WEST BENGAL STATE UNIVERSITY

BARASAT, 24 PARGANAS (N)

B. Sc. in Electronics (Honours) (1+1+1) Years Syllabus

With Effect From: 2009-2010

Syllabus for three-year B.Sc. Honours Course
Detailed Syllabus

Distribution of Papers, Marks and Lectures/Periods

Part-I F.M: 200

Paper I - ELTA 122 101 **F.M: 100**

Modules	Marks	Lectures/periods
1. Mathematical & Numerical Methods: Theory	50 (40+10(internal assessment))	40
2. Circuit Theory: Theory	25 (20+05 (internal assessment))	20
3. Heat & Thermodynamics: Theory	25 (20+05 (internal assessment))	20

Paper II - ELTA 122 102 **F.M: 100**

Modules	Marks	Lectures/periods
1. Statistical Mechanics: Theory	25 (20+05 (internal assessment))	20
2. Quantum Mechanics: Theory	25 (20+05 (internal assessment))	20
3. Electricity and PSPICE: Practical	40 + 10	

Paper I - ELTA 122 101 **F.M: 100**

Module 1: Mathematical & Numerical Methods: **40+10 (Internal Assessment)**

Vector analysis: Definition and classification of vectors, Scalar and vector products, Vector calculus-application to simple problems. Theorems-Gauss' divergence, Stokes, Green's with simple applications.

Matrix: Addition, subtraction, multiplication, non-commutativity, Hermitian and unitary matrices, digitalization, eigen values and eigen vectors for real symmetric matrix, quadratic forms.

Differential Equations: First and second order differential equations, equations with constant coefficients (homogeneous and inhomogeneous).
Second order linear differential equation with variable coefficients, outlines of Frobenious method of power series solution, illustration by special functions (Hermite, Bessel, Legendre polynomials, beta and gamma functions)
Partial differential equation and its solution in different co-ordinate systems, wave equation and its solution.

Fourier's Series: Definition of linear independence and completeness of set of functions. Fourier's theorem (proof not required), equations involving Fourier's coefficients, analysis of simple waveforms using Fourier series, Fourier integral.

Laplace transform: Properties and simple problems.

Numerical Method: Solution of algebraic and transcendental equations by bisection method, Newton-Raphson method. Numerical differentiation. Numerical integration: Simpson's 1/3 rule, Gauss's quadrature. Solution of ordinary linear differential equations: Euler's method, Runge Kutta method.

Module 2: Circuit Theory **20+05 (Internal Assessment)**

Loop and nodal Analysis: Kirchoff's current and voltage laws, examples of loop and nodal analysis. Network theorems: superposition, reciprocity, Thevenin's, Norton's theorem, maximum power transfer theorem, bisection, Millman theorem T-pi and to pi-T transformation.

Wave shaping circuits: Frequency response of R-C networks-passive filter, integrator, differentiator, phase lead-lag circuit, passive filter (first order only).

Transients: Use of Laplace transforms- theorems and application in transient analysis of different electrical circuits with and without initial conditions. Growth and decay of current in LR circuit, Charging and discharging of capacitors in CR and LCR circuits, Oscillatory discharge, time-constant.

Network Topology: graph of network concept of tree branch, tree link. Incidence matrix, Tie-set matrix and loop currents, cut set matrix and node pair potentials. Two-port networks-open circuit impedance and short circuit admittance parameters and their interrelations.

Alternating current: LR, CR and LCR circuits. Power factor, series and parallel resonant circuits, Q-factor, selectivity. Magnetically coupled circuits-Mutual inductance, linear transformer, ideal transformer, T and Pi equivalent circuits.

A.C. Bridges: Generalized Wheat- stone bridge, Anderson's Bridge, Maxwell's.

Module 3: Heat & Thermodynamics **20+05 (Internal Assessment)**

Kinetic theory of gases: Evidence of molecular motion, association of heat with molecular motion. Basic assumptions of the kinetic theory of gases. Derivation of Maxwell's law of distribution of molecular speeds from probabilistic approach, average velocity, RMS velocity and most probable velocity. Boltzmann's extension of Maxwell's law. Temperature dependence of velocity distribution.

