

**Syllabus for the Trade
of**

TECHNICIAN POWER ELECTRONICS SYSTEMS

(SEMESTER PATTERN)

UNDER

CRAFTSMAN TRAINING SCHEME

**Re-designed in
2014**

By

Government of India

**Directorate General of Employment & Training
Ministry of Labour & Employment (DGET)**

GENERAL INFORMATION

1. **Name of the Trade** : **TECHNICIAN POWER ELECTRONICS SYSTEMS**
2. **NCO Code No.** :
3. **Duration** : 02 years (Four semesters having duration of six months each)
4. **Power Norms** : 5 Kw
5. **Space Norm** : 70 Sq mtrs
6. **Entry Qualification** : Passed 10th class examination under 10+2 system of education
7. **Unit Size (No. of Students)** :20 Trainees

8. Instructor's/Trainer's Qualification :

- a) B.E./B.Tech in Electronics/Electronics & Telecommunication /Electronics & Communication with one year experience in the relevant field
OR
- b) Diploma in Electronics/Electronics & telecommunication/ Electronics & Communication from recognized board of technical education with two years experience in the relevant field.
OR
- c) NTC/NAC in the trade with three years' experience respectively in the relevant field

9. **Desirable qualification** : Preference will be given to a candidate with Craft Instructors Certificate (CIC).

Note: At least one Instructor must have Degree / Diploma in the relevant field.

COURSE INFORMATION

Trade: - TECHNICIAN POWER ELELCTRONICS SYSTEMS

1. Introduction :-

This course is meant for the candidates who aspire to become a Technician to Maintain and Repair Power Electronic Equipment.

2. Deliverables:- After successful completion of this course the trainee shall be able to perform the following skills with proper sequence.

1. Identify various active and passive components and their applications.
2. Handle different types of Electronic measuring Instruments
3. Identify different types of faults in electronics equipments.
4. Repair & maintenance computer hardware & networking
5. Repair and maintenance of SMPS, UPS, Inverter, solar power system and various analog and digital circuits.
6. Repair and maintenance of electronics pneumatics systems, fiber optics.
7. Installation of various transducer, sensor.
8. Repair maintenance of microcontroller based systems.
9. Repair maintenance& installation of A.C./ D.C. Drive, Servo motors etc
10. Repair maintenance& installation of PLC Controlled system.
11. Repair maintenance& installation of Electrical control of AC/DC machines.

Employment Opportunities:- On successful completion of this course, the candidates shall be gain fully employed in the following industries:

1. Various Industries involved in Manufacturing Machine Controls.
2. Industrial automation related industries
3. Service industries like BSNL, MTNL, Home appliances manufacturing company, Railways, ISRO, Naval dockyard, RCF, BPCL etc.
4. Various Power electronics related industry.
5. In public sector industries like BHEL, BEML, NTPC, etc and private industries in India & abroad, petrochemical industries like ONGC, IOCL, HPCL etc
5. Private companies involved in executing turn key projects relating to automation, drives, mechatronics based projects
6. Self employment

Further learning pathways:

- On successful completion of the course trainees can opt for addition NCVT certificates in the following courses by doing the Third and Forth semester since the first and second semester is common for all three Electronics courses.
 - A. Mechanic Electronic Consumer appliance
 - B. Electronics Mechanic
- Also on successful completion of the course they can pursue Apprenticeship training in the reputed Industries / Organizations.
- They can have lateral entry to Diploma course

Syllabus for the Trade of “Technician Power Electronics Systems”

Duration: 6 Months

First Semester

Semester Code: PES: SEM I

Fundamentals of Electrical and Electronic components

OBJECTIVES:

- Familiarize with basics of electricity
- Identify and Use different hand tools
- Testing of electrical parameters, cables and measurements
- Identify and test cells/batteries
- Identify and test passive electronic components
- Use electronic components in different circuits
- Practice soldering and de-soldering of various types of electrical and electronic components
- Identify and test semiconductor devices
- identify , disassemble, and assemble a computer system
- replace various functional parts HDD, CDD, SMPS, Memory etc
- Practice of OS, Clean the system using Antivirus software and maintain the computer system
- Work with MS office packages
- Familiarize with internet browsing, creation of mail IDs, download desired data from internet using search engines

SYLLABUS FOR TRADE PRACTICAL AND TRADE THEORY SEMESTER-I

Week No	Trade practical	Trade theory
1	<p><u>Trade and Orientation</u> Visit to the institute and workshops. Introduction with the principal and other staffs. Care and safe working habits, safety precautions to be demonstrated to the trainees. Elementary first aid practice. Identify different types of fire extinguishers. Do's and Don'ts and standard practices to be followed in the institute</p>	<p>Introduction to NCVT and certification mechanism. Semester system and its flexibility for the trainee and to the institute. EM trade and its applicability in industries. Expectations of the industry from trainees after the completion of the trade. The skills to be acquired to become part of industry. Introduction to safety, safety signs, and measures to be taken to maintain the standards of safety of personal working and the equipments. Different first aid mechanisms to rescue the affected by electric shocks or any physical injuries.</p>
2 – 3	<p><u>Hand Tools and their uses</u></p> <ul style="list-style-type: none"> • Demonstration and uses of hand tools- screw drivers, pliers, tweezers, tester, wire stripper, electrician knife, steel rule, scriber, punches, hack saw, hammer, files, bench vice and drilling machine. • Simple mechanical fixtures • Identification of types of screws, bolts, nuts, washers, rivets, clamps, connectors • Fix screws of different sizes on wooden boards • Cutting of wooden blocks using hand/hack saw • Simple fitting practice and drilling practice • Simple sheet metal works 	<p>Identification, specifications, uses and maintenance of commonly used hand tools. Riveting of tags and lugs, cutting and bending of sheet metals, chassis and cabinets.</p>
4 – 5	<p><u>Basics of AC and Electrical Cables</u></p> <ul style="list-style-type: none"> • Identify the Phase, Neutral and Earth on power Socket. • Construct a test lamp and use it to check mains healthiness. • Use a Tester to monitor AC power. • Measure the voltage between phase and 	<p>Basic terms such as electric charges, Potential difference, Voltage, Current, Resistance. Basics of AC & DC. Terms such as +ve cycle, -ve cycle, Frequency, Time period, RMS, Peak, P-P, Instantaneous value. Single phase and Three phase supply. Terms like Line and Phase voltage/ currents. Insulators,</p>

	<p>ground and rectify earthing.</p> <ul style="list-style-type: none"> • Identify and test different AC mains cables. • Skin the electrical wires /cables using the wire stripper and cutter. • Measure the gauge of the wire using SWG. • Prepare the mains cable for termination. • Crimp the lugs to wire end and Solder the lugs to wire end • Solder/crimp/terminate different types of electrical connectors • Measure AC and DC voltages using multi meter. 	<p>conductors and semiconductor properties. Different type of electrical cables and their Specifications. Types of wires & cables, standard wire gauge(SWG). Classification of cables according to gauge(core size), number of conductors, material, insulation strength, flexibility etc.</p>
6	<p><u>Cells & Batteries</u></p> <ul style="list-style-type: none"> • Identify the primary and secondary cells • Measure and test the voltages of the given cells/battery using analog / digital multimeter. • Charging and discharging the battery. • Maintain the secondary battery. • Use a hydro meter to measure the specific gravity of the secondary battery. 	<p>Battery /Cells: construction, types of primary and secondary cells, materials used, Specification of cells and batteries. Charging process, efficiency, life of cell/battery. Selection of cells / Batteries etc. Use of Hydrometer. Types of electrolytes used in cells and batteries. Series / parallel connection of batteries and purpose of such connections.</p>
7-9	<p><u>Passive Components</u></p> <ul style="list-style-type: none"> • Identify the different types of resistors • Measure the resistor values using colour code and verify the reading by measuring in multi meter • Identify the power rating using size • Verify ohms law • Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter • Identify different inductors and measure the values using LCR meter • Identify the different capacitors and measure capacitance of various capacitors using LCR meter • Make an electro magnet. • Install a solenoid valve in a flow line. • Identify and test the circuit breaker and other protecting devices. • Dismantle and identify the different parts of a relay. • Connect a relay in a circuit and test for its working • Dismantle and identify the different parts of the electrical contactor • Connect a contactor in a circuit and test for its working 	<p>Ohm's law and its variables. Resistor-definition, types of resistors, their construction & specific use, color-coding, power rating. Equivalent Resistance of series parallel circuits. Distribution of V & I in series parallel ckts. KVL& KCL with applications. Principles of induction, inductive reactance, Types of inductors, construction, specifications and applications (energy storage concept). Self and Mutual induction. Behavior of inductor at low and high frequencies. series and parallel combination, Q factor. Capacitance and Capacitive Reactance, Impedance. Types of capacitors, construction, specifications and applications. Dielectric constant. Significance of Series parallel connection of capacitors. Capacitor behavior with AC and DC. Concept of Time constant of a RC circuit. Concept of Resonance and its application in RC, RL& RLC series and parallel Types and circuit Properties of magnets and their materials, preparation of artificial magnets, significance of electro magnetism, types of cores.</p>

