

**INSTRUMENTATION SECTOR**

**ADVANCED MOUDLES**

**OF**

**SIX MONTHS DURATION**

## Upgradation of ITIs into Centres of Excellence- Broad guidelines for implementation of Advanced Module of “Sector Instrumentation”

These Centers will be providing multiskill training to meet the skill requirement of particular sector of industry with their active involvement in all aspects of training. The training will be provided in three parts as given below:

- ◆ Training in Basic skill areas for a period of one year.
- ◆ Training in Advanced modules of six months duration after Broad based basic Training(BBBT)
- ◆ Testing & Certification both for the Broad Based Basic Training & Advanced Module Training during subsequent six months will be conducted under the aegis of NCVT .
- ◆ Training in specialized modules mainly by the industry (The course curricula, duration etc will be designed in consultations with the IMC/local industry). The trade testing & certification for specialized module will be done jointly by the State Government & Industry. Said certificate will have recognition from NCVT
- ◆ As per the recommendations of the EFC, Training in the shop floor should constitute atleast 25-40% of the curriculum.

The training Programme will have multi-entry and multi-exit provisions as given below:

- Trainee can opt to go to the labour market after completing broad based basic training of one year duration or after completing advanced module/s.
- Multi-entry and multi-exit provisions would enable a trainee to take admission for advanced/ additional advanced /specialized module as per his/her need .

### **Guidelines for Training in Advanced modules**

- A minimum of three modules would be essentially needed, so as to ensure that all the 96 trainees are accommodated in the three modules may be selected in consultation with IMC for which in two shifts .
- If it is felt that available modules for which the course curricula has been developed at National Level are not sufficient to cater to the needs of local industry in a particular state, States are free to select module as per need in consultation with industry . They may develop suitable module(s) accordingly in consultations with the industry clearly indicating tool & equipment list , instructor qualifications , space norms etc. & forward the same to DGE&T for seeking approval of NCVT.
- A trainee at a time can opt only for one Advanced Module .
- Admission Criteria, Space requirement, Qualification of instructor of the various modules of “**Instrumentation** ” sector are attached herewith.

**Admission to Advanced Module for the graduates of ITI in related trades:**

There is a provision for lateral entry for graduates of ITIs (NTC /NAC passed out from conventional system ) of the related trades subject to availability of seats in Advanced Module. Trades of conventional system mentioned against each advanced module in the enclosed statement, could be offered admission in Advanced Module .

MODULE NO.	NAME OF THE MODULE	Admission criteria	Space requirement	Duration In Weeks	Qualification/Status Of Instructor
IAT-01	<b>Industrial Electronics &amp; Instrumentation</b>	Completed BBT in Instrumentation OR NTC/NAC in Instrumentation OR Diploma in Instrumentation	70 sq m	24 weeks	Degree in Electronics /Instrumentation Engg with minimum three years teaching/industrial experience in the relevant field  OR  Diploma in Electronics /Instrumentation Engg with min five years teaching/industrial experience in the relevant field  OR  HNTC in Related area with min five years teaching/industrial experience in the relevant field .
IAT-02	<b>Analytical Instrumentation</b>	Completed BBT in Instrumentation OR NTC/NAC in Instrumentation OR Diploma in Instrumentation			
IAT-03	<b>Process Control Instrumentation</b>	Completed BBT in Instrumentation OR NTC/NAC in Instrumentation OR Diploma in Instrumentation			
IAT-04	<b>Medical Instrumentation</b>	Completed BBT in Instrumentation OR NTC/NAC in Instrumentation /Medical Electronics OR Diploma in Instrumentation			
IAT-05	<b>Optical Instrumentation</b>	Completed BBT in Instrumentation OR NTC/NAC in Instrumentation OR Diploma in Instrumentation			
IAT-06	<b>Electronic Test &amp; Measuring Instruments</b>	Completed BBT in Instrumentation OR NTC/NAC in Instrumentation / Mechanic Electronics OR Diploma in Instrumentation			

**MODULE : INDUSTRIAL ELECTRONICS & INSTRUMENTATION****DURATION : SIX MONTHS (24 WEEKS)**

<b>WEEK No.</b>	<b>THEORY</b>	<b>PRACTICAL</b>
1	Revision, Introduction to hand tools, familiarization with basic measuring instruments, soldering, basic atomic structure, conductor insulator and semiconductor.	Visit to various sections of the Institute. Introduction with Principal and staff, Identification of hand tools and various measuring instruments, soldering, soldering practice on PBC.
2	Operational amplifier construction, input impedance, open loop gain, closed loop gain, inverting amplifier, summing amplifier, integrator differential Op-Amp initialization procedures, CMRR Slew rate offset voltage, voltage follower, voltage to current converter and current to voltage converter, instrumentation amplifier.	Construct and measure output waveforms in inverting non-inverting and summing amplifier, differential amplifier, voltage follower integrators, voltage to current converter and current to voltage converter
3	Oscillators, basic oscillator, tank circuit, damped and un-damped oscillations, Hartley oscillator and culprits oscillator wienbridge oscillator. Integrator, operational amplifier integrator and differentiator. Fixed amplitude sweep, miller time base generator and boot strap time base generator, blocking, oscillators.	Plot the characteristics of phototransistor. Assemble and measure frequency in Hartley oscillator and Culprits oscillator, Crystal oscillator, Weinbridge oscillator. Familiarize with various type of opt coupler. Photo operated S/W.
4	Multivibrators, monostable, bistable and Astable multivibrator, its working, bistable multivibrator with two inputs and two outputs, voltage controlled inverter, their working principle and circuit functions.	Assemble and observe the outputs of monostable, bistable and astable multivibrators using transistors and IC555. Assemble and observe the output of two bistable multivibrator. Astable multivibrator as a VCO. Construct and measure the output of simple inverter, familiarize with emergency lamps fault finding in SMPS.
5	Wave forms, sine wave, unit step, pulse on time, off time duty cycle, delay time, rise time, fall time, clipper, clamper, biased clipper, biased clamper.	Assemble and observe the outputs in clipper, clamper, biased clipper and clamper, differentiator and integrator. Verify the OP AMP as differentiator, as integrator.
6 – 9	Thyristor, SCR its construction and characteristics, SCR forward and reverse bias, various firing methods, SCR gate firing circuit, SCR in AC circuit and natural commutation and forced commutation phase control action of SCR, RC firing circuit, UJT its	Testing of SCR by multimeter, plot the forward characteristics of a SCR, find the latching current and holding current. AC switching circuit by UJT, find the characteristics of UJT, relaxation oscillators. Construct and observe output of UJT firing circuit,

WEEK No.	THEORY	PRACTICAL
	<p>characteristics, stand of ratio, UJT relaxation oscillator, UJT firing circuit pedestal and ramp circuit, temperature controller. SCR with inductive load di/dt characteristics. SCR protection circuit DIAC characteristics, TRIAC construction and characteristics and power control circuit light dimmer fan DC motor speed control using SCR.</p>	<p>light dimmer circuit, pedestal and ramp circuit. Characteristics of DIAC, DIAC as a DC pulse generator, characteristics of TRIAC fan regulated DC motor speed control method and armature current control method. Phase control circuits using SCR, DC Flasher using SCR, Battery charging circuit using SCR, Crow bar protection with SCR.</p>
10 - 11	<p>Digital and analog signals, basic logic functions, basic logic gages, number system, combination, logic gate NOR, NAND, XOR, DNOR, truth tables timing diagram. Excess three code, gray code, BCD code, ASCII code. Application of logic gates, DeMorgan's theorem, universal logic gages, concepts of Carnage map, half adder, full adder, two's compliment, subtraction, controlled inverter, 2's compliment adder/subtractor, 4 bit adder/subtractor. Digital ICs level, Integration families of TTI, ECL and CMOS device positive and negative logic standard TL, Totem pole output propagation delay time and dissipation, TTL characteristics, standard loading.</p>	<p>Realise simple electrical control circuits using various gates. Construct and test half adder, full adder and subtractor circuits. Interface &amp; TTL with CMOS logic. Verify the function of inverter, handle and use TTL and CMOSA family integrated circuits. Familiarization with functional diagram. Convert a binary number to BCD vice versa.</p>
12	<p>Flip-Flop: RS flip-flops, clocked RS with preset, clear inputs, d, JK&lt; T,MSJK flip-flops, timing diagrams, series shift register, bidirectional, parallel, series in parallel out, parallel in series out registers, converters and parallel to series converter. Counter ripples, counter up timing diagram frequency divides, down counter up, counter, decade counter, ring counter and Johnson's counter.</p>	<p>Construct &amp; Test Microprocessor, Down &amp; Up/Down counters using different flip-flops. Connect a thumbwheel S/W and preset a counter. Construct &amp; test a serial to parallel circuit and vice versa.</p>
13	<p>Display devices, LED display, seven segment display, nixle tube, LCD display, display drives, dot-matrix display format, monitors, 4 digit BCD counter with display multiplexing and demultiplexing D to A converter, resistive network, binary ladder, comparator, A to D converter, counter type conversion and continuous type conversion, applications of A/D and D/A converter. Memory, programmable switch concept and type of primary, ROM, RAM, PROM,</p>	<p>Familiarization with common anode, cathode and seven segments, LED display, LCD display and display drivers, construct and observe output of resistive network and binary ladder. D/A converter, observe the output of comparator with different inputs, familiarize with A/D converter familiarize with memory ICs, parallel expansion of memory ICs, EPROM ICs, EPROM programmer, RAM ICs. Connect a thumbwheel S/W and display the set number on a sever</p>

WEEK No.	THEORY	PRACTICAL
	EPROM and EAPROM concept of cache SIMM, SDRAM, SGRAM, VRAM, etc.	segment display. Display a binary number on a 7 segment display.
14	Feed back systems, transducers, various type of transducers used for the process, variable temperature, flow pressure level and speed, their types, functions and working principle, control amplifiers, their necessity, differentiating amplifier, actuators and final control element control valve, solenoid relays, stepper motors and servo motor, their constructional, working principle and applications.	Construction working of various digital instruments their principal block and Schmitt diagram, fabrication, operational, service maintenance and repair content development in progress. Observe the output of various transducers like strain gauge, load cell, LVDT, taco generator, flow sensors, capacitance probe, DP cell etc. Construct and observe output of P amplifiers. Integrator and differentiator, familiarize with motorized control valve and solenoid relay speed. Construct a stepper motor control circuit using discrete digital design
15	IR LEDS, Photo diode for photo transistor, its characteristics and application, optical sensor, opto-computers, circuits with opto isolation, characteristics of LASER diodes Fiber optics applications.	Familiarization with IR LEDS, Photo diodes, photo transistors, optical sensor, opto couplers, LASWR diodes & its applications. Introduction of Fiber optics, its application. Display the contents of a RAM/ROM location on a display. Load a byte of data into a specific RAM location.
16	Microprocessor it introduction, Block diagram & Architecture of 8085 Microprocessor, its internal data operation and registers accumulator, ALU, flags, program counter, control unit, micro instruction and macro instruction, memory interfacing, I/O ports, keyboard interfacing, interrupts interfacing, concept about monitor, Pin configuration, Principle device application and its interrupts and memory organization, classification, format and timing. Brief idea about instruction set, interfacing with 8259, 8357, 8255, 8251, 8279, 8155, 8253, etc. Application such as DAC/ADC stepper motor, traffic light controllers.	Familiarization with 8085 Microprocessor Kit sub systems, its input output connectors for the hardware function and operation. Programme to perform integer division 8 bit by 8 bit & 16 bit by 8 bit. Programme to perform conversion BCD to ASCII, BCD to Hexadecimal. Experiment interfacing Microprocessor with DAC/ADC, Traffic light & stepper motor

