

CURRICULUM OF “INTERNET OF THINGS”

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**National Vocational & Technical
Training Commission**

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Introduction

Definition/ Description of the training programme for *Internet of Thing*

The Internet of Things (IoT) is a network of resource constrained nodes being capable of automating an existing manual procedure.

Purpose of the training programme

The IoT programme is to engage young people with a programme of development that will provide them with the knowledge, skills and understanding to start this career in Pakistan. The specific objectives of developing these qualifications are as under:

- Improve the professional competence of the trainees
- Provide opportunities for recognition of skills attained through non-formal or informal pathways
- Improve the quality and effectiveness of training and assessment for IoT industry

Overall objectives of training programme

The overall objectives of the IoT program are producing skilled staff to:

- Web application developer
- Electronics assistant for IoT
- Hardware and software for IoT

Competencies to be gained after completion of course

- Develop Program and Frontend using framework
- Develop and integrate database with web Applications
- Make rectifier using diodes
- Use of Bipolar Junction Transistor (BJT) and MOSFET in different circuits
- Apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application
- Verify Truth Tables of Digital Gates
- Construct & Verify Combinational Logic Circuit
- Construct and Verify Function of Flip Flops
- Use 555 IC as Multi vibrator
- Construct Shift Registers and Counters with The Help of Flip Flops
- Configure Arduino
- Configure Node MCU
- Configure Raspberry Pi
- Configure ESP-32 with LORA

Trainee entry level

The entry requirement for this qualification would be Matric with science with level 2 certificate of IoT. Age 18 years or above

Minimum qualification of trainer

Teaching staff qualification should be BS (EE) with specialization in computer, BS (Computer Engineering, Computer Science, Software Engineering, I.T, Computer Networks, Cyber security, Data Science, and IOT) or equivalent.

Recommended trainer: trainee ratio

The recommended maximum trainer: trainee ratio for this programme is 1 trainer for 25 trainees.

Medium of instruction i.e. language of instruction

Instruction will be Urdu and English.

Duration of the course (Total time, Theory & Practical time)

This curriculum comprises 14 modules. The recommended delivery time is 600 hours. Delivery of the course could therefore be full time, 5 days a week, for 6 months. Training providers are at liberty to develop other models of delivery, including part-time and evening delivery.

The full structure of the course is as follow:

Module Level-3	Theory¹ Days/hours	Workplace² Days/hours	Total hours
Module 1 Develop Program and Frontend using framework	9	39	48
Module 2 Develop and integrate database with web Applications	8	36	44
Module 3 Make rectifier using diodes	11	39	50
Module 4 Use of Bipolar Junction Transistor (BJT) and MOSFET in different circuits	8	36	44
Module 5 Apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application	9	33	42
Module 6 Verify Truth Tables of Digital Gates	9	39	48
Module 7 Construct & Verify Combinational Logic Circuit	10	39	49
Module 8 Construct and Verify Function of Flip Flops	7	36	43
Module 9 Use 555 IC as Multi vibrator	9	33	42
Module 10 Construct Shift Registers and Counters with The Help of Flip Flops	8	30	38
Module 11 Configure Arduino	8	24	32
Module 12 Configure Node MCU	8	30	38
Module 13 Configure Raspberry Pi	8	33	41
Module 14 Configure ESP-32 with LORA	8	33	41

¹ Leaving Module hours in training provider premises

² Training workshop, laboratory and on-the-job workplace

Summary – overview of the curriculum

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of modules
Module 1 : Develop program and frontend using framework Aim: The aim of this module to develop advanced knowledge, skills and understanding to Develop program and frontend using framework	LU1. Collect Requirement to develop front end LU2. Create and Optimize responsive web page for different device LU3. Create PHP based web app LU4. Perform testing of application LU5. Debug application	9	39	48
Module 2 : Develop and integrate database with web applications Aim: The aim of this module to develop advanced knowledge, skills and understanding to Develop and integrate database with web applications	LU1. Manipulate the Database LU2. Administrate the Database	8	36	44

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of modules
Module 3 : Make rectifier using diodes Aim: The aim of this module to develop advanced knowledge, skills and understanding to make rectifier using diodes	LU1. Identify basic electronic components LU2. Construct half wave and Full Wave center tapped Rectifier LU3. Make voltage regulator using Zener diode LU4. Make Seven Segment Display Using Light Emitting Diode	11	39	50
Module 4 : Use of Bipolar Junction Transistor (BJT) and MOSFET in Circuits Aim: The aim of this module to develop advanced knowledge, skills and understanding to use of bipolar junction transistor (bjt) and mosfet in circuits	LU1. Use BJT as an operational amplifier LU2. Implement MOSFET as a switch.	8	36	44

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of modules
Module 5 : Apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application Aim: The aim of this module to develop advanced knowledge, skills and understanding to apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application	LU1. Construct relaxation oscillator using UJT LU2. Construct switching circuit using SCR LU3. Construct the dimmer circuit using DIAC & TRIAC LU4. Construct full wave converter and observe natural commutation.	9	33	42
Module 6 : Verify Truth Tables of Digital Gates Aim: The aim of this module to develop advanced knowledge, skills and understanding to verify truth tables of digital gates	LU1. Verify the truth table of AND gate LU2. Verify the truth table of OR gate LU3. Verify the truth table of NOT gate LU4. Verify the truth table of NAND gate LU5. Verify the truth table of NOR gate LU6. Verify the truth table of X-OR gate LU7. Verify the truth table of X-NOR gate	9	39	48

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of modules
Module 7 : Construct & Verify Combinational Logic Circuit Aim: The aim of this module to develop advanced knowledge, skills and understanding to Construct & Verify Combinational Logic Circuit	LU1. Apply Karnaugh mapping & Boolean algebra to simplify logic expressions LU2. Construct & verify the truth table of Half adder/subtractor LU3. Construct & verify the truth table of Full adder/subtractor LU4. Verify Decoder LU5. Operate seven segment display with seven segment decoder LU6. Verify Encoder LU7. Verify multiplexer and DE- multiplexer	10	39	49
Module 8 : Construct and Verify Function of Flip Flops Aim: The aim of this module to develop advanced knowledge, skills and understanding to construct and verify function of flip flops	LU1. Construct and verify the truth table of RS latch using NAND gate LU2. Construct and verify the truth table of clocked RS latch using NAND gat LU3. Verify function of D flip flop. LU4. Verify function of JK/T flip flop	7	36	43
Module 9: Use 555 IC as Multivibrator Aim: The aim of this module to develop advanced knowledge, skills and understanding to Use 555 IC as Multivibrator	LU1. Construct 555 IC as A-stable Multivibrator LU2. Construct 555 IC as Mono-stable Multivibrator LU3. Construct 555 IC as Bi-stable Multivibrator and verify its set and reset conduction	9	33	42

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of modules
Module 10: Construct Shift Registers and Counters with The Help of Flip Flops Aim: The aim of this module to develop advanced knowledge, skills and understanding to Construct Shift Registers and Counters with The Help of Flip Flops	LU1. Construct a 4 bit shift register by Using Flip Flops LU2. Construct a 4-bit binary counter Using Flip Flops LU3. Construct 4-bit synchronous Counter with D flip-Flops LU4. Troubleshoot different combinational logic circuits.	8	30	38
Module 11 : Configure Arduino Aim: The aim of this module to develop advanced knowledge, skills and understanding to configure Arduino	LU1. Embed Code in Arduino LU2. Control LED with Arduino	8	24	32
Module 12 : Configure NodeMCU Aim: The aim of this module to develop advanced knowledge, skills and understanding to configure NodeMCU	LU1. Embed Code in NodeMCU LU2. Control LED with NodeMCU	8	30	38

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of modules
Module 13: Configure Raspberry Pi Aim: The aim of this module to develop advanced knowledge, skills and understanding to Configure Raspberry Pi	LU1. Set-up Raspberry Pi LU2. Set-up Programming Environment	8	33	41
Module 14: Configure ESP-32 with LoRa Aim: The aim of this module to develop advanced knowledge, skills and understanding to configure ESP-32 with LoRa	LU1. Perform connection of ESP-32 with LoRa Transceiver Module LU2. Perform embedding Code in ESP-32	8	33	41

LEVEL 3

Module 1 : Develop Program and Frontend using framework.

Objective of the module: The aim of this module that is to enable candidate will be able to develop program and frontend using framework.

Duration:	48 hours	Theory:	09 hours	Practical:	39 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1. Collect Requirement to develop front end	The trainee will be able to: <ul style="list-style-type: none"> Organize interview sessions for clients. Prepare Software requirement specification (SRS) Document Prepare Prototyping or visuals based on SRS Gather information regarding storage spaces. Verify the completeness of SRS 	<ul style="list-style-type: none"> Introduction to Software Requirements Engineering Kinds of Software Requirements (Non-Functional, Domain, Inverse, Design and Implementation Requirements etc) Describe Specific Elicitation Techniques Including the Interviewing, Scenarios, Prototyping and Participant Observation Explain the modes of Interviews: formal or informal, in person or virtually. Explain different Surveys or Questionnaires Tools (google form, SurveyMonkey) Introduction to SRS documents. Element of SRS documents. Describe the Prototyping 	Theory: 02 hrs Practical: 06 hrs Total: 08 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Non Consumable <ul style="list-style-type: none"> Computer system Multimedia 	Classroom, Computer Lab

		<ul style="list-style-type: none"> Requirement Validation Techniques (Completeness checks, Consistency checks, Validity checks, Realism checks, Ambiguity checks Verifiability) <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to create Questionnaire Tools (google form, SurveyMonkey) Practice to make SRS document according to client requirement 			
LU2. Create and Optimize responsive web page for different device	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> Design mockups using different components of web pages Design responsive web page for different screens sizes. Implement mockup to all screen sizes through frontend frameworks Apply media queries to the layouts 	<ul style="list-style-type: none"> Explain web page and its design Describe the technique to Design Layouts / mockups. Explain different types of screens sizes in pixels Describe HTML and its tags. Basic concept of Javascript and its use Concept and use of frontend development framework (bootstrap) Techniques to implement the right framework to achieve the responsiveness on all the screens. 	<p>Theory: 01 hrs</p> <p>Practical: 06 hrs</p> <p>Total: 07 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners <p>Non Consumable</p> <ul style="list-style-type: none"> Computer system Multimedia 	Classroom, Computer Lab

