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

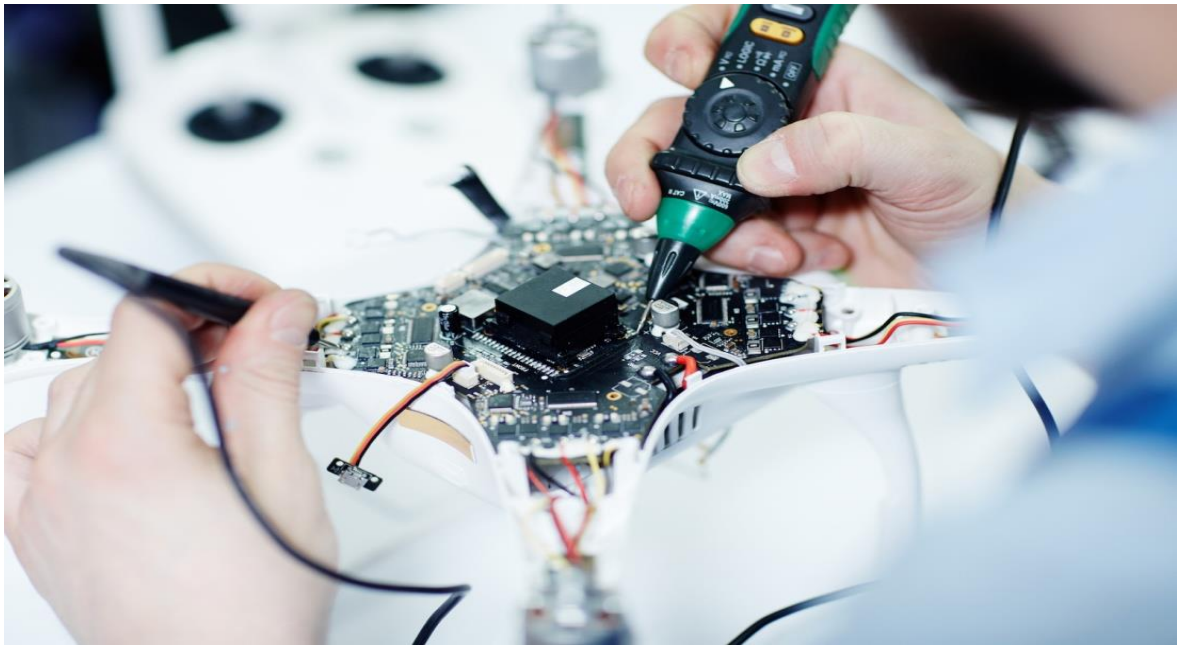
COMPETENCY BASED CURRICULUM

DRONE TECHNICIAN

(Duration: Six Months)
Revised in July 2022

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 3



SECTOR – AEROSPACE & AVIATION

कौशल बलम्
Directorate General of Training

DRONE TECHNICIAN

(Non-Engineering Trade)

(Revised in July 2022)

Version: 2.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL - 3

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

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1. COURSE INFORMATION

During the six months duration of **Drone Technician** trade a candidate is trained on professional skills and professional knowledge related to job role. In addition to this a candidate is entrusted to undertake project work and extra-curricular activities to build up confidence. The broad components covered related to the trade are categorized in six months duration as below:-

The trainee begins with learning first aid, fire fighting and various safety practices for working in industrial environment. Identify & select different types of drones, drone rules and regulations, drone applications, and important safety precautions. Identify & select different drone's mechanical parts, aerodynamics of wings, propellers and disassembly and reassembly of common drone platform with flying practices. Identify and test various electronic SMD components using proper measuring instruments and Identify, place, solder and de-solder and different SMD discrete components and ICs package with due care and following safety norms using proper tools/setup. Measure different type electrical parameters and record the data related with drone hardware. Identification of different type of batteries, battery specifications and their charging techniques used in drone. Test different sensors, their characteristics and repair which are commonly used in different drones. Identify, select and test hardware assembly, driver for BLDC motors. Inspect, test and execute GPS navigation and telemetry module, different RF blocks and antennas used in RF transmitter and receiver. Test and troubleshoot Flight Controller Board (FCB), Electronic Speed Controller (ESC) and its associated peripherals. Calibrate and troubleshoot drone gimbal and drone payload. Identify and resolve common error messages and corrections by Software debugging. Inspect, test and execute primary and secondary servicing with troubleshoot malfunctioning, and repair issues discovered.

Also the trainee will learn to Communicate with required clarity, understand technical English, environment regulation, productivity and enhance self-learning.

2. TRAINING SYSTEM

2.1 GENERAL

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of the economy/ labour market. The vocational training programs are delivered under the aegis of Directorate General of Training (DGT). Craftsman Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) are two pioneer programs of DGT for propagating vocational training.

'**Drone Technician**' Trade under CTS is one of the newly designed courses. The CTS courses are delivered nationwide through network of ITIs. The course is of six months duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory and Trade Practical) imparts professional skills and knowledge, while Core area (Employability Skills) imparts requisite life skills. After passing out of the training programme, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognized worldwide.

Candidates broadly need to demonstrate that they are able to:

- Read and interpret technical parameters/ documentation, executes work, identify necessary materials and tools.
- Perform tasks with due consideration to safety rules, accident prevention regulations.
- Apply professional knowledge & employability skills while performing the job and maintenance work.
- Check the circuit/ equipment/ panel as per drawing for functioning, identify and rectify faults/ defects.
- Document the technical parameters related to the task undertaken.

2.2 PROGRESSION PATHWAYS

- Can join Aviation industry/other sectors as drone technician for implementing different applications of Drone and will progress further as Senior Technician, Supervisor and can rise up to the level of Manager.
- Can work in a Drone service centre or start own Drone Training Centre and become Entrepreneur in the related field.
- Can join Advanced Diploma (Vocational) courses under DGT as applicable.