WEEK No.	THEORY	PRACTICAL
17 - 18	<p>Introduction to basic 8051 Micro controller its memory management, counters, interrupts, pin configuration, interfacing and applications, I/O Ports, Basic Assembly Language, Programming process, tools and techniques.</p> <p>Programming the 8051 for moving the data in addressing mode, external data mode, push and pop op-codes &amp; data exchange. Logical operation, rotate and swap operations, arithmetic operations like additions, subtractions, multiplications, division, decimal arithmetic, flags, incrementing decrementing, jumping of call operation, returns.</p> <p>Various SFRs and description. Interrupt programming, serial communication in 8051.</p>	<p>Familiarization of 8051 micro controller based kit and study the hardware, function, memory structure and operation of 8051 micro controller kit.</p> <p>Write and execute program for Multiplication of unsigned / signed numbers, division of unsigned / signed numbers, sorting strings in ascending and descending order, modular programming using subroutines.</p> <p>Interfacing using chips, Use of 8279 for communication, use of 8155 (for serial comm..) Traffic light controller by using 8253.</p>
19 - 21	<p>Switch mode power supplies and their working principles.</p> <p>Principles of Inversion and Inverter circuits using different techniques.</p> <p>Pulse width modulation and their applications.</p> <p>UPS principles and various types. (On line/Off line/Line interactive, etc.)</p> <p>AC Motor fundamentals, speed control techniques.</p> <p>DC Motor fundamentals and speed control techniques.</p> <p>Discrete control of AC motor using conventional techniques.</p> <p>Discrete control of DC motor using conventional techniques.</p> <p>DC drive, block diagram and different stages.</p> <p>AC drive, block diagram and different stages.</p> <p>Tachometers and their principles of operation.</p> <p>Micro controller based DC motor drive and parameter settings using necessary software.</p> <p>V/F controlled AC drive and parameters setting using necessary software</p>	<p>Measure and monitor test points/way forms at different stages of SMPS.</p> <p>Measure and monitor test points/way forms at different stages of different types of Inverters.</p> <p>Generation of PWM wave forms using discrete ICs</p> <p>Measure and monitor test points/way forms at different stages of UPS. (On line/Off line/Line interactive, etc.)</p> <p>Measure and monitor test points/way forms at different stages of Analog (Conventional) DC drives.</p> <p>Measure and monitor test points/way forms at different stages of Digital DC drives.</p> <p>Configure different parameters and control AC drive.</p>
22	<p>Industrial Instruments used for Non destructive testing .</p> <p>Principles of RF heating.</p> <p>Ultrasonic equipment used in industrial</p>	<p>Operation of Stroposcope and related measurements. Tachometers and measurements.</p> <p>Identify stages of RF heating control</p>

<b>WEEK No.</b>	<b>THEORY</b>	<b>PRACTICAL</b>
	metal testing. Principles of working of Flaw detector.	equipment and measure wave forms / test points. Perform metal testing using ultrasonic testers.
23 - 24	Principles of working and Programming of PLCs, Addressing concepts, I/O modules, Wiring practices, Interfacing of digital and analog I/O field devices to PLCs, different type of signal modules ( special purpose modules such as high speed counter, thermocouple/RTD modules etc), control of PID loops using PLCS, Applications of PLCS in CNC MACHINES, speed control of motor, Bottle filling, Batch processing, SCADA & Introduction to DCS	Wire field devices to I/O modules Find out the address of field devices and identify them on the program on line Make simple programs and run them to control devices such as relays, solenoid valves etc Edit and make simple modifications and run the programs Troubleshoot the most widely occurring faults using the diagnostic facilities available in the software Interface PLC with AC DRIVE and DC drive and control vital parameters

## **EQUIPMENT LIST: INDUSTRIAL ELECTRONICS & INSTRUMENTATION**

<b>S.No.</b>	<b>Name of the Equipment</b>	<b>Quantity</b>
1.	Soldering iron	10 Nos.
2.	Desoldering pumps	10 Nos.
3.	Soldering station	5 Nos.
4.	IC voltage regulator trainer	5 Nos.
5.	Different regulated power supply PCBs	10 Nos.
6.	Inverter (Transistor, SCR & MOSFET based)	As Required
7.	Battery Charger	1 No.
8.	UPS (On line & Off line)	1 No. Each
9.	SMPS (different make)	5 Nos.
10.	Trigger Module for SCR	5 Nos.
11.	Trigger Module for TRIAC	5 Nos.
12.	Digital IC Trainer	5 Nos.
13.	Logic Probe / Logic Pulsar	5 Nos.
14.	Function generators	5 Nos.
15.	Frequency counters	5 Nos.
16.	Pulse generators	5 Nos.
17.	Oscilloscopes	10 Nos.
18.	Analog multimeters	10 Nos.
19.	Digital multimeters	2 Nos.
20.	IC Tester	5 Nos.
21.	Analog Trainer kits	2 Nos.
22.	LCR meter with display	5 Nos.
23.	FET voltmeters	As Required
24.	Relay & contactors of various types	1 No.
25.	PA System	2 Nos.
26.	LIC trainer kits	5 Nos.
27.	Power supplies of various types	5 Nos.
28.	Tachometers	2 Nos.
29.	Microprocessor Trainer Kit (8085 & 8086)	5 Each (8085, 8086)
30.	Microcontroller Trainer Kits	5 Nos.
31.	Interfacing Modules such as Stepper Motor, Traffic Light, DAC/ADC, Logic Controller	2 Sets
32.	PLC (Allen Bradley)	
<b>TOOLS:</b>		
1.	Tweeter	10 Nos.
2.	Screw driver set	10 Nos.
3.	Pliers set	10 Nos.
<b>FURNITURE:</b>		
1.	Table (Work benches)	5 Nos.
2.	Chairs	20 Nos.
3.	Elmira	4 Nos.
4.	Book shelf	4 Nos.
5.	White Board	1 No.

**MODULE : ANALYTICAL INSTRUMENTATION**

**DURATION : 6 MONTHS (24 WEEKS)**

**Unit-0 Revision of Basic Electronics.**

Fundamental of AC/DC and magnetism.

Types of Meters,

Passive components

Review of electronic devices & circuits

Op-Amp.

Digital Electronics

**Unit 1: Introduction to Analytical Instrumentation.**

Analytical instruments broad view.

Elements of analytical instruments, basic definition

Role of analytical instrumentation

Applications of analytical instrumentation

Quantitative and qualitative analysis

Industries using analytical instrumentation.

**Unit –2 Balances**

Scan gauge pressure transducer, load cell

Function of balance

Measurement of balance, accuracy, error, readability, linearity

Calibration of balances, primary & secondary standards.

**Unit –3 Vacuum**

Vacuum measurements, different vacuum units

Pirani gauge, penny gauge meclaud gauge,

Vaddum pumps, different types diaphragm pumps, diffusion pumps, oil pumps, turbo molecular pumps

Vacuum oven, filtration systems.

**Unit-4 density measurements**

Hygrometers,

Density of gases

Metering orifice, impulse wheel methods, specific gravity measuring systems.

Viscometers.

**Unit-5 Liquid analysis**

Concept of PH, PH meter electrodes

Concept of conductivity, conductivity meter, conductivity electrode

Ion selective potentiometer

Analyzers for measurement of ammonia, silica, sodium and dissolved oxygen

**Unit-6 Thermal analysis**

Basic principles of

- Differential scanning calorimeter
- Thermogravimetry
- Thermo mechanical analysis
- Differential thermal analysis

### **Unit-7 Environmental pollution monitoring**

Air pollution monitoring instrument –carbon monoxide, sulphuric oxide, nitrogen dioxide.

Hydrogen and ozone

Smoke monitor, visible emission monitoring

System emission and absorption of radiation

Einstein relation, pollution inversion

Chemical Oxygen demand & Biological Oxygen demand equipment/instruments.

### **Unit-8 X-ray methods.**

Introduction to X-rays

Concept of x-ray tube and its schematic

Types of x-ray tubes

Different detectors, ionization chamber, Geiger counter, proportional counter, scintillation counter, CCD.

Concept of x-ray absorption methods.

X-ray fluorescence methods

Bragg's law

X-ray diffraction and diffractometers, types

Concept of goniometer, types.

### **Unit-9 Density measurements**

Hygrometers,

Density of gases

Metering orifice, impulse wheel methods, specific gravity measuring systems, Viscometers

### **Unit: 10 Introduction to absorption and emission spectroscopy**

Nature of electromagnetic radiation

Electromagnetic spectrum

Concept of absorption & transmittance.

Relation between incident radiation, Absorption and radiant power

Beer-lambert's law,

Block diagram of instrument modules for measuring absorption of radiation.

Definition of spectrophotometer

Different types of spectrophotometers, brief function.

### **Unit-11 UV-VIS spectrophotometer.**

Different types of radiation sources, (Deuterium discharge lamp, Incandescent lamp)

Different types of detectors(Photo diode/transistor, photo multiplier)

Explain about filters(absorption filters, interference filters)

Functions of monochromator, prism, grating.

Function of slits

Sample handling, cuvettes

Optical schematic of single beam /double beam spectrophotometers.

### **Unit-12 Infrared spectrophotometer.**

Basic principle of IR spectroscopy

Vibration of molecules

Types of IR radiation sources, nichrom coil

Types of detectors, Thermal detectors

Sample handling, gases, liquids, film, pellet, pellet preparation.

Optical schematic of IR spectrophotometers

Fourier transfer concepts & FTIR

### **Unit-13 Flame emission spectroscopy/fluorescence spectroscopy**

Flame emission spectroscopy

Basic principle, concept of nebulisation, burners

Schematic of flame emission spectrophotometer.

Fluorescence spectrophotometer. Basic principle

Basic components of fluorescence instrumentation

Different sources

Schematic of fluorescence spectrophotometer.

### **Unit-14 chromatography**

Introduction to basic principles

Classification of chromatography

Paper and thin layer chromatography

Glass column separations

Liquid chromatography(LC)

Block diagram of general instrumentation of LC

Concept of mobile phase and stationary phase.

