Swami Ramanand Teerth Marathwada University, Nanded
Syllabus for PET Examination-

Subject: Electronics

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i) **Paper on Section A:**

Research Methodology

ii) **Paper on Section B:**
Based on UG syllabus
Based on PG syllabus

Swami Ramanand Teerth Marathwada University, Nanded

PET Examination (Electronics)
Syllabus for Section-B

Based on Under Graduate (UG) syllabus

Unit – I: Semiconductor Devices and Instrumentation

Semiconductor Diodes:

Construction, working and V/I characteristics of P-N Junction diode, Zener diode, LED, Photodiode, varactor diode.

Transistors :

Construction of NPN and PNP transistor, F-F, R-R-, F-R biasing, α_{dc} and β_{dc} of a transistor and their relationship, C-E transistor Characteristics: Collector curves and base curves. Construction, working and characteristics of JFET, construction, working and characteristics of MOSFET.

Rectifiers and Voltage Regulators

Block diagram of a power supply, half and full wave rectifiers, bridge rectifier, load regulation and line regulation, zener shunt regulator.

CRO and Multimeter:

Multimeter, applications of multimeter, sensitivity of multimeter, Cathode ray oscilloscope, cathode ray tube, deflection sensitivity of CRT, applying signal across vertical plates, display signal waveforms on CRO, signal pattern on screen, various controls of CRO, applications of CRO.

Unit – II: Combinational and Sequential Logic Circuits

Arithmetic and Combinational Logic Circuits

Half adder, full adder, parallel binary adder, introduction of encoder, decoders, multiplexer and demultiplexers with suitable example.

Flip-Flops

SR latch , SR flip flop, JK flip flop, Master Slave JK flip flop, D type flip flop, T type flip

Counters and Registers:

Asynchronous counters : two, three, four bit and decade counter.

Synchronous counters : two, three, four bit counter and decade counter, modulus of the counter, mod-3 and mod-5 counters, ring counter.

Shift Registers : Serial-in Serial-out, Serial in - Parallel out, parallel in - serial out, parallel in - parallel out configurations.

ADC and DAC convertors :

Digital to analog converter (R-2R ladder network), Analog to digital convertor

Unit III: Amplifiers, Oscillators and Multivibrators :

Load Lines and DC Bias Circuits: DC Load line, Q-Point and Maximum Undistorted Output, Need for Biasing a Transistor, Factors Affecting Bias Variations, Stability factor, Beta

Sensitivity, Stability Factor for CB and CE Circuits, Base Bias with Emitter Feedback, Base Bias with Collector Feedback, Base Bias with Collector and Emitter Feedback, Voltage Divider Bias, Load Line and output Characteristics, AC Load line,

Small Signal Amplifiers: h-parameters, Transconductance Model, Analysis of CE Amplifier, CB Amplifier, CC Amplifier using h-parameters, Numerical Problems

Sine Wave Oscillators: Introduction to Positive and Negative Feedback, Requirement of an Oscillator, Barkhausen Criterion, Hartley Oscillator, Colpitt's Oscillator, R-C Network, Phase Shift Oscillator, Wien Bridge Oscillator (Circuit diagram, Working, Expression of Frequency and Condition for Oscillations)

Multivibrators And Sweep Circuits: Transistor as a Switch, Transistorized Astable Multivibrator, Transistorized Monostable Multivibrator, Transistorized Bistable Multivibrator (working and waveforms), Introduction to Sweep Circuits, Sweep Voltage Waveforms, Exponential Sweep, RC Ramp Generator.

Unit IV: Fundamentals Of Microprocessors:

Introduction To Microprocessor Intel 8085: Semiconductor Memories (RAM, ROM, PROM, EPROM, EEPROM), Block Diagram of Microcomputer (Microprocessor Based System), Block Diagram of Intel 8085, Function of Each Block, Functional Pin Diagram of Intel 8085, Features of Intel 8085

Instruction Set Of Intel 8085 : Instruction Format (1 byte, 2 byte, 3 byte), Addressing Modes, Classification of Instructions, Instruction Set of 8085

Programming And Interrupts of 8085 : Simple Programs Based on Data Transfer, Arithmetic, Logical, Branching and Machine Control Instructions, Interrupts:-Hardware Interrupts, Software Interrupts, Priority Structure of 8085 Interrupts

Introduction To Microprocessor Intel 8086: Block Diagram of Intel 8086, Function of Each Block, Functional Pin Diagram of Intel 8086, Features of Intel 8086.