	<ul style="list-style-type: none"> • Construct and test RC time constant circuit • Construct a RC differentiator circuit and convert triangular wave into square wave • Construct and test series and parallel resonance circuit 	Electromagnetic Relays, types, construction, specifications- coil voltage and contact current capacity.
10	<p><u>Transformers</u></p> <ul style="list-style-type: none"> • Identify different types of mains transformers and test. • Identify the primary and secondary transformer windings and test the polarity. • Identify different sizes, shapes of cores used in low capacity transformers. • Measure the primary and secondary voltage of different transformers • Construct a low voltage night lamp • Identify and test the variac 	Working principle of a Transformer, Transformer construction, Types of cores used. Specifications of a transformer, Step-up, Step down and isolation transformers with applications. Different type of losses in Transformers, Phase angle, phase relations, active and reactive power, power factor and its importance in the industry.
11- 12	<p><u>AC & DC measurements</u></p> <ul style="list-style-type: none"> • Identify the meter for measuring AC & DC parameters • Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R) • Replace the fuse, battery for the given multimeter • Identify the different controls on the CRO front panel and observe the function of each controls • Measure DC voltage, AC voltage ,time period using CRO • Identify the different controls on the function generator front panel and observe the function of each controls • Connect the function generator to CRO and observe the different wave forms 	Introduction to electrical measuring instruments, Importance of meter, classification of meters, forces necessary to work a meter. MC and MI meter, range extension, need of calibration, characteristics of meters and errors in meters. Multi meter, use of meters in different circuits. Care and maintenance of meters. Use of CRO, Function generator, LCR meter
13	<p><u>Soldering & De-soldering and switches</u></p> <ul style="list-style-type: none"> • Identify different types of soldering guns and practice soldering of different electronic active and passive components and IC bases on lug boards and PCBs • Join the broken PCB track and test • Practice de-soldering using pump and wick • Prepare component for soldering. • Demonstrate soldering and de-soldering using soldering and de-soldering stations • Identify and use SPST, SPDT, DPST, DPDT, tumbler, push button, toggle, 	Different types of soldering guns, related to Temperature and wattages, types of tips. Solder materials and their grading. Use of flux and other materials. Selection of a soldering gun for specific requirement. Soldering and De-soldering stations and their specifications. Different switches and their specification, uses.

	<p>piano switches used in electronic industries</p> <ul style="list-style-type: none"> • Make a panel board using different types of switches for a given application 	
14-15	<p><u>Rectifiers</u></p> <ul style="list-style-type: none"> • Identify diodes, diode bridges • Record the specifications of different diodes using data book/ web site • Identify different packaging styles of diodes and heat sinks types • Test the given diode using multi meter • Construct and test Diode as a half wave, full wave and Bridge rectifier. • Construct a rectifier with capacitor filter circuit and measure the output voltage • Use CRO to observe the ripple from rectifiers for different load and filter capacitors • Identify and Test Zener diode. • Construct and test Zener based voltage regulator circuit. 	<p>Semiconductor component number coding for different electronic components such as Diodes, Zeners. PN Junction, Forward and Reverse biasing of diodes, Interpretation of diode specifications Forward current and Reverse voltage, packing styles of diodes. Diode Bridge Modules. Rectifier configurations, their efficiencies, Filter components and their role in reducing ripple. Working principles of Zener diode / specifications / applications, Varactor diode /Tunnel diode/ specifications with applications.</p>
16	<p><u>IC Regulators</u></p> <ul style="list-style-type: none"> • Identify the different types of fixed +ve and -ve regulator ICs and the different current ratings (78/79 series) • Identify the pins • Construct a fixed voltage regulator as a variable one by floating the reference • Identify the different heat sinks for IC based regulators • Observe the output voltage of different IC regulators by varying the input voltage • Construct a dual power supply by using the fixed IC regulators with current limiting and short circuit protection features 	<p>Regulated Power supply using 78XX series, 79XX series, Op-amp regulator, 723 regulator , (Transistorized & IC based) voltage regulation, error correction and amplification etc.</p>

17-21	<p><u>Computer Hardware, OS, MS office Networking</u></p> <ul style="list-style-type: none"> • Identification of various indicators, Connectors, ports on the computer cabinet • Identify drives and their capacity. • Identify various connectors and cables inside the cabinet & Identify connections to rear side and front panel of the cabinet • Identify various parts of the system unit and motherboard • Disable certain functionality by disconnecting the concerned cables (like USB, SERIAL, Flat) • Replace the CMOS battery • Replace/Extend a memory module • Test and Replace the SMPS • Replace the given HDD on the system • Replace the given DVD on the system • Configuring and troubleshooting display problems • Boot the system from different options • Practice various features of OS • Perform maintenance of the computer using standard tools provided in the OS • Install a Printer driver software and test for print outs • Install antivirus software and scan the system and Explore the configuration options in the antivirus software • Install MS office software • Use start menu, check available programs in computer, use search, settings, run and options. Creation of short cuts • Changing screen savers • Create folder and files, Drawing pictures using paint, using menus of paint • Explore different Menu/Tool/ Format/status bars of MS word and practice the options: Editing the text, saving the text, changing the font and size of text. • Creation of brochures and taking the printouts • Practice the Mail merge and Hyperlink options • Prepare a power point presentation on any three known topics with various design features • Prepare a power point presentation with different animation and visual effects. • Invoke excel sheet from MS WORD and vice versa • Convert the given PDF File into WORD File 	<p>Basic blocks of a computer, Hardware and software, I/O devices, keyboard, types of mouse and their working, Different types of printers, their function and inter-connection and their advantages HDD, CDD, DVD. Various ports in the computer.</p> <p>POST Booting concept.</p> <p>Windows O.S.</p> <p>MS widows: Starting windows and its operation, file management using explorer, Display & sound properties, screen savers, font management, installation of program, setting and using of control panel., application of accessories, various IT tools and applications, Components of desk top</p> <p>Concept of word processing.: MS word – Menu bar, standard tool bar, saving, copying, deleting & retrieving files, page setting, editing, formatting, advance features i.e. highlighting, cut & paste, subscript & superscript drawing features, mail merging, Hyperlink, tables and borders, printing of document etc.</p> <p>Excel – Worksheet basics, data entry and formulae. Moving data in worksheet using tool bars and menu bars, Formatting and calculations, printing worksheet, creating multiple work sheets, creating charts, changing chart types, Adding titles, legends and gridlines, colouring charts, printing charts, placing charts in a word file.</p> <p>Introduction to power point Basics of preparing slides, different design aspects of slides, animation with slides etc</p> <p>Concept of Internet, Browsers, Websites, search engines, email, chatting and messenger service. Downloading the Data and program files etc.</p> <p><u>Computer Networking:-</u></p> <p>Network features-Network topologies, protocols- TCP/IP, UDP, FTP, models, types, network components, network medias, Specification and standards, types of cables, UTP, STP, Coaxial cables. Network components like hub, Ethernet switch, router, NIC Cards, connectors,</p>
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	<p>using suitable software. (<i>use free downloadable software</i>)</p> <ul style="list-style-type: none"> • Use of search engines, Creation of email accounts, sending and receiving the mails configuration of email clients. • Identify the cables and network components. • Making UTP cross cables and testing, Making straight cables and testing, Making cable layout drawing 	<p>media and firewall. Difference between PC & Server.</p> <p>Operating system -OS, NOS-features, types etc.</p> <p>Identify physical topology of a network and members of the network, Internet search engines and applications.</p>
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SYLLABUS FOR WORKSHOP SCIENCE AND CALCULATION SEMESTER-I

Week No	Workshop calculation & Sc.
1	FPS,CGS,SI Units dimensions and conversions
2 – 3	Fundamentals and derived units, Supplementary units
4 – 5	Basic algebra - algebraic formula. Simultaneous equation– quadratic equations.
6	Simultaneous linear equation in two variables. Factorization.
7-9	Ohms law: Current, voltage, resistance and related problems, multiple and submultiples units, electric power, power dissipation in resistance, power formulas. Calculation of Equivalent resistance of series and parallel circuits Calculation of voltage and current in series and parallel resistive circuits
10	Calculations related to transformers, turns ratio, voltage ratio, current ration & efficiency,
11-12	Calculations related extension of Direct-current meters: Moving coil meter Loading effect of voltmeters related problems
13	Heat and temperature, its units and specific heat of solids, liquids and gases
14-15	Half wave, full wave and bridge rectifier dc output, ripple factor, efficiency calculations
16	Calculation on zener regulator circuits.
17-21	Time constant calculation of RC circuit. Voltage, current, phase angle and Impedance calculation of RC, RL Circuits Voltage, current, phase angle and Impedance calculation of RLC Circuits Calculation of resonant frequency of series and parallel circuits

