



List of Revised Courses

Department : *Electronics and Communication Engineering*

Program Name : *B.Tech.*

Academic Year : *2019-20*

List of Revised Courses

Sr. No.	Course Code	Name of the Course
01.	EC03TPC01	Electronic Devices
02.	EC03TPC02	Digital System Design
03.	EC03TPC03	Signal and Systems
04.	EC03TPC04	Network Theory
05.	EC03TPC05	Mathematics-III
06.	EC04TPC05	Analog and Digital Communication
07.	EC04TPC06	Analog Circuits
08.	EC04TES05	Electronics Measurement & Instrumentation

प्रभगाध्यक्ष (इले. एव सचार अभियंत्रिकी)
H.O.D. (Elect. & Comm. Engineering)
प्रौद्योगिकी संस्थान
Institute of Technology
गु. घा. वि., बिलासपुर (छ.ग.)
G. G. V. Bilaspur (C.G.)



Minutes of Meetings (MoM) of Board of Studies (BoS)

Academic Year : 2019-20

School : School of Studies of Engineering and Technology

Department : Electronics and Communication Engineering

Date and Time : June 27, 2019 - 11:00 AM

Venue : E-Class Room

The scheduled meeting of member of Board of Studies (BoS) of Department of Electronics and Communication Engineering, School of Studies of Engineering and Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur was held to design and discuss the B. Tech. Second year (III and IV semesters) scheme and syllabi.

The following members were present in the meeting:

1. Prof. Shrish Verma (External Expert Member BoS, Dept. of ECE, NIT Raipur)
2. Mr. Vikas Patel, (External Expert Member BoS, Senior SDE, BSNL Bilaspur)
3. Mr. Nipun Kumar Mishra (HOD, Assistant Prof., Dept. of ECE-cum Chairman, BOS)
4. Mr. Shrawan K. Patel (Member BoS, Assistant Professor, Dept. of ECE)
5. Dr. P.S. Shrivastav (Invited Member, Assistant Professor, Dept. of ECE)
6. Dr. Sandeep Singh (Invited Member, Assistant Professor, Dept. of Mathematics)

Following points were discussed during the meeting

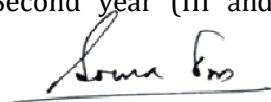
1. CBCS based evaluation scheme of B. Tech. Second year (III and IV semesters) was discussed and finalized.
2. Courses of B. Tech. Second year (III and IV semesters) are discussed one by one and the changes have been incorporated as per the valuable suggestions of Expert member.

The committee discussed and approved the scheme and syllabi. The following courses were revised in the of B. Tech. Second year (III and IV semesters):

- ❖ Electronic Devices (EC03TPC01)
- ❖ Digital System Design (EC03TPC02)
- ❖ Signal and Systems (EC03TPC03)
- ❖ Network Theory (EC03TPC04)
- ❖ Mathematics-III (EC03TPC05)
- ❖ Analog and Digital Communication (EC04TPC05)
- ❖ Analog Circuits (EC04TPC06)
- ❖ Electronics Measurement & Instrumentation (EC04TES05)

The following new courses were introduced in the of B. Tech. Second year (III and IV Semesters):

- ❖ Constitution of India (EC03TMC02)
- ❖ Microcontrollers (EC04TPC07)
- ❖ Effective Technical Communication (EC04THS03)


वर्भागाध्यक्ष (इले. एव संचार अभियंत्रिकी)
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Signature & Seal of HoD



Scheme and Syllabus

SCHEME OF EXAMINATION
B.TECH (FOUR YEAR) DEGREE COURSE
SECOND YEAR, ELECTRONICS & COMMUNICATION ENGINEERING
SCHOOL OF ENGINEERING & TECHNOLOGY, GGUV BILASPUR (CG) 495009
SEMESTER III (SECOND YEAR)
EFFECTIVE FROM SESSION 2019-20