2.3 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of six months:-

S No.	Course Element	Notional Training Hours
1.	Professional Skill (Trade Practical)	420
2.	Professional Knowledge (Trade Theory)	120
3.	Employability Skills	60
	Total	**600**

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of the course and at the end of the training program as notified by the DGT from time to time.

a) The Continuous Assessment (Internal) during the period of training will be done by **Formative Assessment Method** by testing for assessment criteria listed against learning outcomes. The training institute has to maintain an individual trainee portfolio as detailed in assessment guideline. The marks of internal assessment will be as per the formative assessment template provided on www.bharatskills.gov.in.

b) The final assessment will be in the form of summative assessment. The All India Trade Test for awarding NTC will be conducted by Controller of examinations, DGT as per the guidelines. The pattern and marking structure is being notified by DGT from time to time. **The learning outcome and assessment criteria will be basis for setting question papers for final assessment. The examiner during final examination will also check** individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

2.4.1 PASS REGULATION

For the purposes of determining the overall result, weightage of 100% is applied for six months and one year duration courses and 50% weightage is applied to each examination for two years courses. The minimum pass percent for Trade Practical and Formative assessment is 60% & for all other subjects is 33%.

2.4.2 ASSESSMENT GUIDELINE

Appropriate arrangements should be made to ensure that there will be no artificial barriers to assessment. The nature of special needs should be taken into account while undertaking the assessment. Due consideration should be given while assessing for teamwork, avoidance/ reduction of scrap/ wastage and disposal of scrap/ waste as per procedure, behavioral attitude, sensitivity to the environment and regularity in training. The sensitivity

towards OSHE and self- learning attitude are to be considered while assessing competency.

Assessment will be evidence based comprising some of the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance and punctuality
- Assignment
- Project work
- Computer based multiple choice question examination
- Practical Examination

Evidences and records of internal (Formative) assessments are to be preserved until forthcoming examination for audit and verification by examination body. The following marking pattern to be adopted for formative assessment:

Performance Level	Evidence
(a) Marks in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices	• Demonstration of good skills and accuracy in the field of work/ assignments. • A fairly good level of neatness and consistency to accomplish job activities. • Occasional support in completing the task/ job.
(b) Marks in the range of 75%-90% to be allotted during assessment	
For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of craftsmanship, with little guidance, and regard for safety procedures and practices	• Good skill levels and accuracy in the field of work/ assignments. • A good level of neatness and consistency to accomplish job activities. • Little support in completing the task/job.
(c) Marks in the range of more than 90% to be allotted during assessment	
For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.	For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.

3. JOB ROLE

Drone Technician performs troubleshooting and maintenance tasks on unmanned aerial vehicles. Test different electronic components, circuits, boards used in Drone to find the faulty part by using instruments like digital storage oscilloscope, mixed signal oscilloscope, spectrum analyzer, waveform generator and multimeter. Replace the faulty board and components and perform basic /SMD soldering/de-soldering.

Disassemble and assemble different parts of drone for testing and repair. Understand different batteries used for power supply of drone, their specifications and testing. Application and testing of different sensors used in drone.

Testing of different motors BLDC etc, Electronic Speed Controller card and it's connectivity with motor. Testing of flight controller and the communication between transmitter and receiver and its calibration.

Testing of landing gear, GPS Module, collision avoidance sensor and it's connectivity with console. Testing of transmitter, the control box to receiver at drone and the communication link. Testing of Gimbal Motor, Controller rand its programming.

The individual in this job identifies different applications in agriculture, surveillance, security and to test the additional specific application based components to connect with drone.

Electrical and Electronic Equipment Mechanics and Fitters and Related Workers, Other; include all other workers engaged in fitting, assembling, repairing and maintaining electronic and electrical equipment, machinery, appliances, etc., not elsewhere classified

Reference NCO-2015:

7419.9900 - Electrical and Electronic Equipment Mechanics and Fitters and Related Workers, Other

Reference NOS: -- ELE/N7308, ELE/N7005, ELE/N9405, ELE/N9401, ELE/N9402, ELE/N9403, ELE/N9404

4. GENERAL INFORMATION

Name of the Trade	**DRONE TECHNICIAN**
Trade Code	DGT/2019
NCO - 2015	7419.9900
NOS Covered	ELE/N7308, ELE/N7005, ELE/N9405, ELE/N9401, ELE/N9402, ELE/N9403, ELE/N9404
NSQF Level	Level - 3
Duration of Craftsmen Training	Six Months (600 Hours)
Entry Qualification	Passed 10th class examination with Science and Mathematics or with vocational subject in same sector or its equivalent.
Minimum Age	16 years as on first day of academic session.
Eligibility for PwD	LD, DEAF, LC, DW, AA, LV, HH
Unit Strength (No. of Student)	24 (There is no separate provision of supernumerary seats)
Space Norms	70 Sq. m
Power Norms	4 KW
Instructors Qualification for:	
(i) Drone Technician Trade	B.Voc/Degree in Aeronautical engineering/ ECE/ EEE/ Mechatronics from AICTE/UGC recognized university/ college with one year experience in building & piloting/servicing drones and good at teaching. Candidates with experience of a drone project or a project experience in Robotics are preferred. **OR** 03 years Diploma in Aeronautical engineering/ ECE/ EEE/ Mechatronics from AICTE / recognized technical board of education or relevant Advanced Diploma (Vocational) from DGT with two year experience in building & piloting/servicing drones and good at teaching. Candidates with experience of a drone project or a project experience in Robotics are preferred. **OR** NTC/ NAC passed in "Drone Technician" with three years experience in building & piloting/servicing drones and good at teaching. Candidates with experience of a drone project or a project experience in Robotics are preferred.

