**NOIDA INTERNATIONAL UNIVERSITY**



**School of Engineering & Technology**

**SCHEME OF EVALUATION & SYLLABUS**

**for**

**BACHELOR OF TECHNOLOGY in Electronics & Communication Engineering**

**[B. Tech. (ECE)]**

**With Minor Specialization**

**In**

**Internet of Things**

**w.e.f. Academic Session 2022-2023 onwards**

4 Years

**B. Tech in Electronics and Communication Engineering with Specialization in Internet of Things**

**Program Educational Objectives (PEOs)**

The Department of Electronics and Communication Engineering has developed and maintained a well-defined set of educational objectives and desired program outcomes. Educational objectives of the program cater to the requirements of the stakeholders such as students, parents, employers, alumni, faculty etc. The program educational objectives are as follows:

* **PEO**1: Provide graduates with a strong foundation in mathematics, science and engineering fundamentals to enable them to devise and deliver efficient solutions to challenging problems in Electronics, Communications and allied disciplines.
* **PEO**2: Impart analytic and thinking skills to develop initiatives and innovative ideas for R&D, Industry and societal requirements.
* **PEO**3: Provide sound theoretical and practical knowledge of E&C Engineering, managerial and entrepreneurial skills to enable students to contribute to the well-being of society with a global outlook.
* **PEO**4: Inculcate qualities of teamwork as well as social, interpersonal and leadership skills and an ability to adapt to evolving professional environments in the domains of engineering and technology.
* **PEO**5: Motivate graduates to become good human beings and responsible citizens for the overall welfare of the society.

**Program outcomes (POs)**

***Engineering Graduates will be able to:***

**PO**1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO**2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO**3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO**4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO**5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO**6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO**7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO**8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO**9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO**10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO**11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO**12**. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PROGRAMME SPECIFIC OUTCOMES (PSOs)**

***On completion of B.Tech. ECE with Specialization in Internet of Things program, graduates will be able to:***

**PSO1.**

Design and develop components and systems for applications related to Electronics & Communication, Embedded systems, Sensors & Data Acquisition Systems, Cloud Computing and Information security in the context of Internet of things.

**PSO2.**

Apply modern engineering tools to solve complex Electronics & Communication Engineering problems pertaining to Internet of things and sensors.

**PSO3.**

Solve interdisciplinary problems in the fields such as Smart Agriculture, Telemetry, Health, Transportation, Energy, automation and others.

**PROGRAM OVERVIEW**

Internet of Things (IoT) is an interdisciplinary program which has its application enormously increased in the past few years, it has a vast scope of usage. IoT generally refers to a growing network of internet-connected devices that find various applications in engineering and sciences. When objects are interconnected across the world it allows people or things using those objects to be connected anytime. Connected things shall ease human life. As an example from urban transport to medical devices, home electronics and appliances to cars, heart monitoring implants and many more.

A four year under-graduate B.Tech course in Internet of Things (IoT) aims to train students to be equipped with a solid theoretical foundation, systematic professional knowledge and strong real-world skills in the IoT field. Through the program, the students shall have a thorough knowledge of electronic engineering and a firm foundation into wireless communication and computer networks. A deep knowledge on IoT devices, systems and networks is also included. The students will develop strong skills in sensors & instrumentation, chip-design and privacy & security of IoT.

**Program offered by**

LPU, Manav Rachna, BML Munjal, VIT

**Specialization Thread**

Following specialization courses will be taught:

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Code** | **Subject Name** | **L-T-P** |
| 1 | IoT01 | Introduction to Internet of Things | 3-0-0 |
| 2 | IoT02 | Introduction to Security of Cyber Physical Systems | 3-0-0 |
| 3 | IoT03 | Ubiquitous Sensing, Computing and Communication | 3-0-0 |
| 4 | IoT04 | Embedded Systems for IoT | 3-0-2 |
| 5 | IoT05 | IoT with Arduino, ESP and Raspberry PI | 3-0-4 |
| 6 | IoT06 | Industrial IoT | 2-0-0 |

**CREDIT DISTRIBUTION**

**Definition of Credit**:

|  |  |
| --- | --- |
| 1 Hr. Lecture (L) per week | 1 credit |
| 1 Hr. Tutorial (T) per week | 1 credit |
| 1 Hr. Practical (P) per week 1 Hours Practical(Lab)/week | 0.5 credits 1 credit |

**Range of credits:**

A range of credits from 150 to 160 for a student to be eligible to get Under Graduate degree in Engineering. For Specialization / Honours Degree program, an additional 18-20 credits are needed to be earned by the student.

