





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	10 <sup>th</sup> 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. <b>Essential Qualification:</b> 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.	<ol> <li>Identify different sensors.</li> <li>Demonstrate the Sensor working.</li> <li>Demonstrate the IoT Gateway.</li> <li>Demonstrate the GPOI connections for Sensors.</li> <li>Demonstrate the Analog and Digital ports.</li> <li>Demonstrate the RTC module, Relays.</li> <li>Practice Programmable Logic Controller (PLC).</li> <li>Demonstrate Operator and Human Machine Interface.</li> </ol>	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 Pressure Sensor PH Sensor Pressure Sensor Soil Moisture Sensor Sound Sensor Ultrasonic Sensor Ultrasonic Sensor Weight Sensor Know your Raspberry Pi Gateway Know your Arduino/ESP32 Gateway PLC PLC Operation and Programming Operator and Human Machine Interface		



Skill 10 Hrs. Professional Knowledge 05 Hrs.demonstrate the use of measuring instruments, testing processes and soldering.instruments. instruments.instruments. instruments.20 Hrs.demonstrate the use of measuring instruments, testing processes and soldering.10. Demonstrate the Soldering process.Testing electronic components20 Hrs.Develop IoT Application Skill 37 Hrs. Skill 37 Hrs.Develop IoT application sug codes and codes and using software.14. Demonstrate Metor and Motion Control.Network Servers, Distributed Servers, Routers, Switches, TCP/ IP StackProfessional Knowledge codes and various communication protocols in multi-user applications.14. Demonstrate the creation of application program logic using software.Network Servers, Routers, Switches, TCP/ IP Stack11. Demonstrate the creation of various communication protocols in multi-user applications.15. Demonstrate the creation of using block programming. 16. Hands-On Application building.If configuration of Network Communication Devices.12. Demostrate the various communication protocols in multi-user applications.17. Configuration of Network Communication Devices.If introduction to IoT and its application in Industry 4.0 Fundamental building Introduction to IoT and its application with Software for IoT Circuit Designing Familiarization with Software for Block Programming Familiarization with Software for Block Programming IoT web/Mobile InterfaceProfessional Skill 22 Hrs.Connect several IoT devices to the cloud,18. Demonstrate the Io			I	1
Professional Knowledge 05 Hrs.of measuring instruments, testing processes and soldering.10. Demonstrate the testing process.Testing electronic components05 Hrs.of measuring instruments, testing process and soldering.10. Demonstrate the Soldering & De-soldering process.9 Parallel & Series circuits Soldering & De-soldering process12. Demonstrate Power & Control Electronics.13. Demonstrate Power & Control Electronics.9 Network Servers, Distributed Servers, Notion Control13. Demonstrate Power & building circuits and working application interphase as well as network servers, routers, switches, and various communication protocols in multi-user applications.14. Demonstrate the creation of application program logic using software.• Network Servers, Distributed Servers, Botulding circuits and using software.13. Demonstrate the working using web/mobile interphase as well as network servers, routers, switches, and various communication protocols in multi-user applications.15. Demonstrate the creation of application of Network Communication Devices.• Network Servers, Gateway Devices, Ethernet, Foundation Fieldbus, Profibus, • Wireless Communication, Linking Technologies, and Multi-User Applications • Introduction to IoT and its applications.14. Demonstrate the interphase as well as network servers, routers, switches, and various communication protocols in multi-user applications.16. Hands-On Application software for IOT circuit Designing • Familiarization with Software for Block Programming • Familiarization with Software for Block Programming • Fam	Professional	Identify &	9. Demonstrate the measuring	Electronic measuring
