NEP Syllabus (Phase–I)
for
UG Electronic Science
West Bengal State University

Contents:

In Phase–I, the syllabus for the following course is presented in this document. Work is in progress for the rest of the syllabus.

Syllabus Preparation Members:

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Semester–I

Major–1 (Theory): Electronics Foundation-I (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit–I: Electronic Materials (33 Lectures)

A. Basic Quantum Physics

1) Basic postulation of quantum mechanics, Wave representation of particle, Phase velocity and Group velocity, Probability density, Heisenberg Uncertainty principle.
2) Schrodinger wave Equation (time independent), Quantum mechanical operators (position, momentum, energy, operator algebra not included), Particle in one dimensional box, Particle in one dimensional barrier potential, Schrodinger equation applied to periodic potential filed – concept of allowed and forbidden energy bands, Classification of materials – Insulators, Conductors, Semiconductors, Dielectrics.

B. Classification of Electrical and Electronic Materials

1) Basic behaviour of Insulators; Conductors; Semiconductors; Dielectrics.
2) Conductive Materials: Free Electron Theory, Factors affecting conductivity of metals.
3) Semiconductor Materials: Types and Characteristics; Brief introduction to dependence of particle distribution properties of material–MB, BE and FD distribution (no mathematical derivation required only qualitative discussion using examples), Fermi Energy Level; Intrinsic, Extrinsic and Compound Semiconductors; E-K diagram, Effective mass, Density of States; Temperature dependence of carrier concentrations and mobility; Direct and indirect bandgap semiconductors; Effect of heavy doping and degenerate semiconductors.

Unit–II: Laws of Electronics and Passive Components (12 Lectures)

A. Basic Laws in Electronics and their applications

1) Charge, Potential, Field, Voltage (DC and AC), Current (DC and AC), Electrical Load, Electrical Power, Root mean square and Average value of AC voltage, Ideal and practical voltage/current sources, Decibel unit is electronics.
2) Coloumb's First and Second Laws in Electrostatics
3) Ohm's Law
4) Kirchhoff Current Law, Kirchhoff Voltage Law
5) First Law of Joule, Second Law of Joule
6) Faraday's Law of Electromagnetic Induction (First, Second and Third or Lenz's Law)
7) Biot Savart Law for Electric and Magnetic field
8) Ampere's Circuital Law
9) Gauss's Law
10) Lorentz force (motion of charged particle in magnetic field)

B. Basic passive components in electronics and their applications

1) Resistors, their various types, series-parallel combination.
2) Capacitors, Capacitive reactance, their various types, parallel plate capacitor, cylindrical capacitor, series-parallel combination, concept of variable capacitor.

3) Inductors, Inductive reactance, their various types, Solenoids (Solenoid, Toroid) series-parallel combination, Self- inductance of a coil, Mutual inductance of two coils.
4) Transformers: Operating principles (with mathematical formulation), Construction, Applications.
5) AC and DC behaviour of basic components, concept of quality factor of a component, phasor relationship between R, L and C.

Recommended Books:

A. For Unit–I
   1. Applied Quantum Mechanics, A.F.J. Levi, Cambridge.
   2. Quantum Mechanics: Theory and Applications, Ajoy Ghatak, S. Lokanathan, Kluwer Academic Publishers.
   3. Quantum Mechanics, Statistical Mechanics and Solid State Physics, D. Chattopadhyay, P.C. Rakshit, S. Chand & Co Ltd.
   4. Elements of Quantum Mechanics, K. Singh, S.P. Singh, S. Chand & Co Ltd.
   5. Solid State Electronic Devices, Ben G. Streetman, S.K. Banerjee, Pearson.
   6. Solid State Physics, S.O. Pillai.
   7. Solid State Physics, A.J. Dekker, Macmillan Education.