Function of solvent delivery systems-HPLC pumps

Sample introduction, syringe injection,

Separation columns , different types

Different detectors-UV, fluorescence, PDS, RI, ELSD.

### **Unit-15: Gas chromatography(GC)**

Basic components of GC, Schematic diagram

Function of sample injection systems

Column oven

Types of detectors, FID, TCD, ECD

Basic of FID

### **Unit-16 Mass spectrometer(MS)**

Basic principles

Different components of MS

Different ionization techniques, EI, CI

Types of detectors-channel electron multiplier

Vacuum system

Types of mass spectrometers, magnetic deflection, TOF , Quadrapole

Concept of interfacing chromatography & mass spectrometry (LC-MS & GC-MS)

### **Unit-17 Basic principles and instrumentation of**

- refractometry
- Interferometry
- Polarimetry
- Optical rotation dispersion
- Capillary electro phoresis

### **Unit –18 Gas analysis**

IR and UV absorption analyzers

Paramagnetic oxygen analysis

Thermal conductivity analyzers

Chemiluminescence analyzer.

### **Unit-19 Indicators and recorders**

Single point indicator, multipoint indicators, analog and digital indicators

Analog and digital recorders, strip chart recorder, x-y recorder, circular recorder, single and multipoint recorders.

### **Unit-20 Computer aided analysis**

Computer organization-hard ware(ALU, control unit, CPU, Memory, IO units, Buses)

Basic computer block diagram

Computer organization-software(machine language, assembly language, high level language, OS translators

Computer –instrument interface

Different communication systems between computer-instrument, IEEE , serial, parallel, LAN< RS-232, optical link.

## **LIST OF EXPERIMENTS**

1. Identification of different components of the UV-VIS spectrophotometer
2. To measure transmission and absorption of a solution using spectrophotometer.
3. Identification of different components of IR spectrophotometer
4. IR pellet making and measurement of IR spectrum
5. Identify the different modules of the LC
6. Identify the different parts of the HPLC pump and measure the flow rate.
7. Identify the different parts of the HPLC detector
8. Identify the different parts of GC
9. Visit to industry for special instruments like mass spectrometer and identify the different parts
10. Visit to industry for special instruments like XRD and identify the different parts
11. Visit to industry for special instruments like DSC/TG and identify the different parts.
12. To find the conductivity ;of the given liquid using conductivity meter
13. To find the PH of the given liquid using PH meter
14. To calibrate the PH meter
15. To study the different ion selective electrodes
16. To find out humidity of the room using hygrometer and comparing with standards
17. To study water analysis kit & measure PH, conductivity, dissolved O<sub>2</sub> , temperature
18. To study the analysis of fuel gases
19. To measure the viscosity of given fluid using viscometer
20. To study the communication (serial, lan, IEE, optical)system between computer and instrument
21. To measure the weight using balance and check the accuracy , repeatability, readability & Linearity.
22. To measure the vacuum of a vacuum pump using vacuum gauges.

## LIST OF INSTRUMENTS/EQUIPMENT ANALYTICAL INSTRUMENTATION

<b>S.No.</b>	<b>Name of the Equipment</b>	<b>Quantity</b>
1.	UV-VIS Spectrophotometer & computer with s/w	1 No.
2.	FTIR spectrophotometer & Computer with s/w	1 No.
3.	KBr press for pellet making	1 No.
4.	HPCL system (modular system) & computer with s/w	1 No.
5.	GC & Computer with s/w	1 No.
6.	Conductivity meter	2 Nos.
7.	pH meters	2 Nos.
8.	Ion selective meter	1 No.
9.	Dissolved O <sub>2</sub> meter	1 No.
10.	Hygrometers	3 Nos.
11.	Water analysis kit	1 No.
12.	Gas analyzers	1 No.
13.	Balances	2 Nos.
14.	Vacuum gauges	2 Nos.
15.	Vacuum pumps	1 No.
16.	Colodmeters	1 No.

TRAINER KITS CAN BE PURCHASED WHEREVER AVAILABLE AS REQUIRED.

## **MODULE : PROCESS CONTROL INSTRUMENTATION (24 WEEKS)**

### **DURATION : 6 MONTHS (24 WEEKS)**

(Two weeks of Basic Electronics Skills and related theory has to be imparted and trouble shooting and fault finding of all the process control instruments has to be carried out)

<b>Week No.</b>	<b>Skill Set</b>	<b>Related Theoretical Instruction</b>
1	Identify, select, verify characteristics and use different type sensors: Proximity sensors, photo-electric sensors, strain gauge, load cell and LDR.	Basics of passive and active transducers – Role, selection and characteristics. Working principles of inductive, capacity sensors, photo – emission, voltaic and conductive cells and their applications. Strain gauge, load cell and LDR – construction and working principles. Earthing and shielding-Safety measures in all units..
2	Identify, select, verify characteristics and use different type temperatures sensors: RTDs , thermister, thermocouples , thermowell , pyrometers and temperature IC's.	Temperature sensing elements – working principles, temperature-resistance characteristic and Industrial applications.
3	Identify, select, verify characteristics and use LVDT and RVDT for different measurements in Industrial applications.	Linear Variable , Differential transformer(LVDT) and Rotary variable Differential transformer(RVDT) – construction, working principles and their Industrial applications.
4	Find out characteristics of <ul style="list-style-type: none"><li>- Photo transistors, photo diode and LED</li><li>- Piezo electric transducer</li><li>- Rotary shaft encoder</li><li>- Smoke detector and Humidity sensor.</li></ul>	Construction, working principles and Industrial applications.
5	Familiarize use of sensors: <ul style="list-style-type: none"><li>- Photo electric sensors for colour detection</li><li>- Wireless sensors</li><li>- Ph electrode and conductivity</li></ul> Practice humidity and moisture measurements.	Construction, working principles and Industrial applications. Charges coupled devices(CCD)-concept.
6	Practice pressure measurements like gauge pressure, vacuum and DP using <ul style="list-style-type: none"><li>- DP meters , Manometers and Elastic pressure sensing elements.</li></ul>	U tube, well type and micro type manometers – construction and working principles. Bourdon tube , Bellows, Capsule, Diaphragm Industrial Applications.
7	Practice pressure measurements using pressure transducers <ul style="list-style-type: none"><li>- Strain gauge</li><li>- Capacitive</li><li>- LVDT and piezo electric.</li></ul>	Operation Instructions and specifications. Measuring procedures.

<b>Week No.</b>	<b>Skill Set</b>	<b>Related Theoretical Instruction</b>
8	Practice operations of <ul style="list-style-type: none"> <li>- Dead weight pressure gauge</li> <li>- Comparator</li> <li>- Low pressure calibrator</li> </ul>	Operation Instructions and specifications. Measuring procedures.
9	Practice vacuum measurements using vacuum gauges.	Vacuum measurement procedures Pirani, Mcleod and Ionisation gauges.
10	Identify and select different types of flowmeters with their functions and specifications. Measure flow of liquid using <ul style="list-style-type: none"> <li>- Variable head / DP flow meter or rotometer</li> <li>- Rotating valve and rotating lobed</li> </ul>	Working principles and measuring techniques of flow meters
11	Practice flow measurements using <ul style="list-style-type: none"> <li>- Orifice plate, Venturi type</li> <li>- Pivot tube</li> <li>- Annobar</li> <li>- Vertex and ultrasonic flow meters</li> <li>- Turbine and mass flow type flowmeters.</li> </ul>	Operation Instructions and specifications. Measuring procedures.
12	Practice level measurements using <ul style="list-style-type: none"> <li>- Sight glass, Float and displacement level gauges.</li> <li>- Capacitive probe technique</li> <li>- Ultrasonic and radiation level gauges</li> </ul>	Construction, working principles, Operation Instructions and specifications. Measuring procedures
13	Practice temperature measurements using <ul style="list-style-type: none"> <li>- Thermometers</li> <li>- Two wire and three wire thermometers</li> <li>- Thermistors</li> </ul>	Thermometer types- By metallic, liquid filled , gas , vapour and pressure thermometers, specifications.
14	Select and use thermocouples (J,K,R,S,E) for temperature measurements in the industry. Measure high temperatures using optical and radiation pyrometers. Adjust, calibrate and test mv Calibrator.	Thermocouple materials and their characteristics, specifications Cold Junction compensation techniques. Mv calculator , constant temperature bath.
15	Operate, verify and compare <ul style="list-style-type: none"> <li>- Thermostat response of temperature controller with specifications.</li> <li>- ON/OFF mode response.</li> <li>- Microcontroller based universal controller- different mode responses.</li> </ul>	Closed Loop system terminology- advantages. Automatic control system elements- functions, servomechanism, process control principles. Feedback controls systems- concept process variables and equation.

<b>Week No.</b>	<b>Skill Set</b>	<b>Related Theoretical Instruction</b>
16	Familiarise the operation PC based automatic process trainer kit Verify responses of ON/OFF and continuous control modes of electronic controller.	Discontinuous modes: Two position, multi position, single speed and multi speed floating types. Continuous modes: P, I, D, PI, PD and PID Operating instructions of automatic Process Trainer.
17	Carryout the following for electronic controllers. <ul style="list-style-type: none"> <li>- Calibration and testing</li> <li>- Optimum setting for unit process</li> <li>- PID mode responses and feed forward control responses.</li> </ul>	Calibration and testing procedure Setting details, feed forward control concept Cascade and Ratio Control Concept Controller tuning methods.
18	Verify responses of ON/OFF, P, I, PI, PD and PID pneumatic controllers. Carryout alignment of PID Pneumatic controller, optimum settings for unit process and response of programmable PID controller.	Pneumatic controller- Blocks-description- modes implementation, Alignment procedure, controller-tuning methods, control system evaluation.
19	Selection, Sizing Operating and maintenance of control valves and valve positioning.	Final control elements: Solenoid , Stepper motor control valve, relays/contacts, of electronic and pneumatic relay logics.
20	Practice, Alignments, Operation, Calibration and use of Electronic recorders and Pneumatic recorders. Carryout preventive maintenance Trouble shoot and rectifications.	Operation and calibration instructions for electronic and pneumatic recorders, Strip chart and circular chart recorders- features Maintenance tools and procedures
21	Adjust, calibrate, operate, test and install <ul style="list-style-type: none"> <li>- Pressure and vacuum gauges</li> <li>- Pressure and DP Transmitters.</li> <li>- P to I, I to P converters.</li> </ul>	Operation, Calibration, Testing and Maintenance instructions. Signal conditioning devices: DP transmitter and I to P and P to I converters, features/ specifications.
22	Practice dismantling and assembling of <ul style="list-style-type: none"> <li>- Pressure gauges and regulator</li> </ul> Installation, maintenance, troubleshoot and rectification.	Dismantling and assembling procedures Pressure regulator construction details. Installation, maintenance and trouble shooting procedures.
23	Measure, calibrate, operate, test and install different flow meters <ul style="list-style-type: none"> <li>- DP , Rotameter, Turbine and Electronic Flow types.</li> </ul> Carryout preventive maintenance.	Instructions for calibration, testing operation and installation. Maintenance tools – preventive and breakdown.
24	Measure, calibrate, operate, test and install different level gauges.	Instructions for calibration, testing operation and installation.

