Model Curriculum

QP Name: Manufacturing and Mechatronics Lead Technician

Version: 1.0

NSQF Level: 4.5

Model Curriculum Version: 1.0

Automotive Skills Development Council |
E-113, Gr Floor, Okhla Industrial Area, Phase – III, New Delhi – 110020

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Training Parameters

Sector	Automotive
Sub-Sector	Manufacturing
Occupation	Production
Country	India
NSQF Level	4.5
Aligned to NCO/ISCO/ISIC Code	NCO-2015/3122.4702
Minimum Educational Qualification and Experience	NSQF Certificate in Fabrication and Service Technician, Level-4
Pre-Requisite License or Training	NA
Minimum Job Entry Age	18 years
Last Reviewed On	30-11-2023
Next Review Date	30-11-2026
NSQC Approval Date	30-11-2023
QP Version	1.0
Model Curriculum Creation Date	30-11-2023
Model Curriculum Valid Up to Date	30-11-2026
Model Curriculum Version	1.0
Minimum Duration of the Course	1200 Hours
Maximum Duration of the Course	1200 Hours

Program Overview

This section summarizes the end objectives of the program along with its duration.

Training Outcomes

A Diploma in Manufacturing Technology is a specialized educational program that focuses on providing students with practical skills and theoretical knowledge related to various aspects of manufacturing processes and technologies.

At the end of the program, the learner should have acquired the listed knowledge and skills.

- **Advanced Manufacturing Processes:**

  Students might learn about more advanced manufacturing methods like CNC machining, additive manufacturing (3D printing), advanced welding techniques, and precision machining.

- **Quality Control and Assurance:**

This could cover topics such as statistical process control, quality inspection methods, root cause analysis, and corrective and preventive actions.

- **Materials Science:**

Deeper understanding of materials used in manufacturing, including their properties, behaviors under stress, and selection criteria for specific applications.

- **Industrial Automation:**

Learn about robotics, and other automation technologies used in modern manufacturing facilities.

- **Production Planning and Control:**

Understanding how to manage production processes efficiently, including scheduling, inventory management, and lean manufacturing principles.

- **Tooling and Fixture Design:**

Designing tools, jigs, and fixtures for various manufacturing processes to ensure accurate and repeatable production.

- **Project Work:**

Collaborating on projects that apply the knowledge gained throughout the program to solve real-world manufacturing challenges.

- **Soft Skills and Communication:**

Developing communication skills, teamwork, and problem-solving abilities that are crucial in an industrial setting.

- **Safety and Environmental Considerations:**

Learning about workplace safety protocols and environmental regulations in manufacturing.

Industry Exposure: Some programs might offer field trips, guest lectures from industry experts, or even internships to provide practical industry exposure.

- **Automation and Technology:**

  Depending on the curriculum, graduates might have knowledge of automation technologies, computerized manufacturing systems, and Industry 4.0 concepts.

- **Environmental and Sustainability Awareness:**

  Some programs may cover environmentally friendly manufacturing practices, emphasizing sustainable processes and waste reduction.

- **Career Opportunities:**

  Graduates should be prepared for entry-level positions in manufacturing industries such as automotive, aerospace, electronics, consumer goods, and more.

- **Continuing Education:**

  A Diploma in Manufacturing Technology can also serve as a steppingstone for further education, such as pursuing a higher-level degree or certifications in specialized areas.

Mandatory & Elective Modules

The table lists the modules and their duration corresponding to the Mandatory & Elective Subjects of the Curriculum.

Subject Details	NOS Code	Subject Type	Theory Duration	Practical Duration	On-the-Job Training Duration	Total Duration
Hydraulics and Pneumatics	ASC/N8382	Core Mandatory	24:00	48:00	48:00	120:00
Lubrication & Mechanical Drives	ASC/N3549	Core Mandatory	24:00	48:00	48:00	120:00
PLC and Electrical Drives	ASC/N8383	Core Mandatory	24:00	48:00	48:00	120:00
Automation	ASC/N8384	Core Elective-1	18:00	36:00	36:00	90:00
Robot Maintenance	ASC/N8385	Core Elective-2	18:00	36:00	36:00	
Best Industrial Practices	ASC/N9841	Non-Core	18:00	36:00	36:00	90:00
Sensors & Actuators	ASC/N8386	Core Mandatory	24:00	48:00	48:00	120:00
SCADA & Industrial Automation	ASC/N8387	Core Mandatory	24:00	48:00	48:00	120:00
I 4.0 Technologies	ASC/N8388	Core Mandatory	24:00	48:00	48:00	120:00
Advance Robotics	ASC/N8389	Core Elective-1	18:00	36:00	36:00	90:00
Technical Troubleshooting and Problem Solving	ASC/N8390	Core Elective-2	18:00	36:00	36:00	
Artificial Intelligence in Automotive Manufacturing	ASC/N8391	Core Elective-3	18:00	36:00	36:00	
Environmental Studies	ASC/N9843	Non-Core	18:00	36:00	36:00	90:00
Employability Skills (120)	DGT/VSQ/0104	Non-Core	48:00	72:00		120:00
Total Duration			**264:00**	**504:00**	**432:00**	**1200:00**

Subject Details

Semester-5
Subject: 1 Hydraulics & Pneumatics
Mapped to ASC/N3126 ,V1.0

Terminal Outcomes:

- Hydraulics and pneumatics are both branches of fluid power engineering that involve the use of fluids (liquid or gas) to transmit and control energy. They find applications in various industries, including manufacturing, construction, automotive, and more.
- Understanding Fluid Properties: Students will grasp the fundamental properties of fluids, including viscosity, density, and pressure, and how these properties influence fluid behavior in hydraulic systems.
- Fluid Power Principles: Learners will comprehend the basic principles of fluid power, such as Pascal's law, which states that a change in pressure at any point in an enclosed fluid will be transmitted undiminished to all points in the fluid.

Duration: *<24:00>*	**Duration**: *<48:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Fluid Properties and Behaviour: Understand the fundamental properties of hydraulic fluids, such as viscosity, density, and compressibility, and how these properties affect fluid behaviour and flow in hydraulic systems. • Pascal's Law: Grasp the principle of Pascal's law and its significance in hydraulic systems, which state that a change in pressure applied to an enclosed fluid will be transmitted undiminished to all portions of the fluid and the walls of its container. • Hydraulic Components: Identify and explain the functions of various hydraulic components, including pumps, valves (directional, pressure, and flow control), actuators (cylinders, hydraulic motors), reservoirs, filters, and accumulators. • Hydraulic Circuit Analysis: Learn to analyse and design hydraulic circuits, considering principles like flow continuity, pressure drop, and load characteristics to achieve desired motion and control in the system.	Hands-On Component Familiarity: Gain practical experience in handling and assembling hydraulic components such as pumps, valves, cylinders, and filters, understanding their functions and interconnections. Fluid Power Circuit Assembly: Develop the ability to assemble and disassemble hydraulic circuits, including selecting appropriate components, connecting hoses, and ensuring leak-free connections. Pressure and Flow Control: Practice adjusting pressure and flow control valves to regulate the behavior of hydraulic actuators and control the speed and force of hydraulic systems. Circuit Design and Simulation: Utilize software tools for hydraulic circuit design and simulation to visualize and analyze the behavior of hydraulic systems before physical implementation. Component Handling and Installation: Gain hands-on experience in handling and installing pneumatic components such as valves, cylinders, and compressors, understanding

• Gas Laws and Behaviour: Comprehend the basic principles of gas behaviour, including Boyle's law, Charles's law, and the ideal gas law, and their implications for pneumatics systems. • Pneumatic Components: Identify and describe key pneumatic components, such as compressors, air preparation units (filters, regulators, and lubricators), valves (solenoid, directional control), cylinders, and air motors. • Pneumatic Circuit Design: Learn to design and analyse pneumatic circuits considering factors like air flow, pressure regulation, and actuator control, to achieve specific tasks and motion.	their placement and connections. Pneumatic Circuit Assembly: Practice building pneumatic circuits by selecting appropriate components, connecting tubing, and ensuring proper air flow and control in the system. Actuator Control and Calibration: Learn how to adjust pneumatic valves and regulators to control the motion and force of pneumatic actuators, ensuring accurate and repeatable performance. Air Preparation and Filtration: Gain practical knowledge of air preparation units, including installing filters, regulators, and lubricators, and understand their role in maintaining clean and dry air.

Classroom Aids:

Whiteboard, marker pen, projector

Tools, Equipment and Other Requirements

Hydraulics-Specific Tools:

Hydraulic Hose Crimper: Equipment for crimping hydraulic fittings onto hoses.

Hydraulic Flaring Tool: Tool for creating flared ends on metal tubing for leak-free connections.

Hydraulic Pressure Test Kit: Kit for testing hydraulic system pressures and diagnosing issues.

