



**NMAM INSTITUTE  
OF TECHNOLOGY**

**Scheme and Syllabus for**  
**B.Tech. (Minor) in Internet of Things**

MINOR IN INTERNET OF THINGS													
Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study/ PBL	Duration in hours	CIE Marks	SEE Marks	Total	
					L	T	P	S/J					
1	IPCC	EC2005-1	Programming Microcontrollers	EC	3	0	2	0	3	50	50	100	4
2	IPCC	EC2006-1	Introduction to IoT Protocols	EC	3	0	2	0	3	50	50	100	4
3	PCC	EC3106-1	Connected Devices Security	EC	2	0	2	0	3	50	50	100	3
4	PCC	EC3108-1	Java Programming	EC	3	0	0	0	3	50	50	100	3
5	PCC	EC3107-1	Embedded Security Chip	EC	2	0	2	0	3	50	50	100	3
6	PCC	EC3604-1	Embedded Linux for IoT	EC	0	0	2	0	3	50	50	100	1
<b>Total</b>					<b>13</b>	<b>0</b>	<b>10</b>	<b>0</b>	<b>18</b>	<b>300</b>	<b>300</b>	<b>600</b>	<b>18</b>

<b>PROGRAMMING MICROCONTROLLERS</b>			
<b>Course Code:</b>	<b>EC2005-1</b>	<b>Course Type</b>	<b>IPCC</b>
<b>Teaching Hours/Week (L: T: P: S/J)</b>	<b>3:0:2:0</b>	<b>Credits</b>	<b>04</b>
<b>Total Teaching Hours</b>	<b>40+0+26+0</b>	<b>CIE + SEE Marks</b>	<b>50+50</b>
<b>Prerequisite</b>	<b>EC1001-1, EC1002-2</b>		
<b>Teaching Department: Electronics &amp; Communication Engineering</b>			
<b>Course Objectives:</b>			
<b>1.</b>	Understanding the architecture of 8 bit Microcontroller.		
<b>2.</b>	Develop application using ATMEGA328 microcontroller Interrupts, Timers/Counters and IO port.		
<b>3.</b>	Understanding Embedded C programming		
<b>UNIT-I</b>			<b>12 Hours</b>
<b>Introduction to 8 bit RISC Microcontroller- ATMEGA328</b>			
Microcontroller Architecture, Memory organization, addressing modes, Basic instructions format, Instruction set, Assembly Language programs, Clock and Machine Cycles.			
<b>UNIT-II</b>			<b>14 Hours</b>
<b>Embedded C programming</b>			
Data Types, variables, declarations, Bitwise operators, Functions in 'C', Pointers and casting, Accessing memory mapped peripheral registers using pointers, Structures and unions.			
<b>UNIT-III</b>			<b>14 Hours</b>
<b>Microcontroller Peripheral Modules</b>			
Programming ATMEGA328 /O port, I/O interfacing examples using C programs (LED, Switch and Seven segment LED), Timers/Counters programming examples using C, Serial communication programming example, External Interrupts, timer interrupts and serial communication interrupts with example programs. I2C and SPI communication protocols			
<b>Course Outcomes:</b> At the end of the course student will be able to			
<b>1.</b>	Describe the architecture and write the assembly language program with relevant instruction set for ATMEGA microcontroller.		
<b>2.</b>	Understand the memory and register model of RISC system		
<b>3.</b>	Write embedded C program for specific embedded application		
<b>4.</b>	Interface different sensors and actuator modules and develop API using embedded C program for any microcontroller		
<b>5.</b>	Develop applications using embedded C programs with IO Ports, Timers, Serial communication and Interrupts of microcontrollers.		