	<u>Essential Qualification:</u> Relevant Regular / RPL variants of National Craft Instructor Certificate (NCIC) under DGT. **Note: Out of two Instructors required for the unit of 2 (1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications. However both of them must possess NCIC in any of its variants.**
(ii) Employability Skill	MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with short term ToT Course in Employability Skills. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above) OR Existing Social Studies Instructors in ITIs with short term ToT Course in Employability Skills.
(iii) Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

5. LEARNING OUTCOME

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

5.1 LEARNING OUTCOME

1. Identify & select different types of drones, drone rules and regulations, drone applications, and important safety precautions. (NOS: ELE/N7308)
2. Identify & select different drone's mechanical parts, aerodynamics of wings, propellers and disassembly and reassembly of common drone platform with flying practices. (NOS: ELE/N7308)
3. Identify and test various electronic SMD components using proper measuring instruments and Identify, place, solder and de-solder and different SMD discrete components and ICs package with due care and following safety norms using proper tools/setup. (NOS: ELE/N7308)
4. Measure different type electrical parameters and record the data related with drone hardware. (NOS: ELE/N7005)
5. Identification of different type of batteries, battery specifications and their charging techniques used in drone. (NOS: ELE/N9401)
6. Test different sensors, their characteristics and repair which are commonly used in different drones. (NOS: ELE/N7308)
7. Identify, select and test hardware assembly, driver for BLDC motors. (NOS: ELE/N9402)
8. Inspect, test and execute GPS navigation and telemetry module, different RF blocks and antennas used in RF transmitter and receiver. (NOS: ELE/N7308)
9. Test and troubleshoot Flight Controller Board (FCB), Electronic Speed Controller (ESC) and its associated peripherals. (NOS: ELE/N9403)
10. Calibrate and troubleshoot drone gimbal and drone payload. (NOS: ELE/N9404)
11. Identify and resolve common error messages and corrections by Software debugging. (NOS: ELE/N9405)
12. Inspect, test and execute primary and secondary servicing with troubleshoot malfunctioning, and repair issues discovered. (NOS: ELE/N7005)

6. ASSESSMENT CRITERIA

LEARNING OUTCOMES	ASSESSMENT CRITERIA
1. Identify & select different types of drones, drone rules and regulations, drone applications, and important safety precautions. (NOS: ELE/N7308)	Apply workshop safety norms.
	Identify & select safety rules to operate drone.
	Apply DGCA safety regulations.
	Recognize Do's and Don'ts of drone.
	Perform drone done registration and NPNT permission before flight.
	Recognize issues Drone pilots encounter including airspace, traffic patterns etc.
	Perform Radio telephony using Standard radio terminology and RT Phraseology.
	Communicate with ATC including Position, Altitude Reporting etc.
	Identify & prepare specific Flight Planning Procedures for Specific drone flights.
2. Identify & select different drone's mechanical parts, aerodynamics of wings, propellers and disassembly and reassembly of common drone platform with flying practices. (NOS: ELE/N7308)	Identify & select different components, parts, block of the drone and its function & their interconnectivity.
	Identify various types of body material used in drone.
	Recognize basic principles of flying like Bernoulli's Principle etc.
	Recognize multi rotor design, various configurations, airframe sizes and construction materials.
	Identify different propeller designs and design using 3D printer.
	Identify different types of motor used in drone.
	Identify & prepare specific flight planning procedures to drone flights.
	Practice drone flying to check to identify faults in drone.
3. Identify and test various electronic SMD components	Identification of different types of SMD Components and measure their value using SMD Technology Kit, Tweezers

using proper measuring instruments and Identify, place, solder and de-solder and different SMD discrete components and ICs package with due care and following safety norms using proper tools/setup. (NOS: ELE/N7308)	and DMM.
	Identify and use SMD soldering and de-soldering rework station.
	Practice soldering and de-soldering the SMD components on the PCB.
	Make necessary practice on SMD soldering station to solder and de-solder various IC's of different packages.
4. Measure different type electrical parameters and record the data related with drone hardware. (NOS: ELE/N7005)	Identify and use different functions of measuring instruments for different measurements of electrical parameters.
	Measurement of voltage dc & ac using Digital Multimeter
	Measurement of current dc & ac using Digital Multimeter
	Measurement of frequency using Digital Multimeter
	Measurement of peak to peak voltage, frequency, time period, and duty cycle using DSO and waveform generator.
	Measurement of analog & digital signal using DSO.
	Measurement of unknown frequency and it's level using spectrum analyzer
5. Identification of different type of batteries, battery specifications and their charging techniques used in drone. (NOS: ELE/N9401)	Identification of different type of batteries Li-ion and Li-Po.
	Recognize different battery specifications.
	Explore different charging techniques to charge batteries.
	Battery management to measure and monitor different parameters of different batteries.
	Inspect battery packs for bulges or leakage.
	Inspect charger for visible damage and perform voltage and current reading of battery.
	Explore Battery power management includes functions for charging, monitoring, and charge protection.
6. Test different sensors, their characteristics and repair which are commonly used in different drones. (NOS: ELE/N7308)	Identify and measure condition of drone sensors.
	Identify and Install types of sensors used in drone.
	Test & measure the resistance, voltage, current and frequency of drone sensors and actuators.
	Test & measure accelerometers, inertial measurement units, tilt and lidar sensor, gyro sensor.

	Write and upload computer code to FCB to test sensors results.
7. Identify, select and test hardware assembly, driver for BLDC motors. (NOS: ELE/N9402)	Identify different BLDC motors and it's specifications
	Test BLDC motor and measure speed-torque characteristics of BLDC Motor.
	Test BLDC Motor driver circuit.
	Identify DC, BLDC and servo motors and test driving circuits.
	Perform running and reversing phenomenon of BLDC Motor
	Demonstration speed control of BLDC Motor using PWM technique.
	Inverted pendulum and its balancing using programming technique of motor.
	Measure thrust to weight ratio and payload.
8. Inspect, test and execute GPS navigation and telemetry module, different RF blocks and antennas used in RF transmitter and receiver. (NOS: ELE/N7308)	Identity different antennas such as patch, helical, and omni-directional and check their radiation patterns.
	Measure frequencies and directivity of the drone antenna.
	Detecting a drone with a Real-Time Spectrum Analyzer.
	Identify the characteristics of RF circuit blocks like amplifier, and filters.
	Identify, configure and operate 433MHz and 2.4 GHz RC transmitter and receiver.
	Operate drone using RC transmitter and receiver.
	Dismantle, identify parts, service and test different parts of the drone system.
	Knowledge of GPS and its hardware interfacing.
	Measure and use signals from GPS module to determine latitude & longitude.
	Explore the interfacing of GPS module to navigation drone.
	Perform experiment to measure, GPGGA, GPGLL, GPGSA, GPGSV, GPRMC and GPVTG values.
9. Test and troubleshoot Flight Controller Board (FCB), Electronic Speed Controller (ESC) and its associated peripherals. (NOS:	Work upon electronic boards to perform specific tasks such as flight control board.
	Programming and configure of parameters in flight control board (FCB).
	Test the different peripheral interconnections with FCB