Sr. No.	Course Code	Course Title	L	T	P	Periods/ week	Evaluation Scheme			Credit
							IA	ESE	Total	
Theory										
1	EC03TPC01	Electronic Devices	3	0	0	3	30	70	100	3
2	EC03TPC02	Digital System Design	3	0	0	3	30	70	100	3
3	EC03TPC03	Signals and Systems	3	0	0	3	30	70	100	3
4	EC03TPC04	Network Theory	3	0	0	3	30	70	100	3
5	EC03TBS05	Mathematics-III	3	1	0	4	30	70	100	4
6	EC03THS02	Engineering Economics	3	0	0	3	30	70	100	3
7	EC03TMC02	Constitution of India	2	0	0	2	0	0	0	0
Practical										
1	EC03PPC01	Electronics Devices Lab	0	0	3	3	30	20	50	1
2	EC03PPC02	Digital System Design Lab	0	0	3	3	30	20	50	1
Total Credits									21	

SEMESTER IV (SECOND YEAR)
EFFECTIVE FROM SESSION 2019-20

Sr. No.	Course Code	Course Title	L	T	P	Periods/ week	Evaluation Scheme			Credit
							IA	ESE	Total	
Theory										
1	EC04TPC05	Analog and Digital Communication	3	1	0	4	30	70	100	4
2	EC04TPC06	Analog Circuits	3	0	0	3	30	70	100	3
3	EC04TPC07	Microcontrollers	3	0	0	3	30	70	100	3
4	EC04TBS06	Numerical Methods	3	1	0	4	30	70	100	4
5	EC04TES05	Electronics Measurement & Instrumentation	3	0	0	3	30	70	100	3
6	EC04THS03	Effective Technical Communication	3	0	0	3	30	70	100	3
Practical										
1	EC04PPC03	Analog and Digital Communication Lab	0	0	2	2	30	20	50	1
2	EC04PPC04	Analog Circuits Lab	0	0	2	2	30	20	50	1
3	EC04PPC05	Microcontrollers Lab	0	0	2	2	30	20	50	1
Total Credits									23	

L : LECTURE T: TUTORIAL P: PRACTICAL IA: INTERNAL ASSESSMENT ESE: END SEMESTER EXAM



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC03TPC01	3	0	0	3 hours	30	70	3

ELECTRONIC DEVICES

Course Objectives:

Students will try to learn:

1. To understand operation of semiconductor devices.
2. To understand DC analysis and AC models of semiconductor devices.
3. To apply concepts for the design of Regulators and Amplifiers
4. To verify the theoretical concepts through laboratory and simulation experiments.
5. To implement mini projects based on concept of electronics circuit concepts.

UNIT-I :Semiconductor concept: Metals, Insulators and Semiconductors, Electrical properties of Ge and Si, Conductivity Equation, Mobility and Conductivity, Electron and holes in intrinsic and extrinsic semiconductors, Donor and Acceptor Impurities, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon, Transport Phenomena of semiconductor, Generation and recombination of carriers, Charge density in Semiconductor, Hall Effect, Injected minority charge carriers, Potential variation within graded semiconductor.

Junction Diode Characteristics: Properties of P-N junction, Open circuited P-N junction, V-I characteristics, Temperature dependence of V-I characteristics, Diode resistance, Current component of PN diode: Space charge capacitance, Charge control description of a diode, Diffusion capacitance, Junction diode switching times, Breakdown mechanism.

UNIT-II :Diode Circuits: Load line concepts, Graphical analysis, Clipper circuit, Clamper, Comparator, Rectifier, Full wave circuits, Filter circuits: Inductor filter, Capacitor filter, LC filter, Multiple LC filter, CLC or π filter, Zener diode regulator circuit.

OTHER DIODES: Negative conductance in semiconductors- Tunnel diode, Photo diode - Photo voltaic effect, Solar cells, Schottky Diode, Varactor Diode, Avalanche diode, PIN diode, LED, LASER.

UNIT-III :Transistor Characteristics: Junction Transistor, Transistor current components, Transistor as an amplifier, Transistor construction, Transistor circuit configuration (CB, CE, CC)- Analytical Expression for transistor characteristics and Operation, Early Effect, Ebers-Moll Model, β -re model, Transistor as a switch.