Unit V: Operational Amplifier, Its Applications And Some Specialized ICs

Operational Amplifier:

Theory of Differential Amplifier, Block Diagram of Op-Amp, Schematic Symbol, Ideal Characteristics, Input Offset Voltage, Input Offset Current, Input Bias Current, Input Impedance, Output Impedance, Open Loop Gain, CMRR, Slew Rate.

Applications of Operational Amplifier: Inverting Amplifier, Non-inverting Amplifier, Op-Amp as Adder, Op-amp as Subtractor, Op-Amp as Integrator, Op-Amp as Differentiator, Op-Amp as Comparator, Op-Amp as Schmitt's Trigger, Solving Differential Equation,

Active Filters: Introduction, First Order Low-Pass Butterworth Filter, Second Order Low-Pass Butterworth Filter, First Order High-Pass Butterworth Filter.

Unit VI: Microprocessor Interfacing:

Basic Interfacing Concepts

Introduction, memory mapped I/O scheme, I/O mapped I/O scheme,

Data Transfer Schemes:-Synchronous, Asynchronous, Interrupt Driven and DMA

Interfacing Chips: Schematic Diagram (Functional Pin Diagram), Block diagram and Operating modes of the ICs-8253, 8255, 8259, 8257, Control registers of 8255 and 8253

Microprocessor Applications : Demultiplexing of AD_7-AD_0 bus, Interfacing concepts of I/O devices using decoder (74LS138), Chip Select logic, Generation of $\overline{MEMR}$, $\overline{MEMW}$, $\overline{IOR}$ and $\overline{IOW}$ signals, Tristate buffer (74LS244), Latches (74LS373), Interfacing switches, LED, relays
Data Converters : Interfacing of ADC 0808 using 8255, Interfacing of DAC 0808 using 8085

Unit VII: Communication Electronics-I

Introduction to Communication Systems: Introduction, Block Diagram of Communication System, Need for Modulation, Types of Modulation, Band Width
Amplitude Modulation: Amplitude Modulation Theory, Mathematical Representation of AM Wave, Modulation Index, Frequency Spectrum of AM Wave, Band Width of AM, Power Relations in AM Wave, AM Circuits: Basic Circuit for BJT Collector Modulation, Amplitude Demodulator Circuit
Frequency Modulation: Theory of Frequency Modulation, Mathematical Representation of FM Wave, Band Width, Generation of FM, Direct Method for FM Generation, Transistor Reactance Modulator, Varactor Reactance Modulator
Pulse Modulation : Introduction, Types: Pulse-Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Pulse Code Modulation (PCM)
Radio Receivers: Introduction, Basic Block diagram of Communication Receiver, Tuned Radio Frequency (TRF) Receiv**er,** Super Heterodyne Receiver, Characteristics of Radio Receivers, Sensitivity, Selectivity, Fidelity, Image Frequency and Its Rejection, Double Spotting
Microwaves And Radar Systems: Microwaves:-Introduction, Reflex Klystron Operation, Mathematical Analysis, Modes, Gunn Effect, Gunn diode
Radar Systems:-Basic Principles, Block Diagram of Basic Pulsed Radar System, Radar Range Equation, Moving Target Indication, CW Doppler Radar
Introduction To Mobile Communication: Historical Perspective, Cellular Systems, Third-Generation (3G) Systems, Fourth-Generation (4G) Systems,
Introduction to Optical Fibers : Fibre Optics, Structure of Optical Fibers, Classification of Optical Fibers, Propagation of Light, Refraction and Snell's law, Total Internal Reflection, Light Propagation through an Optical Fibre, Acceptance Angle and Numerical Aperture, Dispersion, Intermodal Dispersion, Fibre Characteristics, Fibre Losses, Calculation of Losses, Choice of Wavelength, Fibre Optic Communications, Applications of Fibre Optic Communication, Advantages of Optic Fibers, Disadvantages of Optic Fibers.

Unit-VIII: Power Electronics

Thyristor: Principles and Characteristics
Introduction, Thyristor family, principle of operations of SCR, static Anode- Cathode characteristics of SCR, The two-transistor model of SCR (Two transistor analogy), Thyristor construction, gate characteristics of SCR, Turn-ON methods of a Thyristor, Construction, working and V-I characteristics of DIAC and TRIAC.
Gate Triggering Circuits
Introduction, Firing of thyristors, gate current amplitude and rise time, gate pulse duration, pulse waveforms, spurious triggering; pulse transformer, pulse transformer in triggering circuits; gate trigger circuits, resistance firing circuit, resistance - capacitance firing circuit, resistor capacitor - full wave trigger circuit.