B. For Unit–II
   1. The Art of Electronics, Paul Horowitz, Winfield Hill, Cambridge University Press.
   2. Fundamentals of Electric Circuits, Alexander, M. Sadiku, McGraw Hill.
   3. Basic Electrical Engineering, I.J. Nagrath, D.P. Kothari, Schaum’s Outline Series, Tata McGraw Hill.
   4. Electric Circuits, Mahmood Nahvi, Joseph A Edminister, K. Uma Rao, Tata McGraw Hill.
   5. Basic Electrical Engineering, C.L. Wadhwa, New Age International Publishers.

Semester–I

Major–1 (Practical): Electronics Foundation-I (Credit:2, Full marks: 50, 60 Laboratory-Hour)

Prerequisite: Introduction to DC voltage source; Introduction to digital multimeter and its applications, Introduction to practical Resistors (with color code, wattage), Capacitors, Inductors, Diodes, Transformers and their specifications, Measurement of resistance of resistor using multimeter, Concept of voltage divider, Measurement of forward and backward resistances of diode using multimeter.

Expt. 1: Verification of Ohm's Law; Verification of Kirchhoff Current Law.

Expt. 2: Verification of equivalent resistance in cases of series and parallel combination of resistors.

Expt. 3: Introduction to AC source, Introduction to CRO/DSO; Measurement of frequency, amplitude and phase of AC sources; Construct a CR circuit for predefined phase difference and measure phase difference with input signals using Lissajous patterns.

Expt. 4: (a) Finding capacitance of a capacitor. (b) Finding the phase difference between the current and voltage across the capacitor.

Hints for (a):

Method-1

Construct a series CR circuit (in which the resistor is a variable resistor) and use a AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_C). Vary the variable resistor until $V_R = V_C$. Measure the value of the resistor (R) when $V_R = V_C$. Under such condition, the unknown capacitance is given by $C = \frac{1}{R\omega} = \frac{1}{R\times 2\pi f}$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_C as a function of R.

Typical values: $V_{AC} = -1\ to + 1, f = 1kHz$, R ~ 1 kΩ pot, C ~ 1 μF.

Method-2

Construct a series CR circuit and use a AC voltage source to excite the circuit, Measure the amplitude of the voltage across the resistor, calculate the amplitude of current thorough the circuit knowing the value of resistor, calculate the impedance in the circuit from the amplitude of the supply voltage and current in the circuit, Calculate the impedance of the circuit with known frequency and resistance value, find the unknown capacitance by equating calculated impedance with experimentally estimated impedance). Plot measured impedance of the circuit as a function of frequency and explanation of the nature of the plot. Repeat the experiment two more times.

Take another unknown capacitor and find is value.

Hints for (b):

View the waveforms across the resistor and capacitor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 5: (a) Finding inductance of an inductor. (b) Find the phase difference between the current and voltage across the inductor.

Hints for (a)

Method-1:

Same as earlier. Construct a series LR circuit (in which the resistor is a variable resistor) and use a AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_L). Vary the variable resistor until $V_R = V_L$. Measure the value of the resistor (R) when $V_R = V_L$. Under such condition, the unknown inductance is given by $L = \frac{R}{\omega} = \frac{R}{2\pi f}$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_L as a function of R. Typical values: $V_{AC} = -1\ to + 1, f = 5kHz$, R ~ 1 kΩ pot, L ~ 10 mH.

Method-2:

Similar to method as described earlier.

Hints for (b):

View the waveforms across the resistor and inductor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 6: Measurement of dielectric constant of a liquid/solid sample (using cylindrical electrodes/parallel plate electrodes).

Hints: Measure the capacitance of the given air-filled capacitor (capacitance can be measured by measuring impedance), say C_0. Now fill the gap between the cylinders/plates by the liquid/solid of interest. Measure the capacitance again, say it is C_d. Then the dielectric constant of the liquid/solid is $k = \frac{C_d}{C_0}$.