Degrees of freedom of molecules: Law of equipartition of energy, Application of the law to calculate specific heats of gases. Values of Cp and Cv and their ratios for monatomic, diatomic and polyatomic gases. Dulong and petit's law. Limitation of the kinetic theory of specific heat.

Free path: Probability of a free path x, mean free path. Distribution of mean free path. Expression for mean free path ignoring the effect of the distribution of molecular speeds.

Scope of thermodynamics, Microscopic and Macroscopic point of view: State variables, thermodynamic equilibrium. Zeroeth law of thermodynamics. Intensive and extensive properties of a thermodynamic system.

External & internal work: Quasi-static process, work done in quasistatic isothermal expansion or compression of an ideal gas. Work and heat, adiabatic and non-adiabatic work, internal energy function. Mathematical formulation and differential forms of the first law of thermodynamics. Heat capacity and molar heat capacity. Definitions of Cp and Cv for an ideal gas. Work done in a quasi-static adiabatic process.

Laws of Thermodynamics: Efficiency of Carnot's cycle, Kelvin-Planck and Clausius statement of the second law of thermodynamics. Equivalence of Kelvin-Plank and Clausius statements. Carnot's theorem. Reversible and irreversible processes. Conditions for reversibility.

Concept of entropy: Entropy and the mathematical formulation of the second law. T-S diagram. Entropy change in an irreversible process. Principle of increase of entropy. Entropy and unavailable energy(statement only). Probabilistic interpretation of entropy (statement). Entropy and disorder. Absolute entropy. Entropy and information (Basic ideas).

Thermodynamic potentials: Helmholtz free energy, enthalpy function,Gibb's free energy, chemical potential. Relation of chemical potential with Fermi level. Maxwell thermodynamic relations.

Reference Books:

1. Advance Engineering mathematics by Kreyszig - John Wiley.
2. Higher Engineering Mathematics by B.S.Grewal - Khanna.
3. Mathematical methods for physicists by Weber & Arfken - Elsevier.
4. Vector Analysis by Spiegel -TMH.
5. Numerical methods by Balaguruswami - TMH.
6. Numerical methods by Mathews – Pearson.
7. Network Analysis by van valkenburg – Pearson
8. Circuit theory by A. Chakraborty – Dhanpat Rai.
9. Engineering citcuir Analysis by Hayl – TMH.
10. Network Analysis by S.Sudhakar – TMH.
11. Circuit theory by Chattopadhayay- Rakshit – New Age.
12. Electrical Technology & circuit theory by B.L.Thereja -.
13. Introduction to PSPICE by Rasid – Pearson.
14. Heat & Thermodynamics by Zemansky & Dittman – MC Grow Hill.

15. Thermal Physics by Roy & Gupta – centsal.

16. Introduction to Quantum Mechanics by Griffiths –Pearson.

17. Classical Mechanics by Goldstein – Pearson.

18. Statistical Mechanics by Pathria – Elsevier.

Paper II - ELTA 122 102 **F.M: 100**

Module 1: Statistical Mechanics: **20+05(Internal Assessment)**

Macroscopic and Microscopic States: Phase space and phase trajectory. The μ-space and the Γ- space. Postulate of equal-a-priori probability. Ensembles. Time average and ensemble average. Density distribution in phase space, Condition for statistical equilibrium. Micro canonical ensemble (concept only). Statistical interpretation of entropy.

Quantum Statistics: Quantization of phase space. Indistinguishability of identical particles. Symmetry of wave function and its relation with spin. Boson and fermions. Effect of symmetry on counting. Examples illustrating counting procedures for MB, BE and FD statistics. Derivation of distribution functions for the three statistics using micro canonical ensemble. Conditions under which the quantum mechanical distribution functions reduce to the classical MB distribution. Comparison between the three statistics.