Hydraulic Cylinder Repair Tools: Tools for disassembling, repairing, and reassembling hydraulic cylinders.

Hydraulic Oil Filtration Equipment: Tools for filtering and maintaining hydraulic fluid cleanliness.

Pneumatics-Specific Tools:

Air Compressor: Equipment for generating compressed air for pneumatic systems.

Pneumatic Fittings Installer/Remover: Tools for assembling and disassembling pneumatic fittings.

Pneumatic Actuator Test Kit: Kit for testing pneumatic actuators, valves, and controls.

Pneumatic Leak Detection Tools: Instruments for identifying air leaks in pneumatic systems.

Air Quality Testing Equipment: Tools for checking the quality of compressed air, including moisture and oil content.

Subject: 2 Lubrication & Mechanical Drives

Mapped to ASC/N3127 ,V1.0

Terminal Outcomes:

- Understanding Lubrication Principles: Demonstrate a deep understanding of lubrication principles, including the role of lubricants in reducing friction, wear, and heat generation in mechanical systems.
- Lubricant Types and Properties: Identify and categorize different types of lubricants (fluids, greases, solids) based on their properties, viscosities, and applications.
- Lubrication Systems: Describe various lubrication systems, including splash lubrication, forced lubrication, and circulating systems, and their appropriate applications.
- Mechanical Drive Components: Identify, describe, and explain the functions of key mechanical drive components, including gears, belts, chains, couplings, and shafts.
- Gear Systems: Understand different types of gear systems, including spur gears, helical gears, bevel gears, and worm gears, and their applications in transmitting motion and power.
- Belt and Chain Drives: Explain the principles of belt and chain drives, including calculating speed ratios, tensioning, and selecting appropriate belt and chain types for specific applications.
- Couplings and Clutches: Analyze the function and types of couplings and clutches used to connect and disconnect mechanical components, ensuring smooth power transmission.

Duration: *<24:00>*	**Duration**: *<48:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Friction and Wear: Understand the fundamental concepts of friction and wear in mechanical systems and their impact on machinery performance and longevity. • Lubricant Properties: Learn about the properties of lubricants, including viscosity, viscosity index, pour point, flash point, and how these properties influence lubricant selection. • Lubrication Mechanisms: Grasp the mechanisms, through which lubricants reduce friction and wear, including boundary lubrication, hydrodynamic lubrication, and elastohydrodynamic lubrication (EHL). • Types of Lubricants: Differentiate between various lubricant types, including oils, greases, solid lubricants,	Lubrication: • Lubricant Selection: Gain practical skills in selecting appropriate lubricants based on machinery specifications, load conditions, temperature, and operating environment. • Lubrication Application: Develop hands-on experience in applying lubricants using proper techniques, including manual lubrication, using centralized systems, and utilizing automatic lubricators. • Lubricant Analysis: Learn how to collect samples of lubricants, perform basic tests (viscosity, contamination, wear debris), and interpret results to assess machinery condition. • Lubricant Handling: Acquire skills in proper lubricant storage, handling, and

and their applications in different machinery and environments. • Power Transmission Concepts: Understand the principles of power transmission in mechanical systems, including torque, speed ratios, and rotational motion. • Gearing Concepts: Learn about gear types, gear trains, gear ratios, gear terminology, and the calculations involved in determining gear ratios and speeds. • Belt and Chain Drives: Grasp the fundamentals of belt and chain drives, including tensioning, calculating speed ratios, and the factors influencing their efficiency and selection. • Couplings and Clutches: Understand the functions and types of couplings and clutches used for torque transmission, connection, and disengagement in mechanical systems. • Shaft Alignment and Balancing: Learn the importance of shaft alignment and dynamic balancing in reducing vibration, improving efficiency, and prolonging the life of mechanical systems.	disposal practices to maintain lubricant quality and prevent contamination. Mechanical Drives: • Gearing Assembly: Gain hands-on experience in assembling gears and gear trains, including meshing gears, setting gear backlash, and verifying proper alignment. • Belt and Chain Installation: Learn practical techniques for installing belts and chains, including tensioning, alignment, and verifying proper engagement. • Coupling and Clutch Handling: Practice assembling and disassembling various types of couplings and clutches, understanding their functions and connection methods. • Shaft Alignment: Acquire skills in performing shaft alignment using alignment tools, ensuring proper alignment for minimizing vibration and wear. • Mechanical Drive Inspection: Develop the ability to inspect mechanical drives for wear, misalignment, and other issues, and identify components that require maintenance or replacement.

Classroom Aids:

Whiteboard, marker pen, projector

Tools, Equipment and Other Requirements

Tools and Equipment for Lubrication:

- Grease Guns: Devices for applying grease to lubrication points in machinery.
- Oil Cans: Containers with spouts for manually applying oil to specific points.
- Centralized Lubrication Systems: Equipment for automatically delivering lubricants to multiple points in machinery.
- Lubricant Dispensing Units: Systems for controlled distribution of lubricants, including pumps, hoses, and fittings.
- Lubricant Analysis Kits: Kits containing tools for collecting fluid samples and performing basic tests on lubricants.
- Oil Filter Wrenches: Tools for removing and replacing oil filters during maintenance.
- Lubricant Storage and Handling Tools: Containers, funnels, and oil transfer pumps for managing lubricants safely.
- Oil Drain Pans: Containers for collecting used oil during oil changes.
- Ultrasonic Leak Detectors: Devices for detecting leaks in compressed air and gas systems.
- Lubricant Labelling and Identification Tools: Labels, markers, and tags for clearly identifying lubrication points.

Tools and Equipment for Mechanical Drives:

- Torque Wrenches: Tools for applying precise torque to fasteners when assembling components.
- Alignment Tools: Devices for accurately aligning shafts and couplings to minimize misalignment.
- Bearing Pullers and Installers: Tools for removing and installing bearings from shafts and housings.
- Gear Pullers: Equipment for removing gears from shafts without damaging components.
- Tension Gauges: Devices for measuring and setting proper tension in belts and chains.
- Belt Alignment Tools: Tools for checking and adjusting belt alignment to prevent wear and vibration.
- Dynamic Balancing Equipment: Machinery for balancing rotating components to reduce vibration.
- Coupling and Clutch Alignment Tools: Tools for aligning and connecting couplings and clutches accurately.
- Mechanical Drive Inspection Tools: Instruments for inspecting gear teeth, chain links, belts, and other components for wear.
- Pulley and Sprocket Pullers: Tools for removing pulleys and sprockets from shafts.
- Bearing Lubrication Tools: Tools for applying grease to bearings and ensuring proper lubrication.
- Personal Protective Equipment (PPE): Safety gear such as gloves, safety glasses, ear protection, and protective clothing.
- Vibration Analyzers: Devices for analyzing and monitoring vibration levels in machinery.

Subject: 3 PLC & Electrical Drives

Mapped to ASC/N3128 ,V1.0

Terminal Outcomes:

- PLC Fundamentals: Demonstrate a comprehensive understanding of the fundamental concepts of Programmable Logic Controllers, including their architecture, components, and operating principles.
- PLC Programming Languages: Master PLC programming languages such as ladder logic, function block diagrams, and structured text, and apply them to design and implement control logic.
- PLC System Design: Design and create complex PLC control systems, including selecting appropriate hardware, developing control algorithms, and designing human-machine interfaces (HMIs).

- PLC Troubleshooting and Debugging: Develop proficiency in diagnosing and rectifying PLC system malfunctions, including identifying software and hardware-related issues and implementing effective solutions.
- Electrical Drive Principles: Demonstrate a deep understanding of electrical drives, including the theory of operation, different types of drives, and their applications in various industries.
- Motor Control Techniques: Master motor control techniques, including speed control, torque control, and position control, using different types of electrical drives.
- Drive Components and Selection: Identify and explain the components of electrical drives, such as power converters, inverters, rectifiers, and motor types, and make informed selections based on application requirements.