Semester–II

Major-2 (Theory): Electronics Foundation-II (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit–I: Mathematic for Electronics (20 Lectures)

3) Ordinary differential equations: Basic Concepts, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations, Second Order homogenous and non-homogeneous differential equations.
4) Introduction to Matrices and Determinants, Types of matrices, Matrix arithmetic, Determinant of a square matrix, Simultaneous Equations and the Characteristic Matrix, Eigenvalues of a square matrix.
5) Introduction to Laplace transform method, Convergence of the integral, Initial and final value theorems, Partial-Fractions Expansions.

Unit–II: Network Analysis (25 Lectures)

4) Network topology and definitions, Mesh analysis, Node analysis.
5) Principle of duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem, Millman's Theorem, Reciprocity Theorem, Compensation Theorem (Substitution Theorem), AC circuit analysis using network theorems.
6) Star-Delta transformation Theorem, Delta-Star transformation Theorem
7) Transient responses of series CR, LR circuits with DC excitation (using differential equation and Laplace transform).
8) Power in AC circuits (average power, instantaneous power), Power factor, Phasor diagram, Bode plot, AC analysis of CR, LR, and LCR circuits, Resonance in series and parallel LCR circuits and their frequency responses, Quality factor and bandwidth.
9) Passive filters: Lowpass, Highpass, Bandpass, Bandstop.
10) Two-port Networks–Impedance (Z) parameters, Admittance (Y) Parameters, h-parameters, Transmission (ABCD) parameters.

Recommended Books:

A. For Unit–I
   1. Engineering Mathematics: A Foundation for Electronic, Electrical, Communications and Systems Engineers, Anthony Croft, Robert Davison, Martin Hargreaves, Pearson.
   2. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers.

B. For Unit–II
   1. Electric Circuits, Mahmood Nahvi, Joseph A Edminister, K. Uma Rao, Schaum's Outline Series, Tata McGraw Hill.
   2. Introduction to Circuit and Network, Gargi Basu, Platinum Publishers.
   3. Basic Electronics, D. Chattopadhyay, P.C. Rakshit, New Age International (P) Ltd.

Semester–II

Major-2 (Practical): Electronics Foundation-II (Credit: 2, Full Marks: 50, 60 Laboratory Hours)

Expt. 1: Verification of Thevenin’s theorem.

Expt. 2: Verification of Norton’s theorem.

Expt. 3: (i) Verification of equivalence of Star-Delta conversion and vice-versa. (ii) Verification of Superposition Theorem.

Expt. 4: Verification of maximum power transfer theorem.

Expt. 5: Study of RC circuit as lowpass and high-pass filter (plot gain in dB as a function of frequency, use semi-log graph paper). Determine pass-band gain, 3 dB point, slope beyond the cut-off from the graph.

Expt. 6: Study frequency responses (amplitude of current Vs frequency) of a series and a parallel LCR circuits. Find the resonance frequency, Q factor and bandwidth for each these circuits.

Expt. 7: Characterization of a Two-port network (for example, a step-down transformer may be considered as a Two-port network).

Semester–I

Minor-1 (Theory): Basic Electronics-I (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit–I: Laws of Electronics and Passive Components (12 Lectures)

C. Basic Laws in Electronics and their applications

11) Charge, Potential, Field, Voltage (DC and AC), Current (DC and AC), Electrical Load, Electrical Power, Root mean square and Average value of AC voltage, Ideal and practical voltage/current sources, Decibel unit is electronics.
12) Coloumb's First and Second Laws in Electrostatics
13) Ohm's Law
14) Kirchhoff Current Law, Kirchhoff Voltage Law
15) First Law of Joule, Second Law of Joule
16) Faraday's Law of Electromagnetic Induction (First, Second and Third or Lenz's Law)
17) Biot Savart Law for Electric and Magnetic field
18) Ampere's Circuital Law
19) Gauss's Law
20) Lorentz force (motion of charged particle in magnetic field)

D. Basic passive components in electronics and their applications

6) Resistors, their various types, series-parallel combination.
7) Capacitors, Capacitive reactance, their various types, parallel plate capacitor, cylindrical capacitor, series-parallel combination, concept of variable capacitor.
8) Inductors, Inductive reactance, their various types, Solenoids (Solenoid, Toroid) series-parallel combination, Self- inductance of a coil, Mutual inductance of two coils.
9) Transformers: Operating principles, Construction, Applications.
10) AC and DC behaviour of basic components, concept of quality factor of a component, phasor relationship between R, L and C.