<b>Course Outcomes Mapping with Program Outcomes &amp; PSO:</b>															
<b>Program Outcomes→</b>	1	2	3	4	5	6	7	8	9	10	11	12	<b>PSO↓</b>		
<b>↓ Course Outcomes</b>													1	2	3
<b>EC2005-1.1</b>	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>EC2005-1.2</b>	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>EC2005-1.3</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>EC2005-1.4</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>EC2005-1.5</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>1: Low 2: Medium 3: High</b>															
<b>TEXTBOOKS:</b>															
<b>1.</b>	Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Naimi <b>“AVR Microcontroller and Embedded Systems: Using Assembly and C for ATMEL AVR”</b> , PHI, 2006 / Pearson, 2006														
<b>2.</b>	Richard H. Barnett, Sarah Cox, and Larry O'Cull <b>“Embedded C Programming and the Atmel AVR”</b>														
<b>REFERENCE BOOKS:</b>															
<b>1.</b>	Patrick Robison <b>“Programming AVR Microcontrollers in C: Using GCC”</b> .														
<b>E Books / MOOCs/ NPTEL</b>															
<b>1.</b>	<a href="http://nptel.ac.in/courses/106108100/">http://nptel.ac.in/courses/106108100/</a>														
<b>2.</b>	<a href="http://nptel.ac.in/courses/108107029/">http://nptel.ac.in/courses/108107029/</a>														

**List of Experiments:**

1. Interfacing LED and Switches with ATMEGA328 Microcontroller
2. Interfacing seven segment LED with ATMEGA328 Microcontroller
3. Writing embedded C program to interface matrix keypad with ATMEGA328 microcontroller
4. Writing embedded C program to interface I2C based temperature sensor with ATMEGA328
5. Interfacing stepper motor using ATMEGA328
6. Interfacing analog sensors (pressure, light or strain) with ATMEGA328
7. Interfacing LCD to ATMEGA328 Microcontroller

## INTRODUCTION TO IOT PROTOCOLS

<b>Course Code:</b>	<b>EC2006-1</b>	<b>Course Type</b>	<b>IPCC</b>
<b>Teaching Hours/Week (L: T: P: S/J)</b>	<b>3:0:2:0</b>	<b>Credits</b>	<b>04</b>
<b>Total Teaching Hours</b>	<b>40+0+26+0</b>	<b>CIE + SEE Marks</b>	<b>50+50</b>
<b>Prerequisite</b>	<b>EC1001-1, EC1002-2</b>		

**Teaching Department: Electronics & Communication Engineering**

### Course Objectives:

<b>1.</b>	Explain the definition and usage of the term "The Internet of Things" in different contexts.
<b>2.</b>	Understand the various concepts, terminologies, and architecture of IoT systems
<b>3.</b>	To introduce the concept of M2M (machine to machine) Communication.
<b>4.</b>	To Learn different protocols used for IoT design
<b>5.</b>	Understand various applications of IoT in different domains

### UNIT-I

<b>IoT Overview</b>	<b>16 Hours</b>
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IoT Introduction and its components, IoT building blocks, Sensors and Actuators, IoT devices, IoT architectural view, Sources of IoT, M2M communication, Examples of IoT, Communication Technologies, IoT levels and deployment templates

### UNIT-II

<b>Design Principles for Web Connectivity</b>	<b>15 Hours</b>
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Web Communication Protocols for Connected Devices, Message Communication Protocols for Connected Devices, Web Connectivity for Connected Devices Network using Gateway, SOAP, REST, HTTP and Web Sockets

#### **Internet Connectivity Principles**

Internet Connectivity, Internet based Communication, IP addressing in IoT, Media Access Control, Application Layer Protocols: HTTP, HTTPS, FTP, Telnet

### UNIT-III

<b>Web of Things and Cloud of Things</b>	<b>09 Hours</b>
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Web of Things versus Internet of Things, Two pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Cloud of Things. IoT Physical Servers, Cloud Offerings and IoT Case Studies: Introduction to Cloud Storage Models, Communication API.

**Course Outcomes:** At the end of the course student will be able to

<b>1.</b>	Explain IoT and describe the basic architecture of IoT.
<b>2.</b>	Explain M2M Communication and communication technologies for IoT
<b>3.</b>	Discuss communication Protocols and web Connectivity for connected devices.
<b>4.</b>	Describe the IP addressing and application layer protocols in IoT.
<b>5.</b>	Discuss the domain specific applications of IoT.