		<ul style="list-style-type: none"> Learn JS loops, objects, and DOM Knowledge of CSS classes, selector types in CSS <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to create a responsive web page containing header, footer, and slider for different devices using media queries 			
LU3. Create PHP based web app	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> Configure environment for PHP development Write basic PHP program Create web page using PHP 	<ul style="list-style-type: none"> Introduction to Programming languages Basic structure of PHP program Knowledge of PHP environment (XAMPP & PHP) Understanding syntax of PHP Types of errors Knowledge of writing PHP program Components of PHP (variable, constants, functions, operators, FOR loop, conditional structures, single arrays) <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to print Hello world program Practice to store input values in variables and display output on screen 	<p>Theory: 02 hrs</p> <p>Practical: 12 hrs</p> <p>Total: 14 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners <p>Non Consumable</p> <ul style="list-style-type: none"> Computer system Multimedia Instructional manual UPS 	Classroom, Computer Lab

		<ul style="list-style-type: none"> Practice to print a table using FOR loop Practice to calculate student result using conditional statement (if-else) Practice to identify a function in a program Practice to create single dimensional array 			
LU4. Perform testing of application	The trainee will be able to: <ul style="list-style-type: none"> Perform User Interface Testing Perform Unit Testing Perform Compatibility Testing Perform Security Testing Perform Performance Testing 	<ul style="list-style-type: none"> Knowledge of DOM rendering. Understanding of media queries. Knowledge of non-functional requirements. Understanding of different types of testing methods Identify testing tool according to your web framework Knowledge of designing test cases Knowledge of elements Compatibility. Knowledge of Processes Knowledge of URL Manipulation Knowledge of SQL Injections Knowledge of XSS cross-side-scripting Knowledge of spoofing Practical Activity: <ul style="list-style-type: none"> Practice to perform unit testing and integrated testing. 	Theory: 02 hrs Practical: 06 hrs Total: 08 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Non Consumable <ul style="list-style-type: none"> Computer system Multimedia 	Classroom, Computer Lab

		<ul style="list-style-type: none"> Practice to check security of application. Practice to check performance of application. 			
LU5. Debug application	The trainee will be able to: <ul style="list-style-type: none"> debug code using debugger Perform validation and verification testing Collaborate with teams to fix and improve products Check software is up-to-date with latest technologies 	<ul style="list-style-type: none"> Knowledge of debug and its process Knowledge of verification and validation Knowledge of procedures to communicate with team. Practical Activity: <ul style="list-style-type: none"> Practice to identify logical and syntax errors from given program 	Theory: 02 hrs Practical: 09 hrs Total: 10 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Non Consumable <ul style="list-style-type: none"> Computer system Multimedia Instructional manual UPS 	Classroom, Computer Lab

Module 2 : Develop and integrate database with web Applications.

Objective of the module: The aim of this module that is to will be able to develop and integrate database with web applications.

	Duration:	44 hours	Theory:	06 hours	Practical:	36 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place	
LU1. Manipulate the Database	The trainee will be able to: <ul style="list-style-type: none">• Create database and entities• Specify primary keys• Set up the table and relationships among database entities• Create and manage database reports, visualizations, and dashboards.	<ul style="list-style-type: none">• Knowledge of database and its entities• Knowledge of relational database management• Use of Data Definition Language such as CREATE, DROP, ALTER, TRUNCATE and RENAME)• Use of Data Manipulation Language (DML) such as (Select, Insert, Update, Delete commands)• Database basic functions• Knowledge of writing code to connect web page with database (PHP, and MySQL)• Methods to find and organize the information required• Knowledge of Data Flow Diagram (DFD)• Knowledge of Entity Relation Diagram.• Understanding of transaction• Integrity constraint	Total: 19 hrs Theory: 04 hrs Practical: 15 hrs	Consumable <ul style="list-style-type: none">• Notebooks• Pencils• Erasers• Sharpeners Non Consumable <ul style="list-style-type: none">• OS Bootable DVD• OS Bootable Mass storage device• Computer system• Hard drive	Classroom, Computer Lab	

		<ul style="list-style-type: none"> • Knowledge of normalization. • Process to Organise information items into major entities • Techniques to analyze the design for errors. • Concept of using server-side scripting language for connectivity with database. <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to make a database containing two tables • Practice to create relationship between tables • Practice to implement database normalization techniques • Practice to make a student record database e.g <ul style="list-style-type: none"> ➤ make four tables named as student info, courses info, course registration, student grade 		<ul style="list-style-type: none"> • RAM • ROM • Multimedia projector • Instructional manual UPS 	
LU2. Administrate the Database	The trainee will be able to: <ul style="list-style-type: none"> • Install and maintain the database server. 	<ul style="list-style-type: none"> • Knowledge of database security. • Knowledge of Database Optimization • Centralized and decentralized database 	<p>Total: 17 hrs</p> <p>Theory:</p>	<p>Consumable</p> <ul style="list-style-type: none"> • Notebooks • Pencils 	Classroom, Computer Lab

	<ul style="list-style-type: none"> • Develop processes for optimizing database security. • Manage database access rights and controls. • Diagnose and troubleshoot database errors. • Create automation for repeating database tasks • Export the database backups • Restore database backups 	<ul style="list-style-type: none"> • Cloud databases (e.g firebase) • Knowledge to Explore/ Recommend and implement emerging database technologies. • Process to set and maintain database standards. • Understanding of user, roles and permissions <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to install, upgrade, and manage database applications at client end. • Practice to make role for users • Practice to assign role to users • Practice to perform basic performance and tuning task 	<p>02 hrs</p> <p>Practical: 15 hrs</p>	<ul style="list-style-type: none"> • Erasers • Sharpeners <p>Non Consumable</p> <ul style="list-style-type: none"> • Computer system • Multimedia • UPS 	
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Module 3 : Make rectifier using diodes

Objective of the module: The aim of this module to get knowledge, skills and understanding to make rectifier using diodes.

Duration:	50 hours	Theory:	11 hours	Practical:	39 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Identify electronic components	The trainee will be able to: <ul style="list-style-type: none"> Identify Resistors and its resistance Calculate the resistance in Series & parallel circuit. Identify Capacitor and its capacitance Calculate the capacitance in Series & parallel circuit Identify Inductor and its inductance Check the inductance in Series & parallel circuit, Identify Diodes as per polarity Identify IC's and its packages 	<ul style="list-style-type: none"> Ohm's law Explain Resistor & its types Colour coding & rating of resistors Process to construct series & parallel circuit of resistor Importance of Resistors in circuit Understanding of Formula for calculation of resistance in series & parallel circuits. Identification of Capacitor & its types Coding & Rating of Capacitor Process to construct parallel and series circuit of Capacitor Understanding of Formula for calculation of capacitance in series & parallel circuits. Purpose to use capacitor in circuit Difference in resistance & capacitance Inductor & its applications in circuits Knowledge of coding & rating of inductor 	Total: 16 hrs Theory: 07 hrs Practical: 09 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> White board Multimedia Diodes Multi Meter Power supply Trainer Resistor Inductor ICs 	Electrical Lab /Workshop

		<ul style="list-style-type: none"> • Calculation of inductance in series & parallel circuits • Differentiation in inductance capacitance & resistance • Understanding of Data sheets • Purpose & use of data sheet • Basic knowledge of IC packages • Types of IC packages • Purpose of different ICs • Function of IC packages in circuit • Explain diode its function • Types of diode • Explain characteristics curve & polarity of diode • Functions of Multi meter for checking diode • Uses of diode in electronic circuits • Draw Diode characteristics curves in forward and reverse Biased • Understanding of Formula for calculation of diode in series & parallel circuits. • Forward biasing • Reverse biasing. <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to construct given series/parallel circuit by using resistor and calculate its resistance • Practice to construct given series/parallel circuit by using 		<ul style="list-style-type: none"> • Capacitor • Source of data sheets • Electrician kit • Bread board / Basic electronics trainer kit. • DC supply • Oscilloscope 	
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		inductor and calculate its inductance <ul style="list-style-type: none"> Practice to construct given circuit by using series/parallel capacitor and calculate its capacitance Practice to connect diode in forward and Revers bias condition and check voltage drop at output waveform through oscilloscope. Practice to use diode in circuit as switch 			
LU2: Construct half wave and Full Wave center tapped Rectifier.	The trainee will be able to: <ul style="list-style-type: none"> Construct circuit Diagram of half wave Rectifier Construct circuit Diagram of Full Wave Rectifier Calculate the ripple Factor. Calculate output voltage using proper formulas 	<ul style="list-style-type: none"> Rectification and its types Types of rectifier. Efficiency of half wave rectifier. Ripple factor of half wave rectifier. Input and output wave forms of half wave rectifier. Efficiency of Full wave center tapped rectifier. Ripple factor of Full wave center tapped rectifier. Input and output wave forms of Full wave center tapped rectifier. Calculation of ripple factor Practical Activity: <ul style="list-style-type: none"> Practice to construct half wave and full wave rectifier and observe output waveform at oscilloscope 	Total: 11 hrs Theory: 02 hrs Practical: 09 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> Diodes Wires Bread board / Basic electronics trainer kit. 	Classroom & Lab

				<ul style="list-style-type: none"> • DC supply • Oscilloscope • Step down Transformer (Normal and center tapped) 	
LU3: Make voltage regulator using Zener diode.	The trainee will be able to: <ul style="list-style-type: none"> • Draw the voltage Regulator circuit. • Select the Zener diode and components as per requirement for voltage regulator. • Install the components for voltage regulator circuits. • Vary the input voltage and note down the effects on output. • Record the difference between input and output 	<ul style="list-style-type: none"> • Types of special diodes • Voltage regulation • Types of regulation (load and line regulation) • Characteristics of Zener diode. Practical Activity: <ul style="list-style-type: none"> • Practice to make voltage regulator using zener diode. 	Total: 11 hrs Theory: 02 hrs Practical: 09 hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable <ul style="list-style-type: none"> • Data sheet of Zener diode. • Zener Diode • Resistors • Wires • Bread board / Basic electronics trainer kit. • Multimeter • Oscilloscope 	Classroom & Lab

				<ul style="list-style-type: none"> Power supply 	
LU4: Make Seven Segment Display Using Light Emitting Diode	The trainee will be able to: <ul style="list-style-type: none"> Draw the Seven Segment Display Circuit Construct Seven Segment Display Circuit using components Verify the numeric digits on Seven Segment Display by providing input to its terminal 	<ul style="list-style-type: none"> Introduction to LED. Working Principle of LED 7 segment display and its purpose. Types of seven segment display 7 segment decoder. 	Total: 14 hrs Theory: 02 hrs Practical: 12 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> LEDs Resistors Wires Digital Trainer Kit. Multimeter DC supply 	Classroom & Lab

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Module 4 : Use of Bipolar Junction Transistor (BJT) and MOSFET in different circuits

Objective of the module: The aim of this module to get knowledge, skills and understanding to use of Bipolar Junction Transistor (BJT) and MOSFET in different circuits.