Unijunction Transistors And Triggering Circuit: Unijunction transistor, basic operation, UJT relaxation oscillator, the UJT as an SCR trigger.
Series And Parallel Operations Of Thyristor: Introduction, series operations of thyristors, need for equilising network; unequal distribution of voltage, difference in reverse recovery time; equilising network design, static equilising network, dynamic equilising network, triggering of series connected thyristors, simultaneous triggering, sequential triggering, optical triggring.
Parallel operation of thyristors, methods for ensuring proper current sharing, triggering of thyristors in parallel, string efficiency, derating.
Phase Controlled Rectifiers: Introduction, phase angle control, single - phase half-wave controlled rectifier (one-quadrant), with resistive load, with inductive load, effect of freewheeling diode, single-phase full-wave controlled rectifier (two quadrant converters), mid-point converter (M-2 connection), single-phase half-controlled Bridge rectifier, half-controlled bridge rectifier with resistive load, half-controlled Bridge rectifier with R-L load.
Thyristor Control Circuits: Phase control circuit for regulating temperature, remote temperature controller, light activated turn-off circuit using DIAC, TRIAC and LDR, 'Off at Dark' circuit, automatic water level indicator using SCR.
Inverters: Introduction, thyristor inverter classification, series inverters, basic series inverter modified series inverter. Basic parallel inverter.
Choppers: Introduction, principle of chopper operation, control strategies, Time Ratio Control (TRC), Current Limit Control, step up choppers, step down chopper.

Unit IX: Introduction to Microcontroller (8051)

Introduction to Microcontroller: Block diagram of microcomputer, block diagram of microcontroller, comparison between
microprocessor and microcontroller, embedded systems, microcontroller survey (8-bit, 16-bit, 32-bit)
Architecture of 8051 Microcontroller: Features, pin out diagram, internal block diagram, CPU registers, flags, PSW, SFRs, PC,
Data -Pointer, SP, Internal RAM/ROM, External memory, I/O ports.
Instruction set of 8051: Addressing modes, Data transfer, arithmetic, logical operations, JUMP, Loop and CALL
instructions, single bit operations, stack and interrupt instructions
8051 Programming: Assembly language programming, instruction syntax, assembler, compiler, simple programms on data transfer, arithmetic and logical operations.
8051 Microcontroller and Embedded Systems
8051 Programming: Assembly language programming examples: arithmetic, logical, single bit, branching, looping and code conversion programs.
Timers and Counters in 8051: Timer modes, timer counter registers, programming the timers in various modes, counter programming.
Interfacing and Applications: Interfacing of LEDs, LCD, switches, relays, stepper motor, interfacing DAC and ADC converters (0808).
Programmable Logic Controllers (PLC): PLC system, internal architecture of PLC (CPU, bus, memory, I/O unit), Ladder & Functional Block programming: Ladder diagrams, PLC ladder programming, logic functions, latching, Boolean algebra, functional blocks, and program examples.

Swami Ramanand Teerth Marathwada University, Nanded

PET Examination (Electronics)

Syllabus

Based on Post Graduate (PG) syllabus

Unit-I : Electronic Devices, Circuits and Optoelectronics :

The Nature of atom, atomic energy level, photon nature of light, collision of electrons with atom, collision of photons with atom, metastable state, electronic structure of elements, band theory of crystals, insulators, semiconductors and metals.

Electrons and holes in intrinsic semiconductors, conductivity of semiconductors, carriers concentration in intrinsic semiconductors, charge densities in semiconductors, Fermi Levels in semiconductors having impurities; diffusion, carrier life time, continuity equation, Hall Effect.

Semiconductor Devices: Tunnel diode and its characteristics, tunnel diode circuits, thermister and its characteristics, application of thermisters, voltage variable capacitor diode, equivalent circuit, piezoelectric crystals, crystal equivalent circuit and performance, crystal oscillator, synthetic piezoelectric devices.

Photo conductive cell, photo diode, solar cell, light emitting diode, phototransistors (constructions, working and characteristics of all devices). Semiconductor laser: stimulated emission, population inversion at a junction, emission spectra for a p-n junction laser, basic semiconductor laser.