### Course Outcomes Mapping with Program Outcomes & PSO:

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
													1	2	3
↓ Course Outcomes															
<b>EC2006-1.1</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-
<b>EC2006-1.2</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-
<b>EC2006-1.3</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-
<b>EC2006-1.4</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-
<b>EC2006-1.5</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-

**1: Low 2: Medium 3: High**

#### TEXTBOOKS:

1. Qusay F. Hassan, **"Internet of Things A to Z, Technologies and Applications"**, John Wiley Publications, 2018.
2. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, **"Internet of Things, Architectures, Protocols and Standards"**, John Wiley Publications, 2019.

#### REFERENCE BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, **"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things"**, 1<sup>st</sup> Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Ovidiu Vermesan, Peter Friess, **"Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems"**, River Publishers, 2013.
3. Rajkumar Buyya, Amir Vahid Dastjerdi, **"Internet of Things: Principles and Paradigms"**, Elsevier, 2016.

#### E Books / MOOCs/ NPTEL

1. <https://nptel.ac.in/courses/106/105/106105166/>
2. <https://nptel.ac.in/courses/108/108/108108098/>

#### List of Experiments:

1. Introduction to IoT Lab
2. Browsing HTML pages using HTTP Server and Controlling GPIO and Reading Sensor Connected to the interfacing Hardware Kit
3. Creation of own Web Server and Web page
4. Working with Thing Speak Cloud Server for IoT
5. Application of Message Queue Telemetry Transport (MQTT) in IoT
6. Working with Eclipse Cloud Server using MQTT Dash
7. Projects

<b>CONNECTED DEVICES SECURITY</b>			
<b>Course code</b>	<b>EC3106-1</b>	<b>Course Type</b>	<b>PCC</b>
<b>Hours / week (L:T:P:S/J)</b>	<b>2:0:2:0</b>	<b>Credits</b>	<b>3</b>
<b>Total teaching hours</b>	<b>27+0+26</b>	<b>CIE + SEE Marks</b>	<b>50+50</b>
<b>Prerequisite: EC1002-2, EC2005-1</b>			
<b>Teaching department(s): Electronics &amp; Communication Engineering</b>			
<b>Course objectives:</b>			
1.	Understand IoT Architecture and potential security vulnerabilities		
2.	Learn cryptography fundamentals required for IoT Security		
3.	Understand attacks on IoT devices and commonly used security mechanisms		
4.	Learn about enhancing security of IoT devices by integrating secure element.		
<b>UNIT-I</b>			<b>10 hours</b>
<b>Introduction to IoT Systems</b>			
<b>IoT Systems:</b> Introduction to IoT, IoT Architecture, IoT threats / Security Vulnerabilities			
<b>Corner stone of Security:</b> Authentication, confidentiality, Integrity, Non-repudiation and Availability. Authentication Mechanisms (Password, Bio, Single/multiple layer)			
<b>Cryptography:</b> Data encryption techniques, Data encryption standards (AES, DES, ECB, CBC), Public Key Cryptography, RSA, ECC, Key Management - Public key certificate and key exchange, Message Digest (MD5, SHA256, HMAC, RIPEMD160), Digital Signature (ECDSA), Random number			
<b>UNIT-II</b>			<b>12 hours</b>
<b>Security by Design</b>			
<b>Attacks on IoT devices:</b> TVR (Threat, Vulnerability, Risks), Attack technologies, Logical Attack, Invasive, Semi-Invasive and Non-Invasive Attacks			
<b>Threat modelling:</b> Asset identification, Identify threats, threat mitigation/measures, Secure Software Development Life Cycle			
<b>IoT Security functions/defences:</b> Device Authentication, Key Provisioning, Secure Communication (TLS), Stored Data Protection, Secure boot, Secure SW/FW update			
<b>Security Concepts:</b> Software Security concepts - Integrity of program flow, data integrity, function parameter integrity, randomization, data masking, full comparison pattern, redundant decision making, Hardware Security concepts - Memory and register encryption/masking, random number generator, Isolation, Secured Architecture (ROSI)			
<b>UNIT-III</b>			<b>5 hours</b>
<b>Device Security</b>			
<b>Platform Security:</b> TEE Overview, TrustZone, ARM PSA, Trusted FM			
<b>Secured MCUs:</b> Overview, Security features			
<b>Secure Elements:</b> Overview (Different form factor), Security features, Introduction to Optiga Trustx, Feature Set.			

