Minor Degree Courses
Offered by
Department of Electronics and Communication Engineering (IoT)

The department of Electronics and Communication (IoT) Engineering offers the following minor degree courses for the students of undergraduate B. Tech. program of other departments in MMMUT Gorakhpur.

Minor Degree Courses offered by ECED (IoT) (For the B.Tech. students of another Department)

1. For holistic development of the students and as per NEP-2020 and AICTE guideline, the students may earn additional 20 credits through the minor degree courses offered by different departments of the University from Semester IV to VIII.
2. Minor degree courses are optional, but it will be helpful to align the need of industries.
3. Students can only opt for one minor degree course during his/her studies of the B. Tech. program
4. If students complete all 5 PE (professional elective) category courses offered for the minor degree (total 20 credit) from the other department for minor degree, he/shell get a B. Tech. degree in his/her own branch.
5. No extra fee for a minor degree course will be charged by the students
6. In case if a student is unable to complete all 5 PE courses as offered by the other department for minor degree at the time of completion of B. Tech. program in his/her own branch then student will get B. Tech. degree in his/her own branch without completing the minor degree course from other Department.
7. The minor degree course may be offered by the department through MOOC, as per the guidelines in B. Tech. ordinance 3.0 for the MOOC course.

Name of Minor 1: Drone Technology

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	EEC-151	Introduction to Drones	3	1	0	4
PE3	EEC-351	Dynamics and Control of Drones	3	1	0	4
PE5	EEC-551	Autonomous Navigation of Drones	3	1	0	4
PE7	EEC-751	Fundamentals of Autonomous Drones Programming	3	1	0	4
PE9	EEC-951	Minor Project	0	0	8	4
Total						**20**

Name of Minor 2: IoT, Robotics & Automation

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE-1	EEC-152	Fundamentals of Analog and Digital Electronics	3	0	2	4
PE-3	EEC-352	Introduction to Embedded Systems & Microcontroller Programming	3	0	2	4
PE-5	EEC-552	IoT Systems and Cloud Integration	3	0	2	4
PE-7	EEC-752	Robotics System and Intelligent Automation	3	1	0	4
PE-9	EEC-952	Minor Project	0	0	8	4
Total						20

Name of Minor 1: Drone Technology

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	EEC-151	Introduction to Drones	3	1	0	4
PE3	EEC-351	Dynamics and Control of Drones	3	1	0	4
PE5	EEC-551	Autonomous Navigation of Drones	3	1	0	4
PE7	EEC-751	Fundamentals of Autonomous Drones Programming	3	1	0	4
PE9	EEC-951	Minor Project	0	0	8	4
Total						**20**

Course Code: EEC-151		**Introduction to Drones**
Course category	:	Program Electives
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, and one Minor test and one Major Theory & Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the basic principles of flight and the evolution of drone technology.
2. Demonstrate knowledge of various types of drones, their classifications, and applications.
3. Explain the working of key drone components including flight controller, ESCs, motors, propellers, GPS, and communication systems.
4. Analyze and apply fundamental concepts of drone aerodynamics and flight stability.
5. Understand regulatory, safety, and ethical aspects related to drone operation.
6. Gain practical knowledge on drone assembly, calibration, pre-flight checks, and basic flight maneuvers.

Topics Covered

UNIT-I

History and evolution of drones: milestones and generations, Classification of drones: fixed-wing, rotary-wing (quadcopters, hexacopters), hybrid drones, Applications: agriculture, defense, surveillance, delivery, environmental monitoring, cinematography, Basic drone components: airframe, motors, ESC (Electronic Speed Controllers), flight controllers, batteries, Types of flight controllers and autopilots, Introduction to drone communication **9** systems and telemetry basics.