Duration: *<24:00>*	**Duration**: *<48:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• PLC Fundamentals: Understand the basic principles of PLCs, including their history, functions, advantages, and applications in industrial automation. • PLC Architecture: Comprehend the architecture of a PLC, including the central processing unit (CPU), input/output modules (I/O), memory, and communication interfaces. • PLC Programming Languages: Learn various PLC programming languages, such as ladder logic, function block diagrams, structured text, and sequential function charts, and their applications in industrial control. • PLC Scan Cycle: Understand the PLC scan cycle, including the steps involved in reading inputs, executing logic, updating outputs, and handling communication tasks. • Digital Logic Concepts: Acquire a solid grasp of digital logic concepts, including Boolean algebra, truth tables, logic gates, and their translation into PLC programming logic. • Electrical Drive Basics: Grasp the fundamental concepts of electrical drives, including the role of drives in controlling motor speed, torque, and direction. • Motor Types: Understand different types of electric motors, including induction motors, synchronous motors, and direct current (DC) motors, and their characteristics. • Power Electronic Converters: Learn	• PLC Programming: Develop hands-on skills in programming PLCs using various languages, such as ladder logic and structured text, to implement control logic for different industrial processes. • PLC Software Familiarity: Gain proficiency in using PLC software platforms to create, edit, and download PLC programs to actual hardware or simulation environments. • I/O Configuration: Practice configuring input and output modules of PLC systems, connecting sensors and actuators, and setting up digital and analog signals. • PLC Wiring and Interfacing: Develop the ability to wire and interface PLCs with various sensors, switches, relays, and actuators in both simulation and real-world scenarios. • Drive Configuration: Develop skills in configuring and parameterizing electrical drives, including setting motor characteristics, current limits, and operating modes. • Motor Control Tuning: Practice tuning motor control loops in closed-loop systems to achieve desired

about power electronic devices such as rectifiers, inverters, and choppers used in electrical drives to convert and control electrical power. • Control Strategies: Comprehend various motor control techniques, including open-loop and closed-loop control, as well as concepts like speed control, torque control, and position control. • Drive Performance Parameters: Understand and calculate key drive performance parameters, such as efficiency, power factor, and dynamic response.	performance, such as accurate speed or position control. • Drive System Setup: Gain hands-on experience in setting up electrical drive systems, including connecting power electronics, motor feedback devices, and control interfaces. • Drive Commissioning: Learn the steps for commissioning electrical drive systems, including initial tests, parameter adjustments, and functional testing. • Drive Troubleshooting: Develop troubleshooting skills to diagnose and resolve issues related to power electronics, motor control, feedback sensors, and communication interfaces.

Classroom Aids:

Whiteboard, marker pen, projector

Tools, Equipment and Other Requirements

Tools and Equipment for PLC:

PLC Programming Software: Software tools used for creating, editing, and testing PLC programs.

PLC Hardware: Actual PLC modules, racks, and I/O modules for hands-on programming and testing.

Laptop or PC: Computer for running PLC programming software and connecting to PLC hardware.

Programming Cable: Cable used to connect the PC to the PLC for program transfer.

Digital Multimeter: Tool for measuring voltage, current, and resistance in electrical circuits.

Wiring Tools: Wire strippers, crimping tools, and screwdrivers for connecting sensors and actuators.

Tools and Equipment for Electrical Drives:

Variable Frequency Drives (VFDs): Devices for controlling the speed and torque of electric motors.

Motor Control Panels: Panels housing VFDs, contactors, circuit breakers, and other motor control components.

Multimeter and Clamp Meter: Instruments for measuring electrical parameters like voltage, current, and frequency.

Motor Feedback Devices: Encoders, resolvers, and tachometers for providing feedback on motor speed and position.

Power Analyzers: Tools for measuring power quality, energy consumption, and efficiency.

Subject: 4 Automation

Mapped to ASC/N1479 ,V1.0

Core-Elective-1

Terminal Outcomes:

- Automation Fundamentals: Demonstrate a comprehensive understanding of the principles, concepts, and advantages of automation in various industries.
- Sensors and Actuators: Identify, select, and apply appropriate sensors and actuators for monitoring and controlling processes in automation systems.
- PLC and Control Systems: Design, program, and implement control systems using Programmable Logic Controllers (PLCs) to achieve desired automation tasks.
- Human-Machine Interface (HMI): Develop and design intuitive HMIs for visualizing and interacting with automated processes, enhancing user experience and control.
- Industrial Communication: Understand and utilize industrial communication protocols (e.g., Ethernet, Modbus, PROFIBUS) to establish seamless data exchange between automation components.
- Robotics and Motion Control: Apply principles of robotics and motion control to automate tasks involving precision movement and manipulation in industrial settings.
- Integration of Automation Systems: Integrate different automation components such as PLCs, HMIs, sensors, drives, and robotics into a cohesive and functional automation system.

Duration: *<18:00>*	**Duration**: *<36:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Automation Concepts: Understand the fundamental concepts of automation, including the reasons for automation, its benefits, and its role in improving efficiency and productivity. • Control Systems Principles: Grasp the principles of control systems, including open-loop and closed-loop control, feedback mechanisms, and control algorithms. • Sensors and Actuators: Learn about different types of sensors (temperature, pressure, proximity, etc.) and actuators (motors, valves, solenoids) used to monitor and control processes in automation. • Signal Conditioning: Understand signal conditioning techniques to convert raw	• Sensor Installation and Calibration: Develop skills in selecting, installing, and calibrating sensors for accurate data collection in real-world automation scenarios. • Actuator Configuration: Gain hands-on experience in configuring and interfacing actuators such as motors, valves, and solenoids to control industrial processes. • PLC Programming and Simulation: Develop proficiency in programming PLCs using various languages, testing logic in simulation environments, and troubleshooting program errors. • HMI Development: Create functional and user-friendly HMIs, designing screens and interfaces that allow

sensor signals into usable digital or analog values for control systems. • Programmable Logic Controllers (PLCs): Explore the architecture, programming languages (ladder logic, function block diagrams), and applications of PLCs in automating industrial processes. • Human-Machine Interface (HMI): Comprehend the role of HMIs in visualization and interaction with automated systems, including design principles and user interface considerations.	operators to visualize and interact with automated processes. • Industrial Communication Setup: Practice configuring and setting up industrial communication networks to establish seamless data exchange between automation components.
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
• Programmable Logic Controllers (PLCs): Hardware and software components for designing, programming, and controlling automation logic. • Human-Machine Interface (HMI): Devices and software for creating graphical user interfaces to monitor and interact with automation systems. • Sensors and Actuators: Various types of sensors (temperature, pressure, proximity, etc.) and actuators (motors, valves, solenoids) for data acquisition and control. • PLC Programming Software: Software tools used for writing, editing, and testing PLC programs. • Robotics Kits: Robotic arms and components for hands-on experience in robot programming and manipulation. • Industrial Communication Equipment: Devices for configuring and establishing communication networks (Ethernet switches, routers, fieldbus modules). • Data Acquisition Systems: Equipment for collecting data from sensors and other devices in automation processes. • Power Supplies: Units for providing stable power to automation components. • Signal Conditioners: Devices for converting and conditioning sensor signals before they are used in control systems. • Multimeters: Tools for measuring electrical parameters such as voltage, current, and resistance. • Oscilloscopes: Devices for visualizing and analyzing electronic signals. • PLC Trainer Kits: Hands-on training systems that simulate real-world automation scenarios for practice and learning. • Simulation Software: Software tools for simulating and testing automation systems before actual implementation.	

Subject: 5 Robot Maintenance

Mapped to ASC/N1480 ,V1.0

Core-Elective-2

Terminal Outcomes:

- Robot System Understanding: Demonstrate a comprehensive understanding of robotic systems, including their components, kinematics, and operational principles.
- Safety Protocols: Implement safety protocols and guidelines to ensure the safety of personnel working with and around robots.
- Robot Troubleshooting: Develop skills in diagnosing and resolving issues in robotic systems, including identifying faults, analyzing error codes, and implementing effective solutions.
- Preventive Maintenance: Apply preventive maintenance techniques to robotic systems, including regular inspections, cleaning, lubrication, and predictive maintenance practices.
- Calibration and Alignment: Perform calibration and alignment procedures to maintain the accuracy and precision of robotic movements.
- End Effector Maintenance: Maintain and repair robotic end effectors (grippers, tools, sensors) to ensure proper functionality during operations.