Duration:	44 hours	Theory:	08 hours	Practical:	36 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Use BJT as an operational amplifier	The trainee will be able to: <ul style="list-style-type: none"> Identify transistor. Identify the base collector & Emitter of transistors. Perform the standard Biasing of PNP & NPN Transistor 	<ul style="list-style-type: none"> Introduction to transistor Construction of transistor Types and symbols of transistor. Biasing requirement of transistor. General current equation of transistor. Use of multimeter/ datasheet to identify the transistor terminals. Gain of amplifier Introduction to amplification and amplifier Need of amplification. Types of amplifier according to transistor configuration Introduction to current, voltage and power amplification. Practical Activity: <ul style="list-style-type: none"> Practice to use BJT as operational amplifier 	Theory: 4hrs Practical: 18 hrs Total: 22 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> Data sheet of Transistor. Transistor Resistors Wires Bread board / Basic electronics trainer kit. Oscilloscope DC supply 	Classroom & Lab

<p>LU2:</p> <p>Implement MOSFET as a switch.</p>	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> • Identify the Gate, Drain & Source of FET. • Perform the standard Biasing of (N-Channel, P Channel) FET. • Measure the Gate-Source voltage (V_{GS}) & Threshold Voltage (V_{th}) • Draw switching circuit of MOSFET. • Construct switching circuit using MOSFET. • Verify switching operation of MOSFET using LED 	<ul style="list-style-type: none"> • Definition of FET • Understanding the power rating of FET and its datasheet • Biasing mechanism and basic formulae of FET's • Difference between JFETs and MOSFETs. • Construction of JFETs and MOSFETs. • Symbols used for JFET and MOSFETs. • Use of multimeter/ datasheet to identify the Gate Source & Drain of FET. • Biasing of FET (JFET, MOSFET) • Characteristic curve of FET. • Operating modes of JFET (Ohmic, saturation and breakdown region) • Switching action of MOSFET. • Working of MOSFET as a switch <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to verify switching operation of MOSFET using LED 	<p>Theory:</p> <p>04hrs</p> <p>Practical:</p> <p>18 hrs</p> <p>Total:</p> <p>22 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires <p>Non Consumable</p> <ul style="list-style-type: none"> • MOSFET • Multi-meter • Resistors • Load (LED) • Power Supplies • Bread board / Basic electronics trainer kit. • Oscilloscope 	
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Module 5 : Apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application

Objective of the module: The aim of this module to get knowledge, skills and understanding to apply thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in various applications.

Duration:	42 hours	Theory:	09 hours	Practical:	33 hours		
Learning Unit	Learning Outcomes	Learning Elements			Duration	Materials Required	Learning Place
LU1: Construct relaxation oscillator using UJT	The trainee will be able to: <ul style="list-style-type: none">• Select the components for relaxation oscillator.• Construct the relaxation oscillator circuit on bread board using given diagram.• Vary the value of input resistor and record the effect on output.	<ul style="list-style-type: none">• Introduction to UJT• Construction of UJT• Inter-base resistance• Voltage division factor• Intrinsic stand-off ratio.• RC time constant• Effect of changing input resistance on output. Practical Activity: <ul style="list-style-type: none">• Practice to construct the relaxation oscillator circuit on bread board and observe the output by varying the input resistance and record values.			Theory-03 Hrs Practical-06 Hrs Total-09 Hrs	Consumable <ul style="list-style-type: none">• Notebooks• Pencils• Erasers• Sharpeners• Cables• Wires Non Consumable <ul style="list-style-type: none">• UJT• Resistors• Capacitor• Wires• Bread board / Basic electronics trainer kit.• Multimeter• Oscilloscope	Classroom & Lab

				• DC supply	
LU2: Construct switching circuit using SCR.	The trainee will be able to: <ul style="list-style-type: none"> • Select the components for SCR switching circuit. • Construct the SCR switching circuit on bread board. • Verify switching operation by triggering the SCR 	<ul style="list-style-type: none"> • Introduction to SCR • Working principle and construction of SCR • Concept of Triggering • Identifying the anode, cathode and gate terminals of a SCR • Function of SCR as a switch Practical Activity: <ul style="list-style-type: none"> • Practice to construct the SCR switching circuit on bread board <ul style="list-style-type: none"> ➤ Connect the circuit with DC supply. ➤ verify switching operation by triggering the SCR 	Theory-02 Hrs Practical-09 Hrs Total-11 Hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable <ul style="list-style-type: none"> • SCR • Resistors • Switch • Load (LED) • Wires • Bread board / Basic electronics trainer kit. • Multimeter • DC supply 	Classroom & Lab
LU3: Construct the dimmer circuit	The trainee will be able to:	<ul style="list-style-type: none"> • Introduction of DIAC & TRIAC • Characteristic of DIAC and TRIAC • Purpose of DIAC and TRIAC. 	Theory-2 Hrs Practical-09 Hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils 	Classroom & Lab

using DIAC & TRIAC.	<ul style="list-style-type: none"> Construct the dimmer circuit using given TRIAC & DIAC. Connect the circuit with AC supply. Vary the potentiometer and record the effect on load (Fan or Lamp) 	<ul style="list-style-type: none"> Working procedure of light dimmer. Knowledge of potentiometer <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to construct the dimmer circuit using given TRIAC & DIAC <ul style="list-style-type: none"> ➤ connect circuit with AC supply ➤ observe the effect on output load (Fan & lamp) by varying resistance through potentiometer. 	Total-11 Hrs	<ul style="list-style-type: none"> Erasers Sharpeners Cables Wires <p>Non Consumable</p> <ul style="list-style-type: none"> TRIAC DIAC Resistors Potentiometer Capacitor Load (Lamp) Wires Bread board / Basic electronics trainer kit. Multimeter 	
LU4: Construct full wave converter and observe natural commutation.	The trainee will be able to: <ul style="list-style-type: none"> Make connection as per diagram. Apply triggering pulse at the gate of SCR. Connect oscilloscope across the load resistor 	<ul style="list-style-type: none"> Diode Rectifier. Introduction to <ul style="list-style-type: none"> ➤ AC to DC Converter (Controlled Rectifier) ➤ DC to DC Converter (DC Chopper) ➤ AC to AC Converter (AC voltage regulator) ➤ DC to AC Converter (Inverter) <p>Practical Activity:</p>	Theory-02Hrs Practical-09Hrs Total-11Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires 	Classroom & Lab

	and record the output wave shape	<ul style="list-style-type: none"> Practice to construct full wave converter and observe natural commutation 		Non Consumable <ul style="list-style-type: none"> SCR's Resistor of 1to100 K ohms Inductor. Resistive load. Wires Bread board / Basic electronics trainer kit Dual trace- Oscilloscope Signal generator 	
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Module 6 : Verify Truth Tables of Digital Gates

Objective of the module: The aim of this module to get knowledge, skills and understanding to Verify the truth table of digital gates.

Duration:	48 hours	Theory:	9 hours	Practical:	39 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Verify the truth table of AND gate.	The trainee will be able to: <ul style="list-style-type: none"> Place (AND gate IC) on bread board. Identify the input, output, Vcc and ground pin. Connect LED to the output pin of IC and apply different logics ant input pins. Record & verify the output result against each given input. 	<ul style="list-style-type: none"> Define logic Knowledge of number system and conversion between them (binary, octal, decimal, and hexa decimal) Understanding of compliments (1's and 2's) Knowledge of binary operators (addition, subtraction, multiplication, division) Define Logic Gate and its symbol. Types of logic gate. Definition of AND logic gate, its symbol and Boolean equation. Boolean Algebra and simplification of equations Circuit analysis Understanding of AND gate IC specifications. 	Theory- 2 Hrs Practical- 6 Hrs Total- 8 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> AND gate (7408 2-input Quad) Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads Digital Multimeter 	Classroom & Lab

		<ul style="list-style-type: none"> • Understanding of truth table. • Equivalent Electrical circuit of AND Gate. <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to convert binary numbers into hexadecimal. • Practice to convert hexadecimal numbers into octal. • Practice to verify AND gate by using AND gate IC. • Practice to Simplify the following Boolean expression • $F(A, B) = (A \cdot B) + A' (A+B)$ • Find the Boolean expression that represents the outputs x and y shown in the following circuit. 		<ul style="list-style-type: none"> • Logic Probe. 	
<p>LU2:</p> <p>Verify the truth table of OR gate.</p>	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> • Place (OR gate IC) on bread board. • Identify the input, output, Vcc and ground pin. 	<ul style="list-style-type: none"> • Definition of OR logic gate, its symbol and Boolean equation. • Understanding of OR gate IC specifications. • Understanding of truth table for OR gate. 	<p>Theory- 1 Hrs</p> <p>Practical- 6 Hrs</p> <p>Total- 7 Hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires 	<p>Classroom & Lab</p>