ELE/N9403)	Configure, test and perform communication FCB with motor, GPS, ESC and sensors.
	Configure and test FCB with battery to monitor battery level and perform defined operation.
	Carry out drone leveling as per procedure using IMU sensor Calibrate the compass, Lidar, and gyro sensor
	Configure, test and perform communication FCB with RF transceiver.
	Write and upload computer code to FCB to test sensors results.
	Configure and check electronic speed control (ESC).
	Test the different peripheral interconnections with ESC
	Configure, test and perform communication of ESC with FCB.
	Configure, test and perform communication of ESC with motor.
	Configure and test ESC parameters on FCB to check its operation.
	Write and upload computer code to FCB to ESC working.
10. Calibrate and troubleshoot drone gimbal and drone payload. (NOS: ELE/N9404)	Identify the different types of drones and its application in different areas.
	Configure HD and thermal image camera with drone.
	Perform Gimbal camera assembly and gimbal calibration.
	Practice Gimbal stabilization and control of cameras using x, y, and z axes rotation.
	Practice remote sensing, surveying & mapping, photogrammetry and precision agriculture using HD and thermal image camera.
	Identify, select different application drones like agriculture, Surveillance, Inspections and gathering Information for disaster management. Also, maintenance, inspection, examinations and investigation of drone.
11. Identify and resolve common error messages and corrections by software debugging. (NOS:	Identify bugs in the software program as per the algorithms used and the libraries.
	Resolve common error messages and apply the correct logic.
	Perform firmware configuration and updates.

ELE/N9405)	Identify and fix issues reported in drone hardware after firmware update. Perform Testing flight procedure and execution with virtualization.
	Download and Install App, Menu, Planning, Set-up / Flight / Application.
	Demonstration and perform base station software to debugging to get GPS and flight data.
	Perform experiments on software debug tool use to identify coding errors at different stages.
	Knowledge and advantage of preventative maintenance of drone.
	Diagnose problems using Log Data / Analyze Data flash Log Data / Remote Communication Log Data / Save and Execute Log Data.
	Upgrade/downgrade drone firmware.
12. Inspect, test and execute primary and secondary servicing with troubleshoot malfunctioning, and repair issues discovered. (NOS: ELE/N7005)	Perform primary and secondary servicing based upon the checklist.
	Test and diagnose drone after 100 hours of flying for preventive maintenance.
	Test and diagnose drone after 500 hours of flying.
	Knowledge about drone troubleshooting check list like Equipment check, System reset, calibration, Motor Troubleshooting, Gimbal rotation, Battery Maintenance, and RF Signal and hardware.
	Diagnose the common drone problem like GPS signals are blocked , Decreased battery life, Wrong direction during flight, Flight Planning, Mechanical issue, and Firmware issue.
	Inspect drone before and after each flight.
	First time drone hardware assembly and test.
	Test, locate the fault and repair a wiring of drone.
	Check bent or cracked on legs and feet of the drone
	Demonstration drone wiring connections with different parts
	Perform takeoff/Landing operation and identify faults in system.

7. TRADE SYLLABUS

SYLLABUS FOR DRONE TECHNICIAN TRADE			
DURATION: SIX MONTHS			
Duration	**Reference Learning outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 42 Hrs; Professional Knowledge 12 Hrs	Identify & select different types of drones, drone rules and regulations, drone applications, and important safety precautions. (Mapped NOS: ELE/N7308)	1. Visit to various sections of the institute and identify location of various installations. 2. Identify safety signs for danger, warning, caution & personal safety message. 3. Practice Use of Personal Protective Equipment (PPE). 4. Practice elementary first aid. 5. Practice Preventive measures for electrical accidents & steps to be taken in such accidents. 6. Practice Use of Fire Extinguishers.	Familiarization with the working of Industrial Training Institute system. Importance of safety and precautions to be taken in the industry/ shop floor. Introduction to PPEs. Introduction to First Aid. Importance of housekeeping & good shop floor practices. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable.
		7. Identify Different types of Drones. 8. Select basic components. 9. Apply principles of flight to Drones. 10. Identify & prepare specific Flight Planning Procedures for specific drone flights.	Different types of Drones, Nomenclatures, History of aerial drones, reputation, airframe, configurations, basic components, current/future uses of drones.
Professional Skill 63 Hrs; Professional Knowledge 18 Hrs	Identify & select different drone's mechanical parts, aerodynamics of wings, propellers and disassembly and reassembly of common drone platform with flying practices.	11. Identify & select different building blocks of the drone. 12. Test drone's different block functionality & their interconnectivity. 13. Identify various types of body material used in drone. 14. Recognize basic principles of flying like Bernoulli's	Understanding Aerial platforms. Types of drones based on aerial platforms. Types of drones based on body material. Introduction to aerodynamics, history of Flight, Newton's Laws of Motion, Bernoulli's Principle, four forces of Fight,

	(Mapped NOS: ELE/N7308)	Principle. 15. Identify multi rotor design, various configurations, airframe sizes and their construction. 16. Identify different propeller designs and design using 3D printer. 17. Design and development of Drone's body component using 3D printer and related software 18. Identify type of motor used in drone. 19. Identify & prepare specific flight planning procedures to drone flights. 20. Practice drone flying to check to identify faults in drone.	three axes of Fight, how they apply to drone Flight. Introduction to 3D printer and its software for designing various types of propellers.
Professional Skill 21 Hrs; Professional Knowledge 06 Hrs	Identify and test various electronic SMD components using proper measuring instruments and Identify, place, solder and de-solder and different SMD discrete components and ICs package with due care and following safety norms using proper tools/setup. (Mapped NOS: ELE/N7308)	21. Identify of different types of SMD Components like resistance, capacitance, diode and inductor. 22. Measure different components values using SMD Technology Kit, Tweezers and DMM. 23. Identify of different types of SMD IC packages. 24. Explore and configure SMD soldering and de-soldering rework station. 25. Practice soldering and de-soldering the SMD components on the PCB. 26. Practice soldering and de-solder various IC's of different packages.	Knowledge about soldering station, soldering tools, soldering iron, soldering wicks, soldering temperature etc. Different types of soldering guns, related to Temperature and wattages, types of tips.
Professional Skill 42 Hrs; Professional Knowledge 12 Hrs.	Measure different type electrical parameters and record the data related with drone hardware. (Mapped NOS:	27. Identify the type of electronic instruments. 28. Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter. 29. Measure AC and DC voltage	Introduction of electrical components resistance, capacitance, inductance, diode, and transistor. Introduction of electrical parameters like DC voltage, DC current, AC voltage, AC current, frequency, duty cycle