**Course code and definition**

|  |  |
| --- | --- |
| **Course code** | **Definitions** |
| BSC | Basic Science Courses |
| ESC | Engineering Science Courses |
| HSMC | Humanities and Social Sciences including Management courses |
| MC | Mandatory Course |
| ECOE | Open Elective |
| EC | Program Core |
| ECEL | Program Elective |
| IoT | Internet of Things |

**Structure of Undergraduate Engineering program:**

|  |  |  |
| --- | --- | --- |
| **S.no** | **Category** | **Credits** |
| 1 | Humanities and Social Sciences including Management courses | 12 |
| 2 | Basic Science courses | 26 |
| 3 | Engineering Science courses including workshop, drawing, basics of  electrical/mechanical/computer etc | 20 |
| 4 | Professional core courses | 51 |
| 5 | Professional Elective courses relevant to chosen specialization/branch | 21 |
| 6 | Open subjects – Electives from other technical and /or emerging subjects | 12 |
| 7 | Project work, seminar and internship in industry or elsewhere | 14 |
| 8 | Mandatory Courses  [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge] | Non-credit |
| 9 | Minor Degree/ Specialization courses | 20 |
| **Total** | | **176** |

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| **FIRST SEMESTER** | | | | | | | | | | | | | |
| **S.**  **No** | **Course Code** | **Subject** | **Period** | | | **Evaluation Scheme** | | | | | |  | **Total Credits** |
|  |  |  | **Sessional Exam** | | | | | **End Exams** | **Subject Total** |  |
|  |  |  | **L** | **T** | **P** | **CA** | | **TA** | | **Total** |  |  |  |
| 1 | BSC103 | Mathematics –I | 3 | 1 | 0 | 20 | | 20 | | 40 | 60 | 100 | 4 |
| 2 | BSC102 | Chemistry-I | 3 | 1 | 0 | 20 | | 20 | | 40 | 60 | 100 | 4 |
| 3 | HSMC101 | English | 2 | 0 | 0 | 20 | | 20 | | 40 | 60 | 100 | 2 |
| 4 | ESC103 | Programming for Problem Solving | 3 | 0 | 0 | 20 | | 20 | | 40 | 60 | 100 | 3 |
| 5 |  | Induction Program |  |  |  |  | |  | |  |  |  | 0 |
|  | | | | | | | | | | | | | |
| 1 | BSC102P | Chemistry-1 Lab | 0 | 0 | 3 | - | - | | 40 | | 60 | 100 | 1.5 |
| 2 | ESC103P | Programming for Problem Solving Lab | 0 | 0 | 4 | - | - | | 40 | | 60 | 100 | 2 |
| 3 | HSMC101P | English Lab | 0 | 0 | 2 | 20 | 20 | | 40 | | 60 | 100 | 1 |
| 4 | ESC102P | Engineering Graphics & Design Lab | 1 | 0 | 4 | - | - | | 40 | | 60 | 100 | 3 |
| **Total** | | |  |  |  |  |  | |  | |  |  | **20.5** |

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| **SECOND SEMESTER** | | | | | | | | | | | |
| **S.N**  **o** | **Course Code** | **Subject** | **Period** | | | **Evaluation Scheme** | | | |  | **Total**  **Credits** |
|  |  |  | **Sessional Exam** | | | **End Exams** | **Subject Total** |  |
|  |  |  | **L** | **T** | **P** | **CA** | **TA** | **Total** |  |  |  |
| 1 | BSC101 | Physics | 3 | 1 | 0 | 20 | 20 | 40 | 60 | 100 | 4 |
| 2 | BSC104 | Mathematics –II | 3 | 1 | 0 | 20 | 20 | 40 | 60 | 100 | 4 |
| 3 | ESC101 | Basic Electrical Engineering | 3 | 1 | 0 | 20 | 20 | 40 | 60 | 100 | 4 |
| 4 | AECC01 | Environmental Studies (MC) | 2 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 0 |
| **PRACTICALS** | | | | | | | | | | | |
| 1 | BSC101P | Physics Lab | 0 | 0 | 3 | - | - | 40 | 60 | 100 | 1.5 |
| 2 | ESC101P | Basic Electrical Engineering Lab | 0 | 0 | 2 | 20 | 20 | 40 | 60 | 100 | 1 |
| 3 | ESC104P | Workshop Practices / Manufacturing Processes Lab | 1 | 0 | 4 | 20 | 20 | 40 | 60 | 100 | 3 |
| **Total** | | |  |  |  |  |  |  |  |  | **17.5** |

