West Bengal State University

PG Syllabus (NEP)

(Effective from 2026-'27)

Programme: M. Sc. in Electronics (2-Year Course)

Eligibility: Major/Minor/MDP with Electronics/Physics/B. Tech(Electronics)

Programme-specific Outcome

Upon successful completion of the M.Sc. in Electronics program, students will be able to:

- PSO 1: Advanced Knowledge in Electronics- Demonstrate in-depth knowledge of core areas of Electronics, including Analog and Digital Electronics, Semiconductor Devices, Control systems, Communication Systems, Signal Processing, Instrumentation, and Emerging Technologies, and apply this knowledge to solve complex problems.
- PSO 2: Research and Innovation- Apply scientific methods and research methodologies to investigate contemporary problems, analyse data, and develop innovative solutions in frontier areas such as the Internet of Things (IoT), robotics, artificial intelligence, renewable energy systems, and advanced communication technologies.
- PSO 3: Interdisciplinary and Digital Competence- Integrate knowledge from Electronics with allied disciplines such as Physics, Mathematics, Computer Science, Data Science, and Mechatronics to address multidisciplinary challenges and adapt to evolving technological demands

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M. Sc. Syllabus (NEP) in Electronics
Draft proposed by the PGBoS in Electronics
(HIGHLIGHTS: Core Papers: 19, DSE: 02, SEC: 01, AEC: 01)
Semester-I

S. No.		Paper Code	Paper Title	Full Marks	Credit
1	Core	ELT2PCOR01T	Analog Circuits	50	4
2		ELT2PCOR02T	Mathematical Foundations of Electronics	50	4
3		ELT2PCOR03T	Physics of Semiconductor Devices and Technology	50	4
4		ELT2PCOR04P	Analog Circuit Laboratory	50	4
5		ELT2PCOR05P	Semiconductor Device Characterization Laboratory	50	4
6	AEC	ELT2PAEC01M	Ability Enhancement in Electronics	50	2

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Semester-II

S. No.		Paper Code	Paper Title	Full Marks	Credit
1	Core	ELT2PCOR06T	Digital Circuits and Systems	50	4
2		ELT2PCOR07T	Control Systems	50	4
3		ELT2PCOR08T	Automation and Intelligent Robotic Systems	50	4
4		ELT2PCOR09P	AI-Assisted Network Analysis and Synthesis	50	4
5		ELT2PCOR10P	Digital Circuit Laboratory	50	4

Semester-III

S. No.		Paper Code	Paper Title	Full Marks	Credit
1	Core	ELT2PCOR11T	Electromagnetic Field and Radiation	50	4
2		ELT2PCOR12T	Electronic Communication Systems	50	4
3		ELT2PCOR13T	Digital Signal Processing	50	4
4		ELT2PCOR14P	Electronic Communication Laboratory	50	4
5	SEC	ELT2PSEC01M	Internet of Things	50	2
6	DSE	ELT2PDSE01T Or ELT2PDSE02T	Optoelectronics or Microprocessor Fundamentals	50	4

Semester-IV

S. No.		Paper Code	Paper Title	Full Marks	Credit
1	Core	ELT2PCOR15T	Instrumentation	50	4
2		ELT2PCOR16T	VLSI and Power Electronics	50	4
3		ELT2PCOR17P	Microprocessor and Microcontroller Laboratory	50	4
4		ELT2PCOR18M	Project Literature Review	50	4
5		ELT2PCOR19M	Project Dissertation	50	4
6	DSE	ELT2PDSE03T Or ELT2PDSE04T	Advanced Microprocessor or Microcontroller	50	4

For detailed syllabi: see overleaf

Detailed syllabi:

Semester-I

ELT2PCOR01T:Analog Circuits

Credit: 4 (3 Lecture + 1 Tutorial), Full Marks: 50

Course Outcome:
Students after successfully completion of the course will gain:

- Knowledge on analog circuit operation and functionality
- Knowledge on analog circuit to solve real-life problems
- Knowledge in making electronic systems

Unit–I: Concept of Basic Analog Circuits

(a) Revisiting fundamentals of Electronics with examples.

(b) Analog signal with examples. Real-life applications of Analog signal.

(c) Diode-Capacitor circuits.

(d) Amplifiers: Amplifiers of various types, single- and multistage-stage amplifiers, feedback in amplifiers.

Unit–II: Advanced Analog Circuits

(e) Op-Amps and their applications (linear and non-linear types).

(f) Wave shaping circuits (Op-Amp- and Diode-Capacitor-based).

(g) Active filters (Op-Amp-based).

(h) Transformers and their applications.

