GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY-BASED CURRICULUM

CERTIFICATE COURSE ON

INTRODUCTION TO INDUSTRY 4.0

NSQF LEVEL – 3.5

SECTOR: CAPITAL GOODS AND MANUFACTURING

INTRODUCTION TO INDUSTRY 4.0

Duration: 240 Hours

NSQF LEVEL – 3.5

(Version: 1.0)

Designed in 2024

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

&

CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

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1. COURSE INFORMATION

1.1 GENERAL

This course has been developed for CTS/CITS trainees to take up as optional courses during the course of study for technical and behavioural upgradation of trainees to meet industry-related job roles. During the 240-hour duration of Introduction to Industry 4.0 course, a candidate is trained in professional skills & knowledge related to the job role. The Broad components covered during the course are given below:

During this course, the trainee will learn how different IoT-enabled applications, products, and services are used in Industry 4.0. How different companies are providing IoT-enabled systems to the manufacturing industry. They will develop hands-on skills in learning and building IoT, Robotics, and AI systems used in Industry 4.0 so they can get future employment in the Smart Manufacturing Industry.

1.2 COURSE STRUCTURE

The table below depicts the distribution of training hours across various course elements during a period of 6 weeks: -

S No.	Course Element	Notional Training Hours
1.	Professional Skill (Trade Practical)	180
2.	Professional Knowledge (Trade Theory)	60
	Total	**240**

1.3 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge, and attitude during the period of the course through assessment at the end of the course through skill testing at the Training Center & CBT through an examination conducted by DGT.

The minimum pass percentage for the skill test is 60% and for theory will be 33% as in the main CTS examination.

2. JOB ROLES

Students will be able to enhance their industry relevance and increase their chances of employability in the IoT domain in roles such as

- Manufacturing Execution System Technician
- Shop Floor Supervisor
- Maintenance Technician
- Smart Equipment Operators
- IoT Technician

Electronics Technicians, Other include all other; Electronics Technicians engaged in research and testing in various fields of electronic engineering, not elsewhere classified

Reference NCO-2015:

      i)   3114.9900 - Electronics and Telecommunications Engineering Technicians, Other

Mapped NOS:

      i)   CSC/N9613

3. GENERAL INFORMATION

Name of the Trade	**INTRODUCTION TO INDUSTRY 4.0**
Reference NCO - 2015	3114.9900
NOS Covered	CSC/N9613
NSQF Level	Level 3.5
Duration of Craftsmen Training	240 Hours
Entry Qualification	10th Class passed and pursuing/ passed out Electronic Mechanic, Electrician, Wireman, IoT Technician (Smart Agriculture), IoT Technician (Smart Healthcare), IoT Technician (Smart City) under CTS and Electronic Mechanic and Electrician under CITS.
Unit Strength (No. of Student), Space & Power Norms	As per Electronic Mechanic trade under CTS
Instructors Qualification	B.Voc/Degree in Mechanical Engg/Electronics/ Instrumentation Engg./ Electrical Engg. (With specialization in IoT/Robotics/AI) from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. OR 03 years Diploma in Mechanical Engg/Electronics/ Instrumentation Engg./Electrical Engg. (With specialization in IoT/Robotics/AI) from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. OR NTC/NAC passed in the trade of Electronics with three years' experience in the relevant field. **Essential Qualification:** Relevant regular/RPL variants of National Craft Instructor Certificate (NCIC) under DGT.
List of Tools and Equipment	As per Annexure – I

4. LEARNING OUTCOME

Learning outcomes reflect the total competencies of a trainee and assessment will be carried out as per the assessment criteria.

LEARNING OUTCOMES

1. Interpret the working of sensors; select, calibrate, and connect sensors, identify & explain the GPIO, Analog & Digital pins of the IoT gateway and microcontroller.
2. Identify & demonstrate the use of measuring instruments, testing processes and soldering.
3. Develop IoT Applications by building circuits and writing application codes and demonstrate the working using web/mobile interphase as well as network servers, routers, switches, and various communication protocols in multi-user applications.
4. Connect several IoT devices to the cloud, Test and monitor data coming from sensors to the cloud, and Control sensors remotely.
5. Demonstrate movement capabilities of Robotic Arms and end-effector control, followed by applying this knowledge to construct a pick-and-place application.
6. Demonstrate 3D modelling of products and utilization of 3D printers by adjusting design parameters to create industrial applications.
7. Create, update, and manage operations, specifications, containers, and work orders in a manufacturing execution system.