Transistor Biasing and Thermal Stabilization: The operating point, Bias stability, Stability factor- Stabilization against variation in I_{CO} , V_{BE} and β , Emitter bias, Collector - to - base bias, Voltage divider bias with emitter bias, Emitter bypass capacitor. Bias compensation.

UNIT-IV: Field Effect Transistor (FET): JFET Construction, Operation, V-I characteristics, Transfer characteristics, Drain characteristics. Metal Oxide Semiconductor Field Effect Transistor (MOSFET)- Construction, Operation and characteristics, Depletion MOSFET, Enhancement MOSFET,



complementary MOSFET.MOS capacitor, C-V characteristics, MOSFET, small signal models of MOS transistor, LED, photodiode and solar cell;

UNIT-V:IC Fabrication: Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

Text/Reference Books:

1. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014.
2. D. Neamen , D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, "Physics of Semiconductor Devices," 3rd edition, John Wiley&Sons, 2006.
4. C.T. Sah, "Fundamentals of solid state electronics," World Scientific Publishing Co. Inc, 1991.
5. Y. Tsididis and M. Colin, "Operation and Modeling of the MOS Transistor," Oxford Univ. Press, 2011.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the principles of semiconductor Physics
2. Understand and utilize the mathematical models of semiconductor junctions and MOS transistors for circuits and systems.



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC03TPC02	3	0	0	3 hours	30	70	3

DIGITAL SYSTEM DESIGN

Course Objectives:

Students will try to learn:

1. To understand number representation and conversion between different representation in digital electronic circuits.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand characteristics of memory and their classification.
4. To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines.
5. To understand concept of Programmable Devices, PLA, PAL, CPLD and FPGA and implement digital system using VHDL.
6. To implement combinational and sequential circuits using VHDL.

UNIT-I :Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De-Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion.

UNIT-II:MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel Shifter and ALU.

UNIT-III :Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machine Charts, Designing Finite synchronous circuits like Pulse train generator, PseudoRandom Binary Sequence generator, Clock generation

UNIT-IV :Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable Logic Devices like FPGA, Logic implementation using Programmable devices.

UNIT-V :VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis & Simulation , VHDL constructs and codes for combinational and sequential circuits.

Text/Reference Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd edition ,2006.
4. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
5. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd edition 2012.



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC03TPC03	3	0	0	3 hours	30	70	3

SIGNALS & SYSTEMS

Course Objectives:

Students will try to learn:

1. To introduce students the concept and theory of signals and systems needed in electronics and telecommunication engineering fields.
2. To introduce students to the basic idea of signal and system analysis and its characterization in time and frequency domain

UNIT-I: Signals and systems as seen in everyday life, and in various branches of engineering and science. Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity additivity and homogeneity, shift-invariance, causality, stability, realizability.

UNIT-II: Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations.

UNIT-III : Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem: The idea of signal space and orthogonal bases.

UNIT-IV : The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z-domain analysis.

UNIT-V: State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

Text/Reference books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
3. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
4. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
5. Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC03TPC04	3	0	0	3 hours	30	70	3

NETWORK THEORY

Course Objectives:

Students will try to learn:

1. To explain the basic concepts and laws of DC and AC electrical networks and solve them using mesh and nodal analysis techniques.
2. To introduce students with the fundamental concepts in graph theory.
3. To analyze circuits in time and frequency domain.
4. To explain concepts of driving point and transfer functions, poles and zeroes of network functions.
5. To introduce open circuit, short circuit, transmission, hybrid parameters and their interrelationship.

UNIT-I: Node and Mesh Analysis, matrix approach of network containing voltage and current sources and reactances, source transformation and duality. Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tellegen's theorem as applied to AC circuits.

UNIT-II: Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.

UNIT-III: Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.

UNIT-IV: Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations.