UNIT-II

Detailed airframe design principles and material selection (carbon fiber, plastic composites, aluminum), Propulsion systems: brushless DC motors, propellers, thrust and torque concepts, Sensors overview: IMU (accelerometer, gyroscope), magnetometer, GPS modules, barometric pressure sensors, Power systems: battery types (LiPo, Li-ion), power management, battery monitoring and charging systems, Communication interfaces: radio frequency, Bluetooth, Wi-Fi, Zigbee, Introduction to payload systems: cameras, sensors, delivery mechanisms **9**

UNIT-III

Aerodynamics fundamentals: lift, drag, thrust, weight, and their relationships, Stability in flight: static and dynamic stability, Degrees of freedom and drone motion: roll, pitch, yaw, Flight modes: manual, stabilized, GPS hold, waypoint navigation, Introduction to flight control algorithms: PID control basics, Manual vs automated flight operation, Pre-flight calibration and setup procedures. **9**

UNIT-IV

Drone safety protocols and risk management, National (DGCA India, FAA USA) and international drone regulations and legal frameworks, Airspace classifications and no-fly zones, Privacy concerns and ethical issues in drone usage, Routine maintenance: battery care, motor inspection, firmware updates, Troubleshooting common issues: signal loss, motor failure, sensor calibration errors, Emerging trends: swarm drones, BVLOS (Beyond Visual Line of Sight) operations. **9**

Books & References

1. Austin, R. Unmanned Aircraft Systems: UAVs Design, Development and Deployment, Wiley, 2010.
2. Zhang, Q. and Yang, L.T., Intelligent UAVs for Mobile Inspection: A Deep Learning Perspective, Springer, 2021.
3. R. K. Sharma, Fundamentals of UAVs and Drone Technology, Khanna Publishing House, 2022.
4. Paul G. Fahlstrom and Thomas J. Gleason, Introduction to UAV Systems, Wiley, 3rd Edition, 2012.
5. Tiwari, R. and Ghosh, A., Drone Technology and Applications, BPB Publications, 2021.

Course Code: EEC-	**Dynamics and Control of Drones**

351		
Course category	:	Program Electives
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, and one Minor test and one Major Theory & Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Understand the fundamentals of drone dynamics including linear and rotational motion.
2. Analyze the forces and moments acting on various types of drones during flight.
3. Explain and model the longitudinal and lateral dynamics of multirotor and fixed-wing UAVs.
4. Demonstrate knowledge of control system design techniques used for UAV stability and navigation.
5. Understand and apply PID and adaptive control strategies for drone flight control.
6. Develop and simulate dynamic models and controllers for drones using MATLAB/Simulink or similar platforms.

Topics Covered

UNIT-I

Reference frames and coordinate systems (inertial, body-fixed), Newton-Euler equations of motion for rigid bodies, Force and moment generation by rotors, Modeling aerodynamic forces and moments, Simplified linearized models for control design, Modeling assumptions and limitations **9**

UNIT-II

Concepts of stability: Lyapunov stability, BIBO (Bounded Input Bounded Output) stability, Open-loop vs closed-loop control systems, Transfer functions and block diagrams, PID controllers: proportional, integral, derivative actions, tuning methods (Ziegler-Nichols, trial and error), State-space representation: state variables, inputs, outputs, Controllability and observability basics. **9**

UNIT-III

Attitude estimation using sensor fusion (Complementary and Kalman filters), Design of attitude controllers: roll, pitch, yaw stabilization, Altitude hold and vertical speed control, Position control: GPS-based navigation control loops, Actuator dynamics and control allocation for multi-rotors, Fail-safe and redundancy mechanisms in control systems. **9**

UNIT-IV

Nonlinear control methods: sliding mode control, backstepping control, Adaptive control to handle changing payloads and disturbances, Robust control to manage uncertainties and external disturbances, Fault detection and isolation techniques, Real-time implementation issues and computational constraints, Simulation tools: MATLAB/Simulink, Gazebo, PX4 SITL **9**

Books & References

1. Bouabdallah, S., Design and Control of Quadrotors with Application to Autonomous Flying, EPFL Thesis, 2007.
2. Beard, R. W., & McLain, T. W., Small Unmanned Aircraft: Theory and Practice, Princeton University Press, 2012.
3. Hoffman, G. M., Huang, H., Waslander, S. L., & Tomlin, C. J., Quadrotor Helicopter Flight Dynamics and Control: Theory and Experiment, Proceedings of the AIAA Guidance, Navigation, and Control Conference, 2007.
4. Bhatia, R., Flight Dynamics and Control of UAV, Wiley India, 2020.

