PG Diploma in Industrial Automation System Design (Certified Industrial Automation System Designer)

Preamble:

Stiff competition, higher quality standards and growing concerns of safety & environmental damage have pushed the Industrial sector to adapt state-of-the-art Automation Techniques for effective utilization of resources and optimized performance of the process plants. Recent trend of merging control systems associated with both factory and process automation demands knowledge from diverse fields. Automation applications span plant automation, discrete and batch process control, embedded machine control and manufacturing production line automation. The industrial automation applications include automation of time critical systems that demand precise real time readings and control.

Qualified automation engineers are needed to meet these requirements of designing appropriate automation systems. But, one need to have knowledge of diversified fields such as PC/ PLC based Control, Instrumentation, H/W, S/W, Networking, Industrial AC Drives, Machine Vision, DCS, SCADA/ HMI, High speed data acquisition, RTOS etc., to become a successful automation engineer.

Objective:

This course is aimed at making an Engineer with appropriate experience; a qualified designer of Industrial automation systems with the use of PLCs, PACs, Industrial Field Instruments, Industrial PCs, SCADA/HMI, Data-acquisition boards, Machine vision, robots, Microprocessor based instruments, and related Software. The course also includes an industrial oriented project work during which the student will be working on specific assignments of his/her choice.

Expected Job Roles:

- Industrial Automation Engineer
- Project Engineer, Assistant Engineer
- Control & Instrumentation Engineer
- Instrumentation Engineer

Duration:

720 Hours - (Theory: 200 hrs + Practical: 380 hrs+ Project: 140hrs)

This course shall be offered as full time intensive course.

Course Outline:

Sl. No	Module Title	Duration (Hours)			Credits	
		Theory	Lab	Total	Theory (hrs/15)	Lab (hrs/30)
1	**Measurements with Industrial Field Instruments, Data Acquisition Systems, Process Plant Control & Automation System Design, Programmable Automation**	60	120	180	4	4

	Controllers (PAC), Automation System Integration &Engineering Concepts					
2	**PLC & PID Controllers & Industrial Networking**	50	100	150	3	3
3	**SCADA/ HMI System Development**	30	60	90	2	2
4	**Distributed Control Systems**	30	60	90	2	2
5	**Industrial Drives & Robotics**	20	40	60	1	1
6	**Project Work**	10	140	150	1	5
	Total Duration/Credits	**200**	**520**	**720**	**30**	

Prerequisites:

Concepts of Basic Electronics, Control Systems and Instrumentation**.**

Eligibility:

BE /B.Tech in Electrical/ Electronics/ Instrumentation/ Chemical Engineering/ Applied Electronics and Instrumentation/ Instrumentation & Control/ Electronics & Communication/ Mechatronics / Computer Science. Students undergoing BTech are also eligible, however they will be issued course certificate only on production of their degree certificate.

Detailed Syllabus and Learning Outcome:

S. No	Module Title	Topics	Duration (Hours)		Learning Outcome
			Theory	Lab	
1	**Measurements with Industrial Field Instruments, Data Acquisition Systems, Process Plant Control & Automation System Design, Programmable Automation Controllers**	• PC based hardware and software for Data Acquisition Systems (DAS) and Control • Standard instrumentation signal levels • Selection of sensors/transducers for Industrial application • Functions of industrial signal conditioners • Signal conditioning requirements of common transducers • Intelligent	60	120	Gain knowledge and skill through theory and practical experiments about: Industrial field instruments like temperature/ flow/ pressure sensors and transmitters, control valves, pumps, I/P converters, etc., Automation system structure, functional levels, instrumentation

	(PAC), Automation System Integration &Engineering Concepts	transmitters/sensors • PC Based Data Acquisition System Design • PC Based DAQ System Buses • Graphical programming for data acquisition, signal processing, Control, analysis & presentation using Measurement and Automation Software • Developing data acquisition and instrument control applications using LabVIEW • Control system design and simulation using LabVIEW • Design of Instrumentation Loops, ISA Symbols & Diagrams • Introduction to Programmable Automation Controllers (PAC) • PAC architecture using NI hardware and software • Data Acquisition & Control with RTOS (NI Field point I/O, cRIO) • RTOS based Industrial Applications			signal levels, signal conditioners, isolators and intelligent transmitters. Data acquisition, analysis and control software NI LabVIEW. PC Based Data Acquisition System Design Graphical programming for data acquisition, signal processing, Control. analysis & presentation using Measurement and Automation Software Process system modelling and simulation using LabVIEW Instrumentation Loops, ISA Symbols & Diagrams Programmable Automation Controllers (PAC) architecture using NI hardware and software
2	**PLC & PID Controllers & Industrial Networking**	• Programmable Logic Controllers & PLC interfacing Techniques • Programming of PLC using Ladder diagrams, Function Block diagram & Structured Text Language • Troubleshooting and maintenance of PLC systems • Implementation of control techniques using PLC • PLC programming with Allen Bradley SLC500 series (SLC5/02 & SLC5/04), RS Logix 500 Software,	50	100	Gain knowledge and skill through theory and practical experiments about: Programmable Logic Controllers (PLC) programming and their interfacing Techniques Troubleshooting and maintenance of PLC systems Implementation of control techniques using PLC PLC configuration and