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| **THIRD SEMESTER** | | | | | | | | | | | | | | |
| **S.No** | **Course Code** | **Subject** | **Period** | | | | **Evaluation Scheme** | | | | | |  | **Total Credits** |
|  |  | |  | **Sessional Exam** | | | | **End Exams** | | **Sub total** |  |
|  |  |  | **L** | **T** | | **P** | **CA** | **TA** | **Total** | |  | |  |  |
| 1 | EC01 | Electronic Devices | 3 | 0 | | 0 | 20 | 20 | 40 | | 60 | | 100 | 3 |
| 2 | EC03 | Digital System Design | 3 | 0 | | 0 | 20 | 20 | 40 | | 60 | | 100 | 3 |
| 3 | EC05 | Signals & Systems | 3 | 0 | | 0 | 20 | 20 | 40 | | 60 | | 100 | 3 |
| 4 | EC06 | Network Theory | 3 | 0 | | 0 | 20 | 20 | 40 | | 60 | | 100 | 3 |
| 5 | BSC201 | Mathematics -III | 3 | 1 | | 0 | 20 | 20 | 40 | | 60 | | 100 | 4 |
| 6 | ESC201 | Engineering Mechanics | 3 | 1 | | 0 | 20 | 20 | 40 | | 60 | | 100 | 4 |
| 7 | HSMC201 | Human Psychology | 3 | 0 | | 0 | 20 | 20 | 40 | | 60 | | 100 | 3 |
| **PRACTICALS** | | | | | | | | | | | | | | |
| 1 | EC02 | Electronic Devices Lab | 0 | 0 | 2 | | 20 | 20 | | 40 | | 60 | 100 | 1 |
| 2 | EC04 | Digital System Design Lab | 0 | 0 | 2 | | 20 | 20 | | 40 | | 60 | 100 | 1 |
| **Total** | | |  |  |  | |  |  | |  | |  |  | **25** |

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| **FORTH SEMESTER** | | | | | | | | | | | | |
| **S.No** | **Course Code** | **Subject** | **Period** | | | **Evaluation Scheme** | | | | |  | **Total Credits** |
|  |  |  | **Sessional Exam** | | | **ESE** | | **Sub**  **Total** |  | |
|  |  |  | **L** | **T** | **P** | **CA** | **TA** | **Total** |  | |  |  | |
| **THEORY** | | | | | | | | | | | | |
| 1 | EC07 | Analog and Digital Communication | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 | |
| 2 | EC09 | Analog Electronics | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 | |
| 3 | EC11 | Microcontrollers | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 | |
| 4 | BSC202 | Biology-I | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 | |
| 5 | HSMC202 | Human values | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 | |
| 6 | MC02 | Python | 3 | 0 | 2 | 20 | 20 | 40 | 60 | 100 | | 0 | |
| **PRACTICALS** | | | | | | | | | | | | |
| 1 | EC08 | Analog and Digital Communication Lab | 0 | 0 | 2 | 0 | 0 | 40 | 60 | 100 | | 1 | |
| 2 | EC10 | Analog Electronics lab | 0 | 0 | 2 | 0 | 0 | 40 | 60 | 100 | | 1 | |
| 3 | EC12 | Microcontrollers Lab | 0 | 0 | 2 | 0 | 0 | 40 | 60 | 100 | | 1 | |
| **Total** | | |  |  |  |  |  |  |  |  | | **18** | |