Week No.	Skill Set	Related Theoretical Instruction
	<ul style="list-style-type: none"> <li>- Float and displacement types.</li> </ul> Installation, maintenance, troubleshoot and rectification	Maintenance tools – preventive and breakdown.
25	Calibrate , test and install <ul style="list-style-type: none"> <li>- RTD's, Thermocouples and wells, thermometers, thermistors, pyrometers, smart transmitters and calibrators</li> </ul> Carryout preventive measurements.	Circuit details of temperature sensors and smart transmitters, operation and maintenance instructions.
26	Practice of Control Panel wiring and pneumatic tubing.	Wiring and tubing procedures.
27	Use of P&I diagrams.	Details of P&I diagrams – Industrial applications.
28	Calibration, loop checking, trouble shoot, start up and shut down for 4 domains ( Temperature, pressure flow and level)	Calibration and loop checking details. Trouble shoot chart and remedies Startup and Shut down instructions. Introduction to PLC and DCS.
29	Use of fiber optic communication links.	Fibre optic cables, types , communications basics, specification of cables.

## EQUIPMENT LIST PROCESS CONTROL INSTRUMENTATION

(24 WEEKS)

<b>S.No.</b>	<b>Item</b>	<b>Quantity</b>
1.	Transducer trainer kits	5 Nos.
2.	Photo voltaic cell	5 Nos.
3.	RTDs	5 Nos.
4.	Ovens	5 Nos.
5.	Pyrometer (optical & radiation)	5 Each
6.	Load cells and strain gauge	5 Nos.
7.	LVDT	5 Nos.
8.	RVDT	5 Nos.
9.	Smoke detector	5 Nos.
10.	Humidity sensor	5 Nos.
11.	Rotary shaft encoder	5 Nos.
12.	Tachometer	5 Nos.
13.	Photo diode/transistor	5 Nos.
14.	Electrical actuator	5 Nos.
15.	DMMs	10 Nos.
16.	Thermometers	5 Nos.
17.	Power supplies (0 to 30V)	5 Nos.
18.	Screw driver set	5 Each
19.	Star screw driver	5 Each
20.	Plier	5 Each
21.	Cutter	5 Each
22.	Liquid filled in steel thermometer	4 Nos.
23.	Vapour filled in steel thermometer	4 Nos.
24.	Bimetal type thermometer (digital)	4 Nos.
25.	Liquid filled thermostat (digital)	4 Nos.
26.	Radiation pyrometer	2 Nos.
27.	Thermocouples J, K, R, S & B type	Six Nos.
28.	Constant temperature bath with mv calibrator	
29.	Smart transmitters (resonant)	4 Nos.
30.	U tube manometer	4 Nos.
31.	Well type manometer	4 Nos.
32.	Micro type manometer	4 Nos.
33.	Inclined tube manometer	4 Nos.
34.	Digital manometer/calibrator	4 Nos.
35.	Bourdon type pressure gauges	6 Nos.
36.	Diaphragm seal pressure gauges	4 Nos.
37.	Low pressure diaphragm & pressure gauges	4 Nos.
38.	Low pressure capsule and pressure gauges	4 Nos.
39.	Digital pressure gauges	6 Nos.
40.	Pressure indicator transmitter	6 Nos.
41.	Digital Bargraph indicator (u based)	6 Nos.
42.	Smart pressure & Differential transmitter	4 Nos.
43.	Dead weight tester transmitter	4 Nos.
44.	Low pressure calibrator	4 Nos.
45.	Process scanner	4 Nos.
46.	Air compressor	2 Nos.
47.	Vacuum pump	2 Nos.

<b>S.No.</b>	<b>Item</b>	<b>Quantity</b>
48.	Quantity flow meters/positive displacement flow meters	6 Nos.
49.	Differential flow system using orifice/annobar/flow nozzles	4 Nos.
50.	Rotometer	4 Nos.
51.	Turbie flow meter	2 Nos.
52.	Electromagnetic flow meter	2 Nos.
53.	Ultrasonic flow meter	2 Nos.
54.	Thermal dispersion gas and liquid flowmeters	2 Nos.
55.	Flow indication/totalizers (u based)	2 Nos.
56.	Smart DP flow meter transmitter	4 Nos.
57.	Sight glasses for liquid level measurement	4 Nos.
58.	Different type of level switches	6 Nos.
59.	Level indicators & transmitters for liquid level (different type)	6 Nos.
60.	Conductivity type level sensor based indicating system	2 Nos.
61.	Ultrasonic level measurement system for liquid	2 Nos.
62.	Level controllers	4 Nos.
63.	Digital barometer pressure indicator	4 Nos.
64.	Smart level DP transmitters	2 Nos.
65.	Microprocessor based recorders for flow, pressure & level	4 Nos.
66.	Proximity, sensors/switches for flow, level, pressure measurement	6 Nos.
67.	Pneumatic secondary recorders	4 Nos.
68.	Pneumatic control valves(Various types)	6 Nos.
69.	Advanced PC Based Automatic process trainer with accessories	2 Nos.
70.	Automatic process control trainer for pressure, flow & level	2 No. Each
71.	Pneumatic PID controller	2 Nos.
72.	Pneumatic process simulator	2 Nos.
73.	Pneumatic transmitter for pressure, flow and level	2 Nos. Each
74.	Pneumatic control valve positioners.(various types)	2 Nos.
75.	Solenoid operated hydraulic valves	2 Nos.
76.	Microcontroller based universal controller, temperature, pressure, flow and level	4 Nos.
77.	Pneumatic recorder	4 Nos.
78.	Microcontroller based strip chart recorder	2 Nos.
79.	Microcontroller based circular chart recorder	2 Nos.
80.	PC based recorder	2 Nos.
81.	Stepper motor control valves	2 Nos.
82.	Smart transmitter	2 Nos.
83.	I to P, P to I converters	2 Nos. Each
84.	Single phase converter	4 Nos.

**MODULE : MEDICAL INSTRUMENTATION**

**DURATION : 6 MONTHS (24 WEEKS)**

Week No	Topic	Theory	Practical
1 - 4	Basic Electronics (Revision)	<p><u>AC/ DC:</u> supply sources, Cells &amp; Batteries, Button cells etc., AC Single phase/3-phase concepts, Star- delta concept, Electrical safety.</p> <p><u>Magnetism:</u> Permanent Magnet/ Electromagnet, Electromagnetic Relay.</p> <p>Types of meters, Analog/ Digital Multimeter etc., C.R.O., Function generator.</p> <p><u>Passive components:</u> Resistor – classification &amp; rating, Capacitor – classification &amp; ratings, Inductor – Classification, Transformer – types. RC, RL, LC, RLC series/ parallel circuits, Resonance etc., &amp; other filter circuits. Introduction to crystal. DC motor, principle of operation, types, constructional details, etc.,</p> <p><u>Review of electronic devices &amp; circuits:</u>&gt;&gt; Diodes, Rectifiers, Filters etc. Bipolar Junction Transistor, Junction Field Effect Transistor, MOSFET, Regulated power supplies, Amplifiers, Oscillators, Multivibrators, UJT, SCR, TRIAC, DIAC, LED, LDR, Photo diode, opto-coupler, SMPS. UPS</p> <p><u>Op-Amp:</u> Basic details of the Op-Amp, Instrumentation amplifiers, Bio-medical applications, 555 IC timer circuit.</p> <p><u>Digital Electronics:</u> Basic concepts, Number system, Gates, Boolean algebra, Introduction to flip-flops, counters, ADC &amp; DAC, LSI, MSI, VLSI, CMOS etc.,</p> <p>Microprocessors: Introduction to MP &amp; MC, Ports etc.,</p>	<ul style="list-style-type: none"> <li>- Demonstration of various multi meters used in electronic industry</li> <li>Measurement of AC/ DC voltages, currents</li> <li>- Checking of passive components, fault discussion,</li> <li>- Checking of transformers,</li> <li>- Testing of cells, batteries, Maint. schedule etc.,</li> <li>- Wave form observation in C.R.O. by using function generator.</li> <li>- Demonstration of different motors,</li> <li>- Layout and repairing of electrical installation, Construction of earth pit and testing, testing of leakage currents.</li> <li>- Demonstration of various filters,</li> <li>- Construction of rectifiers, Filter circuits</li> <li>- Construction of CE amplifiers and testing</li> <li>- Construction of Oscillators and testing</li> <li>- Construction of power supplies and testing</li> <li>- SCR, TRIC circuits and testing, Speed control of motors etc.,</li> <li>- Study of different amplifiers using Op-Amp, instrumentation amplifier and testing.</li> <li>- Testing of different Logic gates, flip-flops, counters, study of digital ICs., etc.Verification of</li> </ul>

Week No	Topic	Theory	Practical
			combinational circuits, Logic gates. - Familiarization with microprocessors and microcontroller based equipment kit, Study of microprocessor applications using trainers etc
5 - 6	Basic Anatomy & Physiology	<p><u>Introduction to anatomy:</u> Surface and regional anatomy, cells, tissues and organs, Terminology, blood and their components</p> <p><u>Human physiology:</u> Blood. Lymphatic system. Skeleton. Muscle. The heart. The lungs. Alimentary canal and associated structures. Abdomen, Organ position in the abdomen, Kidney Organs of the head and neck. The brain</p> <p><u>Electro physiology:</u> Nerves, nerve structure, resting potential, action potentials (regeneration), action potential (propagation), volume conductor effects, recorded nerve signals.</p>	<ul style="list-style-type: none"> <li>- Demonstration of Human body and its parts by using Charts, various clay &amp; other models,</li> <li>- Hospital visit.</li> <li>-Construct &amp; test a wheat stone bridge.</li> <li>-Construct &amp; test a Thermo couple.</li> <li>-Construct &amp; test a strain gauge using LVDT.</li> </ul>
7 - 8	Electrodes & Transducers	<p><u>Introduction to medical electronics:</u> Overview of various departments in hospital, equipment found in various department and specialties.. Static &amp; dynamic characteristics of electronic equipment, standards. Generic block diagram of biomedical equipment.</p> <p><u>Introduction to electrode:</u> Electrode, bio-potentials, types of electrodes, shapes &amp; their applications, electro conductive jelly.</p> <p><u>Introduction to Transducer:</u> Define Transducer, classification, configuration of a Whetstone Bridge, Types of transducers used in biomedical instrumentation. Temperature measurement using thermistors, thermocouples, liquid-in-glass thermometer, solid-state sensor.</p>	<ul style="list-style-type: none"> <li>- Construct &amp; test a Strain gauge based on resistance, capacitance / inductance.</li> <li>- Use of various electrodes, making measurements with them,</li> <li>- Use of various transducers and correct usage in the respective area.</li> <li>- Care and maint. of electrodes/ transducers, Sensors.</li> </ul>