	ELE/N7005)	using Digital Multi-meter. 30. Measure AC and DC current using Digital Multi-meter. 31. Measure frequency using Digital Multi-meter. 32. Measure the analog signals like of peak to peak voltage, frequency, time period, and duty cycle using of DSO. 33. Measure the frequency and level of RF signals using of spectrum analyzer. 34. Practice function generator and Arbitrary Waveform Generator.	and Introduction to electrical and electronic measuring instruments. Working Principle of multimeter, digital storage oscilloscope, spectrum and waveform generator.
Professional Skill 21 Hrs; Professional Knowledge 06 Hrs.	Identification of different type of batteries, battery specifications and their charging techniques used in drone. (Mapped NOS: ELE/N9401)	35. Identify different type of batteries Li-ion and Li-Po. 36. Record and recognize different battery specifications. 37. Explore different charging techniques to charge batteries. 38. Measure and record different parameters of batteries using Battery management platform. 39. Inspect battery packs faults for bulges or leakage. 40. Identify fault related with chargers such as visible damage, voltage and current. 41. Measure and record different parameters of charging controller using software. 42. Calculate maximum discharge and battery capacities in order calculate flight time.	Introduction of different types of batteries used in drone. Understand different specifications and their significance of batteries. Different charging circuits or batteries, What is battery management system (BMS) and different Building Blocks of BMS.
Professional Skill 42 Hrs; Professional Knowledge 12Hrs	Test different sensors, their characteristics and repair which are commonly used in different	43. Identify and measure condition of drone sensors. 44. Explore different converters like V/I, I/V, F/V, V/F. 45. Verify frequency response of low pass and high pass filters.	Introduction of different sensors used in drone like accelerometers, inertial measurement units, tilt and lidar sensor, gyro sensor. Principle of operation of various sensors used in drone;

	drones. (Mapped NOS: ELE/N7308)	46. Test and measure different amplifier functions. 47. Measure and record the resistance, voltage, current and frequency of different sensors used in drone. 48. Test & measure accelerometers, inertial measurement units, tilt and lidar sensor, gyro sensor. 49. Write and upload computer code to FCB to test sensors results. 50. Calibrate the compass, Lidar, and gyro sensor. 51. Measure and record angular rate, force, and magnetic field through IMU. 52. Perform amplification of low power signals using current, power, instrumentation, differential, inverting, non-inverting and buffer amplifier circuits.	their roles and characteristics. Selection of appropriate sensor as per requirement. Understanding and importance of signal conditioning like voltage to current, current to voltage, frequency to voltage and voltage to frequency convertor, inverting amplifier, non-inverting amplifier, instrumentation amplifier, differential amplifier, power amplifier, current amplifier. How to calibrate Compass sensor, Lidar Sensor, Gyro sensor. Concept of sensor calibration and using sensors in digital & analog mode.
Professional Skill 42 Hrs; Professional Knowledge 12Hrs	Identify, select and test hardware assembly, driver for BLDC motors. (Mapped NOS: ELE/N9402)	53. Identify different BLDC motors and their specifications 54. Inspect and test BLDC Motor driver circuit. 55. Measure and record speed-torque characteristics of BLDC Motor. 56. Explore driving circuit of DC, BLDC and servo motors. 57. Perform running and reversing phenomenon of BLDC Motor. 58. Demonstration speed control of BLDC Motor using PWM technique. 59. Practice Inverted pendulum balancing using programming technique and PID tuning. 60. Measure thrust to weight ratio and payload.	Introduction to different motors like DC, BLDC, servo motors, working, understanding its functioning. Studying BLDC motor using PWM techniques, speed torque characteristics, degree of freedom in drone. Performing mathematical calculations like payload calculation, speed control techniques, thrust to weight ratio. Introduction of Inverted Pendulum and PID control. PWM Duty operation and Motor control by Encoder counter.

Professional Skill 21 Hrs; Professional Knowledge 06 Hrs	Inspect, test and execute GPS navigation and telemetry module, different RF blocks and antennas used in RF transmitter and receiver. (Mapped NOS: ELE/N7308)	61. Identity different antennas like patch, helical, and omni-directional. 62. Record and plot radiation pattern of different antennas. 63. Measure directivity of the antenna. 64. Identify the characteristics of RF circuit blocks like amplifier and filters. 65. Configure and operate 433MHz and 2.4 GHz RC transmitter and receiver. 66. Perform and check connectivity of transmitter and receiver used in drone. 67. Understand GPS and its hardware interfacing with FCB. 68. Connect and Measure and record data of GPS module to determine latitude & longitude. 69. Perform experiment to record, GPGGA, GPGLL, GPGSA, GPGSV, GPRMC and GPVTG values.	Various types of antennas used for drones and their characteristics. Introduction of antenna radiation pattern and directivity. Fundamentals of MIC amplifier and different filter used in RF range. Introduction to RF signals and components used for RC transmitter and receiver. Fundamentals of GPS and concept of navigation systems. Usage of signals from GPS satellites to determine latitude, longitude and altitude.
Professional Skill 21 Hrs; Professional Knowledge 06 Hrs	Test and troubleshoot Flight Controller Board (FCB), Electronic Speed Controller (ESC) and its associated peripherals. (Mapped NOS: ELE/N9403)	70. Identify different flight control board and electronic speed control. 71. Perform programming and configure flight control board (FCB). 72. Identify, explore and test interconnectivity of different peripheral with FCB. 73. Establish connection of FCB with motor, GPS, ESC and sensors. 74. Configure, test and record FCB with battery to monitor battery level and perform return to home operation. 75. Perform and carry out drone leveling using IMU sensor. 76. Perform calibration of	Introduction to Flight controller boards and its connectivity with different peripherals like sensors, ESC, GPS, RF module. Introduction Electronic Speed Controller and its connection with motor. ESC configurations using FCB to control speed and direction of motor. Introduction to flight control box and various commands used in it. Configuration techniques for FCB with various motors, GPS etc.