Recommended Books:

1. Integrated Electronics, Millman, Halkias, **McGrawHill**
2. Electronic Principles, A. Malvino, D. J. Bates, **Tata McGraw Hill**
3. Op-Amps and Linear Integrated Circuits. Ramakant A Gayakwad, **PHI**.
4. Electronic Circuits, Donald A Neamen, **Tata McGraw Hill**
5. Electronic Devices & Circuit Theory, Robert Boylestad, **Pearson**
6. For Diode-Capacitor Circuits: https://doi.org/10.1119/1.5026994

ELT2PCOR02T: Mathematical Foundations of Electronics

Credit: 4 (3 Lecture + 1 Tutorial), Full Marks: 50

Course Outcome:

After successful completion of the course, students will be able to:

- Solve Matrix Algebra and Eigenvalue analysis to solve electronic system related problems.
- Solve differential equations and transform techniques for electronic systems.
- Utilize complex variable theory in network analysis, Signal processing, and Electromagnetic theory.
- Use probability and statistical techniques for data analysis, noise characterization, and communication systems.

Unit I: Linear Algebra and Matrix Methods

(a) Rank of a matrix and system of linear equations, Physical interpretation of Rank, Vector spaces and linear independence, Eigenvalues and eigenvectors, Diagonalization of matrices, Applications in circuit and network analysis, State-space representation of systems

(b)**Applications:** Circuit equations, Stability analysis of systems, Signal representation

Unit II: Differential Equations and Mathematical Modelling

(c)**Ordinary Differential Equations**: Introduction to first order, second order, homogeneous, nonhomogeneous equations,Cauchy-Euler equations, Initial and boundary value problems.
(d)**Partial differential equations:**Homogeneous and non-homogeneous boundary conditions, Solutions by separation of variables and series expansion methods.
(e)**Applications:** RC, RL and RLC circuits, Semiconductor transport equations, Heat and diffusion problems in electronics.

Unit III: Transform Methods and Signal Analysis (10 Hours)

(f) **Laplace Transform:** Properties and theorems, Inverse Laplace Transform.
(g) **Fourier Transform:** Properties and applications, Frequency-domain analysis.
(h) **Applications:** Signal processing, Communication systems.

Unit IV: Complex Variables and Functions

(i) Complex number algebra, Analytic functions, Cauchy-Riemann equations, Complex integration, Cauchy's Integral Theorem, Cauchy's Integral Formula, Taylor series.

(j)**Applications:** Network theory, Signal analysis, Electromagnetic wave propagation.

Unit V: Probability and Statistics for Electronics

(l) Fundamentals of probability, Conditional probability and Bayes' theorem, Random variables, Probability density and distribution functions, Discrete distributions, Binomial, Poisson, Continuous distributions: Normal distribution.

(m) Measures of central tendency: Mean, Median, Mode, Measures of dispersion: Variance, Standard deviation, Sampling theory, Correlation and regression analysis.

(n)**Applications:** Noise analysis, Reliability of electronic systems, Communication channels.

Recommended Books:

1. Higher Engineering Mathematics, B. S. Grewal, **Khanna Publication**
2. Mathematical Physics, B. D. Gupta, **Vikas**
3. Advanced Engineering Mathematics, Erwin-Kreyszig, **Wiley**

ELT2PCOR03T: Physics of Semiconductor Devices and Technology

Credit: 4 (3Lecture + 1Tutorial), Full Marks: 50

Course Outcome:

After successful completion of the course,Studentswill be able to:

- Understand the crystal structure, bonding, and electronic properties of solid-state materials.
- Analyze charge transport mechanisms in semiconductors and their influence on device behavior.
- Explain the operation and characteristics of semiconductor devices including diodes, transistors, and optoelectronic devices.
- Evaluate the role of advanced electronic materials in modern device technologies.

Unit I: Crystal Structure and Electronic Properties of Solids

(a) Crystal structures and symmetry, Lattice, unit cell, Miller indices, Crystal defects and imperfections, Bonding in solids: Ionic, Covalent, Metallic, and Van der Waals bonding, Free electron theory, Energy bands in solids, Metals, Semiconductors, and Insulators, Effective mass and Density of states

(b) Applications: Electronic materials and Semiconductor technologies

Unit II: Semiconductor Materials and Carrier Transport

(c) Intrinsic and extrinsic semiconductors, Fermi-Dirac statistics, Carrier concentration and Fermi level, Carrier generation and recombination, Drift and diffusion mechanisms, Continuity equation, Hall effect and mobility measurements, Direct and indirect bandgap semiconductors.