Course Code: EEC-	**Autonomous Navigation of Drones**

551		
Course category	:	Program Electives
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, and one Minor test and one Major Theory & Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Understand the fundamentals of autonomous drone navigation and mission planning.
2. Demonstrate knowledge of onboard sensors such as GPS, IMU, LiDAR, and vision-based systems for navigation.
3. Apply SLAM (Simultaneous Localization and Mapping) techniques for real-time environment mapping.
4. Understand the role of AI and machine learning in enabling autonomous decision-making in drones.
5. Develop, simulate, and test autonomous navigation algorithms using platforms like ROS, PX4, and Gazebo.
6. Gain understanding of navigation mechanism of drones.

Topics Covered

UNIT-I

Definition and scope of autonomous navigation in UAVs, Overview of sensors for navigation: GPS, IMU, LIDAR, sonar, optical flow sensors, cameras, Environment perception and situational awareness, Concept of path planning and obstacle avoidance, Coordinate systems and map representations: occupancy grids, point clouds. **9**

UNIT-II

GPS-based localization and its limitations, Inertial navigation systems (INS) and sensor fusion techniques, Simultaneous Localization and Mapping (SLAM) concepts: feature extraction, data association, Visual SLAM and LiDAR-based mapping, Obstacle detection: clustering and segmentation techniques, Real-time constraints in mapping and localization. **9**

UNIT-III

Classical algorithms: Dijkstra’s algorithm, Sampling-based algorithms: Rapidly-exploring Random Trees (RRT), Probabilistic Road Maps (PRM), Trajectory planning: polynomial trajectories, minimum snap trajectories, Dynamic re-planning and obstacle avoidance during flight, Multi-agent path planning basics (for swarm drones), Cost functions and optimization criteria. **9**

UNIT-IV

Integration of navigation with flight control systems, Software architecture for autonomous **9** navigation: middleware and ROS framework, Simulation environments for testing: Gazebo, AirSim, RotorS, Hardware-in-the-loop (HIL) and software-in-the-loop (SIL) testing, Case studies: autonomous delivery drones, precision agriculture drones, Challenges in real-world deployment: weather, GPS denial, communication loss.

Books & References

1. Zhang, Q., & Yang, L.T., Intelligent UAVs for Mobile Inspection: A Deep Learning Perspective, Springer, 2021.
2. Beard, R. W., & McLain, T. W., Small Unmanned Aircraft: Theory and Practice, Princeton University Press, 2012.
3. Siegwart, R., Nourbakhsh, I.R., & Scaramuzza, D., Introduction to Autonomous Mobile Robots, MIT Press, 2011.

Course Code: EEC-751		**Fundamentals of Autonomous Drones Programming**
Course category	:	Program Electives
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, and one Minor test and one Major Theory & Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Understand the programming architecture of autonomous drones including onboard and ground control systems.
2. Gain proficiency in programming flight controllers using platforms such as PX4, ArduPilot, and DroneKit.
3. Develop autonomous flight missions using APIs in Python, C++, and MAVLink communication protocols.
4. Integrate and program various sensors such as GPS, IMU, and cameras for real-time data processing.
5. Understand the basics of ROS (Robot Operating System) and apply it in drone applications.
6. Design and test custom autonomous behaviors like waypoint navigation, object tracking, and geo-fencing using simulation tools such as Gazebo and Q Ground Control.

Topics Covered

UNIT-I

Overview of popular open-source autopilot platforms: PX4, ArduPilot, Introduction to drone SDKs: DJI SDK, MAVSDK, DroneKit, Embedded programming languages: C/C++, Python, ROS (Robot Operating System) basics, Communication protocols: UART, SPI, I2C, CAN, MAVLink, Setting up integrated development environments (IDE), toolchains, cross- **9** compilation.

UNIT-II

Reading sensor data from IMU, GPS, barometers using embedded code, Signal conditioning and filtering techniques: low-pass filters, Kalman filter basics, Data fusion algorithms for robust state estimation, Logging and transmitting telemetry data, Handling asynchronous sensor data and interrupts, Memory management and data storage on embedded systems. **9**

UNIT-III

Implementing flight control algorithms: PID loops for attitude and altitude control, Programming waypoint navigation and geofencing, writing autonomous mission scripts and behavior trees, Handling real-time constraints and task scheduling, Safety programming: fail-safe behaviors, emergency landing scripts, Debugging embedded systems and software tools. **9**

UNIT-IV

Mission planning APIs and scripting autonomous sequences, Simulation of drone missions using SITL and HITL frameworks, Integration with ground control stations (QGroundControl, Mission Planner), Performance profiling and optimization of drone software, Field testing: deployment considerations, real-time telemetry monitoring, Case studies: package delivery, surveillance, search and rescue. **9**