<b>Course Outcomes:</b> At the end of the course student will be able to	
1.	Describe the IoT architecture and identify the security threats for IoT Devices
2.	Classify different cryptographic mechanisms relevant for IoT Device security
3.	Describe threat modelling and Identification of defensive mechanisms
4.	Discuss the importance of hardware-based security
5.	Explain concepts in designing Secure edge devices

**Course Outcomes Mapping with Program Outcomes & PSO:**

Program Outcomes →	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓			
													1	2	3	
↓Course Outcomes																
<b>EC3106-1.1</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	
<b>EC3106-1.2</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	
<b>EC3106-1.3</b>	3	2	2	-	2	-	-	-	2	1	2	1	3	-	-	
<b>EC3106-1.4</b>	3	1	2	-	-	-	-	-	-	-	-	-	3	-	-	
<b>EC3106-1.5</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	

**1: Low 2: Medium 3: High**

**TEXTBOOKS:**

1.	V K Pachgare, <b>“Cryptography and Information Security”</b> , PHI Publication, 3 <sup>rd</sup> Edition, 2019. Brian
2.	Russell, Drew Van Duren, <b>“Practical Internet of Things Security”</b> , Packt Publishing, 2016.

**REFERENCE BOOKS:**

6.	Catherine H. Gebotys, <b>“Security in Embedded Devices”</b> , Springer, 2010.
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**E Books / MOOCs/ NPTEL**

1.	<a href="http://ethesis.nitrkl.ac.in/4170/1/Buffer_Overflow_Attacks_%26_Countermeasures.pdf">http://ethesis.nitrkl.ac.in/4170/1/Buffer_Overflow_Attacks_%26_Countermeasures.pdf</a>
2.	<a href="https://trustedconnectivityalliance.org/wp-content/uploads/2020/01/NFC_Secure_Element_Stepping_Stones_v1.0.pdf">https://trustedconnectivityalliance.org/wp-content/uploads/2020/01/NFC_Secure_Element_Stepping_Stones_v1.0.pdf</a>
3.	<a href="https://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-630.pdf">https://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-630.pdf</a>
4.	<a href="https://www.dsci.in/sites/default/files/documents/resource_centre/IoT%20Security%20Guide.pdf">https://www.dsci.in/sites/default/files/documents/resource_centre/IoT%20Security%20Guide.pdf</a>

## List of Experiments:

1. Performing symmetric cryptographic operations on a 32 bit MCU
2. Performing RSA cryptographic operations on a 32 bit MCU
3. Performing ECC cryptographic operations on a 32 bit MCU
4. Performing Message Digest operation on a 32 bit MCU
5. Performing fault attack on code running on a 32 bit MCU
6. Performing side channel attack on code running on a 32 bit MCU
7. Secure communication with cloud using cryptographic libraries running on a 32 bit MCU
8. Performing symmetric cryptographic operations using a Secure Element connected to a 32 bit MCU
9. Performing asymmetric cryptographic operations using a Secure Element connected to a 32 bit MCU
10. Performing Certificate and Message Digest operations using a Secure Element connected to a 32 bit MCU
11. Secure communication with cloud using a Secure Element connected to a 32 bit MCU
12. Project work
13. Project work

