VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

Nature of certificate: Post Graduate Diploma

Title of the Course: Post Graduate Diploma in Industrial IoT

Proposed Maximum Duration: 1 year

Total Hours: 480 hours

Mode of course delivery: Hybrid

Offered by: V. R. Jamdar Siemens Center of Excellence, VNIT Nagpur (Interdisciplinary Studies)

Eligibility: B.Tech (Any) Completed / M.Tech (Any) Ongoing

Course Objective:

1. Develop expertise in the design and implementation of Industrial Internet of Things (IIoT) systems, including the use of sensors, data acquisition systems, wireless communication protocols, and cloud-based platforms.
2. Understand the fundamentals of Supervisory Control and Data Acquisition (SCADA) systems, including their architecture, components, and applications in industrial automation and control.
3. Gain proficiency in Human-Machine Interface (HMI) software tools, including the ability to design and develop effective graphical user interfaces for industrial automation and control systems.
4. Develop skills in cyber security and risk management for IIoT, SCADA, and HMI systems, including the identification of potential threats and vulnerabilities, and the implementation of appropriate security controls.
5. Develop effective communication and teamwork skills, including the ability to collaborate with cross-functional teams to design, implement, and manage IIoT, SCADA, and HMI systems in industrial settings.

Course Structure:

Year	Sem	Course Code	Course Name	L	T	P	Credits
First	1st	PGDIIOT401	Programmable Logic Controllers	0	0	6	3
First	1st	PGDIIOT 402	Basics of electronics and embedded systems	3	1	0	4
First	1st	PGDIIOT 403	Edge Computing	3	0	0	3
First	1st	PGDIIOT 404	SCADA and HMI	1	0	6	4
First	1st	PGDIIOT 405	Introduction to Industrial Internet of Things	0	0	6	3
First	1st	PGDIIOT 406	Introduction to Industrial Networking	1	0	4	3
Sub Total							20
First	2nd	PGDIIOT 407	Data Analytics for IIoT	3	1	0	4
First	2nd	PGDIIOT 408	Industrial IoT security	2	1	2	4
First	2nd	PGDIIOT 409	Industrial cloud platforms	1	0	6	4
First	2nd	PGDIIOT 410	Professional Development	1	0	2	2
First	2nd	PGDIIOT 411	Industrial Case Study	0	0	6	3
First	2nd	PGDIIOT 412	Industry Project	0	0	6	3
			Subtotal	15	3	22	20
						Total	40

Course Outcomes:

1. Students can develop a comprehensive understanding of Internet of Things (IoT) technologies, including sensors, communication protocols, cloud computing, and data analytics.

2. The program can provide students with hands-on experience in designing, implementing, and managing IoT-based solutions for industrial applications.

3. The program can provide students with an understanding of IoT security and privacy issues, including data encryption, access control, and device authentication.

4. The program can help students develop effective communication and teamwork skills through group projects and case studies, which are essential for working in cross-functional teams in industrial IoT settings.

5. Graduates of the program can be better equipped to take on roles in IoT-based industrial applications and other areas of technology, due to their in-depth knowledge of IoT technologies and their practical experience in designing and implementing industrial IoT solutions.

Attendance: As per institute rule book. (100 % mandatory, 25% relaxation may be given by course coordinator)

Course Evaluation: Mid-term (30%) + End Term (30%) + Teacher's Assessment (40% which includes project)

Course Fees: Rs. 96,000 + 18% GST

Course Proposed by VRJSCOE Team to BoS (Interdisciplinary Studies)

Course Coordinators:

Prof. U. A. Deshpande
(Professor Incharge, IoT Lab of VRJSCOE)

Dr. Pradhnya Ghare
(Professor Incharge, Process Instrumentation Lab of VRJSCOE)

Dr. Pradyumn Chaturvedi
(Professor Incharge, Mechatronics Lab of VRJSCOE)

Lab Coordinator(s):
Trainers for IoT Lab, Process Instrumentation and Mechatronics Lab and Center Manager

Course Execution Coordinator:

Prof. Shital S. Chiddarwar
Center Head
V R Jamdar Siemens CoE

Syllabus for PGDIIOT401-Programmable Logic Controllers –(0-0-6-3)

1. Introduction to PLCs, the basics of PLCs, including their history, how they work, and their applications in industry.

2. PLC Programming, ladder logic, function block diagrams, and sequential function charts, an introduction to programming software such as Siemens TIA Portal or Step 7.

3. Sensors and Actuators, various types of sensors and actuators that are commonly used in PLC systems, such as proximity sensors, pressure sensors, and motors.