5. SYLLABUS

SYLLABUS – INTRODUCTION TO INDUSTRY 4.0			
Duration: 240 Hours			
Duration	**Reference Learning outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Professional Skill 22 Hrs. Professional Knowledge 08 Hrs.	Interpret the working of sensors; select, calibrate, and connect sensors, identify & explain the GPIO, Analog & Digital pins of the IoT gateway and microcontroller.	1. Identify different sensors. 2. Demonstrate the Sensor working. 3. Demonstrate the IoT Gateway. 4. Demonstrate the GPOI connections for Sensors. 5. Demonstrate the Analog and Digital ports. 6. Demonstrate the RTC module, Relays. 7. Practice Programmable Logic Controller (PLC). 8. Demonstrate Operator and Human Machine Interface.	Details of the working principles of each sensor • Accelerometer • Climate Sensor (Temp & Humidity) • Compass Sensor • Flame Sensor • Flow Sensor • Gas Sensor-Analog • GPS • Hall Effect Sensor • IR Sensor • Keypad • Health sensors (pulse & oxy) • Motion Sensor • Particulate Matter Sensor • PH Sensor • Pressure Sensor • Soil Moisture Sensor • Sound Sensor • TDS Sensor • Ultrasonic Sensor • Vibration Sensor • Weight Sensor IoT Gateway • Know your Raspberry Pi Gateway • Know your Arduino/ESP32 Gateway PLC • PLC Operation and Programming • Operator and Human Machine Interface

Professional Skill 10 Hrs. Professional Knowledge 05 Hrs.	Identify & demonstrate the use of measuring instruments, testing processes and soldering.	9. Demonstrate the measuring instruments. 10. Demonstrate the testing process. 11. Demonstrate the Soldering & De-soldering process. 12. Demonstrate Motor and Motion Control. 13. Demonstrate Power & Control Electronics.	• Electronic measuring instruments • Testing electronic components • Parallel & Series circuits • Analog & Digital circuits • Soldering & De-soldering process • Motor and Motion Control
Professional Skill 37 Hrs. Professional Knowledge 08 Hrs.	Develop IoT Applications by building circuits and writing application codes and demonstrate the working using web/mobile interphase as well as network servers, routers, switches, and various communication protocols in multi-user applications.	14. Demonstrate & teach how to build circuits involving IoT gateway and sensors using software. 15. Demonstrate the creation of application program logic using block programming. 16. Hands-On Application building. 17. Configuration of Network Communication Devices.	• Network Servers, Distributed Servers, Routers, Switches, TCP/ IP Stack • Gateway Devices, Ethernet, Foundation Fieldbus, Profibus, • Wireless Communication, Linking Technologies, and Multi-User Applications • Introduction to IoT and its application in Industry 4.0 • Fundamental building blocks of IoT • Familiarization with Software for IoT Circuit Designing • Familiarization with Software for Block Programming • Familiarization with Python Programming • IoT web/Mobile Interface
Professional Skill 22 Hrs. Professional Knowledge 08 Hrs.	Connect several IoT devices to the cloud, Test and monitor data coming from sensors to the cloud, and Control sensors remotely.	18. Demonstrate the IoT Service in the cloud using any industrial platform. 19. Demonstrate collection of sensor data in the cloud platforms.	• Benefits of cloud computing • IoT service in the cloud • Collecting sensor data & storing in the cloud • Device Connectivity & Communication

		20. Demonstrate Mobile/Web server interface to manage IoT Gateway.	• MQTT, IFTTT, ZigBee and LoRa protocol • Mobile browser to IoT Gateway Communication
Professional Skill 35 Hrs. Professional Knowledge 10 Hrs.	Demonstrate movement capabilities of Robotic Arms and end-effector control, followed by applying this knowledge to construct a pick-and-place application.	21. Demonstrate movement of the Robotic Arm. • Left to Right • Forward Backward extension • Raise and lower the arm • Control movement of end-effector 22. Build a Pick and Place application for Robotic arm.	• Role of robotics in Industry 4.0 • Industrial robots • Understanding robotic movements • Connecting physical components of the robot • Understanding control, motion, distance, displacement • Robot programming using block designer. • Conveyor belt movement • Actuators, Mechatronics, HMI, PLC Systems, understanding using automation simulation software.
Professional Skill 32 Hrs. Professional Knowledge 13 Hrs.	Demonstrate 3D modelling of products and utilization of 3D printers by adjusting design parameters to create industrial applications.	23. Demonstrate 3D printer & its various parts and functions. 24. Demonstrate printing of the model on the 3D printer. 25. print a new functional part for a selected use case.	• Introduction to 3D printing and its applications in industry 4.0 • Understanding 3D printing & difference between traditional manufacturing vs 3D printing • Fundamental building blocks of 3D printing • 3D printing technologies and materials • Introduction to 3D printing parameters • Introduction to slicing software with each parameter and its effect on the 3D printed model.