Week No	Topic	Theory	Practical
		Displacement/force/acceleration measurement using potentiometers, variable inductance differential transformer (LVDT), strain gauges – measurement types	
9	Bioelectric amplifier	<p><u>Bio-medical signals</u>: Types, definition, characteristics</p> <p><u>Bioelectric amplifiers</u> &gt;&gt; definition, different configurations, Define terms used in bioelectric amps (e.g.: inverter, offset null, zero suppression, summing junction, common mode rejection and virtual ground), need of bioelectric amplifier.</p> <p>Differential amplifier, instrumentation amplifier, isolation amplifier &amp; their types</p>	<p>-To sketch the different bioelectric signals (state typical magnitude and frequency)</p> <p>-Construct &amp; test &gt;&gt; Differential amplifier using op-amp, instrumentation amplifier using op-amp, isolation amplifier.</p> <p>-Instrumentation amplifier &gt;&gt; type number, package, pin diagram.</p>
10	Cables, wires & connectors	Medical probe cable, co axial cable, connectors – for various applications, specification etc. Explain methods of pre-wiring and ways to wire existing buildings including entry, attic and crawl space precautions and methods of fishing walls and routing wiring through false ceilings, List the standards used in the electrical wiring of buildings, good earthing procedure	<p>-Properly prepare cable ends</p> <p>-Install fittings on cable ends and splices,</p> <p>-Wiring a small room as per standards</p> <p>-Preparation of wiring diagram</p> <p>-Earth preparation as per standards</p>
11	Safety	<p>Hazards of medical equipment, physiological effects of electricity, body &amp; skin resistance, classes and type of medical equipment, electrical safety codes and standards, Earthing &amp; macro shock, leakage currents, microshock (cardiac shock), Equipotential grounding, isolation and circuit breakers.</p> <p>Introduction to electrical safety tester</p> <p><u>Electrical Safety testing</u> &gt;&gt; receptacle test, Ground-to-chassis resistance test, chassis leakage current test, lead-to-ground leakage current test, lead-to-lead leakage current test, lead isolation test.</p> <p>Typical values of resistance and leakage current as per IEC 601 test standards</p>	<p>-Identify the class of the medical equipment by power cord and symbol represented on the equipment</p> <p>-Open a circuit breaker and identify the components</p> <p>-Demonstration on equipotential grounding</p> <p>-Familiarization with electrical safety tester</p> <p>-Construct a circuit to perform receptacle test</p> <p>-Perform ground pin to chassis resistance test using multimeter</p> <p>-Perform chassis leakage current test using multimeter</p> <p>-Perform lead-to-ground</p>

Week No	Topic	Theory	Practical
		<p>Preventive maintenance for reducing electrical hazards, reducing ground faults hazards, Describe fire safety rules commonly required for medical equipment maintenance personnel, Precautions required for H.I.V. or TB prevention for hospital workers, List extra precautions biomedical personnel must take to maintain cleanliness standards in medical facilities</p> <p>General safety standards for electro medical equipments</p>	<p>leakage current test using multimeter</p> <ul style="list-style-type: none"> <li>-Perform lead isolation test using multimeter</li> <li>-Perform safety test using electrical safety tester</li> <li>-Develop an electrical safety program for a typical hospital</li> </ul>
12 - 15	Clinical Instruments	<p><u>Introduction:</u> Different type of analytical equipments, Hot air Oven, Incubator, Water bath etc., Purpose, Use, Circuit constructional details, Temperature measurement and Control</p> <p>Introduction to chromatography, Colorimeter, Spectrophotometer, Flame photometer, Working principle, Block diagrams, pH meter, Conductivity meter, Electrophoresis, Auto analyser, Blood gas analyser, Analytical balance, Centrifuge, Microscope, blood cell counter, sterilizers, autoclave</p>	<ul style="list-style-type: none"> <li>- Set the temp. and measure as per the test requirement for heating the sample using Hot air Oven, Incubator, Water bath.</li> <li>- Trace the circuit diagrams.</li> <li>- Identify various controls available on the control panel of colorimeter, Spectrophotometer- meter, Flame photometer and Measure the concentration of the material present in the given sample</li> <li>- Identify various controls and practice their use, Measure acid/ base condition of the given sample using pH meter</li> <li>- Identify various controls and practice their use, measure the concentration of the given sample using Conductivity meter</li> <li>- Identify various controls and practice their use, measure protein etc. content in the given sample solution using Electrophoresis equipment</li> <li>- Identify various controls and practice their use of other equipment</li> <li>-Replacing of fuse, damaged controls</li> <li>-Routine maintenance of all clinical lab</li> <li>-Do's &amp; don'ts in using clinical equipments</li> </ul>

Week No	Topic	Theory	Practical
16	Physio - therapy	<p><u>Introduction:</u> list various physiotherapy equipment and their application</p> <p><u>Short wave diathermy:</u> Basic principle of operation, cable used, radiator used, functional blocks, common problems</p> <p>Ultrasound diathermy: Basic principle of operation, cable used, radiator used, functional blocks, common problems</p> <p>Microwave diathermy: Basic principle of operation, cable used, radiator used, functional blocks, common problems, introduction to Electromagnetic Spectrum</p> <p>Infrared (IR) &amp; UV radiation in physiotherapy, IR lamps, UV sources : construction, types of light source used, application</p> <p><u>Wax bath:</u> construction</p> <p><u>EMG machine</u> &gt;&gt; EMG signal – waveform, characteristics, need block diagram, function, specification, Electrode used and positioning, operation</p>	<ul style="list-style-type: none"> <li>-Identify various controls available on the control panel and practice its operation of the short-wave diathermy machine</li> <li>- Identify various controls available on the control panel and practice its operation of the Micro-wave diathermy machine</li> <li>- Identify various controls available on the control panel and practice its operation of the Ultrasound diathermy machine</li> <li>- Routine maintenance on short wave diathermy, Microwave diathermy and Ultrasound diathermy machines.</li> <li>-Replacing fused bulb in a IR AND UV source</li> <li>-Replacing heating coil in a wax bath</li> <li>- Study of front panel control and functions of EMG machine</li> <li>-Carry out routine maintenance</li> </ul>
17 - 20	Radiology Equipment (X-ray)	<p><u>Introduction of imaging systems</u> &gt;&gt; need, types - X-Ray, ultrasound, CT scan, MRI, PET, etc and their application</p> <p><u>X-Rays</u> &gt;&gt; List the different types of X-Ray systems and their function, X-Ray generation, range of X-rays, Properties, Interaction of X-rays with media, effects of radiation, radiation Hazards &amp; Safety, Introduction to dose meter</p> <p><u>X-Ray radiography system</u>&gt;&gt; Block diagram, X-Ray tube – construction, types, specification, Scattered radiation control, common problems.</p> <p><u>Dark room</u> &gt;&gt; basics, procedure for developing X-Ray film</p>	<ul style="list-style-type: none"> <li>- Draw the layout of a X-Ray room</li> <li>- Identify &amp; draw various controls available on the control panel of the X-ray machine</li> <li>- Know the operating procedure of the each control of the X-ray machine.</li> <li>- Draw x-ray machine and its sections.</li> <li>- Dark room layout.</li> <li>- Identify various stages involved in the process of the film development.</li> </ul>

Week No	Topic	Theory	Practical
	Radiology equipment (Ultra sound)	<p><u>Physics of ultra sound</u> &gt;&gt; basics of ultrasound physics, wavelength, frequency &amp; velocity, reflection, interactions of ultra sound with tissue – acoustic impedance, generation of Ultrasound</p> <p><u>Diagnostic ultra sound scanner</u>&gt;&gt; block diagram, principle of operation Transducer probe - types and application Scanning modes - A-mode, B-mode, M- mode etc. Image processing controls, image presentation controls, image measurement controls of u/s scanner</p>	<ul style="list-style-type: none"> <li>- Draw the layout of ultrasound room</li> <li>- Identify, draw and name the parts of ultrasound machine</li> <li>- Identify &amp; draw various controls available on the control panel of the ultrasound machine</li> <li>- Practice tracing of organs in the human body using different controls of the U/S scanner</li> <li>- Practice connecting the film unit to the U/ S scanner</li> </ul>
21 -23	Cardiac Equipment	<p><u>Introduction</u> &gt;&gt; need, list out the different cardiac equipments and their function, ECG signal – waveform, characteristics</p> <p><u>ECG machine</u> &gt;&gt;classification, block diagram of single channel recorder, function, galvano mechanism, specification, Electrode used and positioning, operation, Functional blocks of ECG machine, functional problems, List the basic care/maintenance of ECG machine Stress test , Holter test, echo cardiograph</p> <p>Pace maker- types, working principle Introduction to EEG</p>	<ul style="list-style-type: none"> <li>-Familiarization of ECG machine front panel / functional controls, electrodes, paper used for recording</li> <li>-Operate ECG machine, loading of paper</li> <li>-Carry out routine maintenance on the machine</li> <li>-Study the front panel control and operation of echo cardiograph</li> <li>-Study the front panel control and operation of pacemaker</li> <li>-BP measurement with manometer and stethoscope</li> </ul>

Week No	Topic	Theory	Practical
	Intensive care equipment	<p><u>Introduction</u> &gt;&gt; need, list out the different ICU/CCU equipments and their function, parameters to be monitored in ICU / CCU / physiological signal – types</p> <p><u>ECG Monitor</u> &gt;&gt; need, block diagram, specification, Electrode used and positioning, operation, Functional blocks of ECG machine, List the basic care/maintenance of ECG monitor</p> <p>Defibrillator &gt;&gt; principle of working, application, paddles and cables used, calculate energy discharged, safety</p> <p><u>Pulse Oximeter</u> &gt;&gt; need, block diagram, specification, Sensor used and positioning, operation, Functional blocks, List the basic care/maintenance</p> <p>BP measurement with sphygmomanometer and stethoscope</p> <p>Working principle of apnea monitor, blood flow phonocardiography, Fetal Monitor, dialysis machine, ventilators.</p>	<p>-Familiarization of ECG monitor front panel / functional controls, electrodes, paper used for recording</p> <p>-Operate ECG machine, loading of ECG paper if supported by the monitor</p> <p>-Carry out routine maintenance on the machine.</p> <p>- Operate Pulse Oximeter, Carry out routine maintenance on the machine.</p>
24.	Respiratory & Operation Theatre Equipment	<p><u>Introduction</u>&gt;&gt; list out the instruments used in the respiratory system and their functions, Describe the various respiratory transducers, Pulmonary parameters, volumes</p> <p><u>Operating room</u>&gt;&gt; Protocols involved in working in the Operating Room (dress code, cleanliness and attitude), List the special equipment used in the OR and their functions, anesthetics used and types commonly used, List the duties of the personnel employed in the Operating Room (e.g.: the nursing staff, biomedical technician, surgeon, etc.), List the functions of the equipment used in the OR</p> <p>Electro surgery generator &gt;&gt; need.</p>	<p>--Familiarization of spirometer &amp; nebulizer machine front panel / functional controls, transducer used</p> <p>- Draw a schematic of an operation theatre</p> <p>-Familiarization of the electrosurgical machine front panel</p> <p>-Safety measures to be adopted when using electro surgery machine</p> <p>-Carry out routine maintenance on electrosurgical machine</p> <p>-Replacement of bulbs in OT lights</p> <p>-visit to hospital</p>

