	11-4
✓	Syllabus Topic : Crowdsourcing	11-4
11.5	Crowdsourcing	11-4
✓	Syllabus Topic : Environment	11-6
11.6	Environment	11-6
✓	Syllabus Topic : Physical Thing	11-6
11.7	Physical Thing	11-6
✓	Syllabus Topic : Electronics	11-7
11.8	Electronics	11-7
✓	Syllabus Topic : Internet Service	11-7
11.9	Internet Service	11-7
✓	Syllabus Topic : Solutions	11-8
11.10	Solutions	11-8
✓	Syllabus Topic : The Internet of Things as Part of the Solution	11-8
11.11	The Internet of Things as Part of the Solution	11-8
✓	Syllabus Topic : Cautious Optimism	11-9
11.12	Cautious Optimism	11-9
✓	Syllabus Topic : The Open Internet of Things Definition	11-10
11.13	The Open Internet of Things Definition	11-10
	• Chapter Ends	11-11
	• Model Question Paper	M-1 to M-1
	• Lab Manual	L-1 to L-85
	• Appendix-A	A-1 to A-5
	• Appendix-B	B-1 to B-7
	• University Question Papers	Q-1 to Q-5

Lab Index

Statement	Name of the Program	Page Nos.
L.1	Starting Raspbian OS, Familiarising with Raspberry Pi Components and Interface, Connecting to Ethernet, Monitor, USB.	L-1 to L-30
L.2	Displaying different LED Patterns with Raspberry Pi	L-31 to L-38
L.3	Displaying Time over 4-Digit 7-Segment Display using Raspberry Pi	L-38 to L-42
L.4	Raspberry Pi Based Oscilloscope	L-43 to L-47
L.5	Controlling Raspberry Pi with WhatsApp.	L-47 to L-52
L.6	Setting up Wireless Access Point using Raspberry Pi	L-52 to L-55
L.7	Fingerprint Sensor Interfacing with Raspberry Pi	L-55 to L-58
L.8	Raspberry Pi GPS Module Interfacing	L-58 to L-63
L.9	IoT based Web Controlled Home Automation using Raspberry Pi	L-63 to L-67
L.10	Visitor Monitoring with Raspberry Pi and Pi Camera	L-68 to L-74
L.11	Interfacing Raspberry Pi with RFID	L-74 to L-78
L.12	Building Google Assistant with Raspberry Pi	L-78 to L-81
L.13	Installing Windows 10 IoT Core on Raspberry Pi	L-82 to L-85