			• Procedure to slice model (Preparing the model for 3D printing) • How to use 3D printer: parts, safety precaution, maintenance

Professional Skill 22 Hrs.
 	
Professional Knowledge 08 Hrs.
	Create, update, and manage operations, specifications, containers, and work orders in a manufacturing execution system.	26. Demonstrate configuration of product.
		27. Demonstrate updating existing product.
		28. Demonstrate creation new Operation.
		29. Demonstrate updating existing operation.
		30. Demonstrate creating new Specification.
		31. Demonstrate updating existing specification.
		32. Demonstrate creating Containers.
		33. Demonstrate adjusting container quantities.
		34. Demonstrate creating a work order.
		35. Demonstrate updating an existing workorder.
			• Overview of MES
			• Introduction to modelling
			• Physical model & modelling sequence
			• Process model & modelling sequence.
			• Execution model & modelling sequence
			• Workflows
			• How to set up MES for automation
			  o Product and part setup
			  o Setting up equipment.
			  o Setting up a process model.
			  o Setting up a dashboard to monitor equipment performance.
			• Equipment status tracking.

Examination			

6. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
1. Interpret the working of sensors; select, calibrate, and connect sensors, identify & explain the GPIO, Analog & Digital pins of the IoT gateway and microcontroller.	Identify various sensors and explain their working principles.
	Demonstrate the connection of sensors to GPIO pins of IoT Gateway and obtaining values.
	Identify the Relays, RTC modules in IoT Gateway.
	Identify differences between Raspberry Pi & Arduino/ESP32 based IoT Gateway.
	Identify the difference between digital and analog sensors.
2. Identify & demonstrate the use of measuring instruments, testing processes and soldering.	Differentiate between Series and Parallel circuits.
	Differentiate between Analog & Digital circuits.
	Identify various electronic measuring instruments.
	Demonstrate operation & interpret measurements of current, voltage, resistance etc. using digital multimeter.
	Demonstrate proficiency in soldering and de-soldering electronic components using soldering gun and de-soldering pump respectively.
3. Develop IoT Applications by building circuits and writing application codes and demonstrate the working using web/mobile interphase as well as network servers, routers, switches, and various communication protocols in multi-user applications.	Demonstrate creating circuit involving IoT Gateway, an input and output sensor/device using circuit designing software.
	Demonstrate creation of application logic to execute and manage an IoT application using Block Programming software or Python programming IDE.
	Demonstrate running of the application using web/mobile interface.
	Identify the IoT building blocks.
4. Connect several IoT devices to the cloud, Test and monitor data coming from sensors to the cloud, and Control sensors remotely.	Identify communication protocols to connect to IoT cloud service.
	Describe the process of sending sensor data to the cloud.
	Demonstrate the collection of sensor data to cloud.
5. Demonstrate movement capabilities of Robotic Arms and end-effector control, followed by applying this	Identify the movements of the Robotic Arm.
	Demonstrate connecting physical components of Robotic Arm.
	Demonstrate the movement of Robotic Arm.

	knowledge to construct a pick-and-place application.	
6.	Demonstrate 3D modelling of products and utilization of 3D printers by adjusting design parameters to create industrial applications.	Identify difference between traditional manufacturing and 3D Printing.
		Identify fundamental building blocks of 3D printing.
		Identify 3D printing technologies and materials.
		Demonstrate designing one 3D application.
		Demonstrate slicing of the model.
7.	Create, update, and manage operations, specifications, containers, and work orders in a manufacturing execution system.	Identify the role of MES in Industry 4.0.
		Identify components of MES.
		Demonstrate configuration of Product and Part.
		Demonstrate configuration of Equipment.
		Demonstrate creation of work order.