(d)**Applications:** Electronic and optoelectronic devices

Unit III: PN Junction and Metal-Semiconductor Devices

(e) Formation and characteristics of PN junction, Depletion region and built-in potential, Current-voltage characteristics, Junction capacitance, Breakdown mechanisms, Schottky barrier diode, Ohmic contacts, Tunnel diode and Varactor diode, Solar cells, Light Emitting Diodes (LEDs).

(f)**Applications:**Rectifiers, switching circuits, and high-frequency electronics

Unit IV: Bipolar and Field-Effect Devices

(g) Bipolar Junction Transistor (BJT**),** Structure and operation, Current transport mechanism, Ebers-Moll model, Switching and frequency response

(h) JFET operation and characteristics, MOS capacitor, MOSFET structure and operation,Threshold voltage, Short-channel effects, CMOS technology.

(i)**Applications:** Analog and digital integrated circuits.

Recommended Books:

1. Solid State Electronic Devices, Ben G. Streetman and Sanjay Kumar Banerjee, PHI Learning Pvt. Ltd.
2. Physics of Semiconductor Devices, S. M. Sze, Wiley.
3. Semiconductor Physics and Devices, Islam, Oxford.
4. Physics of Semiconductor Devices, Shur, PHI.
5. The Physics of Low-dimensional Semiconductors- An Introduction, John N. Davies, Cambridge University Press.

ELT2PCOR04P: Analog Circuit Laboratory

Credit: 4 (Practical), Full Marks: 50

Students after successfully completion of the course will gain:

- Skill on the functionality of analog circuits
- Skill on circuit fabrication and their operation
- Skill on operating basic laboratory instruments

(a) Sawtooth wave generation using Diode-Capacitor circuit.

(b) Comparator circuit using Op-Amp.

(c) Inverting and or Non-inverting amplifier: Constancy of Gain-bandwidth product (experiment with minimum of 3 gains).

(d) Application of Op-Amp as mixer circuits (two circuits).

(e) 1st Order Active Low pass and/or high pass filter.

(f) Wave shape conversion circuit using Op-Amp.

ELT2PCOR05P: Semiconductor Device Characterization Laboratory

Credit: 4 (Practical), Full Marks: 50

Course Outcome:

After successful completion of the course, students will gain:

- Skill to characterize Solar Cell
- Skill to characterize LDR
- Skill to characterize pn junction
- Skill on operating advanced device characterization instruments

(a) Solar Cell: V-I characteristics under illumination and dark condition; measurements of various parameters.
(b) Experiment to find resistivity of a material
(c) Experiment to find Dielectric permittivity of a material (liquid and solid samples)
(d) Experiment to find dc and ac resistance of a conducting material
(e) Experiment to find the tangent loss of a material (using capacitor)
(f) Bandgap and Capacitance characterization of a PN junction.
(g) LDR characterization laboratory experiments.
(h) I–V characterization of diodes (Si-diode, Ge-diode, Zener diode, LED).

ELT2PAEC01M: Ability Enhancement in Electronics

Credit: 2 (Mixed Mode), Full Marks: 50

Course outcomes:

- Students will prepare themselves for independent solving problems in Electronics
- Students will gain knowledge and enhance their skill to handle problemsof Electronics

UnitI: Hands-on Training &Solving Problems in Basic Analog Electronics
(a) DC power supply chips (78xx series and 79xx series), (b) Analog circuits, (c) Bipolar transistors, (d) FET, (e) Oscillator, (f) Amplifiers including OP-Amps

Unit II: Hands-on Training &Solving Problems in Basic Digital Electronics
(g) Combinational logic circuits, (h) Sequential logic circuits (basics)

Recommended books:
Books related past-years questions papers and solutions for NET/GATE.

Semester – II

ELT2PCOR06T:Digital Circuits and Systems

Credit: 4 (3Lecture + 1Tutorial), Full Marks: 50

Course Outcome:
Students after successfully completion of the course will gain:

- Knowledge on Digital circuit operation and functionality
- Knowledge on Digital circuit to solve real-life problems
- Knowledge in making Digital systems

Unit I: Boolean Algebra, Logic Minimization and Combinational Circuit Design

(a) Number systems, Boolean Algebra, Karnaugh Maps, Quine-McCluskey minimization method, Hazard analysis and elimination
(b) Design using NAND and NOR gates, Adders and Subtractors, Carry Look-Ahead Adder, Multiplexers and Demultiplexers, Encoders and Priority Encoders, Decoders, Magnitude Comparators, Code Converters