SYLLABUS FOR ENGINEERING DRAWING SEMESTER-I

Week No	Engineering Drawing
1	Engineering drawing and its importance
2 – 3	Free hand sketches of straight line, square, rectangle, circle, polygon etc.
4 – 5	Free hand sketches of hand tools
6	Types of lines
7-8	Dimensions and its types. Use of drawing instruments, T square, set square etc. Lettering practice
9	Types and Scaling of drawings. Electrical symbols
10- 11	Symbols of electronic components
12	Schematic diagram of Moving coil meter, Moving Iron meters,
13	Schematic diagram voltmeter, Ammeter, Ohm meter.
14-15	Draw Half wave, full wave and bridge rectifier circuits with and without filters
16	Regulated power supplies with capacitors
17-21	Orthographic 1 st angle projection

Syllabus for the Trade of “Technician Power Electronics Systems”

Duration: 6 Months

Second Semester

Semester Code: PES: SEM II

Analog and Digital Electronic Circuits

OBJECTIVES

- Construct and test simple amplifier circuits
- Construct and test wave shaping circuits
- Identify and test power electronic components
- Identify and test opto electronic devices
- Practice SMD Soldering and De-soldering of Simple SMD components
- Identify and verify truth tables of various digital ICs using Data book
- Practice circuit simulation software to simulate and test the circuits
- Stimulate and test various circuits using the software
- Identify and test various types of LEDs and LED displays
- Construct and test various OP-AMP IC based circuits
- Construct and test 555 IC based application circuits

**SYLLABUS FOR TRADE PRACTICAL AND TRADE THEORY
SEMESTER-II**

Week No	Trade practical	Trade theory
1	<p style="text-align: center;"><u>Transistor</u></p> <ul style="list-style-type: none"> • Identify PNP and NPN Transistors • Record the different specification of transistors using data book/web site • Identify different transistors with respect to different packaging styles, power, switching transistor, heat sinks • Measure E-B, C-B & C-E terminal resistances and infer. • Construct and test a transistor based switching circuit to control a relay (use Relays of different coil voltages and Transistors of different β) • Construct a Transistorized amplifier vary the gain by changing the circuit components 	<p>Construction, Working of a PNP and NPN Transistors. Purpose of E, B & C Terminals. Flow of currents into and out of terminals of PNP/ NPN Transistors and their relations. Significance of β of a Transistor Need for Biasing of Transistor junctions, Interpretation of main parameters of a Transistor. V_{BE}, V_{CB}, V_{CE}, I_C, I_B, Junction Temperature, junction capacitance, Frequency of operation, Discuss a Transistor application as a switch. Discuss a Transistor application as an amplifier. Define input impedance and output impedances</p> <p>Transistor power ratings & packaging styles, use of different heat sinks.</p>
2-3	<p style="text-align: center;"><u>Amplifier</u></p> <ul style="list-style-type: none"> • Construct and test voltage divider bias • Construct and Test a common emitter amplifier with and without bypass capacitors • Construct and Test common base amplifier • Construct and Test common collector/emitter follower amplifier • Construct and Test Darlington amplifier • Construct and test a two stage RC Coupled amplifier • Construct and test a Class B complementary push pull amplifier • Construct and test class C Tuned amplifier 	<p>Transistor (CB, CE & CC) configurations and their characteristics and applications</p> <p>Transistor biasing circuits and stabilization Techniques.</p> <p>Classification of amplifiers according to frequency, mode of operation, methods of coupling, Voltage amplifiers- voltage gain, loading effect. Configuration of common emitter, common base, common collector transistor, their definition characteristics and applications. Single stage CE amplifier, (CC amplifier) emitter follower circuit and its advantages RC coupled amplifier, Distinguish between voltage and power amplifier, Push pull amplifier and class C tuned amplifier Alpha, beta, voltage gain, Concept of dB dBm. Feedback and its types.</p>

4	<ul style="list-style-type: none"> • Demonstrate Colpitts oscillator, Hartley oscillator circuits • Construct and test a RC phase shift oscillator circuits • Construct and test a crystal oscillator circuits • Demonstrate Astable, monostable, bistable circuits using transistors. 	<p>Introduction to positive feedback and requisites of an oscillator, Study of Colpitts, Hartley, Crystal and RC oscillators.</p> <p>Types of multi vibrators and study of circuit diagrams</p>
5	<p><u>Wave shaping circuits</u></p> <ul style="list-style-type: none"> • Construct and test shunt clipper • Construct and test series and dual clipper circuit using diodes • Construct and test clamper circuit using diodes • Construct and test Schmitt trigger circuit using transistors 	<p>Diode shunt clipper circuits and Clamping /limiting circuits and their applications.</p> <p>Schmitt trigger circuits</p>
6-7	<p><u>Power Electronic Components</u></p> <ul style="list-style-type: none"> • Identify FET transistors and record main parameters from the Data book • Test the given FET using multi meter • Construct and test a FET Amplifier • Identify SCRs of different ratings and the packages • Test different SCRs using a Multi meter and component tester • Construct a test circuit to test SCRs • Construct a test circuit of SCR using UJT triggering • Identify different heat sinks used with SCRs. • Construct a snubber circuit for protecting SCR use freewheeling diode to reduce back emf. • Construct and test solid state relay. • Construct a jig circuit to test DIAC • Identify and test a TRIAC using multi meter • Construct a simple dimmer circuit using TRIAC • Identify and Test a UJT using multi meter • Construct UJT based free running oscillator and change its frequency. 	<p>Construction of FET, differentiate it with BJT. Purpose of Gate, Drain and source terminals and voltage / current relations between them, Impedances between various terminals. Interpret the main parameters of the FET. Suitability of FET amplifiers in measuring device applications. Working of power electronic components such as SCR, TRIAC, DIAC and UJT.</p>
8	<p><u>MOSFET & IGBT:</u></p> <ul style="list-style-type: none"> • Identify MOSFET by its number 	<p>Working of MOSFET, Power MOSFET</p>

	<ul style="list-style-type: none"> Identify different heat sinks used with various power MOSFET devices. Construct MOSFET test circuit with a small load Identify IGBT by its number Construct IGBT test circuit with a small load 	and IGBT - their types, characteristics, switching speed, power ratings and protection. Differentiate FET with MOSFET, differentiate a Transistor with IGBT.
9	<p><u>Opto Electronics:</u></p> <ul style="list-style-type: none"> Identify different types of LEDs Test LEDs using DC supply and measure voltage drop and current using multimeter Identify and test LDR, Identify photo voltaic cell Construct a circuit to test a photo voltaic cell Construct a circuit to switch a lamp load using photo diode Construct a circuit to switch a lamp load using photo transistor. Identify Opto coupler input and output terminals and measure the quantum of isolation between i/o terminals (Opto Transistor, TRIAC and SCR) and operate a Relay by connecting a switch 	Working and application of LED, IR LEDs, Photo diode ,photo transistor, its characteristics and application, optical sensor, opto-couplers, circuits with opto isolators, characteristics of LASER diodes
10	<p><u>Basic SMD (2,3,4 terminal components):</u></p> <ul style="list-style-type: none"> Identification of 2,3,4 terminal SMD components De-solder the SMD components from the given PCB Solder the SMD components in the same PCB Check for cold continuity of PCB Identification of loose /dry solder, broken tracks on printed wired assemblies 	Introduction to SMD technology Identification of 2,3,4 terminal SMD components, advantages of SMD components over conventional lead components Introduction to solder paste and machine. Soldering of SM assemblies - Reflow soldering Tips for selection of hardware, Inspection of SM.
11	<p><u>Basic Gates:</u></p> <ul style="list-style-type: none"> Identify different Logic Gates (AND, OR, NAND, NOR, X-OR, X-NOR, NOT ICs) by the number printed on them and draw I/O pin-out numbers. Verify the truth tables of all Logic Gate ICs by connecting switches and LEDs. Construct and verify the truth table of all the gates using NAND and NOR gates Use digital IC tester to test the various 	Introduction to Digital Electronics. Difference between analog and digital signals, Logic families and their comparison, Logic levels of TTL and CMOS. Number systems (Decimal, binary, octal, Hexadecimal) BCD code, ASCII code and code conversions. Logic Gates and their truth tables, propagation delay, power dissipation and noise immunity