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| FIFTH SEMESTER | | | | | | | | | | | | | | |
| **S.No** | **Course Code** | **Subject** | **Period** | | | **Evaluation Scheme** | | | | | | | **Total Credits** | |
|  |  |  | **Sessional Exam** | | | **End Exams** | | **Subject Total** | |  | |
|  |  |  | **L** | **T** | **P** | **CA** | **TA** | **Total** |  | |  | |  | |
| **THEORY** | | | | | | | | | | | | | | |
| 1 | EC13 | Electronic Measurements and  Instruments | 3 | 0 | 0 | 20 | 20 | 40 | | 60 | | 100 | | 3 |
| 2 | EC15 | Computer Architecture | 3 | 0 | 0 | 20 | 20 | 40 | | 60 | | 100 | | 3 |
| 3 | EC16 | Probability Theory and Stochastic Processes | 3 | 0 | 0 | 20 | 20 | 40 | | 60 | | 100 | | 3 |
| 4 | EC17 | Digital Signal Processing | 3 | 0 | 0 | 20 | 20 | 40 | | 60 | | 100 | | 3 |
| 5 | ECEL\* | Program Elective – 1 | 3 | 0 | 0 | 20 | 20 | 40 | | 60 | | 100 | | 3 |
| 6 | HSMC 501 | Management-I (Organizational Behavior) | 3 | 0 | 0 | 20 | 20 | 40 | | 60 | | 100 | | 3 |
| 7 | IoT01 | Introduction to Internet of Things | 3 | 0 | 0 | 20 | 20 | 0 | | 60 | | 100 | | 3 |
| **PRACTICALS** | | | | | | | | | | | | | | |
| 1 | EC14 | Electronic Measurements & Instrument s Lab | 0 | 0 | 2 | 0 | 0 | 40 | | 60 | | 100 | | 1 |
| 2 | EC18 | Digital Signal Processing Lab | 0 | 0 | 2 | 0 | 0 | 40 | | 60 | | 100 | | 1 |
| **Total** | | |  |  |  |  |  |  | |  | |  | | **23** |

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| SIXTH SEMESTER | | | | | | | | | | | | |
| **S.No** | **Course Code** | **Subject** | **Period** | | | **Evaluation Scheme** | | | | | | **Total Credits** |
|  |  |  | **Sessional Exam** | | | **End Exams** | | **Subject Total** |  |
|  |  |  | **L** | **T** | **P** | **CA** | **TA** | **Total** |  | |  |  |
| **THEORY** | | | | | | | | | | | | |
| 1 | EC19 | Control Systems | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 |
| 2 | EC20 | Computer Network | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 |
| 3 | ECEL\* | Program Elective – 2 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 |
| 4 | ECEL\* | Program Elective – 3 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 |
| 5 |  | Open Elective-1 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 |
| 6 | MC02 | Constitution of India | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 0 |
| 7 | IoT02 | Introduction to Security of Cyber-Physical Systems | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 |
| 8 | IoT03 | Ubiquitous Sensing, Computing and Communication | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | | 3 |
| **PRACTICALS** | | | | | | | | | | | | |
| 1 | EC21 | Computer Networks Lab | 0 | 0 | 4 | - | - | 40 | 60 | 100 | | 2 |
| 2 | EC22 | Control Systems Lab | 0 | 0 | 2 | - | - | 40 | 60 | 100 | | 1 |
| 2 | EC23 | Mini Project/Electronic Design workshop | 0 | 0 | 4 | - | - | 40 | 60 | 100 | | 2 |
| **Total** | | |  |  |  |  |  |  |  |  | | **26** |

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| **SEVENTH SEMESTER** | | | | | | | | | | | | | | | | | | | |
| **S.No** | **Course Code** | **Subject** | | **Period** | | | | | **Evaluation Scheme** | | | | | | |  | | | **Total Credits** | |
|  | |  | |  | **Sessional Exam** | | | | | | **End Exams** | **Subject Total** | | |  | |
|  |  |  | | **L** | | **T** | | **P** | **CA** | | **TA** | | **Total** | |  |  | | |  | |
| 1 | ECEL\* | Program Elective – 4 | | 3 | | 0 | | 0 | 20 | | 20 | | 40 | | 60 | 100 | | | 3 | |
| 2 | ECEL\* | Program Elective – 5 | | 3 | | 0 | | 0 | 20 | | 20 | | 40 | | 60 | 100 | | | 3 | |
| 3 | ECEL\* | Program Elective – 6 | | 3 | | 0 | | 0 | 20 | | 20 | | 40 | | 60 | 100 | | | 3 | |
| 4 |  | Open Elective-2 | | 3 | | 0 | | 0 | 20 | | 20 | | 40 | | 60 | 100 | | | 3 | |
| 5 | IoT04 | Embedded Systems for IoT | | 3 | | 0 | | 0 | 20 | | 20 | | 40 | | 60 | 100 | | | 3 | |
| 6 | IoT05 | IoT with Arduino, ESP and Raspberry PI | | 3 | | 0 | | 0 | 20 | | 20 | | 40 | | 60 | 100 | | | 3 | |
| PRACTICALS | | | | | | | | | | | | | | | | | | | |
| 1 | ECP1 | Project Stage-I | 0 | | 0 | | 10 | | - | - | | 40 | | 60 | | | 100 | 5 | |
| 2 | IoT04P | Embedded Systems for IoT Lab | 0 | | 0 | | 2 | | 0 | 0 | | 40 | | 60 | | | 100 | 1 | |
| 3 | IoT05P | IoT with Arduino, ESP and Raspberry PI Lab | 0 | | 0 | | 4 | | 0 | 0 | | 40 | | 60 | | | 100 | 2 | |
| **Total** | | |  | |  | |  | |  |  | |  | |  | | |  | **26** | |