		compass, Lidar, and gyro sensor. 77. Test communication link between FCB and RF transceiver. 78. Write and upload computer code to FCB to test sensors results. 79. Test and record data of motor connectivity with ESC. 80. Perform motor rotation using FCB and ESC. 81. Test signal flow into drone to test ESC parameters on FCB to check its operation. 82. Write and upload computer code to FCB to ESC working.	
Professional Skill 42 Hrs; Professional Knowledge 12Hrs	Calibrate and troubleshoot drone gimbal and drone payload. (Mapped NOS: ELE/N9404)	83. Identify the different types of drones and its application in different areas. 84. Identify different features and controls of HD and thermal image camera. 85. Test and install Gimbal camera assembly. 86. Perform and test Gimbal stabilization 87. Perform drone camera control using x, y, and z axes rotation. 88. Test and install different cameras on gimbal assembly. 89. Practice remote sensing, surveying & mapping, photogrammetry and precision agriculture using HD and thermal image camera. 90. Identify and record different application drones and their logged data for investigation.	Fundamental applications of various types of drones. Implementation and handling of HD and thermal image camera for remote sensing and mapping. Introduction to photogrammetry. Image recognition with OpenCV using the drone camera. Fundamental techniques for stabilizing Gimbal.

Professional Skill 42 Hrs; Professional Knowledge 12Hrs	Identify and resolve common error messages and corrections by software debugging. (Mapped NOS: ELE/N9405)	91. Identify bugs in the software program as per the algorithms used and the libraries. 92. Resolve common error messages and apply the correct logic. 93. Perform firmware configuration and updates. 94. Download and Install App / Menu / Planning / Set-up / Flight / Application. 95. Demonstration and perform base station software to debugging to get GPS and flight data. 96. Perform experiments on software debug tool use to identify coding errors at different stages. 97. Setup python and Arduino environment. 98. Remote automatic drone operation using Python. 99. Knowledge and advantage of preventative maintenance of drone. 100. Diagnose problems using Log Data / Analyze Data flash Log Data / Remote Communication Log Data / Save and Execute Log Data. 101. Upgrade/downgrade drone firmware Identify error message and resolve approach.	Introduction to software debug tool use to identify coding errors at different stages of development. Introduction to various drone operation using Python and Arduino and setup development environment. Firmware and hardware integration with common errors and their solutions. Introduction to software debugging tools and how to identify cause of coding errors. Introduction to ground base station assembly Introduction to preventive measures for drones.
Professional Skill 21 Hrs; Professional Knowledge 06 Hrs	Inspect, test and execute primary and secondary servicing with troubleshoot malfunctioning, and repair issues discovered. (Mapped NOS: ELE/N7005)	102. Perform primary and secondary servicing based upon the checklist. 103. Test and diagnose drone after 100 hours of flying for preventive maintenance. 104. Test and diagnose drone after 500 hours of flying. 105. Knowledge about drone troubleshooting check list like Equipment check, System reset, calibration, Motor Troubleshooting,	Fundamentals of primary and secondary services. Basics of Gimbal handling and its maintenance. Fundamentals of handling errors rise from GPS. Introduction to battery life maintenance, flight path monitoring. Studying throttle control by moving in either direction. Concept of Visual Inspection and Why Is It Important. Understand the various checks to be carried out to ensure the alignment

		Gimbal rotation, Battery Maintenance, and RF Signal and hardware. 106. Diagnose the common drone problem like GPS signals are blocked , Decreased battery life, Wrong direction during flight, Flight Planning, Mechanical issue, and Firmware issue. 107. Inspect drone before and after each flight. 108. First time drone hardware assembly and test. (03 hrs.) 109. Test, locate the fault and repair a wiring of drone. 110. Check bent or cracked on legs and feet of the drone. 111. Demonstration drone wiring connections with different parts. 112. Perform takeoff/Landing operation and identify faults in system.	of control surfaces.

SYLLABUS FOR CORE SKILLS
1. Employability Skills (Common for all CTS trades) (60 Hrs)

Learning outcomes, assessment criteria, syllabus and Tool List of Core Skills subjects which is common for a group of trades, provided separately in www.bharatskills.gov.in /dgt.gov.in

ANNEXURE-I

List of Tools & Equipment			
Drone Technician (For batch of 24 Candidates)			
S No.	**Name of the Tools and Equipment**	**Specification**	**Quantity**
A. GENERAL TOOLS			
1.	Pliers		06 nos.
2.	Soldering Station		06 nos.
3.	Multi meter		06nos.
4.	Tweezers	Smart SMD tester tweezer resistance capacitance, diode test auto power off low battery indication.	06 nos.
5.	Binoculars		06 nos.
6.	Anemometer		06 nos.
7.	Magnifier		06 nos.
B. List of Equipment			
1.	Unassembled drone	Quad copter kit includes: • GPS Module • Propellers • Frame • BLDC Motors • ESC (Electronic Speed controllers) • FCB (Flight Controller Board) • Camera • Guard • Lipo Battery and Charger • RF Transmitter and receiver • Drone base • Receiver cables • Hovering function using LiDAR sensor • Mission planning function: Waypoint routing, event execution	04 nos.
2.	Electricity Lab	DC power supply: +5V,1A (Fixed); +12V, 500mA, 5V Relay, different coils with turns 200 ,400,800,1600,3200 ,core types E,I,U single pole and toggle switch , light bulbs Galvanometer : 30 - 0 – 30with software and component box containing Resistances,	03 nos.