	digital ICs (TTL and CMOS)	
12	<p><u>Combinational Circuits:</u></p> <ul style="list-style-type: none"> • Construct Half Adder circuit and verify the truth table. • Construct Full adder and verify the truth table. • Construct the Adder cum Subtractor and verify the result • Construct and Test a 2 to 4 Decoder • Construct and Test a 4 to 2 Encoder • Construct and Test a 4 to 1 Multiplexer • Construct and Test a 1 to 4 De Multiplexer 	<p>Combinational logic circuits such as Half Adder, Full adder, Parallel Binary adders, 2-bit and four bit full adders. Magnitude comparators. Half adder, full adder ICs and their applications for implementing arithmetic operations Basic Binary Decoder and four bit binary decoders.. Concept of encoder and decoder, Need for multiplexing of data. 1:4 line Multiplexer /De-multiplexer.</p>
13	<p><u>Flip Flops:</u></p> <ul style="list-style-type: none"> • Identify different Flip-Flop (ICs) by the number printed on them • Construct and test four bit latch using 7475 . • Verify the truth tables of Flip-Flop ICs (RS, D, T, JK, MSJK) by connecting switches and LEDs 	<p>Introduction to Flip-Flop. S-R Latch, Gated S-R Latch, D- Latch. Flip-Flop: Basic RS Flip Flop, edge triggered D Flip Flop, JK Flip Flop, T Flip Flop, Master-Slave flip flops and Timing diagrams, Basic flip flop applications like data storage , data transfer and frequency division.</p>
14-15	<p><u>Electronic circuit simulation software</u></p> <ul style="list-style-type: none"> • Prepare simple digital and electronic circuits using the software • Simulate and test the prepared digital and analog circuits • Convert the prepared circuit into a layout diagram. • Explore various troubleshooting and fault finding resources provided in the simulation software. 	<p>Study the library components available in the circuit simulation software. Various resources of the software.</p>
16-17	<p><u>Counter & shift Registers:</u></p> <ul style="list-style-type: none"> • Construct and test a four bit asynchronous binary counter using 7493. • Construct and test 7493 as a modulus-12 counter. • Construct and test a four bit Synchronous binary counter using 74163. • Construct and test synchronous Decade counter. • Construct and test an up/down synchronous decade counter using 74190 and monitor the output on LEDs. 	<p>Basics of Counters, types of counters, two bit and three bit Asynchronous binary counters and decade counters with the timing diagrams. 3-bit Synchronous counters and synchronous decade counters. Types of seven segment display, BCD display, BCD to decimal decoder. BCD to 7 segment display circuits, Basics of Register, types and application of Registers.</p>

	<ul style="list-style-type: none"> • Identify and test common anode and common cathode seven segment LED display using multi meter • Display the two digit count value on seven segment display using decoder/driver ICs. • Construct a shift register using RS/D/JK flip flop and verify the result • Construct and test four bit SIPO register • Construct and test four bit PIPO register • Construct and test bidirectional shift registers 	
18-21	<p><u>Op – Amp & Timer 555 Applications:</u></p> <ul style="list-style-type: none"> • Use analog IC tester to test the various analog ICs • Construction and testing of various Op-Amp circuits Inverting, Non-inverting and Summing Amplifiers • Construct and test Differentiator and Integrator • Construct and test a zero crossing detector • Construct and test Instrumentation amplifier • Construct and test a Binary weighted and R-2R Ladder type Digital-to-Analog Converters. • Construct and test Astable timer circuit using IC 555 • Construct and test mono stable timer circuit using IC 555 • Construct and test VCO (V to F Converter) using IC 555 • Construct and test 555 timers as pulse width modulator. 	<p>Block diagram and Working of Op-Amp, importance, Ideal characteristics, advantages and applications. Schematic diagram of 741, symbol, Non inverting voltage amplifier, inverting voltage amplifier, summing amplifier, Comparator, zero cross detector, differentiator, integrator and instrumentation amplifier, other popular Op-Amps.</p> <p>Block diagram of 555, functional description w.r.t. different configurations of 555 such as mono stable, Astable and VCO operations for various application</p>

SYLLABUS FOR WORKSHOP SCIENCE AND CALCULATION SEMESTER-II

Week No	Workshop calculation & Sc.
1-2	Calculation of transistor currents and amplification factor(gain)
3-4	Gain dB calculation of voltage, current and power
5-6	Arithmetic and geometric progression, sum of n-terms, simple calculations Mensuration – Find the area of regular objects like triangle, rectangle, square and circle.
7-8	Mensuration: volumes of cube, cuboid, sphere cylinder.
9	Calculation of frequency of LC and RC oscillator and multivibrator circuits
10	Calculation of LED, IRLED and photo diode currents
11	Trigonometry ratios, identities
12	Problems on conversion of Decimal numbers to binary, octal, and Hexadecimal
13	Bit, byte, nibble, KB, MB ,GB
14-16	Addition and subtraction of Binary, Octal and Hexadecimal Numbers
17-18	Calculation of frequency division in flip-flops/counters
19-21	Inverting and non inverting amplifier gain calculations Time period and frequency calculation of Astable, monostable multivibrators using IC555

SYLLABUS FOR ENGINEERING DRAWING SEMESTER-II

Week No	Engineering Drawing
1	Single stage amplifiers, Multistage amplifiers
2-4	Class 'A', Class 'B', Push pull, Complimentary symmetry circuits
5-6	Crystal and RC Oscillators circuits, Multivibrators
7	Symbols for different wave shapes, Square, saw tooth, sine, triangular, Pulse. clipper and clamper circuits
8-9	UJT, FET, MOSFET, DIAC, TRIC, SCR, IGBT symbols and circuits of FET Amplifier, SCR using UJT triggering, snubber circuit, light dimmer circuit using TRIAC, UJT based free running oscillator
10-11	Orthographic 3 rd angle projection of very simple objects
12	LED, IRLED, photo diode, photo transistor, opto coupler symbols symbols of Logic gates
13	Half adder, full adder, multiplexer and de-multiplexer
14-16	Logic diagram and symbols of Flip flops
17-18	Logic diagram of 3- bit asynchronous, synchronous and decade counters
19-21	Op-Amp block diagram Inverting and non-inverting configuration, pin diagram of 555,741 Functional block diagram of IC555 and Astable, Monostable circuits using IC555

A. Tools & Equipments for the trade of Technician Power Electronics Systems for First and Second Semester

TRAINEES TOOL KIT FOR 20 TRAINEES +1 INSTRUCTOR

Sl No.	Names of the Items	Quantity
1.	Connecting screwdriver 100 mm	10 Nos
2.	Neon tester 500 V.	6 Nos
3.	Screw driver set (set of 5)	10 Nos
4.	Insulated combination pliers 150 mm	6 Nos
5.	Insulated side cutting pliers 150 mm	8 Nos
6.	Long nose pliers 150 mm	6 Nos
7.	Soldering iron 25 W. 240 V.	10 Nos
8.	Electrician knife	6 Nos
9.	Tweezers 100mm	10 Nos
10.	Digital Multimeter (3 ½ digit)	10 Nos
11.	Soldering Iron Changeable bits 10 W	6 Nos
12.	De- soldering pump	10 Nos

B. General Machinery Shop outfit

Sl.No	Name of the items	Quantity
1.	Steel rule 300mm	4 Nos
2.	Steel measuring tape-3 m	4 Nos
3.	Tools makers vice 100mm (clamp)	1 Nos
4.	Tools maker vice 50mm (clamp)	1 Nos
5.	Crimping tool (pliers)	2 Nos
6.	Magneto spanner set	2 Nos
7.	File flat 200mm bastard	2 Nos
8.	File flat 200mm second cut	2 Nos
9.	File flat 200mm smooth	2Nos
10.	100mm flat pliers	4 Nos
11.	100mm round Nose pliers	4 Nos
12.	Scriber straight 150mm	2 Nos
13.	Hammer ball pen 0.5Kg	1 No
14.	Allen key set (set of 9)	1 No
15.	Tubular box spanner (set of 6Nos)	1 set
16.	Magnifying lenses 75mm	2 Nos
17.	Continuity tester	6 Nos
18.	Hacksaw frame adjustable	2 Nos
19.	Cold chisel 20mm	1 No
20.	Scissors 200mm	1 No
21.	Handsaw 450mm	1 No
22.	Hand Drill Machine	2 Nos
23.	First aid kit	1 No