Week No	Topic	Theory	Practical
		<p>principle of operation, List the frequencies commonly used by electrosurgical scalpels, type of waveforms generated (coagulate, cut), List the safety measures to be adopted when using</p> <p><u>Operation theatre light</u> &gt;&gt; types, construction, bulbs –specification</p> <p>Endoscope &gt;&gt; principle of working</p> <p>Operating microscope &gt;&gt; principle of working</p>	

## EQUIPMENT LIST

<b>S/No.</b>	<b>Name of the Equipment</b>	<b>Quantity</b>
1.	HUMAN ANATOMY MODELS	1 SET
2.	HUMAN ANATOMY CHARTS	1 SET
3.	HUMAN ANATOMY CDS	AS REQUIRED
4.	ULTRASOUND DIATHERMY	2 Nos.
5.	MICROWAVE DIATHERMY	2 Nos.
6.	SHORT WAVE DIATHERMY	2 Nos.
7.	TENS UNIT	2 Nos.
8.	INTERFERENTIAL THERAPY MACHINE	2 Nos.
9.	ELECTRONIC TRACTION MACHINE	2 Nos.
10.	EMG MACHINE	2 Nos.
11.	WAX BATH	1 No.
12.	PHOTOTHERAPY LAMPS [IR/UV ETC]	4 Nos.
13.	INCUBATOR	2 Nos.
14.	OVEN	2 Nos.
15.	WATER BATH	2 Nos.
16.	CALORIMETER	4 Nos.
17.	SPECTROPHOTOMETER	2 Nos.
18.	FLAME PHOTOMETER	2 Nos.
19.	MICRO SCOPE – FOR PATHLOGY	2 Nos.
20.	PH METER	2 Nos.
21.	CONDUCTANCE METER	2 Nos.
22.	ELECTROPHORESIS	1 No.
23.	SEMI AUTO ANALYZER	1 No.
24.	BLOOD CELL COUNTER	2 Nos.
25.	BLOOD GAS ANALYZER	2 Nos.
26.	CENTRIFUGE (ELECTRICAL )	2 Nos.
27.	CENTRIFUGE (HAEMATOCRIT)	2 Nos.
28.	ULTRA SOUND MACHINE WITH FILM UNIT	2 Nos.
29.	COLOUR DOPPLER ULTRA SOUND MACHINE	1 No.
30.	PHANTOM	2 Nos.
31.	THERMAL PRINTER	2 Nos.
32.	MOBILE X-RAY MACHINE- 100MA	2 Nos.
34.	DENTAL X-RAY MACHINE	1 No.
35.	DOSI METER	2 Nos.
36.	FILM DRYER	1 No.
37.	300 MA X-RAY MACHINE**	--
38.	X-RAY SERVICE TOOLS & EQUIPMENTS	2 SETS
39.	DARK ROOM ACCESSORIES	AS REQUIRED
40.	EMG MACHINE	1 No.
41.	EEG MACHINE**	--
42.	AUDIOMETER	2 Nos.
43.	DIALYSIS MACHINE**	--
44.	EEG SIMULATOR**	--
45.	SINGLE CHANNEL ECG RECORDER	6 Nos.
46.	MULTI CHANNEL ECG RECORDER	2 Nos.
47.	ECG MONITOR / CARDIAC MONITOR	4 Nos.
48.	DEFBRILLATOR	2 Nos.
49.	NON-INVASIVE BLOOD PRESSURE METER	4 Nos.

<b>S/No.</b>	<b>Name of the Equipment</b>	<b>Quantity</b>
	[SPYGMANOMETER]	
50.	STETHOSCOPE	4 Nos.
51.	PACE MAKER	2 Nos.
52.	ECG WAVE FORM SIMULATOR	2 Nos.
53.	PULSE OXIMETER	2 Nos.
54.	VENTILLTOR & ASSOCIATED UNITS	1 No.
55.	NEBULIZER- ULTRASONIC, DIAPHRAGM, PISTON	2 Nos.
56.	APNOEA MONITOR	2 Nos.
57.	FOETAL MONITOR	1 No.
58.	HOLTER MACHINE	2 Nos.
59.	ELECTRO SURGERY UNIT [DIATHERMY]	2 Nos.
60.	ENDO SCOPE [FIBRE OPYTICS]	1 No.
61.	OPERATION THEATRE LAMP	1 Nos.
62.	SURGEON'S HEAD LAMP	1 No.
63.	THEATRE LIGHTING [VARIOUS]	4 Nos.
64.	VOLTAGE STABILIZER, 5KVA OR AS REQUIRED	1 No.
65.	ANY OTHER SPARE FUNCTIONAL CIRCUIT BOARD / CARD	AS REQUIRED
66.	MAINTENANCE TOOL KIT	20 SETS
67.	WORK BENCH / TABLE / TEST BENCH	5 Nos.
68.	REVOLVING CHAIR / STOOL [FOR PARTICIPANTS]	20 Nos.
69.	STAFF TABLE	2 Nos.
70.	REVOLVING CHAIR [FOR STAFF]	2 Nos.
71.	STEEL RACKS	6 Nos.
72.	STEEL ALMIRAH	3 Nos.
73.	STEEL LOCKERS FOR 20 PARTICIPANTS	AS PER AVAILABLE DESIGN
74.	GLUCO METER	2 Nos.

**\*\* EQUIPMENTS NEED NOT BE PURCHASED. THE PARTICIPANTS CAN BE TAKEN FOR A VISIT FOR HAVING EXPOSURE ON THESE EQUIPMENTS**

**LIST OF EQUIPMENT REQUIRED FOR  
MEDIA DEVELOPMENT & TEACHING AID**

<b>CATEGORY</b>	<b>S.NO</b>	<b>NAME OF THE EQUIPMENT</b>	<b>TOTAL QTY</b>
MEDIA DEVELOPMENT & TEACHING AID	1.	DESK TOP COMPUTER / LAP TOP	06 Nos.
	2.	SOFTWARE FOR MEDIA DEVELOPMENT & PRESENTATION [LIKE MS-OFFIC OR ANY OTHER LATEST SOFTWARE]	1 No.
	3.	LCD PROJECTOR	1 No.
	4.	OVER HEAD PROJECTOR	2 Nos.
	5.	TV	1 No.
	6.	CD / DVD PLAYER	1 No.
	7.	MUSIC SYSTEM	1 No.
	8.	LASER PRINTER	2 Nos.
	9.	AMPLIFIER SYSTEM WITH SPEAKERS & CHORDLESS MICROPHONE [S] & SHIRT MOUNTED MICROPHONE	1 No.
	10.	ANY OTHER SPARE CIRCUIT BOARDS / SPARE PARTS FOR THE EQUIPMENT	AS REQUIRE D
	11.	GLASS BOARD	1 No.
	12.	WHITE BOARD	1 No.
	13.	COMPUTER TABLE	2 Nos.
	15.	COMPUTER REVOLVING CHAIR	2 Nos.
	FURNITURE FOR CLASS ROOM	16.	TABLE FOR CLASS ROOM
17.		CLASS ROOM CHAIR FOR STAFF	1 No.
18.		CLASS ROOM CHAIR FOR STUDENTS	20 Nos.
19.		FURNITURE FOR FOR TV	1 No.
20.		FURNITURE FOR AUDIO SYSTEM	1 No.
MISCELLANEOUS	21.	UPS, 3 KVA OR AS REQUIRED	1 No.
CIVIL WORK [AIR CONDITIONONG / PARTIONING / CARPETING ETC FOR CLASS ROOM ]	22.	--	AS REQUIRE D

**MODULE : OPTICAL INSTRUMENTATION**

**DURATION : SIX MONTHS (24 WEEKS)**

Week No.	Theory	Practical
1 - 6	<p>Measuring unit system, Precision and errors, construction working of measuring tools like, sale, vernier caliper, micrometer Height gauge, thread ring and plug gauge, various kind of cutting tools. Grinding tools, attachments of grinding machines.</p> <p><u>Surface Hardening:</u> Introduction of surface hardening, tempering annealing and normalizing, heat treatment method, and hardness testing.</p> <p><u>Super finishing:</u> Principle of super finishing, electrolytic etching and inachining surface coating, chemical colouring, powder coating, practice on CNC lathe Machine(Trainer Model).</p> <p><u>OPTICAL PHYSICS:</u> Source of light, nature of light, theories of optical spectrum, Luminance, Luminous flux, Threshold wave length, monochromatic light, reflection, refraction, Absorptions, Transmittance, Radiation, Infrared and ultra violet radiation.</p>	<ul style="list-style-type: none"> <li>• Skill and accuracy based work practice on Lathe and Instrument lathe machine, Milling machine and Shapers.</li> <li>• Practice on Use of special attachments, proper clamping and centering of jobs on above machines.</li> <li>• Tools and Cutter grinding practice, using pedestal and surface grinding machine. Grinding practice of taps and reamers.</li> <li>• Practice on three Directional Engineering Machine.</li> <li>• Practice on Heat treatment of steel, (annealing, hardening and tempering).</li> <li>• Visit to Industry to have Demo and understand Honning, Lapping, Ultrasonic machining, electrolyte cutting, surface coating, chemical colouring and powder coating.</li> <li>• Fabrication of conical, cylindrical, cuboids, pyramids, shapes using sheets.</li> <li>• Practice of fitting of lenses and mirrors on Holders for optical instruments.</li> <li>• Visit to Industry to understand lens manufacturing process, and coatings.</li> </ul>
7- 10	<p>9. Reflection and refraction, laws of reflection, reflection on plane and curved surface, Lens formula, method of finding of focal length, magnification factor and refractive Index. Optical Flats and their application Prism, light refraction through PRISM, Optical grating. Scattering of light in Atmosphere. Eye glass their types and specification, Magnifying lens and their resolution,</p> <p><u>Radiometry land Photometry ;</u> Terms related to radiometry and photometry, Laws of illumination, photometry and radiation measuring</p>	<ul style="list-style-type: none"> <li>• To verify laws of reflection using plane mirrors.</li> <li>• To find focal length of convex and concave mirrors, by different methods.</li> <li>• To find focal length of convex and concave lenses.</li> <li>• To dismantle and assemble and adjust land test optical bench.</li> <li>• To find magnification of lenses.</li> <li>• To operate optical Disc to understand laws of light.</li> <li>• To understand refraction using optical flats.</li> </ul>