	<ul style="list-style-type: none"> • Connect LED to the output pin of IC and apply different logics and input pins. • Record & verify the output result against each given input. 	<ul style="list-style-type: none"> • Equivalent Electrical circuit of OR Gate. <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to find 1's and 2's complements of given binary numbers. • Practice to verify OR gate by using OR gate IC 		<p>Non Consumable</p> <ul style="list-style-type: none"> • OR gate (7432 2-input Quad) • Bread board / Digital Trainer Kit. • 5V DC supply • LEDs. • Connecting leads • Digital Multimeter • Logic Probe. 	
<p>LU3:</p> <p>Verify the truth table of NOT gate.</p>	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> • Place (NOT gate IC) on bread board. • Identify the input, output, Vcc and ground pin. • Connect LED to the output pin of IC and apply different logics and input pins. 	<ul style="list-style-type: none"> • Definition of NOT logic gate, its symbol and Boolean equation. • Understanding of NOT gate IC specifications. • Understanding of truth table. • Equivalent Electrical circuit of NOT Gate. <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to calculate addition and multiplication of binary numbers using operators. 	<p>Theory-1Hrs</p> <p>Practical-6Hrs</p> <p>Total-7 Hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires <p>Non Consumable</p> <ul style="list-style-type: none"> • NOT gate (7404 Hex) 	Classroom & Lab

	<ul style="list-style-type: none"> Record & verify the output result against each given input 	<ul style="list-style-type: none"> Practice to calculate subtraction and division using 2's complement. Practice to verify NOT gate by using NOT gate IC 		<ul style="list-style-type: none"> Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads Digital Multimeter Logic Probe. 	
LU4: Verify the truth table of NAND gate.	The trainee will be able to: <ul style="list-style-type: none"> Place (NAND gate IC) on bread board. Identify the input, output, Vcc and ground pin. Connect LED to the output pin of IC and apply different logics and input pins. Record & verify the output result against each given input 	<ul style="list-style-type: none"> Definition of NAND logic gate, its symbol and Boolean equation. Understanding of NAND gate IC specifications. Understanding of truth table. Equivalent Electrical circuit of NAND Gate. Practical Activity: <ul style="list-style-type: none"> Practice to verify NAND gate by using NAND gate IC. Practice to Implement circuits using NAND gates only Implement the following function using AND, OR gates $F = (A+B).C' + A'D$ 	Theory- 1 Hrs Practical- 3 Hrs Total- 4 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> NAND gate (7400 2-input Quad) Bread board / Digital Trainer Kit. 5V DC supply LEDs. 	Classroom & Lab

				<ul style="list-style-type: none"> • Connecting leads • Digital Multimeter • Logic Probe. 	
LU5: Verify the truth table of NOR gate.	The trainee will be able to: <ul style="list-style-type: none"> • Place (NOR gate IC) on bread board. • Identify the input, output, Vcc and ground pin. • Connect LED to the output pin of IC and apply different logics and input pins. • Record & verify the output result against each given input 	<ul style="list-style-type: none"> • Definition of NOR logic gate, its symbol and Boolean equation. • Understanding of NOR gate IC specifications. • Understanding of truth table. • Equivalent Electrical circuit of NOR Gate. Practical Activity: <ul style="list-style-type: none"> • Practice to Implement circuits using NOR gates only <ul style="list-style-type: none"> ➤ Implement the following function using AND, OR gates ➤ $F = (A+B).C' + A'D$ 	Theory-2 Hrs Practical- 6 Hrs Total- 8 Hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable <ul style="list-style-type: none"> • NOR gate (7402 2-input Quad) • Bread board / Digital Trainer Kit. • 5V DC supply • LEDs. • Connecting leads • Digital Multimeter 	Classroom & Lab

				<ul style="list-style-type: none"> Logic Probe. Connecting leads Multi-meter 	
LU6: Verify the truth table of X-OR gate.	The trainee will be able to: <ul style="list-style-type: none"> Place (X-OR gate IC) on bread board. Identify the input, output, Vcc and ground pin. Connect LED to the output pin of IC and apply different logics and input pins. Record & verify the output result against each given input. 	<ul style="list-style-type: none"> Definition of X-OR logic gate, its symbol and Boolean equation. Understanding of X-OR gate IC specifications. Understanding of truth table. Equivalent Electrical circuit of X-OR Gate Practical Activity: <ul style="list-style-type: none"> Practice to build XOR gate using basic gates.(AND,OR,NOT) 	Theory- 1 Hrs Practical- 6Hrs Total- 07 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> X-OR gate (7486 2-input Quad) Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads Digital Multimeter 	Classroom & Lab

				<ul style="list-style-type: none"> Logic Probe. 	
LU7: Verify the truth table of X-NOR gate.	The trainee will be able to: <ul style="list-style-type: none"> Place (X-NOR gate IC) on bread board. Identify the input, output, Vcc and ground pin. Connect LED to the output pin of IC and apply different logics ant input pins. Record & verify the output result against each given input 	<ul style="list-style-type: none"> Definition of X-NOR logic gate, its symbol and Boolean equation. Understanding of X-NOR gate IC specifications. Understanding of truth table. Equivalent Electrical circuit of X-NOR Gate Practical Activity: <ul style="list-style-type: none"> Practice to build XNOR gate using basic gates.(AND,OR,NOT). 	Theory- 1 Hrs Practical- 6Hrs Total- 07 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> X-NOR gate (74266 2-input Quad) Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads Digital Multimeter 	Classroom & Lab

				• Logic Probe.	
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Module 7 : Construct & Verify Combinational Logic Circuit

Objective of the module: The aim of this module to get knowledge, skills and understanding to construct & verify combinational logic circuit

Duration:	49 hours	Theory:	10 hours	Practical:	39 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Apply Karnaugh mapping & Boolean algebra to simplify logic expressions.	The trainee will be able to: <ul style="list-style-type: none"> • Apply Boolean algebra & Karnaugh mapping to simplify SOP & POS. • Construct logic circuits with simplified SOP & POS. 	<ul style="list-style-type: none"> • Laws and rules of Boolean algebra. • Understanding of SOP & POS. • Understanding of the Karnaugh mapping. • Use of Karnaugh map to simplify SOP & POS. • Don't-Care Conditions in Karnaugh mapping. • Understanding of commutative and distributive law i.e $\checkmark A \cdot (B + C) = (A \cdot B) + (A \cdot C)$ and $\checkmark A + (B \cdot C) = (A + B) \cdot (A + C)$ Practical Activity: <ul style="list-style-type: none"> • Practice to Simplify two-input Boolean functions <ul style="list-style-type: none"> ➤ Simplify the following Boolean expression using a k-map of size 2x2. $F(A, B) = (A \cdot B) + A' (A+B)$ • Practice to Simplify three-input Boolean functions. 	Theory- 1 Hrs Practical- 03 Hrs Total- 4 Hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable	Classroom & Lab

		<p>➤ Simplify the following Boolean expression</p> $F(A, B, C) = (A+C') + C(C.A' + (B.A) + C)$			
<p>LU2:</p> <p>Construct & verify the truth table of Half adder/subtractor</p>	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> Place (AND gate IC) & (XOR gate IC) on bread board. Connect LED to the output pin of IC and apply different logics at input pins. Record & verify the output result against each given input Design, Construct, and test a half-adder circuit using one XOR gate and two NAND gates 	<ul style="list-style-type: none"> Introduction to combinational and sequential logic circuits Definition of adder and subtractor. Types of adder and subtractor.. Schematic diagram of Half adder and its operation. Function of X-OR and AND gate. Verification of the truth table of Half adder and subtractor. <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to build Half Adder Circuit that performs 1-bit binary addition). Given that P and Q are two 1-bit binary numbers, S is the 1-bit Sum of P and Q, and C is the CARRY bit. <p>(a) Find out the Boolean functions S and C..</p> Practice to build Half Subtractor Circuit that performs 1-bit binary subtraction). Given that P and Q are two 1-bit binary numbers, D is the 1-bit Difference of P and Q, and C is the CARRY bit. 	<p>Theory-1 Hrs Practical-03 Hrs Total-4 Hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires <p>Non Consumable</p> <ul style="list-style-type: none"> X-OR gate (7486 2-input Quad) AND gate (7408 2-input Quad) Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads 	<p>Classroom & Lab</p>

		(a) Find out the Boolean functions D and C.		<ul style="list-style-type: none"> Digital Multimeter 	
LU3: Construct & verify the truth table of Full adder/subtractor.	The trainee will be able to: <ul style="list-style-type: none"> Place (AND gate IC) & (XOR gate IC) on bread board. Identify the input, output, Vcc and ground pin. Connect LED to the output pin of IC and apply different logics at input pins. Record & verify the output result against each given input Design, Construct, and test a full-adder circuit using two ICS, &7486 and &7400 	<ul style="list-style-type: none"> Schematic diagram of Full adder and its operation. Identification of devices/ components required for construction of Full adder/ subtractor circuit. Construction of Full adder/ subtractor circuit. Understanding the pin configuration of ICs. Verification of the truth table of Full adder/ subtractor. Practical Activity: <ul style="list-style-type: none"> Practice to Implement a 2-bit parallel adder using FullA's. Practice to Implement a 2-bit parallel Subtractor using FullS's. 	Theory-2Hrs Practical-3 Hrs Total-5 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> X-OR gate (7486 2-input Quad) AND gate (7408 2-input Quad) OR gate (7432 2-input Quad) Bread board / Digital Trainer Kit. 5V DC supply LEDs. 	Classroom & Lab