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| **EIGTHTH SEMESTER** | | | | | | | | | | | | | | | | | | | | |
| **S.No** | **Course Code** | **Subject** | **Period** | | | | | | **Evaluation Scheme** | | | | | | | |  | | **Total Credits** | |
|  | |  | |  | | **Sessional Exam** | | | | | | **External Exam** | | **Subject Total** | |  | |
|  |  |  | **L** | | **T** | | **P** | | **CA** | | **TA** | | **Total** | |  | |  | |  | |
| 1 | ECEL\* | Program Elective –7 | 3 | | 0 | | 0 | | 20 | | 20 | | 40 | | 60 | | 100 | | 3 | |
| 2 |  | Open Elective-3 | 3 | | 0 | | 0 | | 20 | | 20 | | 40 | | 60 | | 100 | | 3 | |
| 3 |  | Open Elective-4 | 3 | | 0 | | 0 | | 20 | | 20 | | 40 | | 60 | | 100 | | 3 | |
| 4 | IoT06 | Industrial IoT | 2 | | 0 | | 0 | | 20 | | 20 | | 40 | | 60 | | 100 | | 2 | |
| PROJECT | | | | | | | | | | | | | | | | | | | | |
| 1 | ECP2 | Project Stage-II | | 0 | | 0 | | 18 | |  | |  | | 200 | | 400 | | 600 | | 9 |
| **Total** | | | |  | |  | |  | |  | |  | |  | |  | |  | | **20** |
| **Total Credits ---- 156+20=176** | | | | | | | | | | | | | | | | | | | | |

**Program Elective Courses:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.N** | **Course Code** | **Course Title** |  | **Preferred Semester** |
| 1 | ECEL1 | Bio-Medical Electronics | V | |
| 2 | ECEL2 | CMOS Design |  | V |
| 3 | ECEL3 | Information Theory and Coding |  | V |
| 4 | ECEL4 | Introduction to MEMS |  | VI |
| 5 | ECEL5 | Electro Magnetic Waves |  | VI |
| 6 | ECEL6 | Speech and Audio Processing |  | VI |
| 7 | ECEL7 | Power Electronics |  | VI |
| 8 | ECEL8 | Nano electronics |  | VI |
| 9 | ECEL9 | Scientific computing |  | VI |
| 10 | ECEL10 | Adaptive Signal Processing |  | VII |
| 11 | ECEL11 | Antennas and Propagation |  | VII |
| 12 | ECEL12 | Digital Image & Video Processing |  | VII |
| 13 | ECEL13 | Mobile Communication and Networks |  | VII |
| 14 | ECEL14 | Mixed Signal Design |  | VII |
| 15 | ECEL15 | Microwave Theory and Techniques |  | VII |
| 16 | ECEL16 | Fiber Optic Communications |  | VII |
| 17 | ECEL 17 | RADAR and Satellite Communication |  | VII |
| 18 | ECEL18 | High Speed Electronics |  | VII |
| 19 | ECEL19 | Wavelets |  | VII |
| 20 | ECEL20 | Wireless Sensor Networks |  | VIII |
| 21 | ECEL21 | Embedded systems |  | VIII |
| 22 | ECEL22 | Error correcting codes |  | VIII |