Duration: *<18:00>*	**Duration**: *<36:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Robot Components and Kinematics: Understand the components of robotic systems, including manipulators, end effectors, and joints, and grasp the fundamentals of robot kinematics and motion planning. • Safety Principles: Comprehend the importance of safety in robot maintenance, including risk assessment, safety protocols, and compliance with safety standards. • Robot Operating Modes: Learn about different operating modes of robots, such as manual mode, teach mode, and automatic mode, and understand their applications. • Robot Programming: Gain knowledge of robot programming languages, such as teach pendant programming, offline programming, and simulation-based programming. • Sensor Integration: Understand the role of sensors in robotic systems, their types (proximity, vision, force/torque), and their integration for accurate feedback and control. • Robot Control Systems: Grasp the concepts of open-loop and closed-loop control in robotic systems, including PID control and inverse kinematics. • Calibration and Accuracy: Learn the importance of robot calibration and	• Safety Procedures: Implement safety protocols when working with robotic systems, including proper lockout/tagout procedures and personal protective equipment (PPE) usage. • Robot Inspection: Develop skills in conducting visual and physical inspections of robotic systems to identify signs of wear, damage, or misalignment. • End Effector Maintenance: Gain hands-on experience in maintaining and repairing robotic end effectors, grippers, and specialized tools used for different tasks. • Sensor Calibration: Practice calibrating and testing sensors used in robotic applications to ensure accurate data acquisition and feedback. • Robot Calibration: Learn how to calibrate robot joints and axes to maintain precision and accuracy in robotic movements. • Greasing and Lubrication: Develop proficiency in proper greasing and lubrication techniques to extend the lifespan of robotic components. • Emergency Stop Procedures: Practice implementing emergency stop procedures and reset protocols to ensure safe shutdown and recovery of

accuracy enhancement techniques to ensure precise robotic movements. • Preventive Maintenance: Understand the concept of preventive maintenance, including routine inspections, lubrication, and replacement of wear-prone components. • Failure Analysis: Develop skills in analyzing robotic system failures, identifying root causes, and formulating effective troubleshooting strategies. • End Effector Maintenance: Gain insights into maintaining and servicing robotic end effectors, grippers, and specialized tools.	robotic systems. • Troubleshooting Techniques: Gain practical skills in diagnosing and resolving common robotic system issues, including identifying faults and implementing corrective actions.
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
• Basic Hand Tools: Screwdrivers, pliers, wrenches, and other hand tools for disassembling and assembling robot components. • Calibration Tools: Equipment for calibrating robot joints, axes, and end effectors to ensure accuracy and precision. • Lubrication Tools: Grease guns, lubrication applicators, and supplies for proper lubrication of robot components. • Diagnostic Devices: Multimeters, oscilloscopes, and other diagnostic tools for analyzing electrical and electronic components. • Safety Equipment: Personal protective equipment (PPE) including safety glasses, gloves, ear protection, and appropriate clothing. • Robot Teach Pendant: Device for programming, controlling, and troubleshooting robotic systems. • Torque Wrench: Tool for applying precise torque when fastening robot components. • Force/Torque Sensors: Sensors used for calibrating and testing the force and torque applied by robot end effectors. • Alignment Tools: Laser alignment tools for aligning robot components and ensuring accurate movement. • Spare Parts: Replacement parts for common robot components that may need to be replaced during maintenance. • End Effector Maintenance Kit: Kit containing tools and components for maintaining and repairing robot end effectors.	

Subject: 6 Best Industrial Practices

Mapped to ASC/N9837 ,V1.0

Terminal Outcomes:

- Workplace Safety: Demonstrate an understanding of basic workplace safety protocols, including hazard identification, proper tool usage, and personal protective equipment (PPE) requirements.
- Work Ethics and Professionalism: Exhibit professionalism, punctuality, teamwork, and effective communication skills in an industrial setting.
- Basic Tool Proficiency: Develop proficiency in using common hand tools, power tools, and measuring instruments relevant to industrial tasks.
- Material Handling: Learn safe and efficient methods for handling materials, including lifting, transporting, and storing items in an industrial environment.
- Basic Manufacturing Processes: Gain familiarity with fundamental manufacturing processes such as machining, welding, assembly, and quality control.
- Precision Measurement: Develop skills in using precision measuring tools such as calipers, micrometers, and gauges to ensure accurate work.
- Workshop Organization: Learn how to maintain an organized and clean workshop, ensuring tools and materials are properly stored and workspaces are safe and efficient.

Duration: *<18:00>*	**Duration**: *<36:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Workplace Safety Principles: Understand the fundamental principles of workplace safety, including hazard recognition, risk assessment, and the importance of adhering to safety protocols. • Industrial Regulations and Standards: Familiarize yourself with industry-specific regulations, safety standards, and guidelines that govern practices within industrial environments. • Work Ethics and Professionalism: Grasp the concepts of professionalism, work ethics, and the importance of punctuality, accountability, and effective communication in an industrial setting. • Basic Manufacturing Processes: Learn about common manufacturing processes, such as machining, welding, casting, and assembly, and understand their applications and limitations. • Technical Drawings Interpretation: Develop skills in reading and interpreting technical drawings, blueprints, schematics, and symbols used in industrial contexts. • Material Properties and Handling: Understand the properties of common industrial materials, their appropriate	• Workplace Safety Implementation: Apply workplace safety protocols by identifying and mitigating hazards, wearing appropriate PPE, and following safety guidelines. • Tool Proficiency: Develop hands-on proficiency in using common hand tools, power tools, and measuring instruments used in industrial tasks. • Material Handling Techniques: Practice safe and efficient methods for lifting, transporting, and storing materials within an industrial environment. • Manufacturing Process Application: Gain practical experience by participating in or observing basic manufacturing processes like machining, welding, or assembly. • Measurement and Metrology Skills: Develop skills in accurately measuring dimensions using precision measuring tools, ensuring precision in work. • Technical Drawing Interpretation: Apply knowledge of technical drawings to accurately interpret and follow assembly instructions and specifications.

handling techniques, and considerations for material selection.	
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
• Safety Equipment: Personal protective equipment (PPE) including safety glasses, gloves, helmets, ear protection, and appropriate clothing to ensure worker safety. • Hand Tools: Common hand tools such as screwdrivers, pliers, wrenches, hammers, and utility knives for various tasks. • Power Tools: Electric or pneumatic tools such as drills, grinders, saws, and impact wrenches for efficient and precise work. • Measuring Instruments: Precision measuring tools like calipers, micrometers, gauges, rulers, and tape measures for accurate measurements. • Workbenches: Sturdy work surfaces equipped with clamps, vises, and holders for securing materials during tasks. • Lifting and Handling Equipment: Hoists, cranes, forklifts, and pallet jacks for safe and efficient material handling. • Welding Equipment: Welding machines, torches, protective gear, and welding accessories for joining metals. • Machining Tools: Lathe machines, milling machines, and CNC machines for precision shaping and cutting of materials. • Safety Signs and Labels: Signage indicating hazardous areas, emergency exits, safety guidelines, and equipment instructions.	

Semester-6

Subject: 1 Sensors & Actuators

Mapped to ASC/N6459 ,V1.0

Terminal Outcomes:

- Sensors and actuators are essential components in various fields, including electronics, robotics, automation, and more. They work together to gather information from the environment, process it, and initiate actions based on that information.
- Measurement and Monitoring: Sensors can provide accurate measurements of physical properties such as temperature, pressure, humidity, light intensity, and more. This information is used for monitoring and control purposes in various industries, including manufacturing, environmental monitoring, and healthcare.
- Data Collection: Sensors collect data from the environment, which can be used for analysis, decision-making, and optimization. This data can be used to detect trends, anomalies, and patterns.

- Feedback Systems: Sensors provide crucial feedback for closed-loop control systems. For instance, in a thermostat, a temperature sensor measures the room's temperature and provides feedback to control the heating or cooling system.
- Mechanical Movement: Actuators are used to generate mechanical movement. In robotics, actuators control the movement of robotic limbs and joints, enabling the robot to interact with its environment.
- Process Control: Actuators are used in industrial processes to control valves, pumps, and other mechanical components. This helps regulate variables such as flow rate, pressure, and temperature.
- Response to Signals: Actuators respond to signals from sensors or controllers. For example, a solenoid valve can be activated by a sensor detecting a certain condition, allowing fluid to flow or stop.
- Feedback Control: In feedback control systems, actuators adjust their behavior based on information received from sensors. For instance, in a cruise control system in a car, actuators adjust the throttle and brakes based on the car's speed as measured by sensors.

Duration: *<24:00>*	**Duration**: *<48:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Sensor Types and Classification: Understand the different types of sensors based on the physical properties they measure, such as temperature, pressure, light, proximity, and motion. • Operating Principles: Grasp the underlying principles behind sensor operation, including phenomena like resistive, capacitive, inductive, piezoelectric, and optical sensing. • Sensing Mechanisms: Learn how sensors convert physical quantities into electrical signals, such as voltage, current, or resistance changes. • Sensitivity and Resolution: Understand the concepts of sensitivity (how well a sensor detects changes in the measured quantity) and resolution (the smallest change a sensor can detect). • Actuator Types and Principles: Familiarize yourself with various types of actuators, including mechanical, electrical, pneumatic, and hydraulic actuators, and understand their underlying principles. • Actuation Mechanisms: Learn how actuators generate mechanical	• Sensor Selection: Learn how to choose the appropriate sensor type for a given application based on factors such as measurement range, accuracy, environmental conditions, and cost. • Sensor Mounting and Placement: Gain skills in properly mounting and positioning sensors to ensure accurate measurements and minimize interference. • Calibration and Testing: Develop the ability to calibrate sensors using known reference standards and perform testing to validate their accuracy and reliability. • Signal Conditioning: Acquire skills in designing and implementing signal conditioning circuits that amplify, filter, and convert sensor signals for accurate processing. • Actuator Integration: Develop skills in integrating actuators into systems and devices, including mechanical design, alignment, and attachment. • Control System Implementation: Learn how to design and implement control systems that regulate actuator behavior based on sensor feedback, including open-loop and closed-loop control.