Professional Knowledge 05 Hrs.instruments, testing processes and soldering.process.numents, testing wrocesses and soldering.process.numents, testing & De-soldering process.Parallel & Series circuitsAnalog & Digital circuitsAnalog & Digital circuitsAnalog & Digital circuitsAnalog & Digital circuitsSoldering & De-soldering processMotor And Motion ControlProfessional Skill 37 Hrs.Develop IoT Applications by building circuits and professional Knowledge 08 Hrs.14. Demonstrate A teach how to build circuits involving loT gateway and sensors using software.• Network Servers, Distributed Servers, Ethernet, Foundation Fieldbus, Profibus, • Wireless Communication, Linking Technologies, and Multi-User Applications applications.• Network Servers, Communication Devices.• Network Servers, Distributed Servers, Bildbus, Profibus, • Wireless Communication, Linking Technologies, and Multi-User 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 Software for Block • Programming • Familiarization with Python Programm	Skill 10 Hrs.	demonstrate the use	instruments.	instruments
Knowledge 05 Hrs.Drocesses and soldering.11. Demonstrate the Soldering & De-soldering process.Parallel & Series circuits • Analog & Digital circuits • Soldering & De-soldering processProfessional Skill 37 Hrs.Develop IoT • Applications by building circuits and demonstrate the working using web/mobile interphase as well as network servers, routers, switches, and various14. Demonstrate the creation of application program logic using software.• Network Servers, Routers, Switches, TCP/ IP StackProfessional working using web/mobile interphase as well as network servers, routers, switches, and various15. Demonstrate the creation of application program logic using block programming.• Network Servers, Routers, Switches, TCP/ IP StackProfessional Stall 22 Hrs.Connect several IoT devices to the cloud,16. Hands-On Application building.• Wireless Communication, building.17. Configuration Devices.• 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 IoT Circuit DesigningProfessional Skill 22 Hrs.Connect several IoT devices to the cloud,18. Demonstrate the IoT Service in the cloud using any• Benefits of cloud computing	Drefessional	of measuring	10. Demonstrate the testing	Testing electronic
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<ul> <li>Soldering, Soldering, Soldering</li></ul>	-	processes and	11. Demonstrate the Soldering	Parallel & Series circuits
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Professional Skill 22 Hrs.Connect several IoT cloud,18. Demonstrate the IoT Service in the cloud using anyFamiliarization with Software for Block Programming e IoT web/Mobile Interface		•		blocks of IoT
Professional Skill 22 Hrs.Connect several IoT devices to the cloud,18. Demonstrate the IoT Service in the cloud using anyDesigning . . . . . . . . .Designing .<		applications.		Familiarization with
Professional Skill 22 Hrs.Connect several IoT devices to the cloud,18. Demonstrate the IoT Service in the cloud using any• Benefits of cloud computing				Software for IoT Circuit
Professional Skill 22 Hrs.Connect several IoT devices to the cloud,18. Demonstrate the IoT Service in the cloud using anySoftware for Block Programming • Familiarization with Python Programming • IoT web/Mobile Interface				Designing
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Professional Skill 22 Hrs.Connect several IoT devices to the cloud,18. Demonstrate the IoT Service in the cloud using anyBenefits of cloud computing				Familiarization with
Professional Skill 22 Hrs.Connect several IoT devices to the cloud,18. Demonstrate the IoT Service in the cloud using any• Benefits of cloud computing				Python Programming
Skill 22 Hrs. devices to the cloud, in the cloud using any computing				• IoT web/Mobile Interface
	Professional	Connect several IoT	18. Demonstrate the IoT Service	Benefits of cloud
	Skill 22 Hrs.	devices to the cloud,	in the cloud using any	computing
Test and monitor dataindustrial platform.• IoT service in the cloud		Test and monitor data	industrial platform.	• IoT service in the cloud
Professional coming from sensors 19. Demonstrate collection of Collecting sensor data &	Professional	coming from sensors	19. Demonstrate collection of	Collecting sensor data &
Knowledge to the cloud, and sensor data in the cloud storing in the cloud	Knowledge	to the cloud, and	sensor data in the cloud	-
08 Hrs. Control sensors platforms. • Device Connectivity &	08 Hrs.	Control sensors	platforms.	-
remotely. Communication		remotely.		