Books & References

1. Learning ROS for Robotics Programming – Aaron Martinez and Enrique Fernandez, Packt Publishing, 2015.
2. Programming for Drones: Using DroneKit-Python and ArduPilot – Agus Kurniawan, PE Press, 2017.
3. Autonomous Navigation and Deployment of UAVs for Communication, Surveillance and Delivery – Yasir Faheem and Sajjad Rizvi, Springer, 2022.
4. Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy – Lentin Joseph, Apress, 2018.
5. Drone Programming with ArduPilot and Python: Build and Control Autonomous Drones Using Open Source Software – Ty Audronis, Packt Publishing, 2024.

Name of Minor 2: IoT, Robotics & Automation

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE-1	EEC-152	Fundamentals of Analog and Digital Electronics	3	0	2	4
PE-3	EEC-352	Introduction to Embedded Systems & Microcontroller Programming	3	0	2	4
PE-5	EEC-552	IoT Systems and Cloud Integration	3	0	2	4
PE-7	EEC-752	Robotics System and Intelligent Automation	3	1	0	4
PE-9	EEC-952	Minor Project	0	0	8	4
Total						20

Detailed Syllabus

Course Code: EEC-152		Fundamentals of Analog and Digital Electronics
Course Category	:	Program Electives
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture:3, Tutorial:0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessments through teaching assessment, attendance, home assignments, quizzes, two minor tests and one major theory examination.
Course Objectives	:	To equip students with foundational knowledge of analog and digital electronics through the study of diodes, transistors, and logic circuits. The course emphasizes practical applications in circuit design, switching operations, and digital systems using combinational and sequential logic.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1: Analyze the characteristics and applications of various types of diodes, including their behavior in rectifiers and switching circuits.
2: Explain the operation, configurations, and biasing techniques of BJTs and FETs,

and evaluate their performance in analog applications.

3: Design and implement combinational logic circuits such as adders, subtractors, multiplexers, and encoders.

4: Develop and analyze sequential logic circuits including flip-flops, counters, and shift registers for various digital applications.

5: Apply the concepts of analog and digital electronics to build basic electronic systems and prepare for advanced study in embedded system design.

6. Be able to convert a real world problem (RWP) into a binary digital system (BDS).

Topics Covered

Unit I **9**

Diode Characteristics and Applications:

P-N junction diode and its characteristics, Mathematical analysis of built-in potential, depletion width, Diode applications (half-wave and full-wave rectifiers, clippers, clampers), Non-ideal diode models, Zener diodes and its applications, Diode capacitance and switching times, Types of diodes (LED, Varactor diode, Schottky diode, Photodiode).

Unit II **9**

Transistor Basics and applications

BJT: Bipolar Junction Transistor (BJT types, operation, configurations, characteristics), Cut-off and saturation operations, Q point, BJT switching times, Applications of BJT, BJT biasing.

FET: Field Effect Transistor (FET types, operation, configurations, characteristics), MOS structure, CV characteristics, Metal-Oxide Semiconductor FET, Complementary MOSFET (CMOS), FET biasing.

Unit III **9**

Combinational Logic Circuits

Basics of Boolean Algebra, Logic Gates, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Full adder using half adder, BCD Adder. Carry Look ahead Adder, Multipliers. Multiplexer/Demultiplexers, Encoders and Decoders, Application of universal logic gates.

Unit IV **9**

Sequential Logic Circuits

Latches, Edge Triggered Flip Flops: SR, D, JK, Master slave JK. Synchronous and Asynchronous counters, Up/Down Counters, Design of Synchronous counters, Cascaded Counters, Counter applications. Shift register functions, Serial in/serial out shift registers, serial in parallel out/shift registers, Parallel In/Parallel out shift registers, bidirectional Shift registers, Shift register counters, Shift register Applications.