				<ul style="list-style-type: none"> Connecting leads Digital Multimeter 	
LU4: Verify Decoder	The trainee will be able to: <ul style="list-style-type: none"> Connect LED to the output pin of IC and apply different logics at input pins. Record & verify the output result against each given input 	<ul style="list-style-type: none"> Understanding of the Decoder. Types of the Decoder. Schematic diagram of Decoder and its operation. Understanding the pin configuration of ICs. Verification of the Decoder. Practical Activity: <ul style="list-style-type: none"> Practice to construct a circuit using decoder with four colour LEDs and demonstrate the functionality of decoder. Practice to Implement 3-variable Boolean expressions using 3-8 decoder. 	Theory-1 Hrs Practical-6 Hrs Total-7 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> IC 7445 BCD to decimal decoder IC 74147 Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads 	Classroom & Lab

				<ul style="list-style-type: none"> Digital Multimeter 	
LU5: Operate seven segment display with seven segment decoder.	The trainee will be able to: <ul style="list-style-type: none"> Insert (7 segment decoder IC) and 7 segment display on bread board. Connect segment display with seven segment decoder input output pins. Record & verify the output result against each given input 	<ul style="list-style-type: none"> Explanation of 7 segment decoder. Seven segment display and its operation. Understanding of pin configuration of 7 segment display. Definition of limiting resistor. Schematic diagram of seven segment displays with seven segment decoder and its operation. Practical Activity: <ul style="list-style-type: none"> Practice to operate seven segment display using seven segment decoder. 	Theory-1 Hrs Practical-6 Hrs Total-7 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> Seven segment display Resistances (1K ohm) 7 segment decoder Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads 	Classroom & Lab

				<ul style="list-style-type: none"> Digital Multimeter 	
LU6: Verify Encoder	The trainee will be able to: <ul style="list-style-type: none"> Connect LED to the output pin of IC and apply different logics at input pins. Record & verify the output result against each given input 	<ul style="list-style-type: none"> Functioning of the Encoder. Types of the Encoder. Understanding the pin configuration of ICs. Schematic diagram of the Encoder and its operation. Practical Activity: <ul style="list-style-type: none"> Practice to encode 4 bit into 2 bit using 4-2 encoder. 	Theory-1 Hrs Practical-6 Hrs Total-7 Hrs	<ul style="list-style-type: none"> NOT gate (7404 Hex NOT gate) OR gate (7432 2-input Quad) OR gate (7410 3-input) Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads Digital Multimeter 	Classroom & Lab
LU7: Verify multiplexer and DE- multiplexer	The trainee will be able to: <ul style="list-style-type: none"> Perform multiplexing Perform DE-multiplexing 	<ul style="list-style-type: none"> Define multiplexing. Define de-multiplexing. Understanding of Multiplexer and DE-multiplexer and their differences. 	Theory-1 Hrs Practical-06 Hrs Total-7 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners 	Classroom & Lab

		<ul style="list-style-type: none"> Schematic diagram other Multiplexer and DE-multiplexer and their operations. <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to Implement following function with multiplexer $F(ABC)=\sum (0,2,3,4,5,6)$ Practice to Implement a 4x1 multiplexer. Write complete logic synthesis (i.e. draw tables, equations, logic diagram where necessary) Practice to Implement a 1x4 de-multiplexer. Write complete logic synthesis (i.e. draw tables, equations, logic diagram where necessary) 		<ul style="list-style-type: none"> Cables Wires <p>Non Consumable</p> <ul style="list-style-type: none"> 74113 input AND Gate. OR gate 7432 2-input Quad 7414NOT Gate 74150 74154 Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads Digital Multimeter 	
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Module 8 : Construct and Verify Function of Flip Flops

Objective of the module: The aim of this module to get knowledge, skills and understanding to construct and verify function of flip flops.

Duration:	43 hours	Theory:	07 hours	Practical:	36 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Construct and verify the truth table of RS latch using NAND gate.	The trainee will be able to: <ul style="list-style-type: none"> Connect LEDs to outputs pins. Apply different logic inputs to Record & verify the output result against each given input 	<ul style="list-style-type: none"> Introduction to latch Types of latch. (High activated & Low activated) Introduction to set and reset function. Practical Activity: <ul style="list-style-type: none"> Practice to connect 2 LEDs with RS latch output and compare result with truth table. 	Theory-02 Hrs Practical-09 Hrs Total-11 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpener Cables Wires Non Consumable <ul style="list-style-type: none"> NAND gate (7400 2-input Quad) DC supply (5 V) LED Connecting leads Bread board 	Classroom & Lab
LU2: Construct and verify the truth table of clocked	The trainee will be able to: <ul style="list-style-type: none"> Connect LEDs to outputs pins. 	<ul style="list-style-type: none"> Difference between latch and flip flop. Working of RS clocked latch. Practical Activity:	Theory-02 Hrs Practical-09 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpener 	Classroom & Lab

RS latch using NAND gate.	<ul style="list-style-type: none"> Apply different logic inputs to Record & verify the output result against each given input 	<ul style="list-style-type: none"> Practice to connect 2 LEDs with clocked RS latch output and compare result with truth table. 	Total-11 Hrs	<ul style="list-style-type: none"> Cables Wires Non Consumable NAND gate (7400 2-input Quad) Digital clock DC supply (5 V) LED Connecting leads Bread board 	
LU3: Verify function of D flip flop.	The trainee will be able to: <ul style="list-style-type: none"> Connect LEDs\ Scope to outputs pins. Apply different logic inputs to Record & verify the output result against each given input 	<ul style="list-style-type: none"> Introduction to D flip flop. Working of D Flip Flop latch Practical activity: <ul style="list-style-type: none"> Practice to Use D flip flop from IC 74xx74, and complete its truth table. 	Theory-02 Hrs Practical-09Hrs Total-11 Hrs	<ul style="list-style-type: none"> Consumable Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable NAND gate (7400 2-input Quad) One 7404 IC – hex inverter (NOT gate) 	Classroom & Lab

				<ul style="list-style-type: none"> • Digital clock • DC supply (5 V) • LED • Connecting leads • Bread board 	
LU4: Verify function of JK/T flip flop	The trainee will be able to: <ul style="list-style-type: none"> • Connect LEDs\ Scope to outputs pins. • Apply different logic inputs to Record & verify the output result against each given input 	<ul style="list-style-type: none"> • Introduction to JK/T flip flop • Working of JK Flip Flop latch Practical activity: <ul style="list-style-type: none"> • Practice to Use JK and T flip flop from IC 74xx76, and complete its truth table. 	Theory-01 Hrs Practical-09 Hrs Total-10 Hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable <ul style="list-style-type: none"> • 74112 (JK flip flop) • Digital clock • DC supply (5 V) • LED • Connecting leads • Bread board 	Classroom & Lab

Module 9 : Use 555 IC as Multivibrator

Objective of the module: The aim of this module to get knowledge, skills and understanding to Construct 555 IC as Multivibrator.

Duration:	38 hours	Theory:	08 hours	Practical:	30 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Construct 555 IC as A-stable Multivibrator.	The trainee will be able to: <ul style="list-style-type: none"> • Draw circuit diagram for A-stable Multivibrator. • Place 555 IC on bread board/trainer • Make connection as per diagram. • Apply voltage to circuit. • Record the output signal wave shape from oscilloscope 	<ul style="list-style-type: none"> • Definition of Multi-vibrator. • Types of Multi-vibrator circuits. • Introduction to 555 IC and its pin diagram. • Understanding of 555 timer IC as A-stable Multi-vibrator. • Understanding of 555 timer IC as Mono-stable Multi-vibrator • Understanding of 555 timer IC as Bi-stable Multi-vibrator. Practical activity: <ul style="list-style-type: none"> • Practice to generate square wave using 555 timer IC as A-stable multivibrator. • Practice to use monostable multivibrator to drive a relay by switching on and off. • Practice to use bistable multivibrator for digital operations (counting, storing binary information). 	Theory- 03 Hrs Practical- 09Hrs Total- 12 Hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable <ul style="list-style-type: none"> • 555 timer IC • Dual trace Oscilloscope 0-20MHZ • Bread board • DC supply (5 V) • Connecting leads • Capacitor 0.01μF • Resistors 10 KΩ 	Classroom & Lab

				<ul style="list-style-type: none"> Digital Multimeter 	
LU2: Construct 555 IC as Mono-stable Multivibrator.	The trainee will be able to: <ul style="list-style-type: none"> Draw circuit diagram for Mono-stable Multivibrator Place 555 IC on bread board/trainer. Make connection as per diagram. Apply voltage to circuit and give triggering pulse at input pin. Record the output signal wave shape from oscilloscope 		Theory- 02 Hrs Practical- 09 Hrs Total- 11 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> 555 timer IC Dual trace Oscilloscope 0-20MHZ Bread board DC supply (5 V) Connecting leads Capacitor 0.01μF Resistors 10 KΩ Digital Multimeter 	Classroom & Lab
LU3:	The trainee will be able to:		Theory- 03 Hrs	Consumable <ul style="list-style-type: none"> Notebooks 	Classroom &

Construct 555 IC as Bi-stable Multivibrator and verify its set and reset conduction.	<ul style="list-style-type: none"> • Draw circuit diagram for Bi-stable Multivibrator. • Place 555 IC on bread board/trainer. • Make connection as per diagram. • Apply voltage to circuit and give triggering pulse at input pin. • Record the output signal wave shape from oscilloscope 		Practical- 12 Hrs Total- 15 Hrs	<ul style="list-style-type: none"> • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable <ul style="list-style-type: none"> • 555 timer IC • Dual trace Oscilloscope 0-20MHZ • Bread board • DC supply (5 V) • Connecting leads • Capacitor 0.01μF • Resistors 10 KΩ • Digital Multimeter 	Lab
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Module 10 : Construct Shift Registers and Counters with The Help of Flip Flops

Objective of the module: The aim of this module to get knowledge, skills and understanding to construct shift registers and counters with the help of flip flops.