Unit II: Sequential Logic Circuits

(c) Latches and Flip-Flops (SR, JK, D, T), Characteristic equations and excitation tables, Race-around condition and Master-Slave Flip-Flops, Registers and Shift Registers, Asynchronous and Synchronous Counters, Ring Counter and Johnson Counter, Design of Mod-N Counters, Timing considerations in sequential circuits
(d) **Application:** Digital Clock and Frequency Counter Systems

Unit III: Finite State Machines, Sequential System Design and Semiconductor Memories

(e) State diagrams and State tables, Moore and Mealy models, State minimization and state assignment, Design of synchronous sequential circuits, Algorithmic State Machine (ASM) charts, Sequence detectors, Control circuit design using FSMs
(f) Memory hierarchy, ROM, PROM, EPROM and EEPROM, SRAM and DRAM, Memory organization and expansion, PLA and PAL, CPLD and FPGA architecture,

Recommended Books:

1. Digital Circuits (Vol.1 and Vol.2), D. Raychaudhuri, **Platinum Publishing**
2. Fundamental of Digital Circuits, Anand Kumar,**PHI**
3. Digital Design, M. Morris Mano,**PHI**
4. Digital Fundamentals, Thomas L. Floyd, **Pearson**
5. Digital Electronics, Diptimam Ray Chaudhuri, Monojit Mitra, **Nonlinear Insights (OPC) Pvt. Ltd**.

ELT2PCOR07T: Control Systems

Credit: 4 (3Lecture + 1Tutorial), Full Marks: 50

Course Outcome:
Students after successfully completion of the course, students will be able to:

- Demonstrate fundamentals of control systems
- Design physical systems for various applications of control systems
- Apply control system for real-life problems

Unit I: Introduction to Control Systems and Mathematical Modelling

(a) Concept of control systems, Open-loop and closed-loop control systems, Feedback and its effects, Types of control systems, Mathematical modelling of physical systems, Differential equation representation, Transfer function concept, Block diagram representation
(b) **Application:**DC Motor Speed Control

Unit II: Signal Flow Graphs and Time-Domain Analysis

(c) Signal Flow Graphs (SFG), Mason's Gain Formula, Block diagram reduction techniques, Standard test signals: Unit impulse, Unit step, Unit ramp, Unit parabolic, Time response of first-order systems, Time response of second-order systems, Performance specifications: Rise time, Peak time, Settling time, Maximum overshoot
(d) **Application:** Servo Positioning Systems

Unit III: Stability Analysis

(e) Concept of stability, Characteristic equation, Necessary and sufficient conditions for stability, Routh-Hurwitz stability criterion, Relative stability, Stability analysis of higher-order systems, Root locations and System behavior
(f) **Application:**Power System Stability

Unit IV: Root Locus Techniques

(g) Root locus concept, Construction of root locus, Root locus rules, Effect of poles and zeros, Breakaway and break-in points, Angle of departure and arrival, Dominant poles, Design using root locus
(h) **Application:**Aircraft Autopilot Systems

Unit V: Frequency-Domain Analysis

(i) Frequency response of linear systems, Polar plots, Bode plots, Gain margin and phase margin, Resonant peak and resonant frequency, Bandwidth, Nyquist stability criterion, Relative stability analysis
(j) **Application:** Communication and Radar Systems

Unit VI: Controller Design and Compensation

(k) Types of controllers: P Controller, PI Controller, PD Controller, PID Controller, Controller tuning methods, Lead compensation, Lag compensation, Lead-Lag compensation, Performance improvement using compensation, Introduction to state-

space representation: State variables, State equations, State transition matrix, Controllability and observability

(l) **Application:** Industrial Process Automation

Recommended Books:

1. Signal and Systems, H. P. Hsu, **Tata McGraw Hill**

2. Signal and System, Oppenheim, Willsky, Nawab,**PHI**

3. Control Systems engineering, Nagrath & Gopal, **New Age**

4. Modern Control Engineering, Ogata, **PHI/Pearson**

5. Control Systems Engineering, R. Anandanatarajan & P.Ramesh Babu, **Scitech**

ELT2PCOR08T: Automation and Intelligent Robotic Systems

Credit: 4 (3Lecture + 1Tutorial), Full Marks: 50

Course Outcome:

After successful completion of the course, students will be able to:

- Understand the fundamentals and architecture of robotic systems.
- Analyze robot kinematics and dynamics.
- Study sensors, actuators, and robot control systems.
- Develop embedded and intelligent robotic applications.
- Understand machine vision and AI-based robotics.
- Explore industrial automation and autonomous systems.