Week No.	Theory	Practical
	system. <b>10. OPTICAL DETECTORS &amp; TRANSDUCERS :</b> Photo emissive cells, photo conductive cells, photo diode, photo transistors, photo voltaic cell, optical transducers, their types and specification, light attenuator and suppressors, photometry radiometry filters Bar Graph : ENCODER & DECODER	<ul style="list-style-type: none"> <li>• To identify, test and practice on use and application of optical sensor and detector.</li> <li>• To plot and study characteristic of LDR, LOD, LDT, Photo voltaic cell.</li> </ul>
11 - 16	Principle, construction & parts working, specification and application of telescope (reflection and refractive), Astronomy Telescope, binocular and Epidiascope, Construction, parts nomenclature, specification and working principle of simple and compound microscopes, Application of microscope in different areas, Graticule, Toolmaker, maker microscopes, Diascopes, Construction, working principle of Overhead Balance, physical single pan optical weighing bridges, Construction, working principle, specification and application of Optical Techometers & Stroboscopes	<ul style="list-style-type: none"> <li>• Identification and laser marking.</li> <li>• To familiarize with optical fiber kit</li> <li>• To determine the losses in optical fiber by measuring Input and Output power of optical fiber.</li> <li>• To determine link in optical fiber.</li> <li>• To assemble dismantling of fiber optics kit.</li> </ul> <p>Exercise on cable printing and testing.</p>
17 - 18	<b>LASER:</b> Basic principle of laser optics, spontaneous and stimulated emission, Laser action, condition of Laser action, Laser beam, characteristics of Laser beam, concept of coherence, Introduction to semiconductor laser, Gas laser Dylaser and their application.	
19 - 24	<b>FIBER OPTICS :</b> Principle of Fiber Optics, optical fibers, classification of optical fibers, Angle and numerical (N.A.), aperture, properties of optical fiber, Testing method of optical fiber, Application of optical fiber, Mechanical properties of optical fibers, specification of optical fiber, lightening method using fiber optics for Industrial measurement and inspection, Multiple optical fiber, Fiber optics sensors and their advantages.	

## LIST OF TOOLS & EQUIPMENTS FOR OPTICAL INSTRUMENTATION

<b>S No</b>	<b>Name of Tool &amp; equipment</b>	<b>Qty</b>
1.	Screw Drivers 100mm	16 Nos.
2.	Screw Drivers 150 mm	16 Nos.
3.	Screw Drivers 300mm	16 Nos.
4.	Screw Drivers Heavy Duty	16 Nos.
5.	Screw Drivers Star Type	16 Nos.
6.	Screw Drivers Set	16 Nos.
7.	Screw Driver Set Philips Type	16 Nos.
8.	Neon Tester	16 Nos.
9.	Caliper out side 15 Cm	16 Nos.
10.	Caliper Inside	16 Nos.
11.	Divider Inside	16 Nos.
12.	Scriber 15 Cm	16 Nos.
13.	Vernier Caliper	16 Nos.
14.	Micro meter	16 Nos.
15.	Sphero meter	16 Nos.
16.	Vernier Height Gauge	16 Nos.
17.	Bevel protractor	16 Nos.
18.	Combination Pliers	16 Nos.
19.	Long Nose Pliers,	16 Nos.
20.	Side Cutting Pliers	16 Nos.
21.	Wire Stripers	16 Nos.
22.	Crimping and Clamping Pliers	8 Nos.
23.	Hand Drill machine	8 Nos.
24.	Moterised portable drill machine	4 Nos.
25.	Drill bit set	4 Nos.
26.	Hammer ball pein 0.250 Kg	4 Nos.
27.	Hammer ball pein 0.500 Kg	4 Nos.
28.	Hammer cross pein 0.250 kg	2 Nos.
29.	Hack Saw frame 200mm	8 Nos.
30.	Tri square	16 Nos.
31.	Tenon saw	4 Nos.
32.	Steel Rule 30 Cm	16 Nos.
33.	Files Flat 2nd Cut 150mm & 300mm	4 Nos.
34.	File Flat Smooth 150 mm & 300 mm	4 Nos.
35.	File Round smooth	16 Nos.
36.	File Half Round Smooth	16 Nos.
37.	File Half Round 2nd Cut	16 Nos.
38.	File Half Round 2nd cut	16 Nos.
39.	Steel Rule & Steel tape	4 Nos.
40.	Straight edge 45o mm Steel	4 Nos.
41.	Surface plate 45X45 Cm	4 Nos.
42.	Universal Scrubbing block	4 Nos.
43.	Taps & Dies Set Complete in B A threads	4 Nos.
44.	Taps & Dies Set Complete up to 15mm by .55 mm in metric system	4 Nos.
45.	Can oil 0.25 Lts	4 Nos.
46.	Can oil 0.5 Lts	4 Nos.

<b>S No</b>	<b>Name of Tool &amp; equipment</b>	<b>Qty</b>
47.	Chisel Cold 19mm flat	4 Nos.
48.	Chisel Cold 25 mm	4 Nos.
49.	"C" Clamp 5 cm	16 Nos.
50.	Bench Vice 12 Cm jaw	8 Nos.
51.	Stake hetch	4 Nos.
52.	Stake hetch Round	4 Nos.
54.	Anvil Face 12 cm X 7 Cm	4 Nos.
56.	Hammer Planishing	4 Nos.
57.	Sheer tin-man's 25 Cm	16 Nos.
58.	Snip Straight 20 Cm	4 Nos.
59.	Snip Curved 20 Cm	4 Nos.
60.	Rivet Set and snap combined 4mm	4 Nos.
61.	Double ended and Box spanners set	8 Each
62.	Bit center 6,8,10, 122 mm	8 Nos.
63.	Auger 12, 16, 20, 22 & 25 mm	8 Nos.
64.	Firmer Gauge 6,8,10,12,15mm	8 Nos.
65.	Standard Sheet metal gauge	8 Nos.
66.	Soldering Iron 15W	16 Nos.
67.	Soldering Iron 30W	16 Nos.
68.	Soldering Iron 65W	4 Nos.
69.	Soldering Gun 250 W	4 Nos.
70.	Temperature Control Soldering & Desoldering Station 15W	4 Nos.
71.	C D Drives ( Laser)	4 Nos.
72.	CD Drives Alignment Kit with Software	2 Nos.
73.	Photo voltaic Cell, Photo diode, LDT, Trainer Kits with some application provision	2 Nos.
74.	Optical pyrometer	
75.	Laser Optics Trainer Kit with attachment	2 Nos.
76.	Tong tester with all Voltage current and continuity testing	8 Nos.
77.	Brad Board with + 5v, +12 V Power supply, & pulse generator	
78.	Singe phase Wattmeter 230v 5kVA	4 Nos.
79.	Earth tester	4 Nos.
80.	Analog Multimeter	4 Nos.
81.	Digital Multimeter 4 -1/2 Digit with capacitance, inductance, frequency and db, temperature Measurement facility	4 Nos.
82.	Drilling Machine 0-12mm moterised with Chucks, Keys All Accessories	2 Nos.
83.	Instrument Lath Machine with all accessories and attachments	4 Nos.
84.	High Precision Lathe Machine with all accessories and attachments	4 Nos.
85.	Pedestal Grinder with wheels with all accessories and attachments	2 Nos.
86.	Surface Grinding Machine with all accessories and attachments	2 Nos.
87.	Milling Machine universal with all accessories and attachments	2 Nos.
88.	Milling Machine Horizontal all accessories and attachments	2 Nos.
89.	Milling Machine vertical with all accessories and attachments	2 Nos.
90.	Shaper machine Milling Machine universal with all accessories and attachments	4 Nos.
91.	X Y Z Direction Engraving Machine	2 Nos.
92.	Carbide Cutter Set	As Reqd
93.	Double ended Buffing Machine with detachable buffing wheels	2 Nos.
94.	Optical Bench with all Milling Machine universal with all accessories and	8 Nos.

<b>S No</b>	<b>Name of Tool &amp; equipment</b>	<b>Qty</b>
	attachments	
95.	Tele Scope	4 Nos.
96.	Astronomy Telescope	4 Nos.
97.	Binocular	4 Nos.
98.	Student Microscope with all attachments	4 Nos.
99.	Medical Microscope with all attachments	4 Nos.
100.	Industrial microscope with all attachments	4 Nos.
101.	Tool maker Microscope with all attachments	4 Nos.
102.	Traveling Microscope	4 Nos.
103.	Stereoscopic Microscope	4 Nos.
104.	Multi purpose microscope	4 Nos.
105.	Theodeolite	4 Nos.
106.	Prismatic Compass	4 Nos.
107.	Liquid Filled Prismatic Compass	4 Nos.
108.	Magnascope	4 Nos.
109.	Optical Tachometer	4 Nos.
110.	Portable multipurpose Microscope	2 Nos.
111.	Micro hardness tester	4 Nos.
112.	Metallurgical Microscope with CCTV Camera & TV	2 Nos.
113.	Fiber Optics Luminance System	4 Nos.
114.	Digital Lux meter	
114.	Fiber Optics Kit With all attachments and accessories	8 Nos.
116.	Fiber Optics cable jointing and handling tools Kit	8 Nos.
117.	Inverter 1 KVA	2 Nos.
118.	UPS off line 750 VA	2 Nos.
119.	Voltage Stabilizers 2 KVA	2 Nos.
120.	LEAD ACID Batteries 120 AH	4 Nos.
121.	Battery Charger SCR/ Misfit based 6A with protections	6 Nos.
122.	LVDT Trainer Kit with accessories	4 Nos.
123.	Load Cell Kit	4 Nos.
124.	Speed measurement Trainer Kit using Techo generator and optical Pulse feed back	4 Nos.
125.	Temperature sensors & measurement System using Thermo couple RDT Thermisters	4 Nos.
126.	LCD Projector with Screen & Lap top	1 No.