LIST OF TOOLS & EQUIPMENT		
INTRODUCTION TO INDUSTRY 4.0		
S No.	**Name of the Tools and Equipment**	**Specification**	**Quantity**
Same as Electronics Mechanic trade under CTS		
Additional Tools and Equipment Required		
1.	Arduino Yun/ESP 32 and Raspberry-pi 4 and above based IoT Gateway can be connected to the cloud, accessories, analog and digital ports, support for stepper motor, servo motors, UART port for serial data communication and separate port for I2C, Integrated RTC, Integrated relays, keypad port Inbuilt DAC and ADC.	Arduino and Raspberry-pi IoT system with all accessories sensors and cloud access minimum of 10 sensors	06 sets
2.	Sensor kit which consists of the following Sensors. a) Temperature and Humidity Sensor b) Smoke Detector Sensors c) Infrared Sensors d) Ultrasonic Sensors e) Weight Sensors f) LDR g) Sound Sensor h) Flow Sensor i) Level Sensor	Interfacing both analog and digital sensors given in the list.	06 sets
3.	FDM 3D Printer with PLA filament	For 3D Printing the designed products	1 No.
4.	Desktop Computer	i3 or above, 4 GB and above RAM	12 No.
5.	PLC with analog and digital I/O	4 channel and above	1 set
6.	Cloud Platform supporting IoT Services such as MQTT	data storage, analysis, and remote access	1 multiuser subscription
7.	Cloud-Based software for IoT Circuit Designing	create, modify, and test circuit designs before implementing them in real-world devices	1 multiuser subscription
8.	Cloud-based software for IoT Block Programming	Write software programs using Programmer IDE also with no code	1 multiuser subscription

		programming.	
9.	Web/Mobile Interface to Manage IoT Application	Execute and run programs in the terminal interface to provide immediate feedback to students on their code performance	1 multiuser subscription
10.	Cloud based IDE for Python Programming	Development environment for writing python program for IoT	1 multiuser subscription
11.	Cloud-based 3D Modelling Software & Slicing Software	3D Modelling software for 3D Printing	1 multiuser subscription
12.	Mechatronics, PLC and Robotics simulation Software or Open source		12 users
13.	MES Software		1 multiuser subscription

ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts and all others who contributed in designing/ revising the curriculum. Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

S No.	Name & Designation Shri/Mr./Ms.	Organization	Remarks
1.	Sunil Kumar Gupta, DDG (ER)	CSTARI, Kolkata	Chairman
2.	G. C. Saha, Joint Director/HoD	CSTARI, Kolkata	Member
3.	Brindaban Das, Deputy Director/HOO	CSTARI, Kolkata	Member
4.	Prodip Mukhopadhyay, former MD WEBEL & Sr. Advisor	MAKAUT, Kolkata	Member
5.	Tapas Kumar Chini, Ex. Senior Professor	SINP, Kolkata & RKM, Belurmath	Member
6.	Aditya Mandal, Head RF Section	VECC, Bidhannagar	Member
7.	Reema Nandi, Associate Manager	Accenture, Unitech Kolkata	Member
8.	S. Chakrabrty	GVR, Kolkata	Member
9.	Biswasjit Jana, Instructor	Don Bosco Technical Institute, Prakcircus	Member
10.	Nishchal, Scientist 'C'	STQC, ERTL(E), Sector-v	Member
11.	Sayan Mondal, Asst. Prof	BIT, Bantala, Kolkata	Member
12.	Patra Kusum Misra, Asst. Prof.	T.C.E Agartala	Member
13.	Niladri Roy, Consultant	TCS	Member
14.	Bijayeelaxmi Panda, Engineer	CTTC	Member
15.	Shekhar Pradhan, Co-Founder & Director of Business Operations	Grok Learning Pvt. Ltd.	Member
16.	Makarand Joshi, Product Manager	Grok Learning Pvt. Ltd.	Member
17.	Himanshu Samal, Global Head Sales & Strategic partnerships	Grok Learning Pvt. Ltd.	Member
18.	Satyabrata Pandab, Engineer	Central Tool Room and Training Centre, Bhubaneswar	Member
19.	Mananjaya Nayak Engineer (Training Department)	Central Tool Room and Training Centre, Bhubaneswar	Member

List of Expert Members participated in the trade committee meeting for finalizing the course curriculum of INTRODUCTION TO INDUSTRY 4.0 under STC on 30.04.2024 at CSTARI, Kolkata

20.	Akshay Jadhav, Sr Design Engineer	Tata Technologies	Member
21.	Sunil Chore, Managing Director	Simusoft Technologies, Pune	Member
22.	Manohar Sadashiv Desai, Technical Head	Skill Bahn LLP, Thane, Maharashtra	Member
23.	B. Sharanappa, Assistant Director	CSTARI, Kolkata	Member
24.	Sk. Altaf Hossain, Assistant Director	CSTARI, Kolkata	Member
25.	M.J. Vijaya Raju, Assistant Director	CSTARI, Kolkata	Member
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31.	Hemant Kujur, Jr. D/Man	CSTARI, Kolkata	Member
32.	Jinendran PK, JC	CSTARI, Kolkata	Member