LIST OF EXPERIMENTS:

1. V-I Characteristics of PN junction and Zener diode.
2. Clipper and clamper circuit design using PN junction diode.
3. Half-Wave, Full wave rectifier with and without filter.
4. V-I Characteristics of Bipolar Junction Transistor.
5. Verify the truth table of all basic and universal logic Gates using their ICs and implement a Boolean function using Basic and Universal Gates.
6. Design four/eight- b i t binary adder and subtractor circuit.
7. Design a circuit to implement a Boolean function using Multiplexer.
8. Design and implement a Seven Segment Display system to display numbers 0 to 9.
9. Design Latch and Flip flops Using logic Gates.
10. Design and Testing of Ripple Counters Using Counter ICs.

Text and Reference Book

Textbook:

1. Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press, 7th Edition, 2017.
2. Robert Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 11th Edition, 2015.
3. Digital Design 5e, Mano / Ciletti, Pearson.
4. Digital Circuits and Design 5e, Salivahanan, Oxford.

References:

1. Jacob Millman, Christos C. Halkias, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw Hill, 2nd Edition, 2017.
2. Donald A. Neamen, "Microelectronics: Circuit Analysis and Design", McGraw Hill, 5th Edition, 2012.
3. Digital Electronics: Principles and Integrated Circuits, Maini, Wiley.
4. Digital Electronics, Kharate, Oxford.
5. Digital Design: Principles and Practices, 4e, Wakerly, Pearson.

Course Code:EEC-352	**Introduction to Embedded Systems & Microcontroller Programming**	
Course Category	**:**	**Program Electives**
Pre-requisite Subject	**:**	**NIL**
Contact hours/week	**:**	Lecture:3, Tutorial:0, Practical:2
Number of Credits	**:**	4
Course Assessment methods	**:**	Continuous assessments through teaching assessment, attendance, home assignments, quizzes, two minor tests and one major theory examination.
Course Objectives	**:**	This course introduces students to embedded systems and microcontrollers, focusing on system architecture,

programming, and real-world interfacing. It covers the 8051 microcontroller, Arduino platform, and Raspberry Pi, enabling students to design and simulate embedded applications such as sensor monitoring, motor control, and multimedia analytics using C/C++ and Python.

Course Outcomes : After completing this course, students will be able to show the following knowledge and skills.

1: Understand what embedded systems are and how they differ from general computers.
2: Learn about the 8051 microcontroller and write simple programs using assembly language.
3: Know the basics of Arduino, its parts, and how it works.
4: Write programs in Arduino to control lights, motors, sensors, and displays.
5: Use Raspberry Pi with Python to work on sound, image, and sensor-based projects.
6: Familiarize with the foundations of open-source and proprietary IDEs for programming microcontrollers.

Topics Covered

Unit I **9**

Introduction to Embedded Systems : Introduction to Embedded Systems, Embedded System Applications, Block diagram of embedded systems, Trends in Embedded Industry, Basic Embedded System Models, Embedded System development cycle, Challenges for Embedded System Design, Evolution of computing systems and applications. Basic Computer architecture: Von-Neumann and Harvard Architecture. Computing performance,
Throughput and Latency, Basic high performance CPU architectures, Microcomputer.

Unit II **9**

Microprocessor: 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions, Mode of Operation, Introduction to I/O and Memory, Timing Diagrams, Introduction to Interrupts. Introduction to C language, Instruction format, C language programming format, Addressing mode, Instruction Sets, Programming 8086 microprocessor.

Unit III: **9**

Microcontroller: Introduction to Microcontroller and its families, Criteria for Choosing Microcontroller, 8051-architecture, operation, pin configuration and functions, memory organization, register, I/O ports, addressing modes, instruction sets, instruction classification. Assembly language programming, Interrupts in 8051. Timer/Counter programming for time delay generation and waveform generation.

Interfacing with ADC, DAC, LEDs and seven segment display

Unit IV: **9**

Arduino and Raspberry Pi: Introduction to the Arduino, creating an Arduino programming Environment, Arduino IDE, Arduino programming. Introduction to the Raspberry Pi, basic functionality of the Raspberry Pi board and its processor, setting and configuring the board, programming on Raspberry Pi

List of Experiments:

1. Write an assembly language code to Perform 8 Bit Addition/Subtraction.
2. To Find the Largest/Smallest Element in an Array Using 8051
3. Write a program of Flashing LED connected to port 1 of the 8051 Microcontroller.
4. Familiarization of Arduino UNO board and Arduino IDE
5. Blinking an LED using Arduino UNO.
6. Write a Program to measure Temperature and Humidity using DHT11 Sensor using Arduino.
7. Building Intrusion Detection System with Arduino and Ultrasonic Sensor
8. Introduction to Raspberry Pi Boards and installation of its Operating System
9. Find distance using Ultrasonic Sensor with Raspberry Pi.
10. Measurement of light intensity and controlling LED using LDR sensor on Raspberry Pi board.