24.	Fire Extinguisher	2 Nos
25.	Bench Vice	1 No
26.	Dual DC regulated power supply 30-0-30 V, 2 Amps	4 Nos
27.	DC regulated variable power supply 0-24 V, 1Amp	2 Nos
28.	LCR meter (Digital)	1 No
29.	CRO Dual Trace 20 MHz (component testing facilities)	2 Nos
30.	Signal Generator, 0-100 KHz	2 Nos
31.	Battery Charger	1 No
32.	Analog multimeter	4 Nos
33.	Function generator (Triangular, square and sine wave)	2 Nos
	Or ELECTRONIC WORK BENCH Instead of sr no's (26,27,29,31,34)	2 Nos
34.	Dimmer state, 3 Amps	2 Nos
35.	Analog Component Trainer	4 Nos
36.	Op Amp trainer	3 Nos
37.	Digital IC Trainer	4 Nos
38.	Digital IC Tester	1 No
39.	Digital and Analog Bread Board Trainer	6 Nos
40.	Rheostats various values and ratings	2 Nos
41.	POWER ELECTRONICS TRAINER with at least 6 no's of onboard applications	4 No
42.	Computers in the assembled form (including cabinet, motherboards, HDD, DVD, SMPS, Monitor, KB, Mouse, LAN card, Blu-Ray drive and player), MS Office education version.	4 Nos
43.	Laptops latest configuration	1 No
44.	Laser jet Printer	1 No
45.	INTERNET BROADBAND CONNECTION	1 No
46.	Electronic circuit simulation software with 6 user licenses	1 No
47.	Different types of electronic and electrical cables, connectors, sockets, terminations.	As required
48.	Different types of Analog electronic components, digital ICs, power electronic components, general purpose PCBs, bread board, MCB, ELCB	As required
49.	Crimping tools as necessary for performing terminations mentioned week no 17-21 of SEMSTER-1	As required

C.WORKSHOP FURNITURE:

Sl.No	Name of the items	Quantity
1	Instructor's table	1 No
2	Instructor's chair	2 Nos
3	Metal Rack, 100cm x 150cm x 45cm	4 Nos
4	Lockers with 16 drawers standard size	2 Nos
5	Steel Almirah, 2.5 m x 1.20 m x 0.5 m	2 Nos
6	Black board/white board	1 No

Syllabus for the Trade of “Technician Power Electronics Systems”

Duration: 6 Months

Third Semester

Semester Code: PES: SEM III

Electrical control and Electro pneumatics

OBJECTIVES:

- Familiarization with DSO
- Familiarization with SMD soldering and de-soldering
- Familiarization with protection device
- Familiarization with microcontrollers device.
- Work with three phase rectifier, chopper, SMPS, inverters, UPS.
- Identify and test various types of sensors used in electronic industries
- Work with DPM Modules to measure various electrical parameters
- Read and interpret electrical control circuits used in industries
- Work with conventional electrical control of AC and DC Machines
- Identify various electro pneumatic devices
- Construct simple electro pneumatic circuits

**SYLLABUS FOR TRADE PRACTICAL AND TRADE THEORY
SEMESTER-III**

Week No.	Practical	Theory
1	<p><u>Digital Storage Oscilloscope:</u></p> <ul style="list-style-type: none"> Identify the different front panel control of a DSO. Measure the Amplitude, Frequency and time period of typical electronic signals using DSO Store a portion of signal waveform using DSO. Take a print of a signal from DSO by co Construct and test function generator using IC 8038nnecting it to a printer. 	<p>Block diagram of CRO and applications of CRO, application of digital CRO, block diagram of function generator. Differentiate a CRO with DSO. Advantages of DSO.</p>
2-3	<p><u>SMD Soldering and De-soldering:</u></p> <ul style="list-style-type: none"> Identify various connections and the setup required for SMD Soldering station Identification of crimping tools for various IC packages. Make the necessary settings on SMD soldering station to de-solder various ICs of different packages (at least four) by choosing proper clamping tools. Make the necessary settings on SMD soldering station to solder various ICs of different packages (at least four) by choosing proper clamping tools. 	<p>Soldering / de-soldering of above components Identification of PGA packages Soldering / De-soldering of above PGA components Cold/Continuity check of PCBs Identification of lose /dry solders, broken tracks on printed wiring assemblies</p>
4	<p><u>PCB Rework:</u></p> <ul style="list-style-type: none"> Prevention of Static charges, Handling of static sensitive devices Familiarizations of various crimping tools, wire wrapping, Conductive adhesives, Chip on Board, Tape Automated bonding. Construction of Printed Circuit Boards (single, Double, multi-layer), Important 	<p>ESD Control in Electronics Introduction to Static charges, Prevention of Static charges, Handling of static sensitive devices, Various standards for ESD Introduction to non soldering interconnections Introduction to crimping, wire wrapping, Conductive adhesives, Chip on Board, Tape Automated bonding. Introduction to components, Printed Circuit</p>

	<p>tests for PCBs</p> <ul style="list-style-type: none"> • Identify different types of soldering guns and practice soldering of different electronic active and passive components and IC bases on lug boards and PCBs • Join the broken PCB track and test • Practice the de-soldering using pump and wick • Prepare component for soldering • Demonstrate soldering and de soldering using soldering and de-soldering stations • Familiarizations of soldering technology, use of materials like solder, flux and cleaning solvents, Usage of correct tools, Component mounting, Solderability testing. • Practicals on soldering Inspection of solder joints, Defects of soldered joints. • Familiarizations to rework and repair concepts. • Practical on Types of conformal coating and its removal methods • Practical on Rework of through hole and surface mount soldered joints • Practical on Repair of damaged track • Practical on Repair of damaged pad • Practical on Repair of Plated through hole • Practical on Repair of solder mask 	<p>Boards Introduction to components, Construction of Printed Circuit Boards (single, Double, multi-layer), Important tests for PCBs</p> <p>Soldering guns Different types of soldering guns, related to Temperature and wattages, types of tips. Solder materials and their grading. Selection of a soldering gun for specific requirement. Soldering and De-soldering stations and their specifications. Reliable Soldering Practices (Manual) Fundamentals of soldering technology, Materials selection like solder, flux and cleaning solvents, Usage of correct tools, Component mounting, Solderability testing, Process for soldering Inspection of solder joints, Defects of soldered joints</p> <p>Introduction to Surface Mount Technology (SMT) Introduction to surface mount technology – advantages Surface Mount components and packages, Introduction to solder paste, Soldering of SM assemblies - Reflow soldering Tips for selection of hardware, Inspection of SM.</p> <p>Rework and Repair of Printed Circuit board assemblies Introduction to rework and repair concepts Types of conformal coating and its removal methods Rework of through hole and surface mount soldered joints Repair of damaged track Repair of damaged pad Repair of Plated through hole Repair of solder mask</p>
5	<p><u>Protection devices:</u></p> <ul style="list-style-type: none"> • Identify different types of fuses along with fuse holders. • Wire an MCB to a motor and run it • Test and rectify defects associated with MCBs. • Connect an ELCB and test the leakage of an electrical motor control circuit. 	<p>Fuse ratings, types of Fuses, Fuse bases, single/three phase MCBs, single phase ELCBs. Types of Contactors, contactor coils and working voltages, contactor contact currents, protection to contactors and high current applications.</p>

6	<p><u>Electrical control circuits:</u></p> <ul style="list-style-type: none"> • Measure the coil winding resistance of the given motor • Prepare the setup and Control an induction motor using a DOL Starter • Construct a direction control circuit to change direction of an induction motor • Connect a overload relay and test for its proper function. 	Fundamentals of single phase Induction motors, synchronous speed, slip, rotor frequency, torque – speed characteristics, Starters used for Induction motors.
7-8	<p><u>Microcontroller</u></p> <ul style="list-style-type: none"> • Identify various ICs & their functions on the given Microcontroller 8051 Kit • Identify the address range of RAM & ROM. • Write data into RAM & observe its volatility • Measure the crystal frequency, connect it to the controller. • Identify the port pins of the controller & configure the ports for Input & Output operation • Connect an input switch & control a lamp using necessary program • Demonstrate the initialization, load & turn on a LED with delay using Timer. • Demonstrate the use of a Timer as an Event counter to count external events. • Demonstrate entering of simple programs, execute & monitor the results 	Introduction to 8051 Microcontroller, architecture, pin details & the bus system. Function of different ICs used in the Microcontroller Kit. Differentiate microcontroller with microprocessor. Interfacing of memory to the microcontroller. Internal hardware resources of microcontroller. I/O port pin configuration. Different variants of 8051 & their resources. Register banks & their functioning. SFRs & their configuration for different applications. Utilization of on chip resources such as ADC. Availability of assembly software & compiler for 8051. Application of microcontroller in domestic, consumer & industries.
9-10	<p><u>Digital panel Meter:</u></p> <ul style="list-style-type: none"> • Identify LED Display module and its decoder/driver ICs • Display a word on a two line LED • Measure/current flowing through a resistor and display it on LED Module • Measure/current flowing through a sensor and display it on a LED module(DPM) • Identify LCD Display module and its decoder/driver ICs • Display a word on a two line LCD • Measure/current flowing through a sensor and display it on a LCD module(DPM) 	Different types of seven segment displays, decoders and driver IC s for them. Concept of multiplexing and its advantages. Block diagrams of 7106 and 7107 and their configuration for different measurements. Use of DPM (Digital Panel Meter) with seven segment displays to display different voltage & current signals. Principles of working of LCD. Different sizes of LCDs. Decoder/Driver ICs used with LCDs and their pin-out diagrams. Scrolling displays and its design. Use of DPM (Digital Panel Meter) with LCD to display different voltage & current