<b>JAVA PROGRAMMING</b>			
<b>Course Code:</b>	<b>EC3108-1</b>	<b>Course Type</b>	<b>PCC</b>
<b>Teaching Hours/Week (L: T: P: S/J)</b>	<b>3:0:0:0</b>	<b>Credits</b>	<b>03</b>
<b>Total Teaching Hours</b>	<b>40+0+0+0</b>	<b>CIE + SEE Marks</b>	<b>50+50</b>
<b>Prerequisite</b>	<b>CS1001-1</b>		
<b>Teaching Department: Electronics &amp; Communication Engineering</b>			
<b>Course Objectives:</b>			
<b>1.</b>	Introduce Java basics and Data Structures.		
<b>2.</b>	Arm the students with the basic object-oriented programming concepts.		
<b>3.</b>	Introduce different techniques like Inheritance, Multithreaded Programming and HTML.		
<b>UNIT-I</b>			
<b>Java Basics and Java Object Oriented</b>			<b>16 Hours</b>
Java Basics: Concepts of OOP, Features of Java, How Java is different from C++, Environmental setup, Basic syntax, Objects and classes, Basic Data Types, Variable Types, Modifier Types, Basic operators, Loop Control, Decision Making, Strings and Arrays, Methods, I/O.			
Java Object Oriented: Inheritance, Overriding, Polymorphism, Abstraction, Encapsulation, Interfaces, and Packages.			
<b>UNIT-II</b>			
<b>Exception Handling, Threading</b>			<b>15 Hours</b>
Exception Handling, Threading: Exception Hierarchy, Exception Methods, Catching Exceptions, Multiple catch Clauses, Uncaught Exceptions Java's Built-in Exception. Creating, Implementing and Extending thread, thread priorities, synchronization suspending, resuming and stopping Threads, Multi-threading.			
JDBC: Introduction, Drivers and architecture, Connections, statement, result set. Store, retrieve and transaction management.			
<b>UNIT-III</b>			
<b>Java File Handling and event Handling:</b>			<b>09 Hours</b>
Serial access files and methods, Two event handling Mechanisms, Event model, Event classes, Event Listener			
<b>Course Outcomes:</b> At the end of the course student will be able to			
<b>1.</b>	Use the syntax and semantics of java programming language and basic concepts of OOP.		
<b>2.</b>	Develop reusable programs using the concepts of inheritance, polymorphism, interfaces and packages.		

3.	Apply the concept of Exception handling, multithreaded programming to write a program using JAVA.
4.	Explain various principles of JDBC and its connectivity to access data from database.
5.	Develop GUI Applications using Event handling mechanisms and perform basic file operations.

### Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓			
													1	2	3	
↓ Course Outcomes													1	2	3	
<b>EC3108-1.1</b>	3	1	-	-	-	-	-	-	-	-	-	-	-	1	3	1
<b>EC3108-1.2</b>	3	1	-	-	-	-	-	-	-	-	-	-	-	1	3	1
<b>EC3108-1.3</b>	3	1	-	-	-	-	-	-	-	-	-	-	-	1	3	1
<b>EC3108-1.4</b>	3	1	-	-	-	-	-	-	-	-	-	-	-	1	3	1
<b>EC3108-1.5</b>	3	1	-	-	-	-	-	-	-	-	-	-	-	1	3	1

**1: Low 2: Medium 3: High**

### TEXTBOOKS:

1. Patrick Naughton & Herbert Schild, "**JAVA The Complete Reference**", TMH.
2. Balaguruswamy, "**Introduction to JAVA Programming a primer**".

### REFERENCE BOOKS:

1. Daniel/Young, "**Introduction to JAVA Programming**", PHI.
2. Jeff Frentzen and Sobotka, "**Java Script**", Tata McGraw Hill,1999.