		Capacitances ,Diodes, Transistors and potentiometers.	
3.	SMD Technology Kit with wall chart	SMD component identification board with SMD components Resistors, Capacitors, Inductors, Diodes, Transistors & IC's packages. Proto boards with readymade solder pads for various SMD Components. SMD Soldering Jig and Wall chart	02 nos.
4.	Multiple Output DC regulated power supply	0-30V, 2 Amps, + 15V Dual Tracking ,5V/5A, Display digital, Load & Line Regulation: ± (0.05 %+100 mV), Ripple & Noise <= 1 mVrms constant Voltage & Current operation	02 nos.
5.	DC Regulated Variable Programmable DC Power Supply	0-30V/3A with numeric keypad, PC interface and LCD for Voltage, Current & Power	02 nos.
6.	Smart SMD tweezer Handheld	SMD tester tweezer with Inductance, capacitance, resistance, and diode test capabilities.	02 nos.
7.	100 MHz Mixed Signal Oscilloscope (4 Analog + 16 Digital Channel)	With more than 20Mpt memory Real time Sampling 1GSa/sec, having LAN Interface, RS232/UART, I2C, SPI trigger & decoding functions, two channel 25 MHz awg plus math functions like differentiation, integration, abs, AND, OR, NOT etc.	01 no.
8.	25 MHz Arbitrary Waveform Generator with Digital Display for Frequency and Amplitude	Two Channel, 125MSa/Sec and 2Mpt memory with more than 150 different arbitrary waveforms, RS232, PRBS and built-in 8th order harmonic generation, and 225 MHz Frequency counter, Connectivity USB Device & Host	01 no.
9.	Handheld 3 $^{3/4}$ Digit Multimeter	Digital Multimeter with 4000 counts, Large Display with Auto/Manual and can measure DCV- 1000V-ACV-750V, DC & AC A – 20A, Resistance 40MΩ, Capacitance up to 200µF, Capacitance and Frequency – 30 MHz	01 no.
10.	3GHz Spectrum Analyzer with built-in Tracking Generator	Frequency Range 9 kHz to 3.2 GHz Resolution Bandwidth (-3 dB): 10Hz to 1 MHz, Display 8" TFT or more	01 no.

		Connectivity: USB Host & Device, LAN(LXI)	
11.	SMD Soldering & De soldering Station with necessary accessories	SMD Soldering & De-soldering, Station Digitally Calibrated, Temperature Control SMD, Soldering & De-soldering, Power Consumption 60 Watts, I/P Voltage 170 to 270 V, De-soldering 70 Watt, Temperature Range 180 to, 480º Centigrade, Power Consumption 270 Watts, Hot Air Temperature 200 to 480º C	02 nos.
OR Drone Workbench		Item no. 4, 7, 8, 10 and 11 can be preferred in the form of workbench.	01 no.
12.	Analog-Digital Circuits Development Platform	Breadboard with 1685 Nos of tie points for circuit design DC power supply: +5V,1A (Fixed); +12V, 500mA (Fixed); ±12V, 500mA (Variable) AC power Supply: 9V-0V-9V,500mA Function Generator: Sine, Square, Triangle (1Hz to 100KHz) Modulating Signal Generator: Voltage, current and frequency on board LCD display. PC Interface - Acquisition from two analog input channel and simulation Software	03 nos.
13.	Applied Mechanics training platform	Spring balance, slotted mass 5, 10, 20, 50, 100gms, brass hanger, pulley , brass force ring, neodymium magnet, rolling masses, friction block, pendulum, inclined plane, stop watch and simulation software	02 nos.
14.	Drone Battery Management Training Systems	Battery characteristics of Lead-Acid Li-Po and Li-ion batteries, DC Power source, DC voltmeter, DC ammeter, PWM based battery charge controller, battery level indicator, computer connectivity through USB and GUI software.	01 no.
15.	Charge Controller training system	PWM based charge controller with reverse polarity protection for battery 12V/42Ah, 12V/3Ah, DC Voltmeters, Ammeter, Resistive rheostat 110□□8Amp.	02 nos.
16.	BLDC (Brushless DC) Motor Training System	200W,2500RPM BLDC motor with mechanical loading arrangement , DC voltmeter , ampere meter and tachometer 24V – 10A	01 no.

		instrumentation power supply , simulation software.	
17.	Inverted pendulum	Inverted Pendulum control and its balance by PID control, Controller : 32bit ARM Cortex-M3 ATSAM3X8EA-AU, Motor : RA35GM, Encoder : E40S6-1024 1024 Pulse Rotary Encoder 2EA, , PWM duty operation and motor control by Encoder counter, Inverted Status Monitoring by Emulation, Integrated development environment, Control DC-motor.	01 no.
18.	Drone Sensor Trainer Kit	Android based 7" Graphical touch LCD with inbuilt cortex processor & DAQ for acquiring analog data and software for viewing the output waveforms with USB storage and HDMI output. Ethernet port to connect real world. Inverting, Non – Inverting, Power, Current, Instrumentation and Differential Amplifier, F to V, V to F, I to V, V to I Converter, High Pass and Low Pass Filter, Buffer, LED, Buzzer, Relay, Included Sensors: Accelerometer, Atmospheric pressure, Gyro, IMU, current, voltage and light.	02 nos.
19.	Antenna training system	RF Frequency 600 to 750MHz, Modulation Generator 1KHz , RF detector folded dipole receiving antenna with digital display , rotation of antenna 0 – 360 degree different antennas ground plane, helical, slot ,folded dipole and patch.	01 no.
20.	Advanced Microwave Integrated Circuit Lab	2.2 - 3GHz RF source with LCD display, Impedance 50Ω, RF level : 5mW, Operating Modes : Sweep, CW, Int. AM, Int. FM, Ext. AM, PC communication Modulating Frequency : 100Hz to 5kHz AM square wave, FM triangular wave, VSWR Meter with filters, amplifier and yagi, dipole and patch antenna.	01 no.
21.	GPS training platform	Channel : 12 Receiver Frequency : 1575.42 MHz Position Accuracy : 25 meters CEP without SA Velocity Accuracy : 0.1 meters/second, without SA Time Accuracy :	01 no.