		signals
11-12	<u>3-phase Rectifier (controlled & Uncontrolled)</u> <ul style="list-style-type: none"> • Construct & test three phase uncontrolled rectifiers (half wave & bridge) • Construct & test single phase Half controlled rectifier using SCR • Construct & test single phase full controlled rectifier using SCR • Construct & test three phase controlled rectifiers (half wave & bridge) using SCR. 	<p>High current rectifiers. Differentiate uncontrolled and controlled rectifiers. Discuss on 3- phase uncontrolled rectifier, control and power circuits and their applications Discussion on 3-phase controlled rectifiers, control and power circuits and their applications</p>
13	<u>Chopper</u> <ul style="list-style-type: none"> • Construct & test chopper circuit using MOSFET • Construct and test step up type chopper circuit • Construct and test step down type chopper circuit • Construct and test IC Based DC-DC converter for different voltages 	<p>Various types of chopper circuits step up, step down, inverting types. Introduction to DC-DC Converters. Applications of DC-DC converters. ICs used for converting DC-DC. Applications of DC-DC converters</p>
14	<u>Power Supply</u> <ul style="list-style-type: none"> • Identify different front panel controls and connectors of the given power supply. • Test the given power supply and limit the output for a specific voltage and current. • Open the power supply and identify major sections and power components with heat sinks. • Test the semiconductor power switches of a power supply. • Operate a programmable power supply and test its features 	<p>Specifications & block diagram of Linear power supplies. Front panel controls and features of various power supplies. Different types of power switches and heat sinks used in power supplies.</p>
15	<u>SMPS</u> <ul style="list-style-type: none"> • Identify various input and output sockets/connectors of the given SMPS. • Apply input and measure outputs using a multimeter. • Test capacity of the given SMPS. • Identify major sections/ ICs/ components of SMPS. 	<p>Block Diagram of Switch mode power supplies and their working principles. Various ICs used in different types of SMPS. Principles of Inversion and Inverter circuits using different techniques. Pulse width modulation and their applications.</p>

	<ul style="list-style-type: none"> • Measure / Monitor major test points of SMPS. • Identify and replace the faulty components. <p>Use SMPS used in TVs and PCs for practice</p>	
16-17	<p><u>Inverters</u></p> <ul style="list-style-type: none"> • Construct & test simple inverter circuit using transistors/MOSFET • Prepare a load bank using resistive & Inductive load upto 2KW for testing of Inverter & UPS • Identify front panel control & indicators of Inverter • Identify & understand the use of back panel sockets & connections. • Connect Battery & load to Inverter & test on battery mode • Open Top cover of Inverter & identify isolator transformer & inverter transformer. • Identify various circuit boards in Inverter and monitor voltages at various test points. • Make load test to measure backup time. • Test Inverter under Fault condition & rectify fault. • Perform all above experiment for three phase Inverter • Measure battery current when inverter is working on Battery Mode & measure load current. 	<p>Inverter – their principle & operation, power rating, change over period.</p> <p>Installation of Inverters, Protection circuits used in inverters– battery level, over load, over charging etc. Various faults and its rectification.</p> <p>Three phase inverter circuits – principle and working.</p> <p>Installation of single phase & three phase Inverter.</p>
18-19	<p><u>UPS</u></p> <ul style="list-style-type: none"> • Identify front panel control & indicators of UPS • Identify & understand the use of back panel sockets & connections • Connect Battery & load to UPS & test on battery mode • Measure battery current UPS is working on Battery Mode & measure load current • Open Top cover of UPS & identify isolator transformer & UPS transformer & additional circuit other than inverter • Identify various circuit boards in UPS and monitor voltages at various test 	<p>Concept of UPS,</p> <p>Difference between Inverters and UPS.</p> <p>Basic block diagram of UPS & operating principle,-explanation of rectifier, battery, inverter, static transfer switch.</p> <p>Types of UPS : Off line UPS, On line UPS, Line interactive UPS & their comparison</p> <p>UPS specifications. Load power factor & types of indications & protections</p> <p>UPS circuit description and working - controlling circuits, Micro controller circuits, power circuits, charging circuits, alarm circuits, Indicator circuits.</p> <p>Three phase UPS Circuits.</p>

	<p>points</p> <ul style="list-style-type: none"> • Perform load test to measure backup time. • Test UPS under Fault condition & rectify fault • Perform all above experiment for three phase UPS 	<p>Installation of single phase & three phase UPS</p>
20-21	<p><u>Fiber optic</u></p> <ul style="list-style-type: none"> • Demonstrate the use of fiber optic trainer kit • Make optical fiber setup to transmit and receive analog and digital data • Demonstrate FM modulation and demodulation using OFC trainer kit using audio signal and voice link • Demonstrate PWM modulation and demodulation using OFC trainer kit using audio signal and voice link • Demonstrate PPM modulation and demodulation using OFC trainer kit using audio signal and voice link 	<p>Introduction to optical fiber as a transmission Media, its advantages over other media, properties of optic fiber, testing, losses, types of fiber optic cables and specifications. Encoding of light. Fiber optic joints, splicing, testing and the related equipments/measuring tools, precautions to be taken laying of cables, safety aspects while handling optical cables</p>

**SYLLABUS FOR WORKSHOP SCIENCE AND CALCULATION
SEMESTER-III**

Week No.	Workshop calculation & Sc.
1	Magnitude and frequency calculations on waveforms of CRO
2-3	Work, power and energy- definition, units, and simple problems
4-6	Problems on Boolean algebra.
7	AC motor speed, frequency calculations
8-9	Memory address calculation
10-11	Temperature-mV-resistance relations range for various sensors
12-13	Calculation of RMS value, efficiency, ac ripple, dc voltage of 3 phase rectifier output
14	Calculation of voltage regulation, firing angle.
15	Calculation of ripple voltage, voltage regulation, output DC voltage.
16-18	Density and relative density. Archimedes principle. Laws of flotation
19-21	Series and parallel battery connections and their voltage current relations

SYLLABUS FOR ENGINEERING DRAWING SEMESTER-III

Week No.	Engineering Drawing
1	Block diagram of CRO Lissajous figures
2-3	SMD IC Packages.
4	741 & 555 pin diagrams , summing amplifier, zero cross detector,
5	Differentiator, integrator and instrumentation amplifier
6	Symbols of MCB,ELCB, MOV, Relays, contactors
7-8	Block diagram of 8051
9-10	Pin diagrams of IC 7106 and 7107
11-12	Circuit diagram of high current rectifier. Circuit diagram of single phase half and full controlled rectifier using SCR.
13	Block diagram of chopper circuit with wave form at various stages.
14-15	Block diagram of Linear power supply. Block diagram of front panel control.
16-17	Block Diagram of Switch mode power supplies with wave forms at different stages
18-19	Block diagram invertors, protection circuits.
20-21	Block diagram UPS

Tools & Equipments for the trade of Technician Power Electronics Systems for Third Semester

Sr. No	Name of Equipment & machinery	Quantity
1	DSO (colour)	1 No
2	Soldering & De soldering Station	1 No
3	SMD Soldering & De soldering Station with necessary accessories	2 Nos
4	DOL starter	1 No
5	AC motor ¼ HP	1 No
6	OR ELECTRICAL TRAINER FITTED WITH RESOURCES MENTIONED AT SL NO (DOL starter, contactors, relays, MCB, Motor suitable for electrical control circuit exercises)	2 Nos
7	Seven segment DPM	6 Nos
8	LCD based DPM	6 Nos
9	Power Electronics Trainer along with triggering circuit	4 Nos
10	Isolation Transformer	2 Nos
11	Three phase variac	2 Nos
12	Power supplies (fixed, variable, dual at least 5A)	1 each
13	Programmable power supply 0-30 V, 2 A	2 Nos
14	SMPS trainer	2 Nos
15	SMPS (used in Computer, PLC , TV)	6 Nos
16	Single phase Inverter 1 KVA,3KVA with batteries	1 No each
17	Clip On meter	1 No
18	Microcontroller trainer kits (8051) along with programming software and applications	4 Nos
19	3 phase inverter 2 KVA	1 No
20	Discharge tester	2 Nos
21	Inverter trainer 500VA	1 No
22	Auto transformer	3 Nos
23	1 phase UPS Online 3 KVA, 1 KVA	1 No each
24	UPS trainer 500VA	1 No
24	3 phase UPS 2 KVA	1 No
25	MOSFET chopper trainer	2 Nos
26	Step up & Step down chopper trainer kit	2 Nos
27	Fiber optic Trainer kit	2 Nos