Unit-II : Digital Fundamentals : System Design & Communication :

Combinational Logic Design: Standard representations for logic functions, Karnaugh map representation of logical functions, simplification of logical functions using Karnaugh map, minimization of logical functions specified in minterms/maxterms or truth table, minimization of logical functions not specified in minterms/maxterms, don't care condition. Designed examples: Arithmetic circuits (half adder, half substractor, full adder and full substractor), BCD- to-7 segment decoder.

Multiplexers and their use in combinational logic design, demultiplexers /decoders and their use in combinational logic design, adder and their use in substractors, BCD adder and substractor, arithmetic and logic unit (ALU), BCD to binary converters, binary to BCD converters, decimal to BCD encoder, octal to binary encoder, decoder/drivers for display devices.

A/D and D/A converters: Digital to analog converters: weighted-resistor D/A converters, R-2R ladder D/A converters, specification for D/A converters. Analog to Digital converters: parallel-comparator A/D converters, successive approximation A/D converters, counting A/D converters.

Digital Communication: Bandwidth requirements, communication channel, signal to noise ratio, channel capacity, Shamman Hastley law, communication via satellite, amplitude modulation, modulation index and its measurement, side bands, power relation, AM transmitter: different AM transmitter circuits, single sided and double sided band systems, vestigial side band systems.

FM and pulsed modulation: narrow band, wide band, FM sensation and demodulation, noise reduction, pulse amplitude modulation and its sampling, signal recovery, cross talk, sensation of PAM and PPM signals.

Sampling theorem, pulse-code modulation (PCM), advantage of digital communication quantization of signals, principle of progressive taxation, compander, transmission bandwidth and SNR, ATI carrier system, differential pulse-code modulation (DPCM), data modulation, adaptive data modulation (ADM), phase shift keying. Digital data communication system, line coding, pulse shaping, scrambling, regenerative repeater, detection error, probability, M-ray communication, digital carrier systems, digital multiplexing.

Unit – III : Power Electronics-I

Thyristors: Principles and characteristics: Thyristor family, principle of operation of SCR, static anode-cathode characteristics of SCR, the two transistor model of SCR, thyristor construction, gate characteristics of SCR, turn-on methods of a thyristor, dynamic turn-on, switching characteristics, turn-off mechanism, turn-off methods, .thyristor ratings, measurements of thyrister parameters.

Gate triggering circuits: Firing of .thyrister, pulse transformers, optical isolators, gate trigger circuits, unijunction transistor, programmable unijunction transistor, phase control using pedestal and ramp triggering, firing system for DC/DC choppers.

Series operations of thyristors, need for equalizing networks, equalizing networks design, parallel operations of thyristor, methods of ensuring proper current sharing, triggering of thyristor in parallel, string efficiency, derating.

Inverters and Choppers: Basic series inverters, self commutated inverters, basic parallel inverters with feedback diode, single phase half bridge inverter, single phase full- bridge inverter. the McMurray inverter, current source inverters: single phase-capacitor commuted current source inverters with resistive load, single phase ASCI. Choppers: Principle of chopper operation , control strategies, step- up chopper, stepup/ down chopper, chopper commutation, Jones chopper, Morgan chopper, a.c.choppers.

Cycloconverters and Dual converters: The basic principle of operation, single-phase to single-phase cycloconverter, three phase half-wave cycloconverters, cycloconverter circuits for three-phase output, ring connected cycloconverter circuits, output voltage equation, control circuit, load-commuted cycloconverter.

Unit – IV: Power Electronics-II

Dual Converters: Principle of dual converter (Ideal Dual Converter), practical dual converter, dual converter without circulating current operation, dual converter with circulating current operation, dual mode dual converter.

Control of D.C. and A.C.Drives: Basic machine equations, breaking modes, schemes for D.C. motor speed control, single phase separately exited drives, braking operation of rectifier controlled separately excited motor, single phase series D.C. motor drives, power factor improvement, three-phase separately excited drives, D.C. chopper drives, closed loop control of D.C. drives, phase locked loop (PLL) control of D.C. drives.Basic principle of operation, squirrel-cage rotor design, speed control of induction motors, stator voltage control, variable

frequency control, rotor resistance control, slip power recovery scheme, synchronous motor drives.

Thyristor Control Circuits and Applications: Temperature control, illumination control, light-activated turn off circuit using DIACTRIAC, and LDR, OFF at dark circuit, automatic street lighting circuit using SCR, automatic battery charger using SCR, light operated SCR alarm, burglar alarm circuit using SCR, direct current circuit breaker using SCR, battery operated inverter circuit using power transistor, SCR-UJT operated timer circuit, over voltage protection, zero voltage switch, integral cycle triggering, switched mode supply (SMPS), uninterruptible power supply (UPS), ARC welding, high voltage D.C. transmission.

