RAICHUR UNIVERSITY

Yeragera, Raichur, Karnataka-584133

DEPARTMENT OF STUDIES IN

PHYSICS

SYLLUBUS

Master of Science in Physics

(I – IV Semester)

Effective From

2023-24

22/4/2023

RAICHUR UNIVERSITY	**RAICHUR UNIVERSITY** **Yeragera, Raichur, Karnataka-584133**

Department of Studies in Physics

Programme: Master of Science in Physics

Programme Overview:

Duration: 2 Years (4 semesters)

Master of Science (M.Sc.) in Physics programme is designed to prepare students for a career in teaching, research or industry by introducing them to a wide range of concepts in physics. Also equipping students in various techniques/methods/skills applicable in research areas of Physics. The programme aims to provide basic understanding of principles & concepts of physics through well structured teaching-leaning process and experimentation to understand the new dimensions of physics.

Programme Educational Objectives (PEOs):

After 3 - 4 years of completion of the programme the graduates will be able to:

1. Demonstrate competency in physics to solve and anaylse contemporary problems.
2. Demonstrate research skills which might include laboratory techniques, numerical techniques and computer programming.
3. Occupy positions in academic/research institutions / industry.
4. Demonstrate leadership qualities to achieve professional and organizational goals with commitment to ethical standards and team spirit.

Programme Outcomes (POs):

At the end of the programme the students will be able to:

1. Apply the domain knowledge to solve practical problems.
2. Apply the mathematical techniques to interpret behavior of physical systems.
3. Demonstrate the ability to design & execute experiments, analyse and interpret the results.
4. Demonstrate the ability to propose and execute a research project, and ethically report the results with concern for society.
5. Work in a group to execute a project and contribute as an individual.
6. Effectively communicate the concepts, applications and research results in physics (both written and oral).
7. Develop lifelong learning habits by continuously updating advances in physics / science.

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Distribution of Courses/Papers in Postgraduate Programme I Semester as per Choice Based Credit System (CBCS) Proposed for PG Program in Physics

M.Sc. I – SEMESTER

Paper code	Paper & Title	Credit	Teaching Hours/Week			Duration of exam (SEE) (Hrs)	Marks		
			L	T	P		Internal	SEE	Total
23PHHCT11	Mathematical Methods of Physics	4	4	-	-	3	30	70	100
23PHHCT12	Classical Mechanics	4	4	-	-	3	30	70	100
23PHHCT13	Atomic, Molecular & Optical Physics	4	4	-	-	3	30	70	100
23PHHCT14	Electronics	4	4	-	-	3	30	70	100
23PHHCP11	Atomic, Molecular & Optical Physics Lab	2	-	-	4	3	20	30	50
23PHHCP12	Electronics Lab	2	-	-	4	3	20	30	50
23PHSEC11	Design of Electrical & Electronics Circuits	2	1	-	2	-	50	-	50
		22	-	-	-	-	**210**	**340**	**550**

I Semester Syllabus

Department Name: Physics

Semester - I

Course Title: Mathematical Methods of Physics	**Course Code:** 23PHHCT11
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Solve differential equations of first & second orders.
2. Apply different transforms to solve mathematical problems of interest in science and engineering.
3. Solve different physical problems which contain complex variables.
4. Apply integral transforms to solve mathematical problems of interest in physics.
5. Formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

Unit	Description	Hours
1	**Differential equations:** Ordinary differential equations: First order homogeneous and non- homogeneous equations with variable coefficients. Second order homogeneous and non-homogeneous equations with constant and variable coefficients. (Ref 1,2,4,5) **Special functions:** Legendre functions: Legendre polynomials, Rodrigue's formula generating function and recurrence relations, orthogonality of Legendre equations. Bessel functions: Bessel functions of the first kind representation relations orthogonality. Hermite functions: Hermite polynomials, generating five recurrence relations, orthogonality. Laguerre functions: Laguerre and associated Laguerre polynomials, recursion relations, orthogonality. (Ref 1,2,3, 4,5)	12
2	**Fourier series:** Fourier's theorem. Cosine and Sine series. Change of interval. Complex form of Fourier series. Fourier integral. Extension to many variables.	12