Syllabus for the Trade of “Technician Power Electronics Systems”

Duration: 6 Months

Fourth Semester

Semester Code: PES: SEM IV

Industrial application of power Electronics

OBJECTIVES

- Familiarize with various mechanical elements of machines
- Troubleshoot solar, Inverters.
- Wire field devices with PLC Modules and interpret the indications on PLC
- Troubleshoot the failure using Diagnostic menu of PLC software
- Familiarize with the AC Drive setup
- Configure AC Drives
- Control and monitor various motor parameters using VFD
- Familiarize with the Servo Drive setup
- Configure servo Drives
- Control and monitor various motor parameters using servo Drive
- Familiarize with DC Drive setup
- Control and monitor various motor parameters using DC drive

SYLLABUS FOR TRADE PRACTICAL AND TRADE THEORY SEMESTER-IV

Week No	Trade practical	Trade theory
1	<p><u>Solar Inverter</u></p> <ul style="list-style-type: none"> • Connect and test solar panel to the Inverter and run the load. • Mount a solar panel to a roof. • Wire a solar panel to a solar controller. • Wire a solar controller to a battery storage station. • Connect storage batteries to a power inverter • Wire a power inverter to an electrical service panel. • Test circuits for voltages. • Installation of Solar Inverter. • Take the trainees to the nearest solar power installation and demonstrate various aspects to cover skills as specified above 	<p>Need for renewable energy sources, Solar energy as a renewable resource. Materials used for solar cells. Principles of conversion of solar light into electricity. Basics of photovoltaic's cell. Types of solar cells. Mono crystalline and poly crystalline PV cells.</p> <p>Define Components like Solar cell, Module, panel and Arrays. Factors that influence the output of a PV module. SPV systems and the key benefits. Difference between SPV and conventional power. Define solar charge controller or regulator and its role.</p> <p>Safety precautions while working with solar systems.</p>
2-3	<p><u>Sensor</u></p> <ul style="list-style-type: none"> • Identify & test different sensors such as RTDs, thermocouples, proximity sensors(inductive, capacitive& photoelectric) , load cells, strain gauge & LVDT, Hall sensor, Tacho-generator • Test the functionality of all the sensors mentioned above using the trainer kit • Refer the data chart & record various parameter ranges in respect of the sensors mentioned above <p>Digital control of field devices Input Devices to develop START (Logic 1) and STOP (Logic 0) pulses</p> <ul style="list-style-type: none"> • Develop AC – DC SIGNAL CONVERTER using push to ON switch, center tapped transformer type full wave rectifier, filter and pot to get Logic 1 (+ 5V); (START pulse) view pulse on oscilloscope • Develop AC – DC SIGNAL CONVERTER using push to ON 	<p>Basics of passive and active transducers – Role, selection and characteristics.</p> <p>Working principles of RTD, Thermocouple, LVDT, Strain gauge, Proximity sensor, Hall Sensor, Tacho-generator, optical sensors. Sensor voltage and current formats</p> <p>DIGITAL/LOGICAL/ON-OFF CONTROL OF ELECTRICAL MACHINES AND OTHER ACTUATORS</p> <p>Industrial control system: electro-magnetic control, static control; comparison; general block diagram; Information gathering section in input section, Decision making section or logic section and Actuating device section or output section; advantages and disadvantages of static control over magnetic relay control; input devices for solid state logic; contact bounce problem;</p>

	<p>switch, bridge type full wave rectifier working on 24 V AC, filter, pot, 12V DC reed relay and separate stabilized + 5V supply to get Logic 1; (START pulse) view pulse on oscilloscope</p> <ul style="list-style-type: none"> • Develop AC – DC SIGNAL CONVERTER using push to OFF switch, center tapped transformer type full wave rectifier, filter and pot to get Logic 0 (0V); (STOP pulse) view pulse on oscilloscope • Develop AC – DC SIGNAL CONVERTER using push to OFF switch, bridge type full wave rectifier working on 24 V AC, filter, pot, 12V DC reed relay and separate stabilized + 5V supply to get Logic 0 (0V); (STOP pulse) view pulse on oscilloscope • Develop AC – DC SIGNAL CONVERTER – using Opto – coupler method, push to ON switch, bridge type full wave rectifier working on 24 V AC, filter, pot, opto coupler or LDR & Lamp source and separate stabilized + 5V supply to develop START pulse 	Capacitive Switch Filters
4-6	<p><u>Electrical control of AC/DC machines</u></p> <ul style="list-style-type: none"> • Identify of (unmarked) terminals of 3 phase induction motors • Construct a self hold contactor circuit and run a 3-Phase Induction Motor • Familiarize with different types of motor and identify different parts. • Study & connect the motor and run (below 5hp) in star, note phase Voltage, line voltage and current. Study and connect and run the motor in Delta and note phase current line current. Phase voltage and line voltage. • Connect and operate an induction motor using DOL starter • Connect and run a 3-phase motor using manual and automatic star-delta starters. 	<p>Fundamentals of AC 3 phase & single phase Induction motors, synchronous speed, slip, rotor frequency , torque – speed characteristics, Starters used for Induction motors, speed control of Induction motors</p> <p>Types of motors: Advantages & Disadvantages among each others.</p> <p>DC Motors– types, working, torque speed characteristics, starting of DC Motors & change the DOR, 3 point and 4 point Starters, speed control of DC motor, Field flux control & armature current control.</p> <p>Brushless DC Motors.</p>

	<ul style="list-style-type: none"> • Change the direction of rotation of Induction motor • Connect & run three phase induction motors in a sequence using contactor & relay • Construct run, stop and jog in both directions of an induction motor • Understand all the information on a Motor template. • Familiarize with diff. types of DC motors. • Connect & run DC shunt motor using 3 point starter. • Change the direction of rotation of DC motor • Control the speed of DC motor by armature control method • Control the speed of DC motor by field control method 	
7	<p><u>Mechanical machine elements</u> Visit to any industry to have exposure on mechanical elements of different machines like Lathe, planning, milling machines and their control cabinets..</p>	Basics of mechanical machine transmission mechanism such as gears, clutches , couplings, barring, belts, carriage beds, coolant & lubricant mechanism, linear scales
8	<p><u>DC Machine control</u></p> <ul style="list-style-type: none"> • Construct circuit for speed control of DC shunt motor. (phase control method) • Construct PWM circuit for the speed control of DC shunt motors. • Control the speed of DC shunt motor using SCR chopper by using trainer. 	DC drives-their principle and working, Types of DC drives- Phase control, PWM, Chopper. Open loop speed control system, Close Loop speed control system.
9-11	<p><u>AC Drives</u></p> <ul style="list-style-type: none"> • Study the AC Drive set up and its connections • Identify different cables and connectors used in the AC DRIVE setup • Identify various input and output terminals of the DRIVE unit, Operator panel and display unit. • Familiarization with PMU & different terminals of Micro – Master AC Drive 	Block diagram of AC Drive – (Sources of supply – Converter /Rectifier – DC Link – Inverter – Motor Load) 1 phase & 3 phase rectifier circuits. Inverter – 1 phase Inverter 3 phase Inverter Switching circuit (Sequence and Switching timing control – PWM Technique & Switching Devices. Microprocessor / Microcontroller) – VFD (Variable Frequency Drive) VV VF Control – (3 phase induction motor) Speed control.