Unit I: Fundamentals of Robotics

- Introduction, History, and Evolution of robotics, Classification of robots, Components of robotic systems, Degrees of freedom (DOF), Coordinate systems and Reference frames, Robot performance specifications
- **Applications:** Manufacturing automation, Medical robots, Service robots

Unit II: Robot Kinematics

- Coordinate transformations, Homogeneous transformation matrices, Forward kinematics, Inverse kinematics, Workspace analysis, Differential motion, Velocity analysis, Jacobian matrix
- **Applications:** Robotic manipulators, Pick-and-place robots, Surgical robots

Unit III: Robot Dynamics and Actuation

- Dynamic modelling of robots, Force and torque analysis, Trajectory planning, Motion control, Electrical actuators, DC motors, Servo motors, Stepper motors, Pneumatic and hydraulic actuators
- **Applications:** CNC machines, Industrial manipulators, Autonomous vehicles

Unit IV: Robot Control and Autonomous Systems

- Open-loop and closed-loop control, PID control, State-space representation, Digital control, Path planning algorithms, Obstacle avoidance, Localization and mapping, Introduction to SLAM
- **Applications:** Self-driving vehicles, Autonomous mobile robots, Warehouse automation

Unit V: Artificial Intelligence and Advanced Robotics

- Introduction to AI in robotics, Machine learning concepts, Computer vision, Image processing for robots
- **Applications:**Smart factories, Agricultural robots, Healthcare robotics

Recommended Books:

1. Introduction to Robotics: Mechanics and Control, John J. Craig, **Pearson**
2. Robotics, Vision and Control, Peter Corke, **Springer**
3. Robot Modeling and Control, M. W. Spong, S. Hutchinson and M. Vidyasagar, **Wiley**
4. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, **PHI**
5. Robotics Technology and Flexible Automation, S. R. Deb& S. Deb, **McGraw Hill Education**

ELT2PCOR09P: AI-Assisted Network Analysis and Synthesis

Credit: 4 (Practical), Full Marks: 50

Course Outcome:

After successful completion of the course, students will be able to:

- Operate AI tools for Electronics Learning
- Apply the fundamental concepts in solving and analyzing different Electrical networks
- Select appropriate and relevant techniques for solving the Electrical network
- Analyzing and synthesizing the networks in time and frequency domain
- Estimate the performance of a particular network from its analysis

Unit I: Introduction to AI tools

(a) Introduction to AI tools, Use of AI tools for Electronics learning
(b) Controlling AI tools for solution of specific problems

Unit II: Network Fundamentals and Circuit Analysis Techniques

(c) Network elements and parameters, Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL), Node-voltage and mesh-current analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity and Millman's theorem, Source transformation
(d) **Application:** Power Distribution and Electronic Circuit Design

Unit III: Transient Analysis of First and Second Order Networks

(e) Initial conditions and Switching operations, Response of RL and RC circuits, Natural and Forced responses, Time constant and Exponential behaviour, Response of RLC circuits, Overdamped, critically damped and Underdamped conditions, Impulse and Step responses, Network differential equations
(f) **Application:** Pulse generation circuits, Timing networks, Switching power supplies, and Communication systems.

Recommended Books:

1. Electric Circuits, Nahvi, Edminister, **McGraw Hill**
2. Circuit Theory (Analysis and Synthesis), A. Chakrobarti, **Dhanpat Rai**
3. Electric Circuit Theory, D. Chattopadhaya, P. C. Rakshit, **S.Chand**
4. Electric Circuits Fundamentals, Sergio Franco, **Oxford University Press**

ELT2PCOR10P: Digital Circuit Laboratory

Credit: 4 (Practical), Full Marks: 50

Course Outcome:

After successful completion of the course, Students will be able to:

- Design Combinational circuits
- Design Sequential circuits
- Gain skills on making Digital Circuits

Unit I: Combinational Logic Design

(a) Design and implementation of logic circuits using basic and universal gates (NAND and NOR).
(b) Design and realization of combinational circuits using Karnaugh maps.
(c) Design and implementation of: Half Adder, Full Adder, Half Subtractor, Full Subtractor
(d) Design and implementation of: 4-bit Ripple Carry Adder, Carry Look-Ahead Adder
(e) Design and verification of: Multiplexers, Demultiplexers, Encoders, Decoders

Unit II: Sequential Logic Design

(f) Verification of characteristics of: SR Flip-Flop, JK Flip-Flop, D Flip-Flop, T Flip-Flop
(g) Design and implementation of: Synchronous counters, Asynchronous counters
(h) Design and implementation of shift registers: SISO, SIPO, PISO, PIPO
(i) Sequence detector design using state machines.
(j) Design and implementation of finite state machines (Moore and Mealy models)