movement, such as through motors, solenoids, piezoelectric elements, and pneumatic systems. • Control and Feedback: Understand how actuators are controlled using feedback from sensors, leading to closed-loop control systems that regulate their behavior. • Response Time and Dynamics: Explore the concept of response time, which determines how quickly an actuator can change its state or position, and how actuator dynamics impact system behavior.	• Programming and Scripting: Acquire programming skills to control actuators using languages like Python, C/C++, or specific microcontroller programming languages. • Actuator Characterization: Gain experience in characterizing actuator performance by measuring parameters such as response time, force, torque, and displacement. • Feedback Loop Tuning: Understand how to optimize control parameters to achieve desired actuator performance, stability, and responsiveness.
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
Equipment for Sensors: Sensor Modules: Various types of sensors such as temperature, humidity, motion, light, and more. Data Logger: Collects and records sensor data over time for analysis and monitoring. Signal Conditioning Components: Amplifiers, filters, and converters to condition sensor signals. Microcontrollers or Microprocessors: Such as Arduino, Raspberry Pi, or other development boards for processing sensor data and controlling actuators. ADC (Analog-to-Digital Converter): Converts analog sensor signals into digital values for processing. Oscilloscope or Logic Analyzer: To observe and analyze sensor output waveforms. Equipment for Actuators: Actuator Modules: Motors, servos, solenoids, and other types of actuators suitable for your application. Motor Drivers: Circuits that control the operation of motors and provide power regulation. H-Bridge ICs: Used to control the direction and speed of DC motors. Control System Components: Microcontrollers, controllers, and programming tools for regulating actuator behavior. Feedback Sensors: Encoders, potentiometers, and other devices for providing position or speed feedback. Mechanical Components: Gears, pulleys, belts, and brackets for building mechanical systems.	

Subject: 2 SCADA & Industrial Automation

Mapped to ASC/N6315 ,V1.0

Terminal Outcomes:

- Supervisory Control and Data Acquisition (SCADA) and industrial automation are technologies used to monitor, control, and manage various processes and systems in industries such as manufacturing, energy, utilities, and more. The terminal outcomes of SCADA and industrial automation include enhanced efficiency, safety, productivity, and reliability across industrial processes.
- Real-time Monitoring: SCADA systems provide real-time monitoring of various processes, allowing operators to have a comprehensive view of the entire industrial operation.
- Remote Control: SCADA enables remote control and operation of equipment and processes, reducing the need for physical presence and improving response times.
- Data Collection and Visualization: SCADA collects data from sensors and devices and presents it in a visual format, making it easier for operators to make informed decisions.
- Alarms and Alerts: SCADA systems generate alarms and alerts when specific conditions or thresholds are breached, allowing operators to take immediate corrective actions.
- Process Automation: Industrial automation streamlines processes by automating tasks that were previously performed manually, leading to consistent and reliable outcomes.
- Reduced Human Intervention: Automation reduces the need for human intervention in routine tasks, minimizing errors and freeing up human resources for more complex tasks.
- Increased Production Efficiency: Automation leads to improved production efficiency, higher throughput, and better utilization of resources.
- Quality Control: Automation systems can incorporate quality control measures, leading to more consistent and higher-quality products.
- Safety Enhancement: Automation removes workers from hazardous environments, improving workplace safety and reducing the risk of accidents.
-

Duration: *<24:00>*	**Duration**: *<48:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
SCADA Architecture: Understand the layered architecture of SCADA systems, including the roles of the supervisory, data acquisition, and control layers. Remote Terminal Units (RTUs) and PLCs: Learn about the functions of RTUs and PLCs (Programmable Logic Controllers) in collecting and processing data from field devices. Human-Machine Interface (HMI): Grasp the principles of designing user-friendly HMIs that provide operators with real-time data visualization and control capabilities. Data Communication Protocols: Explore communication protocols used for data exchange between various SCADA components,	• SCADA System Configuration: Gain hands-on experience in setting up SCADA systems, configuring communication protocols, and establishing data links with field devices. • HMI Development: Learn how to design and create effective Human-Machine Interfaces (HMIs) that provide operators with clear data visualization and control options. • Data Tagging and Mapping: Practice tagging and mapping field device data to SCADA system points for proper organization and representation.

such as Modbus, DNP3, OPC, and more. Data Acquisition: Understand the process of data acquisition from sensors, devices, and other sources, including sampling rates, accuracy, and signal conditioning. Control Systems: Learn about different types of control systems, including open-loop and closed-loop systems, and understand the concept of feedback control. Sensors and Actuators: Understand the role of sensors in gathering data and actuators in controlling physical processes, as well as the principles of interfacing with them. Programmable Logic Controllers (PLCs): Explore the architecture, programming languages, and functions of PLCs in automating processes. Industrial Networks: Gain knowledge of communication networks used in industrial automation, such as Ethernet, Profibus, Modbus, and their protocols.	• Alarming and Event Configuration: Configure alarms and events in SCADA systems, set up alarm priorities, and establish notification methods for operators. • PLC Programming: Gain practical skills in programming Programmable Logic Controllers (PLCs) using various languages like ladder logic, structured text, or function block diagrams. • Sensor and Actuator Interfacing: Learn how to interface sensors and actuators with PLCs, ensuring proper signal conditioning and accurate data exchange. • Control System Tuning: Practice tuning control algorithms, such as PID controllers, to achieve desired process performance while minimizing overshoot and oscillations. • Industrial Networking: Set up and configure industrial networks for communication between PLCs, HMIs, and other devices, ensuring data exchange and system coordination.

Classroom Aids:

Whiteboard, marker pen, projector

Tools, Equipment and Other Requirements

- Personal Computer: A computer is essential for programming, configuring, and monitoring SCADA and automation systems.
- Communication Devices: Devices like routers, switches, and cables for setting up local area networks (LANs) and connecting various components.
- Multimeter: Used for measuring voltage, current, and resistance during troubleshooting and maintenance.
- Screwdrivers and Hand Tools: Basic tools for assembling and disassembling components, connectors, and enclosures.
- SCADA Software: Software platforms like Ignition, Wonderware, or WinCC for creating SCADA applications and configuring HMIs.
- HMI Display: Hardware components such as touch screen displays for interacting with SCADA systems.
- Field Instruments and Sensors: Sensors (temperature, pressure, level, etc.) used to collect data from the physical processes.
- Remote Terminal Units (RTUs) or PLCs: Devices for interfacing with field instruments and sending data to the SCADA system.

- Communication Protocols: Devices like protocol converters or gateways for converting different communication protocols used in SCADA networks.
- PLC (Programmable Logic Controller): Hardware for controlling various processes and machinery.
- PLC Programming Software: Software platforms like Siemens TIA Portal, Rockwell Studio 5000, or Codesys for programming PLCs.
- Sensors and Actuators: A variety of sensors (proximity, temperature, pressure, etc.) and actuators (motors, solenoids, valves) for automation control.
- Motor Drivers and Controllers: Devices to control the operation of motors and actuators.

Subject: 3 Industry 4.0 Technologies

Mapped to ASC/N8379 ,V1.0

Terminal Outcomes:

- Industry 4.0, often referred to as the fourth industrial revolution, encompasses a set of advanced technologies that are transforming manufacturing and various industries. The terminal outcomes of Industry 4.0 technologies include significant improvements in efficiency, productivity, flexibility, and innovation.
- Smart Manufacturing: Industry 4.0 technologies enable the creation of smart factories where machines, devices, and systems communicate and collaborate autonomously to optimize production processes.
- Digital Twinning: Digital twins are virtual replicas of physical assets, processes, or systems. The terminal outcome is the ability to model, simulate, and analyze real-world systems in a virtual environment, improving design, performance, and maintenance.
- Interconnected Systems: Industry 4.0 technologies facilitate the integration of different components, systems, and processes across the value chain, resulting in seamless data exchange and communication.
- Data-Driven Decision-Making: By harnessing data from sensors, machines, and processes, Industry 4.0 allows for data-driven decision-making, leading to more accurate and informed choices.