	<ul style="list-style-type: none"> • Demonstration – Access parameter number & values • Familiarization with parameters • Parameter values for various operation • Commissioning parameter numbers and values • Installation of AC Drive(similar to SIEMENS MM-420/440) • Familiarization with:- Commissioning & Quick Commissioning(similar to SIEMENS MM-420/440) • Reset to default value / Factory setting values • MM Drive Programming /Parameterization for different control operations- • ON/OFF, Forward/Reverse, Jog (R)/Jog (L), braking and speed control 	<p>Introduction of PID controller. Installation of AC Drive / Siemens Micro master Drive – MM-420/440 Commissioning / Quick commissioning of MM –420/440 Micro – Master Drive – Programming (Parameterization)</p>
12-13	<p><u>DC Drives</u></p> <ul style="list-style-type: none"> • Familiarization with different parts and terminals of DC Drive. • Familiarization with parameters and operation for accessing parameter number and values. • Start up procedure demonstration. • Parameterization for variation of motor speed through POT with Armature voltage feedback (with internal setting). • Parameterization – Control drive through POT with encoder feedback (with internal setting). • Parameterization – Control the drive speed through external speed raise/ lower buttons. 	<p>Tacho-generator /Encoder technical data Related to DC drive. Block diagram of DC Drive. Converter bank – Gate Trigger set circuit Hardware description of DC Drive. Description of 6RA70 Siemens (or similar) master drive. Start up procedure (Quick Commissioning) Terminal Diagram of 6RA70 DC Drive Function of 6RA70. BICO Technology. Parameterization of DC Drive – 6RA70 – BICO Parameterization</p>
14-15	<p><u>Servo Motor</u></p> <ul style="list-style-type: none"> • Construct a simple circuit to control servo motor using IC 555. • Connect servo motor with drive & control its parameters. • Connect servo motor to computer for monitoring & controlling of various parameters. 	<p>Servo mechanism, Servo motor principal, Difference between motors & servo motor. Types of servo motor AC & DC - brushless servo motor & permanent magnet servo motor construction & application. Control method for servo motor. Study of servo drive.</p>

	<ul style="list-style-type: none"> • Parameter programming of servo motor • Various control method for controlling velocity & torque. 	
16-17	<p><u>Electronic Pneumatics</u></p> <ul style="list-style-type: none"> • Identify different pneumatic and electro pneumatic components • Construct and control a single acting cylinder • Construct and control a double acting cylinder • Construct and control single/double acting cylinder using series/parallel circuits • Construct and perform bidirectional control of a cylinder. • Construct and control automatic return of a double acting cylinder • Construct and control oscillating motion of a double acting cylinder • Construct and control a latching circuit using single or double acting cylinder • Construct and control automatic return initiated by a limit switch. • Throttle a cylinder to adjust forward and return strokes. • Adjust the pressure as per the requirements 	<p>Introduction to pneumatic power source and measure of compressed air, storage and transmission of compressed air, applications of pneumatics in the industries. Symbols of different pneumatic and electro pneumatic components. Various supply elements such as compressors, reservoir, pressure regulating valve, service unit etc</p> <p>Various input elements such as push button valves, roller lever valves, proximity switches, Air barriers etc</p> <p>Various pneumatic control elements, processing elements such as directional control valves, shuttle valves, non-return valves, pressure control valves, Timers and sequencers etc</p> <p>Function and application of solenoid valves Limit switches, memory valves, pressure dependent valves and time dependent valves</p>
18-21	<p><u>PLC</u></p> <ul style="list-style-type: none"> • Identify various indicators on PLC Modules and interpret • wire various digital input and output devices to the respective modules • wire analog input and output devices to the respective modules • connect and configure PLC hardware on the software • Develop and run simple programs to read sensor status and to control various outputs • Force input and output devices using software • Perform online editing of a rung/network • Prepare data tables and monitor 	<p>Evolution of control technology Advantages of PLCs Modular architecture of PLCs, working principle of PLCs Various modules and addressing Wiring of field devices to various modules, interpretation of indications on CPU and other modules Specification of PLC Modules Implementation of relays, timers and counters using PLCs</p>

**SYLLABUS FOR WORKSHOP SCIENCE AND CALCULATION
SEMESTER-IV**

Week No.	Workshop calculation and Sc.
1-3	Complex numbers system Addition, subtraction, Multiplication and division in complex numbers.
4-5	Stress and strain, Modules of elasticity
6-7	Problems on DC motors Calculation of slip, frequency, torque of induction motors
8-9	Property of material such as ductility, malleability, Hardness, brittleness, elasticity, plasticity, toughness
10-11	Vector – definition of scalar and vector, notations.
12-13	Representation of vectors. Addition and subtraction of vectors.
14-15	Triangle law of vectors. Parallelogram law of vectors
16-17	Revision
18-21	Understanding of simple ladder diagrams

**SYLLABUS FOR ENGINEERING DRAWING
SEMESTER-IV**

Week No.	Engineering Drawing
1	Orthographic 1 st angle projection
2-3	Symbols of Thermistor, thermo couple, strain gauges, LVDT, proximity sensors Circuit diagram of signal convertor push to on, push to off, different methods, output amplifier using transistor, output amplifier using SCR
4-6	Schematic diagram of DOL starter, forward, reverse (manual, semi automatic and automatic) 3 point and 4 point Starters Schematic diagram of star delta starter, armature & field winding of DC motor
7	Free hand sketch of machine elements
8	Block diagram of DC drive
9-11	Block diagram of AC drives
12-13	Free hand sketches of popular drives
14-15	Section view of servo motors
16-17	Various symbols of pneumatic and Electro pneumatic components.
18-21	Basic block diagram of PLC. Wiring diagrams input/ output modules.

Tools & Equipments for the trade of Technician Power Electronics Systems for Fourth Semester

Sr. No	Name of Equipment & machinery	Quantity
1	DC shunt motor 1HP with 3 point starter	1 No
2	Tachometer	2 Nos
3	Rheostat 1Kohm	2 Nos
4	3 phase induction motor 1Hp with DOL starter	1 No
5	5 hp squirrel cage induction motor with star-delta starter	1 No
6	DC drive trainer with 1hp motor using phase control method	1 No
7	DC drive trainer with 1hp motor using SCR chopper circuit	1 No
8	Programmable DC drive with motor (Simoreg DC master) 6RA70	1 No
9	Solar panel based Inverter 500VA	1 No
10	VVVF drive trainer with 1 hp 3 phase motor	1 No
11	AC drive (Siemens Micro master 420) with AC motor 1hp	1 No
12	PLC Systems with digital I/P, O/P modules and software	3 Nos
13	Solenoid 24 V AC	4 Nos
14	Lamp 24 V AC	6 Nos
15	AC power supply 24 V, 50 Hz, 2 A	2 Nos
16	DC power supply +12 V 2 A	2 Nos
17	DC power supply +5 V 2 A	2 Nos
18	Electronic Pneumatics trainer	2 Nos
19	Servo Motor drive Trainer	2 Nos
20	Sensor trainer Kit - Various field sensors and actuators(industrial grade switches, push buttons, pilot lamps, proximity sensors, Thermocouples, RTDs, load cells, strain gauge, LVDT, opto-switches, smoke detectors, level switches, solenoid valves, reed relays, Hall sensor, tacho-generator, low amp contactors etc.	2 Nos

List of the Trade Committee Members

Sl. No.	Name & Designation	Organization	Remarks
1	M.R.K Naidu ,Head (CR&D)	ECIL, Hyderabad	Chairman
2	Pradeep Doshi , SVP	ESSCI, NewDelhi	Member
3	T. Venkataswamy, Assit. Engg.	BHEL, Hyderabad	Member
4	A Prasanna Lakshmi, Faculty	BHEL, Hyderabad	Member
5	T. Venkateswara Sharma, Sr. Officer HR	BEL, Hyderabad	Member
6	P. Chandrashekhar, MD	Techno Design Group, Hyderabad	Member
7	S.CH. Appa rao, Managers(operations)	BEL, Hyderabad	Member
8	T. Ram Mohan Rao, Sr.Manager	BDL, Hyderabad	Member
9	B Udaya Bhaskar Rao, DGM Electronics	BDL, Hyderabad	Member
10	M Manoharan, MD	Automation Solution, Hyderabad	Member
11	S K Sastry, MD	EPROSYS, Hyderabad	Member
12	KBR Siva Prasad	HAL, Hyderabad	Member
Mentor			
1.	R.L Singh, DDG(T)	DGET, MOLE, NewDelhi	Mentor
Members of Core Group			
2.	C.S Murthy, DDT	ATI-EPI, Hyderabad	Member
3.	C.H Ravi , DDT	ATI-EPI, Mumbai	Member
4.	L K Mukherjee, DDT	CSTARI, Kolkata	Member
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6.	C. Ramasubramanian, DDT	AHI, Bangalore	Member
7.	H.C Goyal, DDT	ATI-EPI, Dehradun	Member
8.	Avinash Kishore, ADT	DGET, MOLE, NewDelhi	Member
9.	R. Malthi, TO	RVTI(W), Bangalore	Member
10.	D K Ojha, DDT	ATI-EPI, Dehradun	Member
11.	DM Basha, TO	ATI, Mumbai	Member
12.	Ashwini Koli, JTA	RVTI, Bangalore	Member
13.	H N Bargal, TO	ITI, Mumbai	Member
14.	R S Nemade, TO	ITI, Mumbai	Member
15.	Z A Gadyal, JTO	ITI, Belgaum	Member
16.	M V Pillai, GI	ITI, Thane	Member