**OPEN ELECTIVES (ECOExx)**

1. Non-Conventional Energy Resources(7th)
2. Quality Management (6th)
3. Operations Research
4. Introduction to Biotechnology
5. Nonlinear Dynamic Systems
6. Product Development
7. Automation & Robotics
8. Soft Computing (Neural Networks, Fuzzy Logic and Genetic Algorithm)
9. Nano Sciences
10. Laser Systems and Applications
11. Space Sciences
12. Polymer Science & Technology
13. Nuclear Science
14. Material Science
15. Finance & Accounting
16. Human Resource Development (7th)
17. Cyber Law & Ethics (8th)
18. Introduction to Philosophical Thoughts
19. Comparative Study of Literature
20. Indian Music System
21. History of Science & Engineering
22. Introduction to Art and Aesthetics
23. Economic Policies in India
24. Entrepreneurship Development(8th)

**Detailed Syllabus**

**Course Code: IoT-01**

**Course Title: Introduction to Internet of Things**

**Course Objective:**

* To make students know the IoT ecosystem.
* To provide an understanding of the technologies and the standards relating to the Internet of Things.
* To develop skills on IoT technical planning.

**Course Contents:**

Module 1 [8 Lectures]

IoT & Web Technology: The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

Module 2 [9 Lectures]

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, an emerging industrial structure for IoT, the international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module 3 [9 Lectures]

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module 4 [8 Lectures]

IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Module 5 [8 Lectures]

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smart Approach. Data Aggregation for the IoT in Smart Cities, Security.

**Text Books/References:**

1. Nitesh Dhanjani, Abusing the Internet of Things, Shroff Publisher/O’Reilly Publisher.
2. Internet of Things, RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, John Wiley and Sons.
3. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.
4. Cuno Pfister, “Getting Started with the Internet of Things”, Shroff Publisher/Maker Media.
5. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1 st Edition, Apress Publications.
6. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/Maker Media Publishers.

**Corresponding Online Resources:**

https://www.coursera.org/specializations/internet-of-things

**Course Outcomes:**

After completion of course, students would be able:

1. To understand the technology and standards relating to IoTs.
2. To understand the critical ecosystem required to mainstream IoTs.
3. To Acquire skills on developing their own national and enterprise level technical strategies.

**Course Code: IoT-02**

**Course Title: Introduction to Security of Cyber-Physical Systems**

**Course Objective:**

* To learn the basics of security and various types of security issues.
* To study different cryptography techniques available and various security attacks.
* Explore network security and how they are implemented in real world.
* To get an insight of various issues of Web security and biometric authentication.

**Course Contents:**

Module 1 [6 Lectures]

Overview of Security and Privacy in Information System.

Module 2 [10 Lectures]

Applied Cryptography & Intrusion Detection, Architecture of Applied Cryptography, One Way Hash Function and Integrity, Encryption Algorithms and Confidentiality, Digital Signature and Authentication (DH, RSA, 2 class), Intrusion Detection and Information Theory.

Module 3 [10 Lectures]

Internet of Things Security, Security and Privacy for IoT Case Study: Smart Home, Smart Grid Network, Modern Vehicle, Wearable Computing & BYOD, Mobile HealthCare.

Module 4 [8 Lectures]

Software-Defined Networks, Introduction of Software-Defined Networks, Security for Software-Defined Networks, Privacy Leakages for Software-Defined Networks, Case Studies: How to Attack Software-Defined Networks.

Module 5 [8 Lectures]

Cyber-Physical Systems (CPS), CPS - Platform components, CPS implementation issues, Intelligent CPS, Secure Deployment of CPS.

**Text Books/References:**

1. Cyber Security, Nina Godbole, John Wiley & Sons.
2. Li Da Xu, Shancang Li, “Securing the Internet of Things”, Syngress.
3. Alasdair Gilchrist, “IoT Security Issues”, De Gruyter
4. Sean Smith, “The Internet of Risky Things”, Sean Smith, Shroff Publisher/O’Reilly Publisher

**Course Outcomes:**

After completion of course, students would be able:

1. To Apply basics of security and issues related to it.
2. To use biometric techniques available and how they are used in today’s world.
3. To investigate Security issues in web and how to tackle them.
4. To Learn mechanisms for transport and network security

**Course Code: IoT-03**

**Course Title: Ubiquitous Sensing, Computing and Communication**

**Course Objective:**

* Basic introduction of all the elements of IoT-Mechanical, Electronics/sensor platform, Wireless and wireline protocols, Mobile to Electronics integration, Mobile to enterprise integration.
* To have an understanding of basics of open source/commercial electronics platform for IoT.
* To have an understanding of basics of open source /commercial enterprise cloud platform for IoT.