Duration: *<24:00>*	**Duration**: *<48:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction to Industry 4.0: Understand the concept of Industry 4.0 as the integration of digital technologies, data, and automation to transform manufacturing and other industries. • Cyber-Physical Systems (CPS): Grasp the concept of CPS, where physical	• IoT Device Setup and Configuration: Gain hands-on experience in setting up and configuring IoT devices, including sensors, actuators, and communication modules, and connecting them to the internet.

systems are interconnected with digital technologies to enable real-time data exchange and decision-making. • Internet of Things (IoT): Learn about IoT, which involves connecting various devices, sensors, and machines to the internet for data exchange and remote control. • Big Data and Analytics: Understand the role of big data in Industry 4.0, including data collection, storage, processing, and analysis to derive insights and support decision-making. • Artificial Intelligence (AI): Explore how AI technologies like machine learning and deep learning are used to automate tasks, analyze data, and make predictions. • Cloud Computing: Understand the use of cloud platforms for storing, processing, and accessing data and applications remotely.	• Data Collection and Processing: Learn how to collect data from IoT devices and sensors, process it using microcontrollers or edge devices, and transmit it to cloud platforms or local servers. • Cloud Services Utilization: Gain proficiency in using cloud platforms like AWS, Azure, or Google Cloud to store, process, and analyze data collected from IoT devices. • Creating Digital Twins: Develop practical skills in creating digital twin models of physical assets or processes using software tools and validating their accuracy through simulation. • Data Visualization and Dashboards: Create interactive dashboards and visualizations to present real-time data collected from sensors and devices using platforms like Grafana or Tableau. • Programming IoT Devices: Develop programming skills for microcontrollers and IoT devices, using languages like Python, C/C++, or specific IoT-focused languages. • Security Implementation: Learn how to implement security measures for IoT devices, including encryption, authentication, and secure communication protocols. • Machine Learning Applications: Gain practical experience in applying machine learning algorithms to analyze IoT data and make predictions or detect anomalies. • Augmented Reality Applications: Develop AR applications for maintenance and training purposes, allowing users to visualize digital information overlaid on the physical world.

Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
IoT and Sensor Deployment: IoT Development Boards: Platforms like Arduino, Raspberry Pi, ESP32, and Particle for prototyping and developing IoT applications. Sensors and Actuators: A wide range of sensors (temperature, humidity, motion, etc.) and actuators (servos, motors) for data collection and control. IoT Communication Modules: Wi-Fi modules, Bluetooth modules, Zigbee modules, LoRa transceivers for enabling communication between devices. Microcontrollers and Microprocessors: Used to process data, control actuators, and manage communication in IoT devices. Breadboards and Jumper Wires: For prototyping and connecting components without soldering. Power Supplies: Provide power to IoT devices and sensors during testing and development. Multimeter: Used for measuring voltage, current, and resistance in circuits. Cloud Computing and Data Analytics: Cloud Platforms: AWS, Azure, Google Cloud for hosting and processing data in the cloud. Database Systems: SQL or NoSQL databases for storing and managing IoT data. Analytics Tools: Software platforms for processing and analyzing data, such as Python libraries (NumPy, Pandas), R, or specific analytics software. Data Visualization Tools: Tools like Tableau, Power BI, or Matplotlib for creating interactive data visualizations. Augmented Reality and Virtual Reality: AR/VR Headsets: Devices like Microsoft HoloLens, Oculus Rift, or HTC Vive for experiencing AR and VR environments. AR/VR Development Software: Software tools for creating AR/VR applications, such as Unity3D, Unreal Engine, or ARCore/ARKit. 3D Modeling Software: Used for creating 3D models and assets for AR/VR applications.	

Subject: 4 Advance Robotics

Mapped to ASC/N8380 ,V1.0

Core-Elective-1

Terminal Outcomes:

- Advanced Robot Design: Proficiency in designing complex robotic systems that involve multiple degrees of freedom, kinematic chains, and advanced mechanical structures.
- Sensing and Perception: Mastery of advanced sensor technologies such as LiDAR, stereo cameras, depth sensors, and tactile sensors for precise perception of the environment.
- Motion Planning and Control: Expertise in developing algorithms for motion planning and control that enable robots to navigate and interact with dynamic and cluttered environments.
- Path Planning: Ability to generate optimal paths for robots in complex spaces considering factors such as obstacles, kinematics, and dynamics.

- Localization and Mapping: Proficiency in simultaneous localization and mapping (SLAM) techniques, enabling robots to build maps of their surroundings and localize themselves within those maps.
- Human-Robot Interaction: Understanding of advanced human-robot interaction principles, including natural language processing, gesture recognition, and safe physical collaboration.

Duration: *<18:00>*	**Duration**: *<36:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Advanced Robot Kinematics and Dynamics: Grasp the mathematical principles that govern the motion and forces in advanced robotic systems with multiple degrees of freedom. • Path and Trajectory Planning: Understand the concepts of path and trajectory planning, including interpolation, optimization, and collision avoidance algorithms. • Robot Control Architectures: Learn about various control architectures such as feedback control, adaptive control, and hybrid control used to stabilize and control advanced robotic systems. • Advanced Sensing Technologies: Explore advanced sensing modalities such as LiDAR, 3D vision, tactile sensing, and inertial measurement units (IMUs) for accurate perception. • Computer Vision for Robotics: Understand computer vision algorithms, including feature extraction, object recognition, and tracking, used for visual perception in robotic systems. • Sensor Fusion: Learn how to combine data from multiple sensors using sensor fusion techniques to improve the accuracy and reliability of perception. • Machine Learning for Robotics: Grasp the fundamentals of machine learning and its applications in robotic tasks, including reinforcement learning, imitation learning, and neural networks. • Localization and Mapping Algorithms: Study localization techniques (e.g., Kalman filters, particle filters) and mapping algorithms (e.g., SLAM) used to build accurate maps and localize	• Robot Hardware Assembly: Gain proficiency in assembling advanced robotic systems, including attaching sensors, actuators, and other components to their mechanical structures. • Robot Programming: Develop practical programming skills for advanced robotics, including writing control code, motion planning algorithms, and high-level behavior scripts. • Robot Simulation: Gain experience using robotic simulation software (such as ROS Gazebo or V-REP) to simulate and test robotic systems before physical implementation. • Advanced Sensor Integration: Learn how to integrate advanced sensors like LiDAR, RGB-D cameras, and tactile sensors into robotic platforms for enhanced perception. • Path Planning and Motion Control: Implement advanced path planning algorithms and control strategies to guide robots through complex environments and manipulate objects. • Computer Vision Integration: Gain hands-on experience integrating computer vision algorithms for tasks like object detection, tracking, and gesture recognition. • Localization and Mapping Implementation: Implement localization and mapping algorithms on robots to navigate autonomously and create maps of their surroundings. • Machine Learning Integration: Apply machine learning techniques to enable robots to learn from data, adapt to changing environments, and improve their performance. • Robot Manipulation and Grasping:

robots within them. • Robot Manipulation and Grasping: Explore advanced techniques for robotic manipulation, including finger design, grasp planning, and object manipulation strategies. • Mobile Robotics: Understand the principles of mobile robots' motion, control, and navigation, including kinematic and dynamic modeling of wheeled and legged robots.	Develop practical skills in designing robotic grippers, performing grasp planning, and executing dexterous manipulation tasks.
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
• Sensors and Perception: • Advanced Sensors: Sensors such as LiDAR, RGB-D cameras, tactile sensors, force sensors, IMUs, and encoders for advanced perception. • Sensor Mounting Hardware: Mounts, brackets, and adapters to securely attach sensors to robotic systems. • Computer Vision Cameras: High-resolution cameras for computer vision tasks like object detection, tracking, and scene analysis. • Software and Programming: • Robot Operating System (ROS): Framework for developing robotic software, communication, and simulation. • Simulation Software: Tools like ROS Gazebo, V-REP, or Unity3D for simulating and testing robotic systems. • Control and Motion Planning: • Motor Controllers: Motor drivers or controllers for precise control of robotic actuators. • Advanced Actuators: High-torque motors, servos, linear actuators, or specialized actuators for specific robotic motions. • Control Hardware: PID controllers, motor controllers, and other hardware for controlling robot motion and behavior. • Kinematic and Dynamic Simulation Software: Tools for simulating robot motion, control, and dynamics.	

Subject: 5 Technical Troubleshooting & Problem Solving

Mapped to ASC/N8381 ,V1.0

Core-Elective-2

Terminal Outcomes:

- Terminal outcomes of technical troubleshooting and problem-solving encompass the culmination of skills and knowledge developed through effectively addressing complex technical challenges across various domains. These outcomes reflect the ability to diagnose, analyze, and resolve intricate issues, leading to improved efficiency, reliability, and innovation.
- Root Cause Analysis: Proficiency in identifying the underlying causes of technical issues, enabling targeted solutions rather than addressing symptoms.
- Diagnostic Skills: Mastery of systematic approaches to diagnose technical problems, using tools, data analysis, and expertise to pinpoint issues accurately.
- Critical Thinking: Advanced critical thinking skills to assess problems from different angles, considering both obvious and hidden factors.
- Analytical Abilities: Expertise in analyzing complex systems, data, and interactions to understand the interplay of variables contributing to issues.
- Problem Localization: Capability to narrow down problems to specific components, subsystems, or processes in intricate systems.