		Emulate500 Software • Allen Bradley CompactLogix Series PLC (1769 L23), RS Logix 5000 Software • SIEMENS SIMATIC S7 controllers (CPU 412-2PN, CPU 314) SIEMENS IM151-1 High Feature, Siemens Touch Panel TP 177B SIMATIC STEP 7 • Professional programming Software S7-PLCSIM • ABB AC500 PLC System, PM 581-ETH CPU • ABB Software PS501-PROG Control Builder • Programming with IEC 61131-3 Languages • System design with PLC • Comparison of different brands of PLCs • Fundamental process control techniques • Controller tuning methods • Introduction to Industrial Networking • Analog and Digital Communications on Plant Floors • RS232-422-485 standards • PLC to PLC & PLC to PC communication • HART and MODBUS • Profibus, DH-485 and Foundation fieldbus			programming with Allen Bradley/ Siemens/ ABB brands of PLCs Programming with IEC 61131-3 Languages Fundamental process control techniques Controller tuning methods Industrial Networking Analog and Digital Communications on Plant Floors PLC to PLC & PLC to PC communication HART and MODBUS Profibus, DH-485 and Foundation fieldbus

3.	**SCADA/ HMI System Development**	• Introduction to SCADA • Different Systems in SCADA like Field Instrumentation, RTUs, communication Networks and Central Monitoring Stations • Intellution's iFIX SCADA Software • National Instrument's LabVIEW DSC (Data logging& Supervisory Control) Software • HMI Development, Data Processing, Control Algorithm Programming • Modem connectivity & SCADA protocols - Modbus/ IEC 60870 • Network Communications, Communication with RTUs • Data Acquisition with Cards and PLCs/RTUs • Database Connectivity • SCADA development for Small Scale Pilot Plants (Case Study) • OPC (OLE for Process Control) Configuration • Comparison of different SCADA packages • Industrial Data Analytics: Use of collected data for decision making, maintenance, control, etc., • IIoT and edge nodes: Basics of IIoT enabled devices and applications • Cyber Security for Industrial Control Systems (ICS)	30	60	Gain knowledge and skill through theory and practical experiments about: Supervisory Control and Data Acquisition (SCADA) Different Systems in SCADA like Field Instrumentation, RTUs, communication Networks and Central Monitoring Stations Intellution'siFIX SCADA Software National Instrument's LabVIEW DSC (Data logging& Supervisory Control) Software HMI Development, Data Processing, Control Algorithm Programming Modem connectivity & SCADA protocols Network communication with RTUs Data Acquisition with Cards and PLCs/RTUs Database Connectivity OPC (OLE for Process Control) Configuration Historical data collection using SCADA software Industrial Data Analytics: IIoT and edge nodes and applications and Connectivity using OPC UA
4.	**Distributed Control Systems**	• Distributed Control System (DCS) architecture • Introduction to ABB Freelance DCS	30	60	Gain knowledge and skill through theory and practical experiments about:

		• Control Builder F Configuration Tool • Project Management and hardware configuration • ABB - AC 800F (IndustrialIT Controller) Process Station • Process visualization software, DigiVis, for Operator Stations • Developing DCS programs, task based programming and function blocks • S800 I/O modules and interfaces • Foundation fieldbus and profibus interfaces to DCS • Device configuration via FDT/DTM • Process measurements & control through fieldbus I/Os • Data access through gateways			Distributed Control System (DCS) architecture ABB Freelance DCS DCS Project Management and hardware configuration ABB - AC 800F (IndustrialIT Controller) Process Station Process visualization software, DigiVis, for Operator Stations Developing DCS programs, task based programming and function blocks Foundation fieldbus and profibus interfaces to DCS Device configuration via FDT/DTM Process measurements & control through fieldbus I/Os Data access through gateways
5.	**Industrial Drives & Robotics**	• Motors & Drives • DC Motor Drives • AC Motor drives • Embedded Controllers for Drives • Industrial Application of drives • Concepts of Industrial Robots, Classification • Robot Task Programming • Applications of Robotics	20	40	Gain knowledge and skill through theory and practical experiments about: Motors & Drives, DC Motor Drives, AC Motor drives, Embedded Controllers for Drives, Industrial Application of drives, Concepts of Industrial Robots, Classification, Robot Task Programming and Applications of Robotics
6.	**Project Work**	In the project work, students will be guided to do project work in advanced technologies of Industrial control and instrumentation.	10	140	Will get exposure to latest technologies of industrial control and instrumentation.