Bose-Einstein Statistics and Blackbody radiation: Applicability of the results of thermodynamics to the radiant energy within an enclosure. Cavity radiation as a photon gas. Density of states for photons. Derivation of Plank's law by applying BE statistics to a photon gas. Energy density as a function of λ &ν. Rayleigh-Jeans formula for low frequencies and Wien's formula for high frequencies. The total radiant energy density: Stefan-Boltzmann law, Stefan's constant. The specific heat at constant volume. Entropy of a photon gas.

Module 2: Quantum Mechanics: **20+05(Internal Assessment)**

Photoelectric phenomenon: Failure of the classical theory. Einstein's photoelectric equation, concept of photon. Compton effect, derivation, Compton shift and simple problems.

Dual nature of radiation: Postulate of de-Broglie on the wave nature of matter. De Broglie's wavelength for non-relativistic and relativistic particles. Phase and group velocity. Wave-particle duality and the principle of complementarity. Representation of de Broglie wave by a wave function $\psi(x, t)$, wave packet. Heisenberg's uncertainty principle. Necessity of probabilistic description in quantum theory.

Basic Postulates of Quantum Mechanics: Specifications of the state of a quantum mechanical system by a wavefunction. Requisite properties of admissible wavefunctions. Normalizability, observables, probability density, Operators associated with Position, momentum and kinetic energy. Hamiltonian, angular momentum in Cartesian coordinates. Commutation relation between operators. Simple properties of Hermitian operators. Representation of observables by Hermitian operators. Eigen values and Eigen functions of Hermitian operators. Expectation value of the measurement of a dynamical observable.

Time-dependent Schrödinger equation: In one dimension and in three dimensions. Wave function description of an electron in free space, Schrödinger equation as an operator equation. Physical interpretation of ψ , probability current density. Time-independent Schrödinger equation. Stationary states.

Application of Schrödinger equation: (a) Free particle moving in one dimension, (b) particle in a one-dimentional infinite potential well, (c) The potential step, (d) The rectangular potential barrier. Linear harmonic oscillator, the hydrogen atom problem, Qualitative treatment.

Reference Books

1. Statistical Mechanics by Laud – New age International.
2. Statistical Mechanics by Pathria – Elsevier.
3. Thermal & Statistical Physics by Reif – McGrowhill
4. Thermodynamics kinetic theory and statistical mechanics by sears & salinger – Narosa
5. Statistical Mechanics by Huang – TMH
6. Introductory quantum mechanics by S.N.Ghosal –
7. Introduction to quantum mechanics by Griffith – Pearson.
8. Quantum Physics by Eisberg & Reisnick – John-wiley.
9. Quantum physics of atoms & molecules by Eisberg & Reisnick – John-wiley.
10. Quantum mechanics by Powell & creshmann – TMH.

Module 3: Electricity and PSPICE: Practical **50**

Electrical part 40

Pspice: 10

1) Experiments on Electricity:
   (a) Verification of
      (i) Thevenin's theorem
      (ii) Norton's theorem
      (iii) Maximum power transfer theorem using a resistive Wheatstone bridge, dc meters.

   (b) Measurement of self-inductance of a coil and measurement of mutual inductance between two coils by Anderson bridge.

   (c) Investigation of inductance in ac circuits:

      (i) To verify the current-voltage characteristics for an inductance in ac circuit and hence to measure the value of inductance.

      (ii) To determine the phase-difference between the current and voltage in a series LR circuit at different frequencies.

      (iii) To study the variation of the reactance of the inductive coil with frequency of the ac source and hence to measure its inductance.

      (iv) To find the value of the loss-angle δ, the resistance of the inductor R and the inductance of the inductor L, from the phasor-diagram.

(2) Investigation of capacitance in an altering current circuit:

   (i) To verify the current- voltage relationship for a capacitor in an ac circuit being linear and hence to measure the value of the capacitance

   (ii) To determine the phase-difference between the current and the voltage in a series CR circuit at different frequencies.

   (iii) To study the variation of the reactance of a capacitor with frequency of the ac source and hence to measure the capacitance.

   (iv) To find the value of the loss-factor and loss-angle δ of a capacitor from the phasor-diagram.