Unit – V: Microprocessor Interfacing Technique, Advanced Microprocessor and Microcontroller

Basic interfacing concepts, interfacing output display, interfacing input keyboard, memory mapped I/O, interfacing memory. 8085 interrupts, programmable interrupt controller: 8259A. Digital to analog (D/A) converters, analog to digital (A/D) converters.

Programmable Interface Devices: Basics in programmable I/Os, the 8155/8156 and 8355/8755 multipurpose programmable devices, the 8279 programmable keyboard / display interface.

The 8255A programmable peripheral interface, the 8253 programmable interval timer, direct memory access (DMA), 8257 DMA controller.

Serial I/O and Data Communication: Basic concept in serial I/O, software controlled asynchronous serial I/O, the 8085 serial I/O lines, SOD and SID, hardware controlled serial I/O using programmable chips.

16 bit Microprocessor: Register organization of 8086, architecture, signal description of 8086, physical memory organization, general bus operation, I/O addressing capability, minimum mode 8086 system and timings, maximum mode 8086 system and timings.

Introduction To 8-bit Micro-controller 8051:8-bit microcontroller, architecture of 8051, signal description of 8051, register set of 8051, important operational features of 8051, memory and I/O addressing by 8051, interrupts of 8051, instruction set of 8051.

Unit – VI : Optical Fiber Communication and Measurements

Optical Fibre: Ray theory of transmission, electromagnetic mode theory for optical propagation, cylindrical fiber, single mode fibers.

Preparation of optical fibers, liquid phase techniques, vapour phase deposition techniques, optical fibers, optical fibers cable, cable design

Joints and couplers fiber alignment and joint loss, fiber splices, fiber connectors, fiber couplers.

Optical Sources and Detectors: Semiconductor lasers (theory of laser action, calculations, modulation frequency response), semiconductor photo diode detectors (quantum efficiency, choice of materials and device structures, impulse and frequency response of p-i-n photo diode, noise of p-i-n photodiode). Avalanche photodiode detectors and photomultiplier tubes (APD designs, bandwidth, noise, photomultiplier tube)

Multiplexers and Demultiplexers: Introduction: Fiber optics switches (general), bypass switches, other optical switches.

Communication System (general) : General, transmitter for fiber optics communication, high performance transmitter circuits, LED-analog transmitters, comparison between analog and digital transmitters, laser-transmitters, digital laser-transmitters, analog laser-transmitters with A/D conversion and digital multiplexing, transmitter design, bit stuffing, fiber optics receiver, a high performance receiver, fiber based modems: Transreceiver.

Fibre Optic Sensors : Introduction, fibre optics sensors, intensity modulated sensors, micro bend strain intensity modulated sensors, liquid level type hybrid sensors, internal effect intensity modulated sensors, phase sensors, diffraction grating sensor, sensors using single mode fibre, interferometric sensor, interferometric pressure sensor, interferrometric temperature sensor, distributed fibre optics sensors, polarization problem in interferometric sensor using single mode fibre, medical applications of fibre sensors, fibre fabry- parrot optics sensors, electric field and voltage sensors, chemical fibre optic gyerseopers, magnetic field and current fibre sensor, military and aerospace applications.

Modulation: Introduction, LED analog modulation, digital modulation, laser modulation, formats of modulation, pulse code modulation, (PCM), intensity modulation (IM)

Optical fiber Communication System : Introduction, important application of integrated optical fiber technology, long hall communication, coherent optical fiber communication ,principles of coherent detection, comparison of coherent and direct detections performance, local area network (LAN)

Measurements of Optical Fiber : Introduction, measurement of numerical aperture (NA) and its related terms, fibre attenuation, measurement of optical time domain reflectometer(OTDR), loss measurement of each mode, scattering losses measurement, measurement of dispersion losses, measurement of refractive index, cut off wavelength measurement, measurement of dispersion together with cut-off wavelength, macro bending loss measurements, measurement of mode field diameter (MFD), near field scanning technique, indirect method, transverse offset technique and variable-aperture technique.

Unit-VII: Microwave Devices, Measurements and Communication

Microwave Tubes:

Klystron, reflex klystron, magnetron-cylindrical and linear, traveling wave tubes (Helix type).