**Course Contents:**

Module 1

Introduction, Overview, Challenges in IoT, Networking Basics of IoT, NFC, Wireless LAN.

Module 2

Location in ubiquitous computing: Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications, Location based social networks (LBSN), LBSN Recommendation.

Context-aware computing: Context and Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture.

Module 3

Privacy and security in ubiquitous computing, Energy constraints in ubiquitous computing.

Wearable computing, Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper, Mobile social networking & crowd sensing, Event based social network.

Module 4

Mobile affective computing: Human Activity and Emotion Sensing, Health Apps, Mobile p2p computing, Smart Homes and Intelligent Buildings, Mobile HCI, Cloud centric IoT, Open challenges, Architecture, Energy Efficiency, Participatory sensing, Protocols, QoS, QoE.

Module 5

IoT and data analytics IoT and Data Management, Data cleaning and processing, Data storage models.

Search techniques, Deep Web, Semantic sensor web, Semantic Web Data Management, Searching in IoT.

Real-time and Big Data Analytics for The Internet of Things, Heterogeneous Data Processing, High-dimensional Data Processing, Parallel and Distributed Data Processing.

**Text Books/References:**

1. N. Jeyanthi, Ajith Abraham, Hamid Mcheick, “Ubiquitous Computing and Computing Security of IoT”.
2. John Krumm, Ubiquitous Computing Fundamentals, CRC Press.
3. Dirk Slama, “Enterprise IoT”, Shroff Publisher/O’Reilly Publisher

**Course Outcomes:**

After completion of course, students would be able:

1. To understand merging technological options, platforms and case studies of IoT implementation in home & city automation.
2. To determine the Market perspective of IoT.

**Course Code: IoT-04**

**Course Title: Embedded Systems for IoT**

**Course Objective:**

* To make students know the basic concept and architecture of embedded systems.
* Different design platforms used for an embedded system for IoT applications.
* To have knowledge about the IoT enabled technology.

**Course Contents:**

Module 1 [7 Lectures]

Purpose and requirement specification, IoT level specification, Functional view specification, Operational view specification, Device and component integration, Pillars of Embedded IoT and Physical Devices: The internet of devices.

Module 2 [8 Lectures]

Design of Embedded Systems: Common Sensors, Actuators, Embedded Processors, Memory Architectures, Software architecture.

Module 3 [7 Lectures]

Inputs and Outputs: Digital Inputs and Outputs, Digital Inputs, Digital Outputs, BusIn, BusOut, and BusInOut, Analog Inputs and Outputs, Analog Inputs, Analog Outputs, Pulse Width Modulation (PWM), Accelerometer and Magnetometer, SD Card, Local File System (LPC1768).

Module 4 [10 Lectures]

IoT Enabling Technologies: Communications, RFID and NFC (Near‐Field Communication), Bluetooth Low Energy (BLE), LiFi, 6LowPAN, ZigBee, Z‐Wave, LoRa, Protocols, HTTP, WebSocket, MQTT, CoAP, XMPP, Node‐RED, Platforms, IBM Watson IoT—Bluemix, Eclipse IoT, AWS IoT, Microsoft Azure IoT Suite, Google Cloud IoT, ThingWorx, GE Predix, Xively, macchina.io, Carriots.

Module 5 [10 Lectures]

Web of Things and Cloud of Things: 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.

**Text Books/References:**

1. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, Internet of Things, John Wiley and Sons.
2. Klaus Elk, “Embedded Software for the IoT”.
3. Perry Xiao, “Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed”.
4. Elizabeth Gootman et. al, “Designing Connected Products”, Shroff Publisher/O’Reilly Publisher.

**Corresponding Online Resources:**

1. Introduction to the Internet of Things and Embedded Systems, https://www.coursera.org/learn/iot

**Course Outcomes:**

After completion of course, students would be able to:

1. Understand the embedded system concepts and architecture of embedded systems.
2. Understand the different hardware/software co‐design techniques for microcontroller‐based embedded systems, apply techniques in IoT applications.
3. To be able to design web/cloud based IoT applications.

**Course Code: IoT-05**

**Course Title: IoT with Arduino, ESP, and Raspberry Pi**

**Course Objective:**

* To give students hands-on experience using different IoT architectures.
* To provide skills for interfacing sensors and actuators with different IoT architectures.
* To develop skills on data collection and logging in the cloud.