Unit–II: Network Analysis (23 Lectures)

11) Network topology and definitions, Mesh analysis, Node analysis.
12) Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem, inter-conversion of between Thevenin's and Norton's equivalent circuits (for DC circuits), AC circuit analysis using network theorems.
13) Star-Delta transformation Theorem, Delta-Star transformation Theorem.
14) Transient responses of series CR, LR circuits with DC excitation (using differential equation).
15) Power in AC circuits (average power, instantaneous power), Power factor, Phasor diagram, Bode plot, AC analysis of CR, LR, and LCR circuits, Resonance in series and parallel LCR circuits and their frequency responses, Quality factor and bandwidth.

Unit–III: PN Junction Diode and Rectifiers (10 Lectures)

1) Ideal and practical diodes, formation of depletion layer, Schockley diode equation, I–V characteristics, reverse saturation current, DC load line, statice and dynamic resistance.
2) Zener diode and it I–V characteristics, reverse saturation current, Zener and avalanche breakdown, Application of Zener diode as voltage regulation.
3) Hal-wave and full-wave centre-tap and bridge rectifiers, expressions for output voltage, PIV, ripple factor and efficiency, Operation with and without shunt capacitor filter.

Recommended Books:

1. The Art of Electronics, Paul Horowitz, Winfield Hill, Cambridge University Press.
2. Electric Circuits, Mahmood Nahvi, Joseph A Edminister, K. Uma Rao, Tata McGraw Hill.
3. Basic Electronics, D. Chattopadhyay, P.C. Rakshit, New Age International (P) Ltd.
4. Fundamentals of Electric Circuits, Alexander, M. Sadiku, McGraw Hill.
5. Electronic Devices and Circuit Theory, Robert L. Boylestad, Louis Nashelsky, Pearson.
6. Basic Electrical Engineering, I.J. Nagrath, D.P. Kothari, Tata McGraw Hill.
7. Basic Electrical Engineering, C.L. Wadhwa, New Age International Publishers.
8. Circuits and Networks: Analysis and Synthesis, A. Sudhakar, S.S. Palli, McGraw Hill.

Minor-1 (Practical): Basic Electronics-I (Credit 2, 60 Laboratory-Hour)

Prerequisite: Introduction to DC voltage source; Introduction to digital multimeter and its applications, Introduction to practical Resistors (with color code, wattage), Capacitors, Inductors, Diodes, Transformers and their specifications, Measurement of resistance of resistor using multimeter, Measurement of forward and backward resistances of diode using multimeter.

Expt. 1: (i) Verification of equivalent resistance in cases of series and parallel combination of resistors. (ii) Construct an unbalance Wheatstone bridge. Connect a milliammeter to measure source current in the circuit. Connect a load resistance and milliammeter in series connecting the other two junction of the bridge. Vary the load resistance and measure the currents through the two milliammeters. Short the load and measure short-circuit current. Disconnect the load and measure the open circuit voltage and resistance across those two terminals with the power supply replaced by a short-circuit. Verify Thevenin's equivalent circuit, Norton's equivalent circuit and verify Star-Delta equivalence.

Expt. 2: Introduction to AC source, Introduction to CRO/DSO; Measurement of frequency, amplitude and phase of AC sources; Construct a CR circuit for predefined phase difference and measure phase difference between input and output signals.

Expt. 3: (a) Finding capacitance of a capacitor. (b) Finding the phase difference between the current and voltage across the capacitor.