Text and Reference Book

Textbook:

1. Muhammod Ali Mazidi, Rolin D. Mckinlay & Danny Sansey, "PIC Microcontroller and Embedded System SPI, UART using Assembly & C for PICI8," Pearson International Edition, 2008.
2. A. N. Sloss, D. Symes, and C. Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier, 2008
3. S. Monk, "Programming the Raspberry Pi" McGraw-Hill Education, 2013.
4. Raj Kamal, Embedded Systems Architecture, Programming, and Design. (2/e), Tata McGraw Hill, 2008.
5. K. V. Shibu, "Introduction to embedded system", McGraw Hill.

References:

1. Steave Furber, "ARM system-on-chip architecture", Pearson, 2nd Edition, 2015.
2 K.Uma Rao, Andhe Pallavi, "The 8051 microcontrollers, architecture and programming and applications", Pearson, 2009.

Course Code: EEC-552		**IoT Systems and Cloud Integration**
Course Category	**:**	**Program Electives**
Pre-requisite Subject	**:**	**NIL**
Contact hours/week	**:**	Lecture:3, Tutorial:0, Practical:2
Number of Credits	**:**	4

Course Assessment methods	:	Continuous assessments through teaching assessment, attendance, home assignments, quizzes, two minor tests and one major theory examination.
Course Objectives	:	This course introduces the fundamentals of the Internet of Things (IoT) and cloud computing. It covers IoT architecture, communication technologies, sensor integration, and programming, along with the basics of cloud infrastructure, service models, and data storage. Students will gain practical knowledge of how IoT systems interact with cloud platforms to build scalable and smart applications.
Course Outcomes	:	By the end of this course, students will be able to understand and apply the skills and ideas listed below.

1: Understand the basic concepts, history, and communication technologies related to the Internet of Things (IoT).
2: Explain the IoT architecture, processing topologies, and integration of sensors, actuators, and microcontrollers.
3: Develop simple IoT applications using programming and cloud data storage.
4: Describe the key features, service models, and infrastructure of cloud computing and its role in modern data systems.
5: Analyze how cloud technologies support IoT systems through virtualization, storage, and delivery models.
6: Connect the intertwined relation between IoT and Cloud Computing.

Topics Covered

UNIT-I **9**

Introduction to IoT

Basics of networking, Basics of network security, Predecessors of IoT, Emergence of IoT, IoT Sensing and actuation, IoT processing topologies and types, IoT connectivity technologies, IoT communication technologies, IoT interoperability.

UNIT-II **9**

Basics of IoT

Internet of Things (IoT) theory, Protocol stack ecosystem, implementation and design cycle; Integration of microcontrollers and sensors; IoT programming; cloud data storage; Sensor interfacing; sensor network architectures; user interface design.

UNIT-III **9**

Cloud Computing

Introduction to Cloud Computing – Need for Cloud Computing, Definition and

Concepts of Cloud, Key Innovations in Modern Cloud Architectures, Comparison between Cloud Computing and Distributed Computing, Concept of Utility Computing. Features of Contemporary Cloud Systems – Massive Scalability, On-Demand Resource Availability, and Elasticity. Service Models in Cloud Computing – Hardware as a Service (HaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Introduction to Data-Intensive Computing and Emerging Cloud Paradigms. Classification of Cloud Environments – Private Clouds and Public Clouds.

UNIT-IV **9**

Cloud Storage and IoT
Fundamental Concepts: Cloud Characteristics, Cloud Delivery Models, Cloud Enabling Technology: broad-band network, virtualization technology, Cloud Infrastructure Mechanisms: Logical Network Perimeter, Virtual Server, Cloud Storage Devices.

LIST OF EXPERIMENTS

1. Setting up Raspberry Pi and connecting to a network.
2. Familiarization with GPIO pins and control hardware through GPIO pins.
3. Use sensors to measure temperature, humidity, light and distance.
4. Connect IOT devices through the cloud using IoT protocols such as MQTT.
5. Controlling IoT devices using Arduino.
6. Create Wireless network of sensors using Zigbee.
7. Write a program on Arduino or Raspberry Pi to upload temperature and humidity data to the Thingspeak cloud.
8. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from Thingspeak cloud.
9. Write a program on Arduino or Raspberry Pi to upload temperature and humidity data to the Thingspeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from Thingspeak cloud.