4. PLC Hardware, input/output modules, communication modules, and power supplies.

5. PLC Troubleshooting, wiring issues or programming errors, and how to troubleshoot them.

6. Advanced Topics such as distributed control systems, PID control, or networked PLC systems.

7. Laboratory Exercises: The laboratory component of the course could include exercises designed to give students hands-on experience with Siemens PLCs. This could include programming exercises, wiring exercises, and troubleshooting exercises.

Text books:

1. User Manual of Siemens TIA Portal, https://cache.industry.siemens.com/dl/files/542/40263542/att_829827/v1/GS_STEP7Bas105enUS.pdf
2. Learn-/Training Textbook, Siemens Automation Cooperates with Education (SCE) TIA Portal Modules for Automation System SIMATIC S7-1200 from Version V14 SP1, https://www.automation.siemens.com/sce-static/learning-training-documents/tia-portal/learn-training-textbook-s7-1200-en.pdf

Syllabus for PGDIIOT 402-Basics of electronics and embedded systems (3-1-0-4)

1. Introduction to Electronics, atomic structure, electric charge, and basic circuit components such as resistors, capacitors, and inductors.

2. Electronic Devices, diodes, transistors, and operational amplifiers, their characteristics and applications.

3. Analog Circuits, design and analysis of analog circuits, such as amplifiers, filters, and oscillators.

4. Digital Circuits, logic gates, Boolean algebra, and combinational and sequential circuits.

5. Microcontrollers and Embedded Systems, architecture, programming, and interfacing with sensors and actuators.

6. Sensors and Actuators, used in embedded systems, such as temperature sensors, accelerometers, and servo motors.

7. Communication Protocols, UART, SPI, and I2C.

8. Design of Embedded Systems, requirements analysis, specification, design, implementation, and testing.

9. Tutorial Exercises designed to give students hands-on experience with microcontrollers and embedded systems. This could include programming exercises, circuit design and analysis, and interfacing with sensors and actuators.

Text Books:

1. Embedded Systems Design: An Introduction to Processes, Tools, and Techniques, Arnold S. Berger, 2001, McGraw Hill , 1st edition

Syllabus for PGDIIOT 403 - Edge Computing (3-0-0-3)

1. Introduction to Edge Computing, definition, architecture, and benefits over cloud computing, different types of edge devices and sensors, such as gateways, microcontrollers, and IoT sensors, and their roles in edge computing systems, infrastructure required for edge computing systems, including networking, storage, and computing resources.

2. Edge Computing Applications, real-time data processing, video analytics, and machine learning, edge computing platforms available, such as OpenFog, EdgeX Foundry, and AWS Greengrass, and how to use them, security issues related to edge computing, such as data privacy, network security, and device security.

3. Edge Computing Standards, Open Edge Computing Initiative, and how they contribute to interoperability and scalability.

4. Siemens MindSphere, cloud-based IoT operating system designed for industrial applications, including its architecture, features, and benefits. MindConnect IoT Extension, MindSphere Edge, a set of software tools and services that enable edge devices to connect to MindSphere, and how it can be used for edge data processing and storage.

5. MindSphere Apps, Asset Performance Management app, and how they can be used to improve operational efficiency and reduce downtime. Siemens Cloud Infrastructure, cloud services and technologies used to provide scalability, reliability, and security. Siemens MindSphere APIs, Time Series API, and how they can be used to develop custom applications and integrate with other systems.

Text Books :

1. Siemens Mindsphere user guide, https://cache.industry.siemens.com/dl/files/499/109483499/att_887971/v1/MindSphere_Getting_Started_V1.1.pdf
2. Edge Computing: Fundamentals, Advances and Applications (Advances in Industry 4.0 and Machine Learning), D. Dharani, G. Sudha Sadasivam, K. Anitha Kumari, M. Niranjanamurthy , Taylor & Francis Ltd; 1st edition, 2021

Syllabus for PGDIIOT 404- SCADA and HMI (1-0-6-4)