Duration: *<18:00>*	**Duration**: *<36:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Problem-Solving Frameworks: Gain knowledge of systematic problem-solving methodologies such as the PDCA (Plan-Do-Check-Act) cycle or the DMAIC (Define-Measure-Analyze-Improve-Control) approach. • Root Cause Analysis (RCA): Understand the concept of identifying the underlying root causes of issues rather than addressing surface symptoms. • Critical Thinking Skills: Develop critical thinking skills to assess problems from multiple perspectives, question assumptions, and explore alternative solutions. • Analytical Techniques: Learn analytical techniques such as SWOT analysis, fishbone diagrams (Ishikawa diagrams), and fault tree analysis to dissect complex problems. • Data Gathering and Analysis: Gain proficiency in collecting and analyzing data, including logs, measurements, and relevant information, to diagnose issues accurately.	• Diagnostic Techniques: Develop skills in using diagnostic tools, equipment, and software to identify the root causes of technical issues accurately. • Data Collection and Analysis: Gain experience in collecting and analyzing data from various sources, including logs, sensors, and measurements, to understand the nature of the problem. • Hands-On Problem Isolation: Learn how to physically inspect and test components, connections, and subsystems to pinpoint problem areas. • Debugging Code and Software: Gain proficiency in debugging software by analyzing code, identifying errors, and applying corrective measures. • Hardware Testing and Calibration: Develop skills in testing hardware components, calibrating sensors, and ensuring proper functionality. • Simulation and Testing: Use simulation tools and test environments to recreate issues, experiment with different solutions, and validate outcomes. • Experimental Prototyping: Design and build experimental setups or prototypes to test hypotheses and

	validate potential solutions.
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
General Tools: Multimeter: For measuring voltage, current, resistance, and continuity in electrical circuits. Screwdrivers: Different sizes and types of screwdrivers for opening up equipment and making connections. Pliers: Various types of pliers for gripping, cutting, and manipulating wires and components. Wire Strippers: Used to remove the insulation from wires for making connections. Crimping Tools: For securely attaching connectors to wires. Tweezers: Precision tweezers for handling small components or making delicate adjustments. Flashlight: For inspecting and troubleshooting in low-light or confined spaces. Magnifying Glass or Loupe: To closely examine small components or solder joints. Toolbox or Tool Bag: To keep all your tools organized and easily accessible. Diagnostic Equipment: Oscilloscope: For visualizing and analyzing electrical signals in circuits. Logic Analyzer: To capture and analyze digital signals and communication protocols. Signal Generator: Used to generate specific test signals for troubleshooting. Thermal Imaging Camera: To identify overheating components or irregular thermal patterns.	

Subject: 6 Artificial Intelligence in Automotive Manufacturing

Mapped to ASC/N9839 ,V1.0

Core-Elective-3

Terminal Outcomes:

- Predictive Maintenance Implementation: Proficiency in implementing AI-based predictive maintenance systems that use sensor data and machine learning algorithms to predict equipment failures and optimize maintenance schedules.
- Quality Control Enhancement: Ability to deploy AI-powered vision systems and algorithms to detect defects, inconsistencies, and quality issues in real-time during the manufacturing process.

- Production Line Optimization: Mastery of AI techniques for optimizing production line operations, including real-time adjustments to minimize bottlenecks, reduce downtime, and improve overall efficiency.
- Demand Forecasting: Skill in using AI-driven algorithms to analyze market trends, historical data, and external factors to predict future demand for specific vehicle models.
- Supply Chain Management Enhancement: Proficiency in utilizing AI for supply chain optimization, ensuring timely availability of parts and materials to support the manufacturing process.

Duration: *<18:00>*	**Duration**: *<36:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Fundamentals of AI: Develop a strong understanding of AI concepts, including machine learning, deep learning, natural language processing, and computer vision, and how they can be applied in the automotive manufacturing context. • AI Algorithms and Techniques: Gain knowledge of various AI algorithms such as regression, classification, clustering, neural networks, and reinforcement learning, and their relevance to manufacturing optimization. • Data Collection and Preprocessing: Understand the importance of data collection, data quality, and preprocessing techniques to prepare data for AI-based analysis and decision-making. • Supervised and Unsupervised Learning: Learn about supervised learning for tasks like predictive maintenance and quality control, and unsupervised learning for tasks like anomaly detection and process optimization. • Deep Learning Architectures: Explore deep learning architectures like convolutional neural networks (CNNs) and recurrent neural networks (RNNs) for tasks such as image recognition and sequence analysis.	• Data Collection and Preparation: Gain experience in collecting and preprocessing data from various sources, such as sensors, IoT devices, and production logs, to prepare it for AI analysis. • Data Labeling and Annotation: Learn how to accurately label and annotate data, especially in image recognition tasks, to train AI models effectively. • Feature Engineering: Develop skills in selecting and engineering relevant features from raw data to improve the performance of AI models. • Machine Learning Model Development: Gain proficiency in developing machine learning models for tasks like predictive maintenance, demand forecasting, and quality control. • Model Training and Tuning: Learn how to train AI models using appropriate algorithms and techniques, and optimize hyperparameters for better performance. • Deep Learning Implementation: Gain hands-on experience in implementing deep learning models like convolutional neural networks (CNNs) for image recognition tasks. • Simulation and Digital Twins: Practice creating digital twins and using simulation tools to model, test, and optimize manufacturing processes. • AI-Powered Vision Systems: Develop skills in setting up and calibrating AI-driven vision systems for quality control and defect detection.

Classroom Aids:
Whiteboard, marker pen, projector
Tools, Equipment and Other Requirements
• Sensors and IoT Devices: Various sensors, such as cameras, LiDAR, RFID, temperature sensors, and accelerometers, to collect real-time data from manufacturing processes and equipment. • Data Collection Infrastructure: Hardware components and connectivity solutions to gather data from sensors and IoT devices, including data acquisition systems and communication protocols. • High-Performance Computing (HPC) Systems: Powerful computing hardware, including multi-core processors, GPUs (Graphics Processing Units), and dedicated AI accelerators for training and deploying AI models. • Data Storage Solutions: Storage infrastructure, such as high-capacity servers or cloud-based storage, to store large datasets used for training and inference. • Robotics and Automation Equipment: Robots, collaborative robots (cobots), and automation systems equipped with AI capabilities for tasks like assembly, welding, material handling, and inspection. • AI Development Platforms: Integrated development platforms that offer tools for data preprocessing, model training, and deployment, such as TensorFlow, PyTorch, and scikit-learn.

Subject: 7 Environmental Studies

Mapped to ASC/N9840 ,V1.0

Terminal Outcomes:

- Terminal outcomes of environmental studies represent the culmination of knowledge and skills gained through the study of environmental science, ecology, conservation, sustainability, and related disciplines. These outcomes reflect an individual's understanding of environmental issues, their ability to contribute to sustainable practices, and their capacity to address complex environmental challenges.
- Environmental Awareness: Develop a comprehensive awareness of the interconnectedness of natural systems, human activities, and the impact of environmental changes.
- Ecosystem Understanding: Gain an in-depth understanding of various ecosystems, their components, interactions, and the role of biodiversity in maintaining ecological balance.
- Sustainability Principles: Master the principles of sustainability, including resource conservation, renewable energy adoption, and waste reduction to ensure a balanced and resilient environment.
- Environmental Policy Knowledge: Understand local, national, and international environmental policies, regulations, and agreements that govern environmental protection and conservation.

Duration: *<18:00>*	**Duration**: *<36:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Interconnectedness of Systems: Understand how ecosystems, climate, geology, hydrology, and human activities are interconnected and influence one another. • Ecosystem Dynamics: Gain knowledge of ecosystem components, energy flows, nutrient cycles, and ecological succession, and how disturbances impact ecosystems. • Biodiversity and Species Interactions: Learn about biodiversity, species interactions, ecological niches, and the importance of preserving biological diversity. • Environmental Ethics and Philosophy: Explore different ethical perspectives related to the environment, addressing issues of intrinsic value, anthropocentrism, and eco-centric values. • Ecological Footprints and Carrying Capacity: Grasp the concepts of ecological footprints and carrying capacity, understanding how human activities impact natural resources and ecosystems.	• Field Research Techniques: Develop skills in conducting field studies, including data collection, observation, sampling, and recording relevant environmental data. • Ecosystem Monitoring: Gain hands-on experience in monitoring and assessing the health and biodiversity of ecosystems, identifying indicators of environmental changes. • Biodiversity Identification: Acquire proficiency in identifying various plant and animal species, understanding their ecological roles and contributions to ecosystems. • Sustainability Practices: Implement sustainable practices in daily life, such as reducing energy consumption, practicing responsible waste management, and promoting eco-friendly behaviors. • Environmental Impact Assessments: Participate in or conduct environmental impact assessments for development projects to evaluate potential effects on natural resources and ecosystems. • Data Analysis and Interpretation: Learn to analyze environmental data using statistical tools, interpret findings, and draw conclusions for informed decision-making.
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
Field Research and Data Collection: • Field Notebooks: For recording observations, data, and notes during field studies. • GPS Device: Too accurately record geographical coordinates of study sites. • Binoculars: For bird watching and observing wildlife from a distance. • Camera: To document field observations, landscapes, and species. • Measuring Tools: Such as measuring tape, ruler, and callipers for taking measurements in the field. • Soil Sampling Kits: For collecting soil samples for analysis. • Water Sampling Equipment: Including water bottles, water quality meters, and sampling kits for collecting water samples.	