Duration:	38 hours	Theory:	8 hours	Practical:	30 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Construct a 4-bit shift register by Using Flip Flops	The trainee will be able to: <ul style="list-style-type: none"> • Draw circuit diagram 4-bit register. • Make connection of D-Flip Flop as per diagram to construct 4-bit shift register. • Apply data at the input of register and give clock pulse. • Recode the output according to the input 	<ul style="list-style-type: none"> • Definition of register • Elements of register (D-Flip Flop) • Types of Register. (SISO, SIPO, PISO, PIPO) • Types of shift register (SHR, SRL, SRL&R) • Schematic diagram of a 4-bit shift register by Using D-Flip Flops and its operations. Practical activity: <ul style="list-style-type: none"> • Practice to Implement a 4 bit universal shift register using D flip flops and 2x1 multiplexers. 	Theory-02Hrs Practical-06 Hrs Total-08 Hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires Non Consumable <ul style="list-style-type: none"> • IC's and Components • Bread board / Digital Trainer Kit. • 5V DC supply • LEDs. • Connecting leads 	Classroom & Lab

				<ul style="list-style-type: none"> Digital Multimeter 	
LU2: Construct a 4-bit binary counter Using Flip Flops	The trainee will be able to: <ul style="list-style-type: none"> Draw circuit diagram counter. Make connection of JK-Flip Flop as per diagram to construct 4-bit binary counter. Connect LEDs to the outputs pins. Apply the clock pulse and record the output. 	<ul style="list-style-type: none"> Definition of counter Types of counter (synchronous & asynchronous) Purpose of counter. Schematic diagram of a 4-bit binary counter using JK or T Flip Flops and its operations Practical activity: <ul style="list-style-type: none"> Practice to construct a 4 bit up counter using D flip flops. 	Theory-02 Hrs Practical-09 Hrs Total- 11 Hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Cables Wires Non Consumable <ul style="list-style-type: none"> DLD trainer IC's and Components Bread board / Digital Trainer Kit. 5V DC supply LEDs. Connecting leads Digital Multimeter 	Classroom & Lab
LU3:	The trainee will be able to:	<ul style="list-style-type: none"> 4-bit synchronous Counter with D Flip-Flops 	Theory-02 Hrs	Consumable <ul style="list-style-type: none"> Notebooks 	Classroom & Lab

Construct 4-bit synchronous Counter with D flip-Flops	<ul style="list-style-type: none"> • Draw circuit diagram synchronous counter. • Make connection of JK-Flip Flop as per diagram to construct 4-bit synchronous counter. • Connect LEDs to the output pins. • Apply the clock pulse and record the output 	Practical activity: <ul style="list-style-type: none"> • Practice to turn on and off LEDs at output after every count of 5 using D flip flops. 	Practical-06 Hrs Total- 08 Hrs	<ul style="list-style-type: none"> • Pencils • Erasers • Sharpeners • Cables • Wires <div>Non Consumable</div> <ul style="list-style-type: none"> • IC's and Components • Bread board / Digital Trainer Kit. • 5V DC supply • LEDs. • Connecting leads • Digital Multimeter 	
LU4: Troubleshoot different combinational logic circuits.	The trainee will be able to: <ul style="list-style-type: none"> • Identify faults in different combinational logic circuits IC's. • Find the faults. • Troubleshoot the faults 	<ul style="list-style-type: none"> • Troubleshooting of combinational logic circuits 	Theory-02Hrs Practical-09 Hrs Total- 11 Hrs	<div>Consumable</div> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables 	Classroom & Lab

				<ul style="list-style-type: none"> • Wires <div> Non Consumable </div> <ul style="list-style-type: none"> • IC's and Components • Bread board / Digital Trainer Kit. • 5V DC supply • LEDs. • Connecting leads • Digital Multimeter 	
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Module 11 : Configure Arduino

Objective of the module: This module aims to provide the required knowledge to configure Arduino.

Duration:	32 hours	Theory:	08 hours	Practical:	24 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Embed Code in Arduino	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> • Install Arduino IDE • Select Serial Port on which Arduino is connected • Select the relevant board from tools. • Verify the connectivity of board with computer • Select and Run Basic Example Project as guided by instructor • Burn the code on Arduino • Identify that code is uploaded successfully. • Troubleshoot configurations of Arduino IDE (if required) 	<ul style="list-style-type: none"> • Knowledge about different type of micro controllers • Understanding of IDEs. • Basic understanding of Arduino IDE. • Process of installing Arduino IDE. • Knowledge of libraries • Adding libraries in Arduino IDE. • Adding additional boards (nodemcu etc.) in Arduino IDE. • Knowledge about USB mini and USB micro • Process of selecting relevant board • Configure programmer settings (upload speed etc.) in Arduino IDE. • Compile example code in Arduino IDE. • Upload program to the connected Arduino board. • Monitoring, compiling and uploading of the program • Troubleshoot errors. • Open Serial Monitor in Arduino IDE. 	<p>Theory: 04 hrs</p> <p>Practical: 12 hrs</p> <p>Total 16 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Cables • Wires <p>Non Consumable</p> <ul style="list-style-type: none"> • Arduino UNO Board • USB mini cable • White board • Multimedia • Internet 	Class room , Lab

		Practical Activity: <ul style="list-style-type: none"> Practice to Install and update USB to Serial driver for Windows Practice to Select the relevant COM port on Arduino IDE Practice to configure required baud rate of COM port in driver. Practice to select relevant board in Arduino IDE Practice to burn Arduino code Practice to verify code burned successfully and troubleshoot if required 		<ul style="list-style-type: none"> Computer system 	
LU2: Control LED with Arduino	The trainee will be able to: <ul style="list-style-type: none"> Connect LED to digital pin Burn blink code from example projects Check LED is blinking. If not, check its connection and rectify Connect LED to PWM pin Burn fade code from example projects Verify LED is fading. 	<ul style="list-style-type: none"> Understanding of pin configuration of Arduino Understanding of Digital and Analog pins Understanding of PWM. Understanding of LED driver circuit. Connect LED with digital pin of Arduino. Describe uploading of LED blink program to the connected Arduino board. Describe the process of connecting LED with PWM pin of Arduino. Upload LED brightness control program in connected Arduino board. 	Theory: 04 hrs Practical: 12 hrs Total 16 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Connecting Wires (FF, FM etc) Non Consumable <ul style="list-style-type: none"> Arduino UNO LED 	Class room, Computer Lab

		<ul style="list-style-type: none"> • Check the status of LED. <p>Practical Activity:</p> <ul style="list-style-type: none"> • Practice to blink multiple LEDs using Arduino • Practice to identify functionality of components in board e.g inputs, outputs, button, pin 		<ul style="list-style-type: none"> • USB mini cable • White board • Multimedia • PWM • Internet • Computer system 	
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Module 12 : Configure Node MCU

Objective of the module: This module covers the skills and required knowledge to configure NodeMCU.

Duration:	38 hours	Theory:	8 hours	Practical:	30 hours
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Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Embed Code in NodeMCU	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> Connect NodeMCU board with computer Install NodeMCU Library in IDE (ESP-8266) Select and Run Basic Example Project as guided by instructor Burn the code on NodeMCU Verify that code is uploaded successfully Troubleshoot configurations of Arduino IDE (if required) 	<ul style="list-style-type: none"> Differentiation between Arduino and NodeMCU Knowledge to configure required baud rate of COM port in driver. Process to select relevant NodeMCU board in Arduino IDE Basic understanding of firmware. Understanding of System on chip (SoC). Configure programmer settings (upload speed etc.) in Arduino IDE. Compile example code in Arduino IDE. Upload program to the connected board. Troubleshoot errors. Open Serial Monitor in Arduino IDE. <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to connect NodeMCU with computer Practice to burn NodeMCU code 	<p>Theory: 04 hrs</p> <p>Practical: 15 hrs</p> <p>Total 19 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners <p>Non Consumable</p> <ul style="list-style-type: none"> Nodemcu Board USB micro cable White board Multimedia Internet Computer system 	Class room , Computer Lab

		<ul style="list-style-type: none"> Practice to verify code burned successfully and troubleshoot if required 			
LU2: Control LED with NodeMCU	The trainee will be able to: <ul style="list-style-type: none"> Connect LED to digital pin Burn blink code from example projects verify LED is blinking. Connect LED to PWM pin Burn fade code from example projects Verify LED is fading Connect NodeMCU with your WIFI Router Check its output on Serial Monitor 	<ul style="list-style-type: none"> Basic understanding of firmware. Understanding of pin configuration of Arduino Understanding of Digital and Analog pins Understanding of PWM. Understanding of LED driver circuit. Process to connect LED with digital pin of Nodemcu. Describe the process of connecting LED with PWM pin of Nodemcu. Describe uploading of LED blink program to the connected board. <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to blink multiple LEDs using NodeMCU 	<p>Theory: 04 hrs</p> <p>Practical: 15 hrs</p> <p>Total 19 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Connecting Wires LED <p>Non Consumable</p> <ul style="list-style-type: none"> White board Multimedia Internet Computer system Nodemcu USB micro cable 	Class room, Lab

Module 13 : Configure Raspberry Pi

Objective of the module: This module aims to provide the required knowledge to demonstrate the understanding to configure Raspberry Pi.