1. Introduction to SCADA and HMI, Definition and purpose, Components and architecture , Advantages
2. SIMATIC SCADA software, Introduction to SIMATIC WinCC, WinCC options and functionalities, design and configuration tools, communication protocols
3. SIMATIC HMI software, HMI design and configuration tools, HMI visualization and interaction options, Communication protocols
4. SIMATIC SCADA and HMI hardware, Introduction, SIMATIC PLCs, RTUs, and I/O devices, SIMATIC HMI panels and panel PCs, Communication protocols and interfaces
5. Data acquisition and analysis with SIMATIC SCADA and HMI, Real-time data acquisition and logging, Data visualization and reporting, Data analysis and trend analysis
6. Cybersecurity in SIMATIC SCADA and HMI systems, Threats to SIMATIC SCADA and HMI systems, Security measures and best practices for securing SIMATIC systems, Siemens' cybersecurity services and support options
7. Case studies and real-world applications, Examples of SIMATIC SCADA and HMI systems in various industries (e.g. manufacturing, energy, water/wastewater, transportation), Case studies on SIMATIC SCADA and HMI system implementation and optimization, Emerging trends

Text Books:

1. Simatic HMI User Manual, https://cache.industry.siemens.com/dl/files/220/109736220/att_879788/v1/WinCC_Working_with_WinCC_en-US_en-US.pdf
2. Simatic SCADA User Manual, https://cache.industry.siemens.com/dl/files/270/1145270/att_36311/v1/Confm1_e.pdf

Syllabus for PGDIIOT 405- Introduction to Industrial Internet of Things (0-0-6-3)

1. Introduction: Sensing & actuation, Communication, networking,
2. Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories
3. Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis
4. Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems.
5. IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture
6. Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking.
7. Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT- Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry.
8. Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies

Text books:

1. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress Berkeley, CA, 2016
2. Industrial Internet of Things: Cybermanufacturing Systems, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, Springer, 1st ed. 2017 edition

Syllabus for PGDIIOT 406- Introduction to Industrial Networking (1-0 - 4- 3)

1. Introduction to Industrial Networking for IIoT, Definition and purpose, Components and architecture, Advantages

2. Industrial Ethernet Networks, types of Ethernet networks (e.g. PROFINET, EtherNet/IP, Modbus TCP), Ethernet network design and implementation considerations, Ethernet network communication protocols and standards (e.g. TCP/IP, UDP, Ethernet/IP)

3. Wireless Networks for IIoT, Types of wireless networks (e.g. Wi-Fi, Bluetooth, Zigbee, 5G) Wireless network design and implementation considerations, Wireless network communication protocols and standards (e.g. MQTT, CoAP, LoRaWAN)

4. IIoT Data Communications, protocols (e.g. OPC UA, MQTT, CoAP), Data transfer methods (e.g. Request/Response, Publish/Subscribe), Security considerations in IIoT data communications

5. Edge Computing for IIoT, Edge Computing architectures and components (e.g. Edge Devices, Edge Gateways), Edge Computing benefits for IIoT applications, Edge Computing platforms (e.g. Azure IoT Edge, AWS Greengrass, Siemens MindSphere)

6. IIoT Cybersecurity, Threats to IIoT systems (e.g. Cyber-attacks, Malware, Data Breaches), Security measures and best practices for securing IIoT systems

Text Books:

1. Industrial Ethernet: A Pocket Guide, Joeri Laureys and Koen Verwerft, ISA, 2002
2. Industrial Wireless Sensor Networks: Applications, Protocols, and Standards (Industrial Electronics), Gerhard P. Hancke, V. Cagri Gungoer, CRC Press Inc, 1st edition, 2013

Syllabus for PGDIIOT 407- Data Analytics for IIoT (3-1-0-4)

Introduction to IIoT and data analytics, basics of IIoT, including its architecture and components, and how data analytics can help businesses improve their operations.

Data collection and management, data collection methods used in IIoT, including sensors, gateways, and other devices, collect, store, and manage large amounts of data.

Data preprocessing, cleaning, transforming, and preparing data for analysis, missing data, outliers, and other anomalies.

Descriptive analytics, summarizing and visualizing data, including statistical methods, charts, and graphs.

Predictive analytics, regression analysis, time-series analysis, and machine learning algorithms.

Prescriptive analytics, optimization algorithms and decision trees.

Data security and privacy encryption, access control, and data anonymization.

Elastic Analytics Concepts, scale data analytics capabilities and handle large volumes of data, Scaling, horizontal scaling, vertical scaling, and elastic scaling.

Text Books:

1. Data Analytics in the Era of the Industrial Internet of Things, Aldo Dagnino, Springer Nature Switzerland AG 2021
2. Internet of things and data analytics handbook, Hwaiyu Ge, John Wiley & Sons, 2017

Syllabus for PGDIIOT 408- Industrial IoT security (2-1-2-4)

Industrial Internet of Things (IIoT) , the applications of IoT in industries, edge computing, mobile technologies, and 3D printing, cybersecurity and the modular architecture of IIoT and how security comes into play with each module.