Hints for (a):

Method-1

Construct a series CR circuit (in which the resistor is a variable resistor) and use a AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_C). Vary the variable resistor until $V_R = V_C$. Measure the value of the resistor (R) when $V_R = V_C$. Under such condition, the unknown capacitance is given by $C = \frac{1}{R\omega} = \frac{1}{R\times 2\pi f}$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_C as a function of R.

Typical values: $V_{AC} = -1\ to +1, f = 1kHz$, R ~ 1 kΩ pot, C ~ 1 μF.

Method-2

Construct a series CR circuit and use a AC voltage source to excite the circuit, Measure the amplitude of the voltage across the resistor, calculate the amplitude of current thorough the circuit knowing the value of resistor, calculate the impedance in the circuit from the amplitude of the supply voltage and current in the circuit, Calculate the impedance of the circuit with known frequency and resistance value, find the unknown capacitance by equating calculated impedance with experimentally estimated impedance). Plot measured impedance of the circuit as a function of frequency and explanation of the nature of the plot. Repeat the experiment two more times.

Take another unknown capacitor and find is value.

Hints for (b):

View the waveforms across the resistor and capacitor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 4: (a) Finding inductance of an inductor. (b) Find the phase difference between the current and voltage across the inductor.

Hints for (a)

Method-1:

Same as earlier. Construct a series LR circuit (in which the resistor is a variable resistor) and use a AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_L). Vary the variable resistor until $V_R = V_L$. Measure the value of the resistor (R) when $V_R = V_L$. Under such condition, the unknown inductance is given by $L = \frac{R}{\omega} = \frac{R}{2\pi f}$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_L as a function of R. Typical values: $V_{AC} = -1\ to + 1, f = 5kHz$, R ~ 1 kΩ pot, L ~ 10 mH.

Method-2:

Similar to method as described earlier.

Hints for (b):

View the waveforms across the resistor and inductor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 5: Study frequency responses (amplitude of current Vs frequency) of a series LCR circuits. Find the resonance frequency, Q factor and bandwidth for each these circuits.

Expt. 6: Study I–V characteristics of PN junction diode. Plot forward biased I–V graph. Find reverse saturation current (Hints: Plot lnI_d versus V_d from forward biased data, interpolate the line up to Y-axis intercept (negative side of Y-axis), say this intercept is $y = \ln I_d^{sat}$, Reverse saturation current $I_d^{sat} = e^y$).

Semester–I/II/III

MDC–1/2/3 (Theory): Interdisciplinary Electronics

(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit–I: Basic Circuit Components (20 Hours)

Energy Source- Concept of A.C. and DC signal. RMS and average value of AC sinusoidal signal, Its need in electronics, Concept of voltage and current sources.

Circuit Elements- Resistors, Inductors, Capacitors. Kirchhoff's current and voltage laws as an extension of laws of conservation of charge and energy.

Behaviour of circuit components under DC and AC excitation concept of reactance and impedance of R, L and C. Qualitative explanation of frequency selective circuits - tuning circuits and filters based on reactance curve. Power in electric circuits – True power, Active power and wattless component. Use of resistors, inductors and capacitors in everyday life, viz tube-light, fans etc. Working principle of transformer and its significance in everyday life.

Unit–II: Semiconductor Devices and Circuits (15 Hours)

Material classification on the basis of electrical conductivity- Insulator, Semiconductor and conductor, importance of semiconductor in Electronics, mechanism of current conduction in semiconductors – electron and hole transport mechanism, intrinsic and extrinsic semiconductors, Basic Concept of P-N Junction, P-N junction diode as a switching element using piece-wise linear model as an approximation of their I-V characteristics.

Rectifier- It's need in electronic circuits, use of diode as Half-Wave and Full-Wave Rectifier using switching model.

Explanation of working of a simple series regulated power supply. Working Principle of Solar Cell, LED, Lithium-ion batteries, Mobile charger.

Unit–III Digital Logic Circuits (10 Hours)

Difference between digital and Analog Electronic circuits.