Duration:	41 hours	Theory:	08 hours	Practical:	33 hours
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Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Set-up Raspberry Pi	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> Download Raspberry Pi OS on your Desktop. Burn Raspberry Pi OS in SD Card. Insert SD card in Raspberry PI. Attach Input Output devices required (Mouse, Keyboard) Install Raspberry Pi OS in Raspberry Pi. Write startup script for Raspberry Pi Execute Basic Linux Terminal commands (make directory, change path) 	<ul style="list-style-type: none"> Knowledge and understanding of terminal Basic Understanding of Raspberry Pi OS Understanding of boot process. Making bootable SD cards. Understanding of Raspberry Pi 3 Board. Basic Linux Commands Importance of date and time setup in Raspberry PI Understanding of executable files command in Linux Editing Linux configuration files. Handling startup scripts Knowledge of shell scripts Connecting Raspberry Pi to the Internet Making Raspberry Pi a Wi-Fi Access Point (Hotspot) <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to download and install OS in Raspberry Pi 	<p>Theory:</p> <p>04 hrs</p> <p>Practical:</p> <p>15 hrs</p> <p>Total:</p> <p>19 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners <p>Non Consumable</p> <ul style="list-style-type: none"> SD card Raspberry Pi3 Internet Computer Multimedia projector Instructional manual UPS 	Class room, Lab

LU2: Set-up Programming Environment	The trainee will be able to: <ul style="list-style-type: none"> • Download GCC compiler through Terminal • Install GCC compiler through Terminal. • Compile and Run “Hello World” Example available on Internet. 	<ul style="list-style-type: none"> • Understanding apt-get repository • Understanding of downloading, installation and remove library command • Understanding of compiler flags • Compiling libraries in Linux • Run executable files in Linux • Producing logs of applications • Understanding of GNU Compiler Collection (GCC) Compiler and compiling process Practical Activity: <ul style="list-style-type: none"> • Practice to compile and run sample code in Raspberry Pi • Practice to identify functionality of components in board e.g inputs, outputs, button, pin 	Theory: 04 hrs Practical: 18 hrs Total 22 hrs	<div>Consumable</div> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners <div>Non Consumable</div> <ul style="list-style-type: none"> • SD card • SD card reader • Raspberry Pi3 • Raspberry Pi Adapter (5V, 2A) • White board • Multimedia • Internet • Computer system 	Class room, Lab
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Module 14 : Configure ESP-32 with LoRa

Objective of the module: This competency module aims to provide the required knowledge to demonstrate the understanding of configure ESP-32 with LoRa.

Duration:	41 hours	Theory:	08 hours	Practical:	33 hours
Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Perform connection of ESP-32 with LoRa Transceiver Module	<p>The trainee will be able to:</p> <ul style="list-style-type: none"> Connect ESP-32 and LoRa Transceiver Module Compare your connections with the circuit diagram provided by your Instructor Select the appropriate Serial Port 	<ul style="list-style-type: none"> Basic Understanding of LoRa and ESP-32 Basic understanding of LoRa protocol Difference between ESP8266 and ESP32 Understanding of Pin Configuration of LoRa and ESP32 Understanding of LoRa sender and LoRa receiver <p>Practical Activity:</p> <ul style="list-style-type: none"> Practice to setup connection of LoRa transceiver module with ESP-32 	<p>Theory:</p> <p>04 hrs</p> <p>Practical:</p> <p>15 hrs</p> <p>Total</p> <p>20 hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Connecting Wires <p>Non Consumable</p> <ul style="list-style-type: none"> ESP32 LoRa module White board Multimedia Internet 	Class room , Lab

				<ul style="list-style-type: none"> Computer system 	
LU2: Perform embedding Code in ESP-32	The trainee will be able to: <ul style="list-style-type: none"> Install LoRa Library (An Arduino library for sending and receiving data using LoRa Radios) in IDE. Select and Run Basic WAN Project on Sender and Receiver (ESP-32) as guided by instructor Burn the code on both ESP-32 Verify that code is uploaded successfully. Troubleshoot Arduino IDE 	<ul style="list-style-type: none"> Understanding of Wireless area network (WAN) Understanding of Packet handling. Basic concept of blocking and non-blocking commands Difference between interrupt and polling Concept of interrupt/polling in LoRa receiver program Interfacing, configuration and Controlling LoRa with ESP32. Practical Activity: <ul style="list-style-type: none"> Practice to compile and run sample code in ESP32 Practice to identify functionality of components in board e.g inputs, outputs, button, pin 	Theory: 04 hrs Practical: 18 hrs Total 22 hrs	Consumable <ul style="list-style-type: none"> Notebooks Pencils Erasers Sharpeners Jumper wires Non Consumable <ul style="list-style-type: none"> ESP32 LoRa module White board Multimedia Internet Computer system 	Class room, Lab

Module 15 Work in a Team Environment

Objective of the module: The aim of this module to get knowledge, skills and understanding to work in a team environment.

Duration: 30 hours **Theory:** 12 hours **Practical:** 18 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU1: Obtain and convey Workplace information	The trainee will be able to: <ol style="list-style-type: none"> 1. Assess the specific and relevant information from the appropriate sources 2. Convey the information using the appropriate medium and ideas 3. Use appropriate non- verbal communication 4. Identify appropriate lines of communication with supervisors and colleagues 	<ul style="list-style-type: none"> • Describe the importance of effective communication • State different Sources of information • State different mode of communication • Explain types of non-verbal communication • Explain mode of communication while operating machines • Explain the method of recording the information/instructions. • 	Theory: 5hrs Practical: 3hrs Total: 8hrs	Consumable <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • Pen • White board marker Non-Consumable <ul style="list-style-type: none"> • White board • Multimedia • Internet 	<ul style="list-style-type: none"> • Class Room/Lab

	<p>5. Use the defined workplace procedures for storage of information</p> <p>6. Inform co-workers and superiors about any deviation</p>	<p>Practical Activity:</p> <ul style="list-style-type: none"> • Role Play each trainee introduce himself. • Convey the job description and company general rules and regulations to fellow workers 		<ul style="list-style-type: none"> • Computer system 	
<p>LU2: Participate in workplace meetings and discussions</p>	<p>The trainee will be able to:</p> <ol style="list-style-type: none"> 1. Express your own opinions 2. Listen other's point of view without interruption 3. Prepare simple questions about workplace procedures 	<ul style="list-style-type: none"> • Describe the protocol of meeting • Describe the role and objective of team. <p>Practical Activity:</p> <ul style="list-style-type: none"> • Participate in mock meeting for preparation to perform job. 	<p>Theory: 2hrs</p> <p>Practical: 5hrs</p> <p>Total: 7hrs</p>	<p>Consumable</p> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • White board marker <p>Non Consumable</p> <ul style="list-style-type: none"> • White board • Multimedia • Internet • Computer system 	<ul style="list-style-type: none"> • Class Room/Lab

LU3: Identify own role and responsibility within team	The trainee will be able to: <ol style="list-style-type: none"> 1. Identify the individual role and responsibilities within the team environment. 2. Recognize the roles and responsibility of other team members. 3. Report relationships within team and external to team 4. Share report with co-workers. 	<ul style="list-style-type: none"> • Describe the importance of creating cooperative work environment • Describe the role and objective of team. • Explain risk of failure team work on the project. • Describe the importance of resolving the co-worker's problems • State plan work and organize required resources in coordination with team Practical Activity: <ul style="list-style-type: none"> • Role Play, get instruction regarding job order from supervisor and convey it to coworkers according 	Theory: 2hrs Practical: 5hrs Total: 7hrs	<div>Consumable</div> <ul style="list-style-type: none"> • Notebooks • Pencils • Erasers • Sharpeners • White board marker <div>Non</div> <div>Consumable</div> <ul style="list-style-type: none"> • White board • Multimedia • Internet • Computer system • White board marker 	<ul style="list-style-type: none"> • Class Room/Lab
LU4: Support the co-workers	The trainee will be able to:	<ul style="list-style-type: none"> • Describe the importance of creating cooperative work environment 	Theory: 2hrs	<div>Consumable</div> <ul style="list-style-type: none"> • Notebooks 	<ul style="list-style-type: none"> • Class Room/Lab

	<ol style="list-style-type: none"> 1. Hand over the required materials and tools timely to interfacing team 2. Work together with co-workers in an effective manner. 3. Address the problems of co-worker effectively 4. Report to immediate boss 	<ul style="list-style-type: none"> • Describe the importance of resolving the co-worker's problems 	Practical: 5hrs	<ul style="list-style-type: none"> • Pencils • Erasers • Sharpeners <div>Non</div> <div>Consumable</div> <ul style="list-style-type: none"> • White board • Multimedia • Internet Computer system	
		Practical Activity: <ul style="list-style-type: none"> • Role Play, Support and guide stressed coworker in his work related activity 	Total: 7hrs		

General assessment guidance for “*Internet of Things*”

Good practice in Pakistan makes use of sessional and final assessments, the basis of which is described below. Good practice by vocational training providers in Pakistan is to use a combination of these sessional and final assessments, combined to produce the final qualification result.

Sessional assessment is going on all the time. Its purpose is to provide feedback on what students are learning:

- To the student: to identify achievement and areas for further work
- To the teacher: to evaluate the effectiveness of teaching to date, and to focus future plans.

Assessors need to devise sessional assessments for both theoretical and practical work. Guidance is provided in the assessment strategy

Final assessment is the assessment, usually on completion of a course or module, which says whether or not the student has "passed". It is – or should be – undertaken with reference to all the objectives or outcomes of the course, and is usually fairly formal. Considerations of security – ensuring that the student who gets the credit is the person who did the work – assume considerable importance in final assessment.

Methods of assessment

For lessons with a high quantity of theory, written or oral tests related to learning outcomes and/ or learning content can be conducted. For workplace lessons, assessment can focus on the quality of planning the related process, the quality of executing the process, the quality of the product and/or evaluation of the process.

Methods include direct assessment, which is the most desirable form of assessment. For this method, evidence is obtained by direct observation of the student's performance.

Examples for direct assessment of Internet of Thing:

- Work performances, for example Create a simple app using app inventor that connects with Arduino board over Bluetooth and receive the sensor data to be displayed.
- Work Performances, for example Develop a regulated power supply that will power up your digital circuit
- Demonstrations, for example Design a Fan dimmer circuit.

- Direct questioning, where the assessor would ask the student why he is preparing for a particular application.
- Paper-based tests, such as short answer questions on health and safety, communication skills etc.

Indirect assessment is the method used where the performance could not be watched and evidence is gained indirectly.

Examples for indirect assessment of Internet of Thing include:

- Work products, IOT Project portfolio
- Workplace documents, such as a report on health and safety etc.

Indirect assessment should only be a second choice. (In some cases, it may not even be guaranteed that the work products were produced by the person being assessed.)

Principles of assessment

All assessments should be valid, reliable, fair and flexible:

Fairness means that there should be no advantages or disadvantages for any assessed person. For example, it should not happen that one student gets prior information about the type of work performance that will be assessed, while another candidate does not get any prior information.