UNIT-V: Convolution theorem and Two four port network and interconnections, Behaviors of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Text/Reference Books

1. Van, Valkenburg; "Network analysis"; Prentice hall of India, 2000
2. Sudhakar, A., Shyamohan, S. P.; "Circuits and Network"; Tata McGraw-Hill NewDelhi, 1994
3. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand basics electrical circuits with nodal and mesh analysis.
2. Appreciate electrical network theorems.
3. Apply Laplace Transform for steady state and transient analysis.
4. Determine different network functions.
5. Appreciate the frequency domain techniques.



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC03TBS05	3	1	0	4 hours	30	70	4

MATHEMATICS - III

Course Objectives:

Students will try to learn:

1. To expand the given periodic function defined in the given range in terms of sine and cosine multiple of terms as a Fourier series.
2. To extremise the functional using integration technique.
3. To form and solve the partial differential equation using different analytical techniques.

UNIT - I : Functions of Complex Variables-Differentiation: Limit, Derivative, Analytic function, Cauchy-Riemann Equations, Harmonic Functions, finding harmonic conjugate, Elementary analytic functions (exponential, trigonometric, logarithmic) and their properties, Conformal mapping, Mobius transformation and their properties.

UNIT - II : Functions of Complex Variables- Integration: Complex Integration, Cauchy's integral theorem, and Integral formula, Liouville's theorem and Maximum- Modulus theorem (without proof), Taylor's & Laurent's series, Singular point, Poles & residues, Residue theorem & its application to contour integration.

UNIT - III : Laplace Transform: Definition, Linearity, Shifting & Scaling properties, Transform of Elementary functions, Transform of Derivatives & Integrals, Multiplication by t & division by t , Inverse Laplace transform, Convolution theorem, Transform of Periodic functions, Unit Step function & Dirac delta function, Initial value and Final value theorems, Application to solution of ordinary differential equations.

UNIT - IV : Fourier Transform: Definition of Fourier Integrals- Fourier Sine & Cosine integrals, Complex form of Fourier integral, Fourier Sine & Cosine transforms, Complex form of Fourier Transform, Linearity, Shifting & Scaling properties, Modulation theorem, Inverse Fourier transform, Fourier transform of derivatives.

UNIT - V : Differential Equations: First order ordinary differential equations-Exact, linear and Bernoulli's equations, Equations not of first degree: equations solvable for p , equations solvable for y , equations solvable for x and Clairaut's type, Second order linear differential equations with constant coefficient.

SUGGESTED BOOKS & REFERENCE:-

1. H K Das, "Advance Engg. Mathematics", S-Chand Publication
2. B S Grewal, "Higher Engg. Mathematics", Khanna Publication
3. Erwin Kreyszig, "Advance Engg. Mathematics", J Willey & Sons
4. Louis A Pipes, "Applied Mathematics for Engineers & Physicists", TMH
5. S.L .Ross, Differential Equations, 3rd Ed., Wiley India,2009.



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC04TPC05	3	1	0	4 hours	30	70	4

ANALOG AND DIGITAL COMMUNICATION

Course Objectives:

Students will try to learn:

1. The fundamentals of basic communication system, types of noise affecting communication system and noise parameters.
2. Need of modulation, modulation processes and different amplitude modulation schemes
3. Different angle modulation schemes with different generation and detection methods.
4. Various radio receivers with their parameters.
5. Need of sampling and different sampling techniques.
6. Generation and detection of pulse modulation techniques and multiplexing.
7. About theoretical bounds on the rates of digital communication system and represent a digital signal using several modulation methods

UNIT-I: Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

UNIT-II: Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

UNIT-III: Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.

UNIT-IV: Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Base band Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

UNIT-V: Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

Text/ReferenceBooks:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M. ;"Communication Systems Engineering", Pearson Education,2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill,2001.



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC04TPC06	3	0	0	3 hours	30	70	3

ANALOG CIRCUITS

Course Objectives:

Students will try to learn:

1. To understand the operation of the various bias circuits of MOSFET and Analyze and design MOSFET bias circuits.
2. To understand the operation and design of multistage. amplifier for a given specification.
3. To understand the operation and design of transformer coupled various types of power amplifier circuits.
4. To understand the effects of negative feedback on amplifier circuits.
5. To analyze the different RC and LC oscillator circuits to.
6. To determine the frequency of oscillation

UNIT-I: Diode Circuits, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.