**Course Contents:**

Module 1 [5 Lectures]

IoT- introduction and its components, IoT building blocks, Sensors and Actuators, IoT Devices, IoT boards (Arduino Uno, ESP 8266-12E Node MCU, and Raspberry Pi 3).

Module 2 [10 Lectures]

Arduino Uno – getting started with the Uno boards, blink program, connection of sensors to the Uno board, reading values of sensors from the Uno board, interrupts. Case study: Temperature/Humidity Control; Case Study: Sending values Temperature/Humidity values to the Internet via GSM module.

Module 3 [10 Lectures]

ESP 8266-12E Node MCU – getting started with the ESP board, Micropython and Esplorer IDE, Flushing the ESP8266 board with micropython, connecting sensors to the ESP board, Connecting ESP board to WiFi, Interfacing ESP with the Cloud (REST API-GET, POST, MQTT), interrupts, comparison of ESP 32 board with the ESP 8266 board. Case Study: Switching light on /off remotely. Case Study: Voice-based Home

Automation for switching lights on/off (Android phone – Google Assistant (Assistant <-> IFTTT), MQTT (ESP <-> IFTTT), ESP 8266 <-> Lights).

Module 4 [8 Lectures]

Raspberry Pi 3 - Rpi3 introduction and installing the Raspbian Stretch OS, Headless - Computer and Rpi3 configuration to connect through SSH via Ethernet, Headless - connecting Rpi3 remotely without Ethernet cable via SSH, IP address, Rpi 3 - Testing the GPIO pins through Scripts.

Module 5 [9 Lectures]

Raspberry pi3 interfacing with Sensor DHT11, Raspberry pi3 python library install and reading sensor feed, 'Plug and play ' type cloud platform overview for integration to IOT devices, 'Plug and play' cloud platform for integration to IOT device - actuator (LED), Plug and play platform - Custom widget (DHT11-Sensor) integration through Python. New - Raspeberry Pi 4 Vs Raspberry Pi3 Mobel B Comparison, LoRawan /LPWAN – Overview.

**Text Books/References:**

1. Rao, M. (2018). Internet of Things with Raspberry Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects. Packt Publishing Ltd
2. Baichtal, J. (2013). Arduino for beginners: essential skills every maker needs. Pearson Education.
3. Schwartz, M. (2016). Internet of Things with ESP8266. Packt Publishing Ltd.
4. Richardson, M., & Wallace, S. (2012). Getting started with raspberry PI. " O’Reilly Publisher Media, Inc."

**Software/Hardware Requirements:**

Python, IOT boards - Arduino UNO, NODEMCU ESP 8266, Raspberry PI 3, Few resistors, potentiometer (5K~10K OHM), breadboard, LEDs, DHT 11 sensor.

**Course Outcomes:**

After completion of course, students would:

1. To understand Arduino Uno, NODE MCU 8266 and Raspberry PI along with critical protocols and its communication to cloud.
2. To apply commonly used IOT protocols such as REST API, MQTT through IOT based demonstration.
3. To solve analog sensor and digital sensor interfacing with IOT devices.

**Course Code: IoT-06**

**Course Title: Industrial IOT**

**Course Objective:**

* To explore the IoT applications in industrial systems.
* To develop design skills in industrial IoT.
* To expose the state of art development in Industry 4.0 and its applications.

**Course Contents:**

UNIT 1 – INDUSTRY 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artifical Intelligence, Big Data and Advanced Analysis

UNIT 2 – INDUSTRIAL IoT : IIoT-Introduction, Industrial IoT: Business Model and Referece Architerture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

UNIT 3 – IIoT ANALYTICS: Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

UNIT 4 – IoT SECURITY:Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT

UNIT 5 – CASE STUDY: Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies : Milk Processing and Packaging Industries, Manufacturing Industries

**Text Books/References:**

1. Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress), 2017
2. Industrial Internet of Things: Cybermanufacturing Systems”by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

**Course Outcomes:**

At the end of the course the student should be able to

1. Understand technologies, Catalysts and precursors of IIoT using suitable use cases.
2. Describe and design IIoT Reference Architecture Framework.
3. Comprehend Access Network Layer and Mid dleware knowledge protocols.
4. Design Software IIoT Systems.
5. Comprehend IIoT WAN Technologies and Protocols.
6. Relate the information Security in IIoT Systems
7. Realize the development of Industry 4.0 and Smart Factories
8. Experiment IoT based solutions for real time industrial applications.