### E Books / MOOCs/ NPTEL

1. <https://www.coursera.org/learn/object-oriented-java>
2. [https://spoken-tutorial.org/tutorial-search/?search\\_foss=Java&search\\_language=English](https://spoken-tutorial.org/tutorial-search/?search_foss=Java&search_language=English)
3. <https://www.udacity.com/course/intro-to-java-programming-cs046>
4. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092introductionto-programming-in-java-january-iap-2010/index.html>

<b>EMBEDDED SECURITY CHIP</b>			
<b>Course code</b>	<b>EC3107-1</b>	<b>Course Type</b>	<b>PCC</b>
<b>Hours/week (L:T:P:S/J)</b>	<b>2:0:2:0</b>	<b>Credits</b>	<b>3</b>
<b>Total teaching hours</b>	<b>27+0+26</b>	<b>CIE + SEE Marks</b>	<b>50+50</b>
<b>Prerequisite: CS1004-1</b>			
<b>Teaching department(s): Electronics &amp; Communication Engineering</b>			
<b>Course objectives</b>			
7.	Understand the architecture of secure elements		
8.	Learn Java Card applet programming		
9.	Learn about industry standards and domain specifications in the context of secure elements		
10.	Understand Global Platform and card content management		
<b>UNIT-I</b>			<b>10 hours</b>
<b>Architecture of Secure Elements</b>			
<b>Hardware architecture:</b> I/O System, CPU, Memory (RAM, EEPROM, FLASH), Co-Processors			
<b>Packaging:</b> Surface Mount Devices (VQFN, XQFN, USON8)			
<b>Software architecture (OS Layers):</b> I/O interface, Hardware Abstraction Layer, Application Layer, Crypto Library			
<b>Industry standards and certification schemes:</b> Connectivity standard alliance, Cybersecurity, Labelling Scheme, ARM PSA, Payment Wearables, Digital Identity Tokens, FIPS Certification.			
<b>UNIT-II</b>			<b>7 hours</b>
<b>Java Architecture</b>			
<b>Java Card architecture:</b> Comparison of Java Card Architecture - Java, why JCRE and JCVM; JCVM, JCRE, JC API, JC Applets, JC Library packages; Approach to Applet development (tools, build flow, cap.); Data Objects, File Structure and command APDUs			
<b>UNIT-III</b>			<b>10 hours</b>
<b>Java Card applet programming</b>			
<b>Applet architecture:</b> Java Card Objects, Atomicity and Transactions, Exception Handling, Handling Command APDUs Design & Develop your Applet.			
<b>Course Outcomes:</b> At the end of the course student will be able to			
1.	Describe the hardware architecture of secure elements and QFN (Quad flat no-lead) USNON8 packaging aspects.		
2.	Discuss usage of Secure element (SE) as per Industry specific standards for applications such as payments, IoT security solutions		

3.	Describe Java Card architecture - typically used Operating system for secure elements															
4.	Design and development of Java card applets															
5.	Demonstrate crypto operations on Embedded secure element.															
<b>Course outcomes mapping with Program Outcomes &amp; PSO:</b>																
Program Outcomes →	1	2	3	4	5	6	7	8	9	10	11	12	PSO			
													1	2	3	
↓Course Outcomes																
<b>EC3107-1.1</b>	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>EC3107-1.2</b>	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>EC3107-1.3</b>	3	-	-	-	1	-	-	-	-	-	-	-	-	3	-	-
<b>EC3107-1.4</b>	3	2	2	-	2	-	-	-	2	1	2	1	3	-	-	
<b>EC3107-1.5</b>	3	2	2	-	2	-	-	-	2	1	2	1	3	-	-	
														<b>1: Low 2: Medium 3: High</b>		
<b>TEXTBOOKS:</b>																
6.	Chen, Zhiqun, <b>“Java card technology for smart cards: architecture and programmer's guide”</b> , Addison-Wesley Professional, 2000.															
7.	Rankl, Wolfgang, and Wolfgang Effing, <b>“Smart Card Handbook”</b> , John Wiley & Sons, 2010.															
<b>REFERENCE BOOKS:</b>																
8.	Mayes, Keith, and Konstantinos Markantonakis, <b>“Smart Cards, Tokens, Security and Applications”</b> , Springer, 2017.															
<b>E Books / MOOCs/ NPTEL</b>																
9.	<a href="https://www.oracle.com/java/java-card/">https://www.oracle.com/java/java-card/</a>															
10	<a href="https://globalplatform.org/specs-library/card-specification-v2-3-1/">https://globalplatform.org/specs-library/card-specification-v2-3-1/</a>															