Subject 8: Employability Skills (120 Hours)

Mapped to DGT/VSQ/N0104

Terminal Outcomes:

- Discuss about Employability Skills in meeting the job requirements

Duration: *<48:00>*	**Duration**: *<72:00>*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Adaptability and Flexibility: Understand the importance of adapting to changing circumstances, learning new skills, and embracing challenges. • Leadership and Decision-Making: Develop leadership qualities, decision-making skills, and the ability to take initiative in various situations. • Ethical and Professional Conduct: Understand professional ethics, integrity, and the importance of maintaining a positive reputation in the workplace. • Cultural Awareness and Diversity: Gain cultural competence, respect for diversity, and the ability to work harmoniously in multicultural environments. • Financial Literacy: Understand basic financial concepts, budgeting, and financial planning for personal and career development. • Continuous Learning: Develop a growth mindset and recognize the importance of continuous learning and professional development. • Negotiation Skills: Learn negotiation techniques for salary discussions, contract agreements, and other workplace situations.	• Adaptation to Change: Navigate unexpected changes or challenges and demonstrate adaptability in adjusting to new circumstances. • Leadership Opportunities: Take leadership roles in group projects, demonstrating initiative, decision-making, and the ability to guide a team. • Ethical Dilemmas: Analyze ethical dilemmas and make informed decisions that align with professional ethical standards. • Cultural Sensitivity: Engage in cross-cultural interactions or projects to demonstrate cultural awareness and sensitivity. • Budgeting and Financial Planning: Create personal budgets and financial plans, demonstrating basic financial literacy and planning skills. • Continuous Learning Initiatives: Engage in online courses, workshops, or self-directed learning to acquire new skills and stay updated in the field. • Negotiation Scenarios: Participate in negotiation exercises to practice salary negotiations or contract discussions.
Classroom Aids:	
Whiteboard, marker pen, projector	
Tools, Equipment and Other Requirements	
Networking Events: Attend career fairs, conferences, and industry meetups to connect with professionals, recruiters, and potential employers.	

Online Learning Platforms: Websites like Coursera, Udemy, and LinkedIn Learning offer courses to enhance specific skills relevant to your career goals.

Personal Branding Resources: Learn how to create an effective LinkedIn profile and develop an online presence that showcases your skills and accomplishments.

Communication Skill Tools: Practice communication skills using platforms like Toastmasters or practice public speaking through video recordings.

Problem-Solving Scenarios: Participate in case competitions, hackathons, or workshops that challenge your problem-solving abilities.

Time Management Apps: Use apps like Trello, Asana, or Todoist to organize tasks, set priorities, and manage deadlines effectively.

Annexure

Trainer Requirements

Trainer Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/ Automobile/ Electronics/ Instrumentation	1	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	5	Mechanical/ Automobile/ Electronics/ Instrumentation	0	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	3	Mechanical/ Automobile/ Electronics	1	Mechanical/ Automobile/ Electronics	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/ Automobile/ Electronics	0	Mechanical/ Automobile/ Electronics	NA
M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	2	Mechanical/Automobile/ Electrical/ Electronics	1	Mechanical/Automobile/ Electrical/ Electronics	NA

M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	3	Mechanical/Automobile/ Electrical/ Electronics	0	Mechanical/Automobile/ Electrical/ Electronics	NA

Trainer Certification	
Domain Certification	**Platform Certification**
"Manufacturing and Mechatronics Lead Technician, version 1.0". Minimum accepted score is 80%.	Recommended that the trainer is certified for the job role "Trainer (VET and Skills)", Mapped to Qualification Pack: MEP/Q2601, V2.0" Minimum accepted score is 80%

Assessor Requirements

Assessor Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	5	Mechanical/ Automobile/ Electronics/ Instrumentation	1	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	6	Mechanical/ Automobile/ Electronics/ Instrumentation	0	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/ Automobile/ Electronics	1	Mechanical/ Automobile/ Electronics	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	5	Mechanical/ Automobile/ Electronics	0	Mechanical/ Automobile/ Electronics	NA
M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	3	Mechanical/Automobile/ Electrical/ Electronics	1	Mechanical/Automobile/ Electrical/ Electronics	NA
M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/Automobile/ Electrical/ Electronics	0	Mechanical/Automobile/ Electrical/ Electronics	NA

Assessor Certification	
Domain Certification	**Platform Certification**
"Manufacturing and Mechatronics Lead Technician, version 1.0". Minimum accepted score is 80%.	Recommended that the Accessor is certified for the job role "Assessor (VET and Skills)", Mapped to Qualification Pack: MEP/Q2701, V2.0" Minimum accepted score is 80%.

Assessment Strategy

1. Assessment System Overview:
    - Batches assigned to the assessment agencies for conducting the assessment on SDMS/SIP or email
    - Assessment agencies send the assessment confirmation to VTP/TC looping SSC
    - Assessment agency deploys the ToA certified Assessor for executing the assessment
    - SSC monitors the assessment process & records

2. Testing Environment:
    - Confirm that the centre is available at the same address as mentioned on SDMS or SIP
    - Check the duration of the training.
    - Check the Assessment Start and End time to be as 10 a.m. and 5 p.m.
    - If the batch size is more than 30, then there should be 2 Assessors.
    - Check that the allotted time to the candidates to complete Theory & Practical Assessment is correct.
    - Check the mode of assessment—Online (TAB/Computer) or Offline (OMR/PP).
    - Confirm the number of TABs on the ground is correct to execute the Assessment smoothly.
    - Check the availability of the Lab Equipment for the particular Job Role.

3. Assessment Quality Assurance levels / Framework:
    - Question papers created by the Subject Matter Experts (SME)
    - Question papers created by the SME verified by the other subject Matter Experts
    - Questions are mapped with Semester-wise Curriculum.
    - Question papers are prepared considering that level 1 to 3 are for the unskilled & semi-skilled individuals, and level 4 and above are for the skilled, supervisor & higher management
    - Assessor must be ToA certified & trainer must be ToT Certified
    - Assessment agency must follow the assessment guidelines to conduct the assessment

4. Types of evidence or evidence-gathering protocol:
    - Time-stamped & geotagged reporting of the assessor from assessment location
    - Centre photographs with signboards and scheme specific branding
    - Biometric or manual attendance sheet (stamped by TP) of the trainees during the training period
    - Time-stamped & geotagged assessment (Theory + Viva + Practical) photographs & videos

5. Method of verification or validation:
    - Surprise visit to the assessment location
    - Random audit of the batch
    - Random audit of any candidate

6. Method for assessment documentation, archiving, and access
    - Hard copies of the documents are stored
    - Soft copies of the documents & photographs of the assessment are uploaded / accessed from Cloud Storage

- Soft copies of the documents & photographs of the assessment are stored in the Hard Drives

References

Glossary

Term	Description
Declarative Knowledge	Declarative knowledge refers to facts, concepts and principles that need to be known and/or understood in order to accomplish a task or to solve a problem.
Key Learning Outcome	Key learning outcome is the statement of what a learner needs to know, understand and be able to do in order to achieve the terminal outcomes. A set of key learning outcomes will make up the training outcomes. Training outcome is specified in terms of knowledge, understanding (theory) and skills (practical application).
OJT	On-the-job training (Mandatory); trainees are mandated to complete specified hours of training on site
Procedural Knowledge	Procedural knowledge addresses how to do something, or how to perform a task. It is the ability to work, or produce a tangible work output by applying cognitive, affective or psychomotor skills.
Training Outcome	Training outcome is a statement of what a learner will know, understand and be able to do upon the completion of the training.
Terminal Outcome	Terminal outcome is a statement of what a learner will know, understand and be able to do upon the completion of a module. A set of terminal outcomes help to achieve the training outcome.

Acronyms and Abbreviations

NOS	National Occupational Standard(s)
NSQF	National Skills Qualifications Framework
QP	Qualifications Pack
TVET	Technical and Vocational Education and Training
SOP	Standard Operating Procedure
WI	Work Instructions
PPE	Personal Protective equipment