Text and Reference Books
Textbook:

1. S. Misra, A. Mukherjee, and A. Roy, *Introduction to IoT*, Cambridge University Press, U.K.
2. S. Greengard, The Internet of Things, MIT Press.

Course Code: EEC-752	**Robotics System and Intelligent Automation**	
Course Category	:	**Program Electives**
Pre-requisite Subject	:	**NIL**
Contact hours/week	:	Lecture:3, Tutorial:1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessments through teaching

		assessment, attendance, home assignments, quizzes, two minor tests and one major theory examination.
Course Objectives	:	This course introduces students to the fundamentals of robotics and mechatronics, focusing on robot types, kinematics, dynamics, and trajectory planning. It covers key concepts like sensors, actuators, transformation matrices, control systems, and robotic vision. Students will gain theoretical and practical knowledge to analyze, model, and design robotic systems for real-world applications, with hands-on exposure to simulation and control techniques.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1: Understand the basic types, structure, and movements of robots, including serial and parallel robots.

2: Learn how to calculate robot motion, speed, force, and plan smooth movement paths.

3: Identify and explain key mechatronic components like sensors, actuators, and electric circuits used in automation.

4: Understand the basics of robotic vision and how robots use cameras and sensors to see and respond to their environment.

5: Learn how control systems work in robots and apply basic control methods like PID and advanced techniques for precise movement.

6: Delve into building an autonomous vehicle capable if accomplishing multiple tasks.

Topics Covered

Unit I: **9**

Fundamentals of Robotics and Kinematics

Introduction – Types and classification of robots, science of robots, technology of robots Elements of Robots – Homogeneous transformation, joints and links, link transformation matrices, actuators, transmission systems, and sensors Kinematics of Serial Robots – Direct and inverse kinematics of serial robots, inverse kinematics of a general 6R robot Kinematics of Parallel Robots – Loop-closure constraint equations, direct and inverse kinematics of parallel robots, mobility of parallel manipulators.

Unit II: **9**

Analysis, Dynamics, and Trajectory Planning

Velocity and Static Analysis of Manipulators – Linear and angular velocity of links, Jacobian for serial and parallel manipulators, singularities, statics of manipulators Dynamics of Serial and Parallel Robots

– Lagrangian formulation, equations of motion, inverse dynamics, and simulation
Trajectory Planning
– Planning smooth and accurate motion paths for robotic systems, Visualization in simulation environment.

Unit III: **9**
Introduction to Mechatronics and Components

Introduction to Mechatronics – Concept and scope of mechatronics, system design with practical examples Electric Circuits and Components – Basic circuit elements, passive and active components, applications in automation Sensors – Measurement of position, speed, stress, strain, temperature, vibration, acceleration, pressure, and flow Actuators – Working principles and types: electromagnetic actuators, solenoids, relays, electric motors (DC, AC, Stepper, Servo), hydraulic and pneumatic actuators.

Unit IV: **9**
Fundamentals of Robotic Vision and Control Systems
Robotic Vision – Basics of robotic vision systems, use of cameras and sensors for environmental perception and Visualization in simulation environment, Control System Analysis – Feedback control fundamentals, system stability, and frequency domain analysis Control System Design – State-space representation, Internal Model Control (IMC), PID control design Manipulator Control Techniques – Computed torque control, robust and adaptive control, advanced control methods including neural networks, soft computing, and force control.

Text and Reference Books
Textbook:

1. Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics: Control, Sensing, Vision and Intelligence, Tata McGraw-Hill, 2008.
2. Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
3. Craig, J.J., Introduction to Robotics: Mechanics and Control, Pearson Prentice Hall, 2005.
4. Wilamowski, B.M., and Irwin, J.D., The Industrial Electronics Handbook – Control and Mechatronics (2nd Edition), CRC Press, Taylor and Francis Group LLC, 2011.
5. Bolton, W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Limited, 2008.
6. Horn, B.K.P., Robot Vision, MIT Press, 1986.
7. Corke, P., Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.