Microwave Solid State Devices:

Tunnel diodes, bipolar transistors, JEFETs, MOSFETs

Transferred electron devices (TEDs):

Gunn diode, LSA diodes, Inp diodes.

Avalanche transit-time devises:

Read diode, IMPATT diode, TRAPATT diode, BARITT diodes.

Microwave Components: Wave-guide and modes of propagation, TE, TM and TEM modes, wave guide tees E-plane and H-plane tees, magic tees, isolator, attenuators, directional coupler, circulators, phase shifter, microwave terminations and detectors.

Propagation of Microwave: Space wave propagation over ideal flat earth, effect of curvature of an ideal earth, various other considerations in space wave propagation, atmospheric effects in space wave propagation, refraction of rays and the radio horizon, duct propagation, tropospheric scattering and reflection, fading of space wave signals.

Unit – VIII: Instrumentation

Transducer: Introduction, electrical transducer, selecting a transducer, resistive transducer, resistive position transducer, strain gauges, resistance thermometer, thermistor, inductive transducer, differential output transducer, linear variable differential transducer (LVDT), pressure inductive transducer, capacitive transducer (pressure), piezo and photo electric transducer, photo-voltaic cell, semiconductor photo diode, the photo transistor, thermo electric transducer, frequency generating transducer.

Signal Conditioning: Introduction, operational amplifiers, basic instrumentation amplifier, applications of instrumentation amplifiers, chopper and modulated IC amplifiers, modulators.

Induction Motors: Introduction, general design features, the rotating magnetic field, slip and rotor speed, rotor induced voltage and frequency, the rotor circuit, complete circuit diagram, characteristics.

Unit IX: Simulation in Electronics: VHDL

VHDL history, capabilities, hardware abstraction.

Basic Language Elements:(A) Identifiers, data objects, data types: subtypes, scalar types, integer types, composite types, array types, record types, access types, incomplete types, file types.(B) Operators: logical, relational, shift, adding, multiplying, miscellaneous.

Behavioral Modeling: Entity declaration, architecture body, process statement, variable assignment statement, signal assignment statement, wait statement, IF statement, case statement, null statement, loop statement, exit statement, next statement, assertion statement, report statement. nertial delay model, transport delay model, creating signal waveform, signal drivers, of transport delay and internal delay on signal drivers. Other sequential statement: multiple processes, postponed process.

Dataflow Modeling: Concurrent signal assignment statement, concurrent Vs. sequential signal assignment, delta delay revisited, multiple drivers, conditional signal assignment statement, selected signal assignment statement, the UNAFFECTED value, block statement, concurrent assertion statement, value of a signal.

Structural Modeling: Component declaration, component instantiation, examples of parity generators, counters, resolving signal values.

Generics and Configurations: Generics, configurations specifications and declaration, default rules, conversion function, direct instantiation, increment binding.

Subprogram's and Overloading: Subprograms, functions, procedures, declarations, subprogram overloading, operator overloading, signatures, default values for parameters.

Packages and Libraries: Package declaration, package body, design file, design libraries, order of analysis, implicit visibility, explicit visibility, library clause, use clause.

Unit X : Integrated Circuit Techniques

Materials for Integrated Circuits: Classification of IC, electronic grade silicon, crystal growth, Czeehralski and float zone crystal growing methods, silicon shaping, lapping, polishing and wafer preparation, vapor phase epitaxy oxidation thermal dry and wet plasma oxidation.

Integrated Circuits Fabrication Technology: Optical lithography, photo mask, photo resist and process, contact and proximity printing, limitations of optical lithography, idea of electron, mask generation, electron optics, idea of an X-ray lithography, wet chemical etching, reactive plasma etching, D.C. plasma excitation, AC plasma excitation, equivalent circuits.

Thin Film for Microelectronics: Evaporation theory, physical vapor deposition methods, design construction of high vacuum coating units, flash electron beam evaporation system, idea of dc and r.f. sputtering system.

Integrated Circuit Fabrication: Doping by diffusion, ion implantation, neutron doping monolithic integrated circuit, fabrication of integrated resistors and capacitors and their equivalent circuit, integrated inductor.

Microelectronic Fabrication: Fabrication of monolithic diodes in various configuration, fabrications of integrated transistors, idea of buried layer fabrication, monolithic circuit layout and design rules fabrication, monolithic circuit layout and design rules, isolation methods, monolithic FET, MOSFET processing, advantages and limitation of MOS devices, idea of HEMT (high electron mobility transistor), CCD, MOS integrated circuit, large and medium scale integration, hybrid integrated circuit.