Significance of binary logic in Digital Electronics - Basic Idea of Boolean Algebra, Logic Symbol and Truth Tables of Basic Logic Gates (AND, OR, NOT), Switching equivalent of Logic gates. Derived Logic Gates (NAND, NOR, XOR and XNOR.

Recommended books:

1. Electronics for Dummies, Gordon McComb, Earl Boysen, Wiley Publishing Inc.

2. Basic Electronics, D. Chattopadhyay, P.C. Rakshit, New Age International (P) Ltd.
3. Electronics: Analog and Digital, I.J. Nagrath, PHI.
4. Basic Electronics: Principles and Applications, Saha, Halder, Ganguly, Cambridge Press.
5. Introduction to Circuit and Network, Gargi Basu, Platinum Publishers.

Semester–I: Skill Enhancement Course

SEC-1: Catch the Python (Credit: 3, Full Marks: 50, 45 Tutorial/Lab Hours)

1. **Introduction to Python**

   Python Introduction, History of Python, Introduction to Python Interpreter and program execution, Python Installation Process in Windows and Linux, Python IDE, Introduction to anaconda, python variable declaration, Keywords, Indents in Python, Python input/output operations.

2. **Python's Operators**

   Arithmetic Operators, Comparison Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Ternary Operator, Operator precedence. Simple examples and exercises.

3. **Python's Built-in Data types**

   String, List, Tuple, Set, Dictionary (characteristics and methods). Simple examples and exercises.

4. **Conditional Statements & Loop**

   Conditional Statements (If, If-else, If-elif-else, Nested-if etc.) and loop control statements (for, while, Nested loops, Break, Continue, Pass statements). Simple examples and exercises.

5. **Function in python**

   Introduction to functions, Function definition and calling, Function parameters, Default argument function, Variable argument function, in built functions in python, Scope of variable in python. Simple examples and exercises.

6. **File Processing**

   Concept of Files, File opening in various modes and closing of a file, Reading from a file, Writing onto a file, some important File handling functions e.g open(), close(), read(), readline() etc. Simple examples and exercises.

7. **Modules**

   Concept of modularization, Importance of modules in python, Importing modules, Built in modules (ex. Numpy). Simple examples and exercises.

Recommended Books:

1. Python Programming for School Students, M. Verma, Adhyan Books.
2. Head First Python – A brain-friendly guide, Paul Barry, O'Reilly.
3. Let us Python, Y. Knetkar, BPB.
4. Python Programming, Reema Theraja, Oxford.
5. Python – the Complete Reference, Martin C Brown, Pearson.

Evaluation Note

1. Theory Paper: (a) Full Marks 50, to be evaluated by University End Semester Examination
   (b) Question Pattern:
   Group – A, 10 Marks (5x2=10), Answer any 5 out of 8 questions.
   Group – B, 40 Marks (5x8=40), Answer any 5 out of 8 questions.

2. Practical paper: (a) 20 Marks Internal Assessment (to be evaluated by College).
   10 Marks for Attendance:
   75% & above – 10 Marks
   65% to less than 75% – 08 Marks
   55% to less than 65% – 05 Marks*
   *to be allowed for examination with condonation fee
   Less than 55% – Barred from appearing in the University exam

   10 Marks for continuous assessment.

   (b) 30 Marks final Examination: LNB =5, Viva=5, Experiment=20.
   (c) Production of LNB in the final examination is compulsory.

3. MDC paper: (a) To be evaluated by College
   (b) 10 Marks Internal Assessment (modality is to be decided by College)
   (c) Question Pattern:
   Group – A, 20 Marks MCQ (20x1=20, Answer 20 out of 20 questions).
   Group – B, 20 Marks (5x4=20, Answer any 4 questions out of 7 questions).

4. SEC paper: (a) To be evaluated by college
   (b) 10 Marks Internal Assessment
   (c) 20 Marks Practical – Examination
   (c) 20 Marks Theory – Examination