Threats to IIoT Systems, cyber-attacks, physical attacks, and insider threats.

Risk Assessment, identifying assets, identifying threats, assessing vulnerabilities, and analyzing risks.

Security Frameworks, as NIST, ISA-99, and IEC 62443 that are used to secure IIoT systems.

Secure Design Principles, secure boot, secure communication, secure firmware updates, and secure access control.

Encryption and Authentication, public-key cryptography, digital signatures, and certificate authorities

Security Monitoring and Incident Response, intrusion detection and prevention systems, security information and event management systems, and security incident and event management systems.

Physical Security, access control, video surveillance, and environmental controls that are used to secure IIoT systems.

Text Books:

1. Internet Of Things Security: Challenges Advances And Analytics, Patel, Auerbach P, Taylor & Francis Group, 2019
2. A Beginner's Guide to Internet of Things Security Attacks, Applications, Authentication, and Fundamentals, B. B. Gupta, Aakanksha Tewari, Taylor & Francis Group, 2020

Syllabus for PGDIIOT 409- Industrial cloud platforms (1-0-6-4)

Introduction to Industrial Cloud Platforms, Microsoft Azure Industrial IoT, AWS IoT, Google Cloud IoT, Siemens Mindsphere, IBM Watson IoT, GE Predix, SAP Leonardo, PTC ThingWorx.

Cloud Computing Fundamentals, visualization, cloud models, deployment models, and service models.

IoT Integration with Industrial Cloud Platforms IoT devices and sensors integration with Industrial Cloud Platforms, and how data from these devices can be processed and analyzed.

Cloud-Based Data Storage and Retrieval, including data management techniques, database systems, and data security.

Cloud-Based Data Analytics, data visualization, machine learning, and predictive analytics.

Cloud-Based Industrial Automation, remote monitoring and control of industrial processes, industrial robotics, and process automation.

Cloud-Based Asset Management, predictive maintenance, asset tracking, and inventory management.

Cloud-Based Supply Chain Management, g logistics optimization, inventory management, and demand forecasting.

Cloud-Based Quality Control, defect tracking, quality assurance, and real-time quality monitoring.

Cloud-Based Security and Privacy, security and privacy concerns associated with using Industrial Cloud Platforms, and the strategies and tools used to mitigate these concerns.

Text Books:

1. Cloud Computing: From Beginning to End, Ray Rafaels, Createspace Independent Publishing Platform, 2015
2. Cloud Computing, Mehul Mahrishi Kamal Kant Hiran, Ruchi Doshi, Dr. Fagbola Temitayo, BPB Publications; 1st edition, 2019

Syllabus for PGDIIOT 410-Professional Development (1-0-2-2)

Introduction to Professional Development for Engineers, The need for lifelong learning in engineering, The benefits of professional development for engineers

Developing Technical Skills, The importance of staying up-to-date with technical skills, Strategies for developing technical skills, such as attending training programs, online courses, and industry conferences

Effective Communication, The importance of effective communication in the engineering profession, Strategies for improving communication skills, such as public speaking, technical writing, and interpersonal communication

Leadership and Management, the importance of leadership and management skills in the engineering profession, Strategies for developing leadership and management skills, such as taking on project management roles, attending leadership training programs, and learning about team building

Ethics and Professionalism, The importance of ethical behavior and professionalism in the engineering profession, Strategies for developing ethical and professional behavior, such as attending ethics training programs, learning about professional organizations, and networking with other professionals

Career Planning and Development, The importance of setting career goals and developing a plan to achieve them, Strategies for career planning and development, such as networking, seeking mentorship, and exploring different career paths within the engineering profession

Workplace Issues, The importance of understanding workplace issues such as workplace diversity, conflict resolution, and work-life balance, Strategies for addressing workplace issues and creating a positive work environment

Professionalism in the Digital Age, The importance of understanding digital professionalism and online communication, Strategies for managing your online presence and using social media to advance your professional goals

Text Books:
1. Strategies and Tips for Time Management, Jack Barrett
2. How to Win Friends & Influence People, Dale Carnegie
3. Start with why, Simon Sinek

PGDIIoT 411 - Industrial Case Study (0-0-0-3) : Candidate has to present a live case study covering all aspects of Industrial IoT. Presentation and report submission will be mandatory.

PGDIIoT 412 - Mini Project (0-0-0-3) : Candidate has to take a live problem from industry, implement various tools of Industrial IoT to solve it. Presentation and report submission will be mandatory.