		Students will be given choice in selecting project among different projects available based on different technologies.			Will get practical knowledge of implementing control strategies with Pilot Plant.
Total Hours = 720			200	520	

Examination & Certification:

NIELIT's NSQF Examination pattern will be followed for Examination & Certification.

Sl No	Examination Pattern	Modules Covered	Duration in Minutes	Maximum Marks
1	Theory Paper – 1	1	90	100
2	Theory Paper – 2	2,3	90	100
3	Theory Paper – 3	4,5	90	100
4	Practical -1	1,2	180	90
5	Practical -2	3,4,5	180	90
6	Internal Assessment	1,2,3,4,5	-	60
7	Project/Presentation /Assignment	1,2,3,4,5	-	60
8	Major Project/Dissertation	6	-	100
	Total			**700**

Note:

1. Pass percentage would be 50% marks in each component, with aggregate pass percentage of 50% and above.
2. Grading will be as under:

Grade	**S**	**A**	**B**	**C**	**D**
Marks Range (in %)	>=85%	>=75%-<85%	>=65%-<75%	>=55%-<65%	>=50%-<55%

3. Theory examination would be conducted online and the paper comprise of MCQ and each question will carry 1 mark.
4. Practical examination/Internal Assessment/ Project/Presentation/Assignment would be evaluated internally.

5. Major Project/Dissertation would be evaluated preferably by External / Subject Expert including NIELIT Officials.
6. Candidate may apply for re-examination within the validity of registration.
7. The examinations would be conducted in English Language only.

Recommended hardware/software tools:

1. Allen Bradley CompactLogix Series PLC (1769 L23 or better) Systems with Digital and Analog I/O modules (isolated)
2. SIEMENS SIMATIC S7 series PLC Systems (1200/300/400 latest CPUs) with Digital and Analog I/O modules (Isolated)
3. ABB AC500 PLC (PM 581-ETH CPU or better) Systems) with Digital and Analog I/O modules (Isolated)
4. HART Modem and Smart Temperature Transmitter with HART interface
5. Smart Transmitter with Profibus interface
6. Analog Isolators -Siemens/ Pepperl make
7. NI Foundation fieldbus training kit
8. Smart Instruments with HART/ Foundation Fieldbus interfaces
9. NI USB-6211 (or better) with connector, cable and accessories
10. cDAQ-9181 CompactDAQ chassis (or better) with thermocouple input module.
11. Distributed Control Systems (DCS) - ABB Freelance 800F with S800 I/O modules and interfaces, Foundation fieldbus and Profibus interfaces
12. Temperature control loop process rig
13. Pressure control loop process rig
14. Level & flow control loop process rig
15. Cascade control loop process rig
16. The above process rigs must be set up with real sized industrial grade instruments (Level, flow, temperature and pressure sensors and Transmitters, pumps, control valves, positioners and I/P converters) and controlled through PLC/ PAC/ LabVIEW/ SCADA/ DCS
17. Power flex 40 AC Drives with Analog input and Output, Digital Input and Output & Relay outputs
18. ACS550 Ac drive with Analog input and Output, Digital Input and Output & Relay outputs
19. DCS 800 DC Drives with Analog input and Output, Digital Input and Output
20. Logo Soft SIEMENS PLC with 12 Inputs and 4 Relay Outputs
21. 3 Phase Induction Motor (>1.0 HP)
22. 3 Phase Induction Motor Trainer
23. Permanent Magnet DC Motor 1.0 HP, 180V
24. DC Motor Trainer
25. RS Logix 5000 Software – academic license

26. Emulate 500 and Logix Pro Simulator – Academic License
27. SIMATIC STEP 7 Professional programming Software – academic license
28. S7-PLCSIM – multiuser academic license
29. CODESYS Software – Academic License
30. GE Fanuc iFIX SCADA Software - Academic license
31. National Instruments LabVIEW Professional Development System – Academic site license
32. National Instrument's LabVIEW DSC (Data logging & Supervisory Control) Software – Academic license
33. Distributed Control Systems (DCS) - ABB Freelance 800F - with Control Builder F and DigiVis – Academic License
34. Drive tools SP Software - Allen- Bradley

Faculty & Support / Lab Instructor:

1. Two Faculties with
   BE/B.Tech. in Electronics & Instrumentation/Applied Electronics and Instrumentation/ Instrumentation & Control/ Electrical/Electrical & Electronics/ Electronics & Communication (minimum 60% marks in qualifying examination)
   And
   Minimum 1 year of appropriate experience in Industrial Automation (in areas such as PLC, LabVIEW, SCADA, DCS, Industrial Field Instruments and Data Acquisition Systems) in carrying out industrial automation related projects, instrumentation & control system research, design& engineering activities/ quality teaching in related areas
   /
   PG Diploma in Industrial Automation of minimum 6 months duration (passed) with minimum 70% Marks (in areas such as PLC, LabVIEW, SCADA, DCS, Industrial Field Instruments and Data Acquisition Systems)

2. One Support / Lab Instructor with at least Diploma in Electronics & Instrumentation/Applied Electronics and Instrumentation/ Instrumentation & Control/ Electrical/Electrical & Electronics/ Electronics & Communication
   And
   Minimum 6 month of appropriate experience in Industrial Automation (in areas such as PLC, LabVIEW, SCADA, DCS, Industrial Field Instruments and Data Acquisition Systems)
   /
   Diploma in Industrial Automation of minimum 6 months duration

References:

1. Process Control Systems: Application, Design, and Tuning 4th Edition by F. Gregg Shinskey, McGraw-Hill Professional

2. Process Dynamics and Control by Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, John Wiley & Sons
3. Programmable Controllers - Selected Applications, L. A. Bryan, E. A. Bryan
4. SCADA: Supervisory Control and Data Acquisition, Stuart A. Boyer, ISA
5. Process/ Industrial Instruments and Controls Handbook, by Gregory Mcmillan, Douglas Considine, McGraw-Hill Education
6. Control systems engineer technical reference handbook By Chuck Cornell, ISA
7. Measurement and Control Basics By Thomas A. Hughes,
8. Process Control Instrumentation Technology, Curtis D. Johnson
9. Industrial Ethernet, By Perry S. Marshall and John S. Rinaldi, ISA
10. Control Loop Foundation- Batch and Continuous Processes, Terry Blevins, Mark Nixon
11. Product/ User/ Maintenance manuals of AB, ABB, Siemens PLCs. ABB 800F DCS, NI LabVIEW, GE Fanuc iFIX SCADA, Smart Transmitters, Control Valves, Process Rigs, etc.,
12. Measurement and Instrumentation Principles, Alan S. Morris, Butterworth-Heinemann
13. Fundamentals of Process Control Theory, By P. W. Murrill
14. Programmable Controllers, Thomas A. Hughes
15. Industrial Instrumentation: Principles and Design by Tattamangalam R. Padmanabhan
16. Principles of Industrial Instrumentation by D Patranabis (Author), Tata McGraw Hill Education
17. Hands-On Introduction to LabVIEW for Scientists and Engineers by John Essick, Oxford University Press
18. Learning with LabVIEW by Robert H. Bishop, Pearson
19. Calibration: A Technician's Guide, Mike Cable, ISA
20. Safety Instrumented System Design: Techniques and Design Verification, By Iwan van Beurden, CFSE, and William M. Goble, CFSE, ISA
21. Practical Distributed Control Systems (DCS), IDC Technology,IDC Technologies
22. Programmable Logic Controllers and Industrial Automation book, Madhuchhanda Mitra, Samarjit Sen Gupta, Penram International Publishing (India) Pvt. Ltd.
23. Modern Control Design with MATLAB and SIMULINK, Ashish Tewari
24. Cascading Logic: A Machine Control Methodology for Programmable Logic Controllers, Gary Kirchof
25. IEC 61499 Function blocks for embedded and distributed control system design Valeriy Vyatkin, ISA
26. Programmable Logic Controllers: An Emphasis on Design and Application, Kelvin T. Erickson, Dogwood Valley Press
27. Safety Instrumented Systems: Design, Analysis, and Justification Paul Gruhn, Harry L. Cheddie ISA
28. Functional Safety, Second Edition: A Straightforward Guide to Applying IEC 61508 and Related Standards, David J. Smith, Kenneth G. L. Simpson, Butterworth-Heinemann
29. DESIGN OF INDUSTRIAL INFORMATION SYSTEMS, Thomas Boucher, Academic Press

30. Functional Safety, Second Edition: A Straightforward Guide to Applying IEC 61508 and Related Standards, David J. Smith, Kenneth G. L. Simpson, Butterworth-Heinemann
31. Industrial Network Security, Second Edition, David J. Teumim, ISA
32. Fieldbuses for Process Control: Engineering, Operation and Maintenance Jonas Berge, ISA
33. Control Valves: Practical Guides for Measurement and Control Guy Borden Jr., Editor, and Paul G. Friedmann
34. ISA Measurement and Control Standards, ISA
35. Control System Documentation: Applying Symbols and Identification, Authors: Thomas McAvinew and Raymond Mulley, ISA

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Prepared By	SASIDHARAN P T	**Aligned NSQF Level**	8
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