Validity means that a valid assessment assesses what it claims to assess, for example, let's imagine if you have **thousands of sensors**, collecting various data all around us. A solution that scale would be to have these microcontrollers sending data securely to the Cloud.

Reliability means that the assessment is consistent and reproducible. The results for the particular application should be the same.

Flexibility means that the assessor has to be flexible concerning the assessment approach. For example, if there is a power failure during the assessment, the assessor should modify the arrangements to accommodate the students' needs.

Assessment strategy for “*Internet of Things*”

This curriculum consists of 14 modules

- Develop Program and Frontend using framework
- Develop and integrate database with web Applications

- Make rectifier using diodes
- Use of Bipolar Junction Transistor (BJT) and MOSFET in different circuits
- Apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application
- Verify Truth Tables of Digital Gates
- Construct & Verify Combinational Logic Circuit
- Construct and Verify Function of Flip Flops
- Use 555 IC as Multi vibrator
- Construct Shift Registers and Counters with The Help of Flip Flops
- Configure Arduino
- Configure Node MCU
- Configure Raspberry Pi
- Configure ESP-32 with LORA

Sessional assessment

The Sessional assessment for all modules shall be in two parts: theoretical assessment and practical assessment. The Sessional marks shall contribute to the final qualification.

Theoretical assessment for all learning modules must consist of a written paper lasting at least half-hour per module. This can be short answer questions.

For practical assessment, all procedures and methods for the modules must be assessed on a sessional basis. Guidance is provided below under Planning for assessment.

Final assessment

Final assessment shall be in two parts: theoretical assessment and practical assessment. The final assessment marks shall contribute to the final qualification.

The final theoretical assessment shall consist of short-answer questions. This part shall cover the technical, functional and generic modules:

For Level -3

- Module 1 Develop Program and Frontend using framework
- Module 2 Develop and integrate database with web Applications
- Module 3 Make rectifier using diodes
- Module 4 Use of Bipolar Junction Transistor (BJT) and MOSFET in different circuits
- Module 5 Apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application
- Module 6 Verify Truth Tables of Digital Gates
- Module 7 Construct & Verify Combinational Logic Circuit
- Module 8 Construct and Verify Function of Flip Flops
- Module 9 Use 555 IC as Multi vibrator
- Module 10 Construct Shift Registers and Counters with The Help of Flip Flops
- Module 11 Configure Arduino
- Module 12 Configure Node MCU
- Module 13 Configure Raspberry Pi
- Module 14 Configure ESP-32 with LoRa

For the final practical assessment each student shall be assessed over a period of one day, with Four hour sessions for each student. During this period, each student must be assessed on his/her ability to the following parameters of security services;

- Area of responsibility
- Tasks
- Guards
- Resources and duties

Complete list of tools and equipment

Sr#	Description	Quantity
1.	Android Studio	Free
2.	Arduino Uno	25
3.	USB mini wire	25
4.	Audio signal generator.	20
5.	AutoCAD software	5
6.	AVO meter/ Digital multimeter	25
7.	Backup software	Free
8.	Bluetooth module	30
9.	Bootable DVD	30
10.	Bootable OS Flash drive/CD	30
11.	Bread board	25
12.	Bread board / Basic electronics trainer kit	25
13.	Bread board / Digital Trainer Kit.	25
14.	Breadboard	25
15.	C IDE	Free
16.	C/C++ IDE	Free
17.	C/Python IDE	Free
18.	Card reader	50
19.	Circuit Breaker.	25
20.	Computer Networks	1
21.	Computer System Minimum 5th generation with 8 GB RAM and SSD	25
22.	Connecting Wires (FF, FM etc)	10 buses
23.	DC supply (5 V)	25
24.	DCVAC supply	25
25.	Digital clock	3
26.	Digital Multimeter	25
27.	Digital Trainer Kit.	20

28.	DLD trainer	20
29.	Dual trace Oscilloscope 0-20MHZ	20
30.	DVD or BLU-RAY writer	25
31.	Electrician Tool kit.	1
32.	ESP32	25
33.	External Hard disks	5
34.	Flash Drive	5
35.	Function Generator	25
36.	Hard Disk drives and Solid State disks.	25
37.	Instructional manual	5
38.	Insulation remover	25
39.	Internet	1
40.	Java IDE	2
41.	Keyborad	25
42.	Lamp holder	120
43.	Laptop	01
44.	Load (Lamp)	120
45.	Logic Probe.	5
46.	LoRA concentrator board	5
47.	LoRa module	5
48.	Manageable switch	4
49.	Mass Storage	5
50.	Modem/DSL	2
51.	Mouse	25
52.	MQTT broker	25
53.	MS Office	2
54.	MS Power BI	2
55.	Multi Meter	5
56.	Multimedia projector	1
57.	Networking Devices (Router, Modem, Hub, Firewall, Access Points, Switches etc)	2 Sets
58.	Networking Tool Kit	4 kits

59.	NFC	4
60.	Nodemcu Board	4
61.	NodeMCU module	4
62.	Nose Plier	25
63.	Office Suit	2
64.	OS Bootable Mass storage device	2
65.	Oscilloscope	5
66.	Pi Controller	50
67.	Plier	50
68.	Potentiometer	5
69.	Printer	2
70.	Projector	01 for each lab/class
71.	Projector screen	01 for each lab/class
72.	Python IDE	2
73.	RAID	2
74.	RAID card	2
75.	RAM	2 of each type
76.	RapidMiner (CD/Mass Storage)	2
77.	Raspberry Pi Adapter (5V, 2A)	4
78.	Raspberry Pi module	4
79.	Raspberry pi	4
80.	RFID antennas	2
81.	RFID reader	2
82.	Rheostat	2
83.	ROM	5
84.	Router	4
85.	Router software/Firmware.	2
86.	RS232 interfaces	25
87.	Scanner	2

88.	Screw	5
89.	SD card	5
90.	SD card reader	5
91.	Series board.	25
92.	Server machine	1
93.	Signal generator	5
94.	Simulator (Packet Tracer)	2
95.	Smartphone	2
96.	Software Development kit	2
97.	Software for Software based RAID.	2
98.	Software to test network.	2
99.	Solder	5
100.	Source of data sheets	2
101.	SPI Interface	5
102.	Step down Transformer	25
103.	Step down Transformer (Normal and center tapped)	25
104.	System (Windows, Linux)	2
105.	Tool kit.	5
106.	Trainer	5
107.	Troubleshooting software.	2
108.	UART transmitter	120
109.	USART transmitter	5
110.	USB micro cable	5
111.	USB mini cable	5
112.	Valid public cloud subscription	1
113.	Voltmeter	12
114.	VPN software.	2
115.	Vulnerability scanning tool	2
116.	Webcam	2
117.	Webcam (digital camera)	2
118.	Weka Software (CD/Mass Storage)	01

119.	White board	1 each class/lab
120.	Wifi module	5
121.	Wifi router	02
122.	Wire Tester	02
123.	Wireless router	02
124.	ZigBee modules	5

List of consumable supplies

1. Note books
2. Inventory registers
3. Pen
4. Pencils
5. Sharpeners
6. Erasers
7. White board markers (Different colors)
8. A4 papers
9. Valid cloud subscription
10. LEDs
11. Female to female header wires
12. Male to female header wires
13. Jumper wires
14. Resistances, capacitors, diodes, zener diode, relays, transistor etc.
15. PVC wires
16. Digital gates
17. Diac,
18. Triac,
19. FETs
20. RJ 45,
21. Category 5 &6 cable
22. Coaxial cable
23. DVD RWR
24. Soldering wire
25. Soldering paste
26. Two way switch
27. One way switch
28. AND gate (7408 2-input Quad)
29. Coupling capacitors
30. DIAC
31. Diodes
32. FET (JFET/MOSFET)
33. Humidity Sensor
34. IC 74147
35. IC 7445 BCD to decimal decoder
36. Inductors
37. Lamp
38. LM741 IC
39. Load (LED)
40. MOSFET
41. NAND gate (7400 2-input Quad)
42. Network cable CAT5,CAT6
43. NOR gate (7402 2-input Quad)
44. Power diodes (general purpose, Fast recovery & Schottky)
45. Push Button
46. PVC Pipe/Duct.
47. Resistive load
48. RFID tags
49. Safety procedures

50. Safety signs
51. SCR
52. Seven segment display
53. Single pole switch
54. Socket
55. Solenoid Valves
56. Temperature Sensor
57. Test Indicator.
58. TRIAC
59. UJT
60. White Board marker
61. Wooden/PVC board.
62. X-NOR gate (74266 2-input Quad)
63. X-OR gate (7486 2-input Quad)
64. Zener Diode
65. IR Sensor
66. IR Ultrasonic Sensor
67. NOT gate (7404 Hex NOT gate)
68. NOT gate (7404 Hex)
69. Occupancy Sensor
70. One 7404 IC – hex inverter (NOT gate)
71. OR gate (7410 3-input)
72. OR gate 7432 2-input Quad

Credit values

The credit value of the National Certificate Security Services is defined by estimating the amount of time/ instruction hours required to complete each competency unit and competency standard. The NVQF uses a standard credit value of 1 credit = 10 hours of learning (Following Higher Education Commission (HEC) guidelines).

The credit values are as follows:

Competency Standard	Estimate of hours	Credit
Develop Program and Frontend using framework	48	4.8
Develop and integrate database with web Applications	44	4.4
Make rectifier using diodes	50	5
Use of Bipolar Junction Transistor (BJT) and MOSFET in different circuits	44	4.4
Apply Thyristors (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in Various Application	42	4.2
Verify Truth Tables of Digital Gates	48	4.8
Construct & Verify Combinational Logic Circuit	49	4.9
Construct and Verify Function of Flip Flops	43	4.3
Use 555 IC as Multi vibrator	42	4.2
Construct Shift Registers and Counters with The Help of Flip Flops	38	3.8
Configure Arduino	32	3.2
Configure Node MCU	38	3.8
Configure Raspberry Pi	41	4.1
Configure ESP-32 with LoRa	41	4.1