		Synchronized to GPS time Update rate : 1 sec. Receiver Sensitivity : -175 dB Serial Communication : 4800 Baud Rate (default) Protocol Messenger : NMEA0183 V 2.2, SiRf binary & RTCMSC-104 V2.0 type 1,2,9 Maximum Speed : 515 meters/sec. Maximum Altitude : 18000 meters Time to First Fix : 45 / 38 / 8 sec	
22.	Wireless Communication modules	Transmitter with RF Range 2.40-2.48GHz, 9 Channels, 500 Hz bandwidth, 160 bands, RF Power less than 20 dB, GFSK Modulation and PPM/PCM. Throttle curves , Pitch curves, Endpoint adjustments, Subtrim, Swash AFR mixes, Servo reversing, Timer, Dual rate, Exponential, and Elevons. Receiver with RF Range 2.40-2.48GHz, 10 channels, 140 bands, Receiver Sensitivity 105dBm, 500 KHz bandwidth, GFSK Modulation.	1 no.
23.	FCB and ESC training platform	Two processors 8bit and 32bit, Cortex-M4F with 6050 MPU, 32bit STM32F103 redundant failsafe co-processor system, 14 PWM/Servo output. Bus interface (UART, I2C, SPI, CAN). Pre-Installed firmware with RTOS for Quadcopter (X and +) configuration, Gyroscope, Accelerometer/magnetometer, Barometer. 4x UART (Serial Ports), One High-Power Capable, 1x CAN, PPM Sum Signal Input. I2C, SPI, 3.3 - 6.6V ADC Inputs. 72-Channel GPS receiver GLONASS, Battery 3000mah, 1000kv Brushless Motor with soldered connector, Propellers, 30A BLDC Electronic Speed Controller, 2.4Ghz 6Ch transmitter with Receiver, Internal Micro USB Port And External Micro USB Port Extension. Provide automatic and manual modes. Provide redundant power input and failover. Multicolor LED lights. Provide multi-tone buzzer Interface. Micro SD recording flight	01 no.

		data. The integrated backup power and backup controller fails, the primary controller fails over to the backup control is safe.	
24.	Drone Gimbal Set with motor and control	2 Axis Brushless Gimbal, Carbon Fiber Material, Motor drivers, On-board MPU.	01 no.
25.	NPNT compliant Micro UAV built for Mapping and Surveillance.	UAV Weight with standard payloads <2 Kg UAV Size with Propeller - < 80 cm x 80 cm Endurance/ Flight time (upto 1km AMSL) :20-25 minutes Range for live transmission (Radius) - 2 km Operating altitude (AGL) - 200m AGL (Above Ground Level) Maximum launch altitude (AMSL) - 3000m AMSL (Above Mean Sea Level) Wind Resistance - Minimum 10 m/s **Failsafe features** • Return to Home on communication failure • Return to Home/Land on low battery or battery issues • Return to home on high winds • Multiple GPS on-board for GPS failure redundancy Autonomy Fully autonomous from Take-off to Landing without using any R/C controller Payload Characteristics - Mapping/RGB/Photogrammetry Payload, 15 MP Ground Control Station Software with data-link equipment	01 no.
26.	HD Payload	1280X720,5X Optical Zoom Video Resolution	02 nos.
27.	Thermal Camera Payload	Resolution 320X240 pixels	02 nos.
28.	Field Repair kits	Allen key set, Magnifying lenses, Scissors, Hand Drill Machine Electric with Hammer, First aid kit, Soldering iron, de-soldering pump, solder wire, flux, Precision set of screw drivers, Handheld multimeter, and Long nose pliers.	02 nos.
29.	Drones and spare parts kit	Li-Po, Li-ion Batteries, BLDC	02 nos.

		motors, Propeller set, FCB, ESC, frame, GPS module.	
30.	Balance Charger		02 nos.
31.	Power distribution board		03 nos.
32.	Laptop latest configuration	Intel i5-9300H with 9th Generation, 2.4 Ghz base speed, 8 GB RAM | Storage 1 TB SSD, Pre-loaded Windows 10 Home with lifetime validity and drone digital learning software, Display: 15.6-inch screen with full HD display, Battery life: 2 hrs.	01 no.
33.	Thrust measurement meter		02 nos.
34.	Indoor netted facility		Size as required in Lab
35.	Outdoor controlled netted testing facility		Size as required for outdoor
36.	Different types of electronic and electrical cables, Connectors, sockets, terminations, Different types of Analog electronic components, digital ICs.		As required
37.	3D printer	High precision stainless steel rail rods, gears, bearings and connectors for smooth printing. Supports various 3D printing filaments, Open Source Software to control 3D printer on PC Windows, Micro SD Card based printing, Mendelian type open-source 3D. NEMA 17 stepping motor, arduino-based microcontroller, motor driver, and various connectors. Heat Bed temperature monitoring. Code (G Code) conversion & transmission & analysis using open-source software & tools.	01 no. (Optional)
38.	Drone upto 18KM	Automatic flight Payload or camera control Up to 3 kg payload IP55 rating Up to 18 km Flight time up to 40 minutes Aircraft dimensions 600 x 600 x 500	01 no. (optional)

		mm (LxWxH) Joystick Controller Auto fly home and landing Camera angle control Camera shutter and zoom Multiple camera switching	

Note: -

1. Internet facility is desired to be provided in the class room.

ABBREVIATIONS

CTS	Craftsmen Training Scheme
ATS	Apprenticeship Training Scheme
CITS	Craft Instructor Training Scheme
DGT	Directorate General of Training
MSDE	Ministry of Skill Development and Entrepreneurship
NTC	National Trade Certificate
NAC	National Apprenticeship Certificate
NCIC	National Craft Instructor Certificate
LD	Locomotor Disability
CP	Cerebral Palsy
MD	Multiple Disabilities
LV	Low Vision
HH	Hard of Hearing
ID	Intellectual Disabilities
LC	Leprosy Cured
SLD	Specific Learning Disabilities
DW	Dwarfism
MI	Mental Illness
AA	Acid Attack
PwD	Person with disabilities


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