		20. Demonstrate Mobile/Web server interface to manage IoT Gateway.	<ul> <li>MQTT, IFTTT, ZigBee and LoRa protocol</li> <li>Mobile browser to IoT Gateway Communication</li> </ul>
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.	<ul> <li>21. Demonstrate movement of the Robotic Arm.</li> <li>Left to Right</li> <li>Forward Backward extension</li> <li>Raise and lower the arm</li> <li>Control movement of end-effector</li> <li>22. Build a Pick and Place application for Robotic arm.</li> </ul>	<ul> <li>Role of robotics in Industry 4.0</li> <li>Industrial robots</li> <li>Understanding robotic movements</li> <li>Connecting physical components of the robot</li> <li>Understanding control, motion, distance, displacement</li> <li>Robot programming using block designer.</li> <li>Conveyor belt movement</li> <li>Actuators, Mechatronics, HMI, PLC Systems, understanding using automation simulation software.</li> </ul>
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	<ul> <li>23. Demonstrate 3D printer &amp; its various parts and functions.</li> <li>24. Demonstrate printing of the model on the 3D printer.</li> <li>25. print a new functional part</li> </ul>	<ul> <li>Introduction to 3D printing and its applications in industry 4.0</li> <li>Understanding 3D printing &amp; difference between traditional manufacturing</li> </ul>
	applications.	for a selected use case.	<ul> <li>vs 3D printing</li> <li>Fundamental building blocks of 3D printing</li> <li>3D printing technologies and materials</li> <li>Introduction to 3D printing parameters</li> <li>Introduction to slicing software with each parameter and its effect on the 3D printed model.</li> </ul>

Professional	Create, update, and	26. Demonstrate configuration	<ul> <li>Procedure to slice model (Preparing the model for 3D printing)</li> <li>How to use 3D printer: parts, safety precaution, maintenance</li> <li>Overview of MES</li> </ul>
Skill 22 Hrs.	manage operations, specifications,	of product. 27. Demonstrate updating	Introduction to modelling
Professional Knowledge 08 Hrs.	containers, and work orders in a manufacturing execution system.	<ul> <li>existing product.</li> <li>28. Demonstrate creation new Operation.</li> <li>29. Demonstrate updating existing operation.</li> <li>30. Demonstrate creating new Specification.</li> <li>31. Demonstrate updating existing specification.</li> <li>32. Demonstrate creating Containers.</li> <li>33. Demonstrate adjusting container quantities.</li> <li>34. Demonstrate creating a</li> </ul>	<ul> <li>Physical model &amp; modelling sequence</li> <li>Process model &amp; modelling sequence.</li> <li>Execution model &amp; modelling sequence</li> <li>Workflows</li> <li>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</li> </ul>
		work order. 35. Demonstrate updating an existing workorder.	<ul><li>performance.</li><li>Equipment status tracking.</li></ul>
	·	Examination	

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#### **6. ASSESSMENT CRITERIA**

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



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



#### **ANNEXURE-I**

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 C	rs			
Additi	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.	<ul> <li>Sensor kit which consists of the following Sensors.</li> <li>a) Temperature and Humidity Sensor</li> <li>b) Smoke Detector Sensors</li> <li>c) Infrared Sensors</li> <li>d) Ultrasonic Sensors</li> <li>e) Weight Sensors</li> <li>f) LDR</li> <li>g) Sound Sensor</li> <li>h) Flow Sensor</li> <li>i) Level Sensor</li> </ul>	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	Execute and run programs in the	1 multiuser
	Application	terminal interface to provide	subscription
		immediate feedback to students on	
		their code performance	
10.	Cloud based IDE for Python	Development environment for	1 multiuser
	Programming	writing python program for IoT	subscription
11.	Cloud-based 3D Modelling Software	3D Modelling software for 3D	1 multiuser
	& Slicing Software	Printing	subscription
12.	Mechatronics, PLC and Robotics		12 users
	simulation Software or Open source		
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.

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

котката			
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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
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13.	Niladri Roy, Consultant	TCS	Member
14.	Bijayeelaxmi Panda, Engineer	СТТС	Member
15.	Shekhar Pradhan, Co-Founder & Director of Business Operations	Grok Learning Pvt. Ltd.	Member
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17.	Himanshu Samal, Global Head Sales & Strategic partnerships	Grok Learning Pvt. Ltd.	Member
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19.	Mananjaya Nayak Engineer (Training Department)	Central Tool Room and Training Centre, Bhubaneswar	Member



20.	Akshay Jadhav, Sr Design	Tata Technologies	Member
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21.	Sunil Chore, Managing Director	Simusoft Technologies, Pune	Member
22.	Manohar Sadashiv Desai,	Skill Bahn LLP, Thane,	Member
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