UNIT-II: High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.

UNIT-III: Oscillators: Review of the basic concept, Barkhausen criterion, RC Oscillators (Phase shift, Wein Bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), Non sinusoidal oscillators, Current mirror: Basic topology and its variants, V-I Characteristics, Output resistance and minimum sustainable voltage (VON), maximum usable load.

UNIT-IV: Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP-AMP Design: design of differential amplifier for a given specification. Design of gain stages and output stages, compensation. OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, Precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop design guidelines.

UNIT-V: Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog to-digital converters (ADC): Single Slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.



Sub Code	L	T	P	Duration	IA	ESE	Credits
EC04TES05	3	0	0	3 hours	30	70	3

ELECTRONICS MEASUREMENT & INSTRUMENTATION

Course Objectives:

Students will try to learn:

1. To explain basic concepts and definitions in measurement.
2. To describe the bridge configurations and their applications.
3. To elaborate discussion about the importance of signal generators and analyzers in Measurement.

UNIT – I: Measurements and Measurement system: Measurements, Significance of measurement, Methods of measurement- Direct and Indirect Method. Instruments and measurement system: Mechanical, Electrical, Electronic instruments; Classification of Instruments: Deflection and null type instruments. Analog and Digital mode of Operation, Application of measurement system, Characteristics of instrument and measurement system: static & dynamic; Elements of a Generalized Measurement System: Primary Sensing Element, Variable Conversion Element, Data presentation Element. Accuracy and precision, Significant figure, types of error, gross error, systematic error- Instrumental, Environmental, Observational Errors, Random error, Probability of error, Probable Error- of a finite number of readings, for combination of components, Limiting error.

UNIT –II: Electromechanical Indicating Instruments: Operating forces, Constructional Details, Types of Support, Torque/Weight Ratio, Control system, Damping- Air friction and Eddy current damping. D'Arsonval Galvanometer- construction, Torque Equation, Dynamic Behavior, Undamped, Damped, Overdamped Motion, Response of Galvanometer. Ballistic Galvanometer. PMMC- Construction, Torque Equation, Voltage/Current Measurement: Ammeter, Voltmeter, Ohmmeter, Multimeter (V.O.M.), Ratiometer, Megger. High frequency Measurement: Q-meter

UNIT – III: AC Bridge: Introduction, Sources and Detectors, General equation for bridge balance, General form of AC Bridge. Maxwell's Bridge, Hay's bridge, Anderson's bridge, De-Sauty's bridge, Schering bridge, Wien's bridge. **Electronic Instruments:** Introduction, Advantage of Electronic voltmeter, VTVM, Differential voltmeter, Electronic voltmeter using rectifier, True RMS reading voltmeter, Calorimeter power meter.

UNIT – IV: Transducers: Classification of transducer, Primary & Secondary, Passive & Active, Analog & Digital, Potentiometer, loading effect, Strain Gauge, Thermistor, Construction of thermistor, Thermocouple, LVDT, Advantage & Disadvantage of LVDT, RVDT, Capacitive Transducer, Piezo-electric transducer, Hall-effect Transducer, Capacitive Transducer, Pressure Transducer.

UNIT – V: Display devices: Digital display method, Segmental display- 7segment & 14 segment display, dot matrix, LED, LCD, TFT, Plasma display, DLP. **Digital voltmeter (DVM):** Types of DVM, Ramp type DVM, Integrating type DVM, Potentiometer type (non-integration type). **Recorders:** Analog Recorder, Null type Recorder, Single point Recorder, Graphical strip chart, X-Y recorders, Magnetic tape recorder, FM recorder. **CRO:** Introduction, Oscilloscope block diagram, CRT, Functional block diagram of sampling, Storage, Dual trace and dual beam oscilloscope.