(3) To draw the resonance curve of a series LCR circuit for different values of R and L/C and hence to determine the Q-factor in each case.

(4) To find the Q-factor from the ratio Vc / Vi at resonance.

(5) To draw the phasor-diagram of voltages ate series resonance.

(6) To observe waveforms and to measure amplitude, frequency and phase with a CRO using a simple RC network.

(7) To study the frequency responses of a low-pass and high-pass RC-network. Also to study the RC-circuit response to sine and square inputs.

(8) To dertermine the Fourier spectrum of square and triangular waveform by using a parallel resonant circuit and CRO.

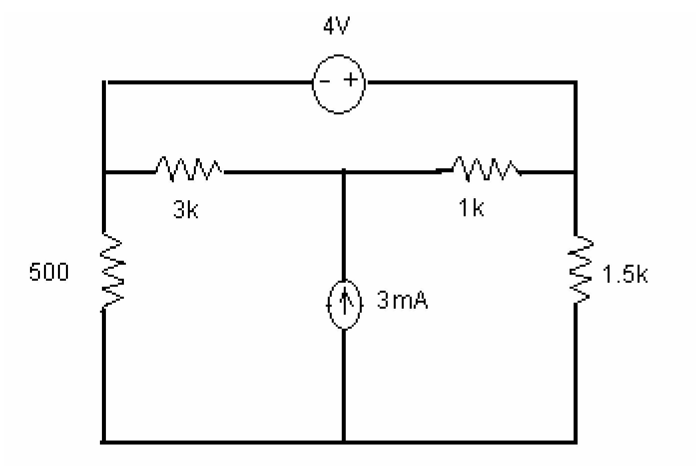
(9) *Experiments on Pspise*.

(a) CIRCUIT ANALYSIS USING SPISE/PSPICE
DC analysis: Independent souces
Use of data statements for passive elements.
Use of data statements for independent current and voltage souces.

Some of the example programs are given below

Example Program:

1. Write the Spice/Pspice source program for the following circuit, run PSpice for DC analysis and obtain the output on screen.



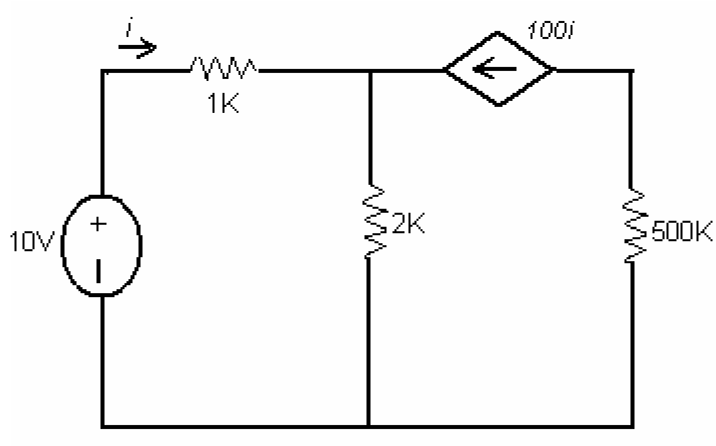
The values of the passive components and sources are for indicative purposes and may be varied

DC Analysis: Dependent sources
Use of data statements for dependent sources '

Voltage-controlled voltage source (VCVS)
Voltage-controlled current source (VCCS)
Current-controlled voltage source (CCVS)
Current-controlled current source (CCCS)

Example Program:

2. Write the Spice/PSpice source program for the following circuit, run PSpice for DC analysis and obtain the output on screen.



The values of the passive components and sources are for indicative purposes and may be varied.

Use of control and output statements in DC analysis
(.OP, .DC, .PRINT, .PLOT and .PROBE)

References:

1. Practical Physics – Rakshit and Chattopadhyay.
2. Advanced Practical Physics – B.Ghose (Vol II)
3. Laboratory manual for electric circuit
4. Introduction to PSPICE – D. Bell (PHI) – Rasid (Pearson).

<u>Rest part of the syllabus will be published in due course</u>