**MODULE : ELECTRONIC TEST AND MEASURING INSTRUMENTS**

**DURATION : 06 MONTHS (24 WEEKS)**

**OBJECTIVE :** Participant will able to:  
**Repair and maintain each of the following instruments/test point study/study of various block diagrams and circuit diagrams.**

<b>Week No.</b>	<b>Theory</b>	<b>Practicals</b>
1	<p>a) Introduction to various tools and their application ,like screw driver, plier, Nose plier, cutter, tweezers, magnifying lens, spanner, LN key, soldering iron, desoldering pump.</p> <p>b) Introduction of various test instruments physically and to know operation and its measurement.</p>	<p>a) Familiarization with various tools and its proper use.</p> <p>b) Familiarization with trainer model of :</p> <ul style="list-style-type: none"><li>i) Analog multimeter</li><li>ii) Digital multimeter</li><li>iii) Pulse generator</li><li>iv) Function generator</li><li>v) Sinewave/squarewave generator</li><li>vi) Regulated power supply</li><li>vii) Storage CRO &amp; CRO</li><li>viii) Digital panel meter</li><li>ix) LCR- Q meter</li><li>x) Logic probes</li><li>xi) Frequency counters</li></ul>
2	<p>Theory, Classifications and colour coding of various passive components like :</p> <ul style="list-style-type: none"><li>a) Resistor</li><li>b) Capacitor</li><li>c) Inductor</li></ul>	<p>Identification of components</p> <ul style="list-style-type: none"><li>a) Resistor<ul style="list-style-type: none"><li>i) Find value with colour coding &amp; multimeter</li><li>ii) Finding wattage</li></ul></li><li>b) Capacitor<ul style="list-style-type: none"><li>i) Types of capacitor</li><li>ii) Polarized &amp; Non Polarized type capacitor</li><li>iii) Value reading with colour coding, multimeter &amp; LCR-Q meter.</li></ul></li><li>c) Inductor – value reading with LCR –Q meter.</li></ul>
3	<p>Theory of various Active components like:</p> <ul style="list-style-type: none"><li>a) Diode</li><li>b) Zener diode</li><li>c) Tunnel diode</li><li>d) Transistor (BJJ)</li><li>e) FET</li><li>f) MOSFET</li><li>g) UJT,(f) IGBT</li></ul>	<p>Identification of components</p> <ul style="list-style-type: none"><li>a) Diode-Variou type of diodes, Testing and reorganization of diode leads with coading and multimeter.</li><li>b) Transistor lead identification (B,E,C) and its testing with multimeter .</li><li>c) NPN/PNP transistor</li></ul>

Week No.	Theory	Practicals
		d) Signal transistor/power transistor e) Type of FET, N-channel, P-channel ,testing of FET f) Identification and testing of MOSFET/UJT/IGBT
4	Theory of : a) SCR b) Diac c) Triac d) Step up & step-down transformer e) Isolation transformer f) Variac g) Introduction to digital IC h) Introduction to Analog IC	Identification and testing of : a) SCR : with multimeter/by suitable biasing b) Diac: with multimeter c) Triac: with multimeter by suitable biasing d) Digital IC testing with digital IC tester and logic probes e) Analog IC testing with analog IC tester f) Testing of transformer
5	Study of Analog multimeter a) Block diagram & specifications b) Construction of moving coil meter c) DC voltage measurement circuit d) Resistance measurement circuit e) DC current measurement circuit	a) Calibration of Analog multimeter b) Construction and repair of moving coil meter. c) Tracing circuit and identification of components d) Ac voltage measurement e) DC current measurement f) Resistance measurement
6	Study of digital multimeter a) Block diagram and specification b) Displays, LED/SCD type c) Introduction to A/D converter d) Study of IC used in DMM/display driver IC, 7106,IC7107 e) AC / DC voltage measurement circuit description f) AC / DC current measurement circuit description g) Resistance measurement circuit	a) Circuit diagram, reading and tracing of circuits b) Calibration of instruments c) Measurement with h) AC/DC voltage i) AC/DC current j) Resistance k) Capacitance/frequency l) hfe/transistor testing
7	Study of pulse generator for block diagram and circuit diagram of (a) Trigger Circuit (b) Gating circuit (c) Auto/Manual circuit (d) Wave form Inversion Circuit	a)To know the operation of pulse generator b)Calibration of pulse generator c)Generating wave form and testing on CRO d)Changing of frequency and pulse repetition rate and see wave form on CRO
8	Study of function generator a)Specification and block diagram b)Study of various circuit diagram	a) Operation and calibration of function generator b) Generation of various wave form on CRO and its measurements c) Tracing of circuit Test point measurement on CRO
9	Study of Sin & square wave signal generator a) Specification and block diagram	a) Tracing of circuit b) Calibration of instruments c) Observation of Sin/Square wave

Week No.	Theory	Practicals
	b) Study of various circuit diagrams	on CRO and its measurements d) Measurements of wave form at various test points
10 - 11	Power supply: 1) Regulated Power Supply a) Need of regulated power supply b) Various type of circuits of regulated power supply c) Regulated power supply ICs 2) SMPS a) Block diagram and circuit diagram of SMPS b) Specifications of SMPS c) SMPS ICs	1) Familiarisation with the power supply a) Testing of power supply circuit b) Tracing of circuit and components c) Line regulation/load regulation/ripple d) Calibration ;of voltage/currents DPMS e) Working with Regulated Power Supply ICs 2) Familiarization with SMPS a) Testing of voltage current waveform on CRO b) Study of duty cycle control logic and its ICs
12 - 13	Study of simple and storage type of cathode ray oscilloscope a) Specification and block diagram b) Coupling circuit c) X Amplifier/Amplifier circuit d) Trigger Amplifier e) Trigger switching circuit f) Time base circuit	Familiarization of front panel, operating knobs of CRO and switches- a) Calibration of CRO b) Measurements i) Frequency ii) Voltage AC/DC iii) Current AC/DC c) Component testing d) Storage of Data/wave forms in storage CRO e) Direct digital display output in storage CRO
14	Study of Digital Panel Meter: a) Block diagram of DPM b) Circuit diagram and its study c) IC used-7106 or any other d) Study of 7-segment display	Familiarization with the front panel and digital display. a) Calibration of DPM b) Application of input voltage and reading output c) Tracing of circuit and components
15	Study of LCR-Q meter a) Block diagram of LCR-Q meter b) Circuit diagram and its study	Familiarization with the front panel, digital read out and various operating switches- a) Measurement of resistance b) Measurement of Capacitance c) Measurement of inductance d) Measurement of quality factor.
16	Study of Logic Probes- A) Block diagram of Logic Probes B) Circuit diagram study of logic probes	Familiarization with various high/low /unstable stage output LED of logic probes- a) Checking of digital IC with the logic probes b) Checking of pulse wave form with logic probes
17	Study of digital frequency counter- a) Block diagram and circuit diagram study of the frequency counter	Familiarization of digital display and various knobs of frequency counter a) Connecting a function generator to

Week No.	Theory	Practicals
	<ul style="list-style-type: none"> <li>b) Study of various IC of frequency counter</li> <li>c) Circuit diagram study of digital display decoder of frequency counter</li> </ul>	<ul style="list-style-type: none"> <li>frequency counter and read the output frequency</li> <li>b) Tracing of circuit of frequency counter</li> <li>c) Checking the various test point on CRO</li> </ul>
18 - 22	Trouble shooting, Repair and maintenance of analog multimeter, digital multimeter, CRO, pulse generator, function generator, sine/square wave generator, power supply, SMPS, LCR-Q meter, logic probe and digital frequency counter	<ul style="list-style-type: none"> <li>a) Reading of block diagram and circuit diagram on PCBs</li> <li>b) Tracing the circuit diagram</li> <li>c) Study and specification of various analog/digital ICs in instruments</li> <li>d) Detecting faulty components</li> <li>e) Creating the fault in instruments and rectify it.</li> </ul>
23 - 24	Calibration and error calculation of all above instruments	<ul style="list-style-type: none"> <li>a) Calibration of instruments given to the points on the PCBs.</li> <li>b) Calibration by matching with the standard instruments.</li> <li>c) Finding the error in readings.</li> </ul>

## COMPONENTS / TOOLS / INSTRUMENTS LIST

Sl.No.	Components	Quantity
1.	Resistance 1 E, 10E, 18E, 100E, 570E, 880E, 1K, 1.8K, 4.8K, 5.6K, 8.2K, 8.9K, 10K, 22K, 47K, 220K, 470K, 880K, 1M, ½ watt each	100 Nos. Each
2.	Resistance wire wound type 10E, 1K, 10K, 22K 5watts each.	50 Nos. Each
3.	Ceramics Resistance 10E, 100E, 1.8K, 10K - 10watt each	20 Nos. Each
4.	Capacitor 10E, 100E, 1.8K, 10K –10Watt each	20 Nos. Each
5.	Various other types of capacitors of different values	100 Nos. Each
6.	Inductor 100 mH, 1000mH, 1H, 10H, 100H – 2watt each	10 Nos. Each
7.	Rectifier diode/1Amp, 2Amp, 4Amp each	50 Nos. Each
8.	Zener Diode 2.4V/5.2V/12V/24V- ½ Watt each	50 Nos. Each
9.	Transistor(Lower power & Power)	50 Nos. Each
10.	FET (N channel & P channel)	30 Nos. Each
11.	MOFET(N channel & P channel)	30 Nos. Each
12.	UJT	10 Nos.
13.	IGBT	10 Nos
14.	Diac	10 Nos
15.	Triac	10 Nos
16.	SCR (Low power & Power)	10 Nos. Each

### TOOLS

Sl.No.	Name of Instrument	Quantity
1.	Soldering Iron(25 watt)	10 Nos.
2.	Desoldering pump	10 Nos.
3.	Screw driver set	5 Sets.
4.	Combination Plier	5 Nos.
5.	Nose plier	5 Nos.
6.	Wire stripper	10 Nos.
7.	Tweezer	10 Nos.
8.	Magnifying Glass	5 Nos.
9.	Spanner Set	5Sets
10	Allen Key (small size)	5 Sets

### INSTRUMENTS

Sl.No.	Name of Instrument	Quantity
1.	Analog Multimeter	10 Nos.
2.	Digital multimeter	10 Nos.
3.	Function Generator Trainer Kit	06 Nos.
4.	Pulse Generator Trainer Kit	06 Nos.
5.	CRO Trainer Kit	06 Nos.
6.	Storage type CRO	03 Nos.
7.	Regulated power supply trainer kit	06 Nos.

8.	SMPS Trainer Kit	06 Nos.
9.	Sin/square wave signal generator Trainer Kit	06 Nos.
10.	Digital IC tester	03 Nos.
11.	Analog IC tester	3 Nos.
12.	Digital panel meter	6 Nos.
13.	Logic Probes	6 Nos.
14.	LCR-Q meter, trainer kit(if trainer kit not available, only LCR-Q meter)	6 Nos.
15.	Tong Tester	6 Nos.
16.	Insulation tester	6 Nos.
17.	Frequency counter trainer kit	6 Nos.
18.	Sophometer (for audible sound measurement)	6 Nos.
19.	Desk top digital multimeter	2 Nos.
20.	Soldering station 25 watt/0-400 degree centigrade	6 Nos.
21.	Desoldering station	6 Nos.