### List of Experiments:

- 1 Setting up the Java Card Development environment
- 2 APDU command construction to perform file system operations
- 3 Design file system access management for confidentiality and integrity protection.
- 4 APDU command construction to perform an authentication operation
- 5 Development of basic Java Card Applet – Command handling and data types

- 6 Development of Java Card Applet - Symmetric Crypto and Random number generation
- 7 Develop a demonstrative Java Card Applet supporting ISO 7816 Record file system
- 8 Development of a closed-loop payment system
- 9 Development of Java Card Applet for Hash
- 10 Development of Java Card Applet for Asymmetric Crypto operation
- 11 Project work
- 12 Project work
- 13 Project work

## EMBEDDED LINUX FOR IOT LAB

<b>Course Code:</b>	<b>EC3604-1</b>	<b>Course Type</b>	<b>PCC</b>
<b>Teaching Hours/Week (L: T: P: S/J)</b>	<b>0:0:2:0</b>	<b>Credits</b>	<b>01</b>
<b>Total Teaching Hours</b>	<b>0+0+26+0</b>	<b>CIE + SEE Marks</b>	<b>50+50</b>
<b>Prerequisite</b>	<b>EC2601-1</b>		

**Teaching Department: Electronics & Communication Engineering**

### Course Objectives:

<b>1.</b>	To give students hands-on experience using Linux based embedded hardware
<b>2.</b>	To provide skills for interfacing sensors and actuators using Embedded linux
<b>3.</b>	To develop skills on data collection and logging in the cloud with the help of Linux OS

### List of Experiments

1. Introduction Raspberry Pi- Linux based Embedded hardware
2. Installation of OS
3. Experiments of Interfacing sensors to Raspberry Pi
4. Experiments on connecting Raspberry Pi to the cloud platform.

**Course Outcomes:** At the end of the course student will be able to

<b>1.</b>	Explain the architecture of Raspberry Pi
<b>2.</b>	Understand the working of Raspberry Pi, its features and how various components can be used with Pi
<b>3.</b>	Experiment with Raspberry Pi and its GPIO pins
<b>4.</b>	Explain the need of GUI, headless mode and API
<b>5.</b>	Discuss connecting Raspberry Pi with Cloud

### Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	1	1	PSO↓			
											1	2	1	2	3	
↓ Course Outcomes																
<b>EC3604-1.1</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	
<b>EC3604-1.2</b>	3	-	2	-	3	-	-	-	-	-	-	-	3	-	2	
<b>EC3604-1.3</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	
<b>EC3604-1.4</b>	3	-	2	-	3	-	-	-	-	-	-	-	3	-	2	
<b>EC3604-1.5</b>	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	

**1: Low 2: Medium 3: High**

### TEXTBOOKS:

1. Simon Monk, **“Programming the Raspberry Pi: Getting Started with Python”**, January, 2012, McGraw Hill Professional

2.	Eben Upton and Gareth Halfacree, <b>“Raspberry Pi User Guide”</b> , August 2016, 4 <sup>th</sup> Edition, John Wiley & Sons
<b>REFERENCE BOOKS:</b>	
1.	The official raspberry Pi Projects Book <a href="https://www.raspberrypi.org/magpiissues/Projects_Book_v1.pdf">https://www.raspberrypi.org/magpiissues/Projects_Book_v1.pdf</a>
2.	Eben Upton and Gareth Halfacree, <b>“Raspberry Pi User Guide”</b> , August 2016, 4 <sup>th</sup> edition, John Wiley & Sons
3.	Alex Bradbury and Ben Everard, <b>“Learning Python with Raspberry Pi”</b> , Feb 2014, JohnWiley & Sons
<b>E Books / MOOCs/ NPTEL</b>	
1.	<a href="https://www.coursera.org/learn/raspberry-pi-platform">https://www.coursera.org/learn/raspberry-pi-platform</a>