	(Ref 1,2,4,5) **Fourier transforms:** Introduction, Properties, Fourier transform of a derivative, Fourier transform of functions of two and three variables, Finite Fourier transforms, Some physical applications. **Laplace transforms:** Introduction, Properties, Laplace transform of the derivative of a function, periodic function and some special functions, Inverse Laplace Transform-Properties and Evaluation, Convolution Theorem. (Ref 1,2,4,5)	
3	**Linear Algebra**: Scalar Products, real & Complex Vector Space, Metric Spaces, linear operator, algebra of linear operators, Norms, Infinite dimensional Vector Space, Hilbert Space. (Ref 4,5,6) **Matrices**: Cayley-Hamiltonian Theorem, matrix representation of operators, Unitary & Hermatian matrices, diagonalization of matrices, Eigen values & Eigen vectors. (Ref 4,5,6)	12
4	**Complex analysis:** Complex Numbers, Functions of a complex variable, Properties of analytic functions, Cauchy's integral theorem, singularities of an analytic function, Cauchy's residue theorem, evaluation of definite integrals. (Ref 1,2,3,4,5) **Vector analysis:** Cartesian and curvilinear coordinate systems; Review of vector algebra; vector differentiation and integration; Line, surface and volume integrations, some examples; Gauss and Stoke's theorems. (Ref 1,2,4,5)	12
5	**Group theory:** Groups, subgroups, classes, Homomorphism and isomorphism, Group representation, Reducible and irreducible representations, Character of a representation, character tables. Construction of representations, Representations of groups and quantum mechanics, Lie groups, The three dimensional rotation group SO(3), The special unitary groups SU(2) and SU(3), The irreducible representations of SU(2), Representations of SO(3) from those of SU (2). Ref (1,2,4,5) **Tensors:** Coordinate transformation in linear spaces, definition and types of tensors, Contravariant and Covariant tensors, symmetric and antisymmetric	12

	tensors. Tensor algebra: Equality, addition and subtraction, tensor multiplication, outer product; contraction of indices, inner product, quotient theorem, Kronecker delta, metric tensor, Christoffel symbols. Ref (1,2,4,5)	

References:

1. Mathematical Physics by Satya Prakash, S Chand and Sons, New Delhi, 2019.
2. Advanced Engineering Mathematics by H.K. Dass, S Chand and Company Ltd., 2013.
3. Mathematical Physics by B. D. Gupta, 3rd Ed, Vikas Publishing House Pvt. Ltd. 2004.
4. Mathematical Methods for Physicist, George Arfken and Hans J Academic press San Diego, 1995.
5. Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, 2011.
6. Linear Algebra – Seymour Lipschutz, Schaum Outlines Series, 4th Edition, 2009.

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Department Name: Physics

Semester - I

Course Title: Classical Mechanics	Course Code: 23PHHCT12
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Solve the problems of motion of particle in a central force field.
2. Develop the knowledge of quantitative and qualitative methods for understanding moving coordinate systems and motion of a rigid body.
3. Organize the importance of Lagrangian concepts of motion.
4. Describe the Variational Principle, Hamilton's equation of motion and Poisson brackets.
5. Interpret the concepts of elastic scattering, inelastic scattering and small oscillations.

Unit	Description	Hours
1	**Review of Newtonian mechanics:** Newton's law's of motion, Mechanics of single particle and system of particles: Conservation of linear momentum, energy and angular momentum (quantitative). **Motion in a Central Force Field:** Equivalent one body problem (quantitative), Motion in a central force field (quantitative),, General features of the motion (qualitative), Motion in an inverse square law force field (qualitative), Equation of the Orbit (quantitative), Nature of the orbits, Kepler's laws of planetary motion (Deduction of third law).	12
2	**Moving Coordinate systems:** Rotating coordinate systems, Coriolis force, Motion on the Earth (qualitative), Effect of coriolis force on freely falling particle (quantitative). **Motion of a Rigid body:** Euler's Theorem, Angular Momentum and Kinetic energy (quantitative), Inertia Tensor, Euler's equations of motion (quantitative),	12

	Torque free motion (quantitative), Euler's angles (qualitative), motion of symmetric top (quantitative), Nutational Motion (quantitative).	
3	**Lagrangian Formulation** Constraints and its types, Generalized co-ordinates, D' Alembert's principle (expression for Virtual displacement, generalised velocity, virtual work, generalized force), Lagrangian equation of motion (quantitative) and its importance, Symmetries and the laws of conservation, cyclic co-ordinates, Velocity dependent potential of electromagnetic field, Rayleigh dissipation function, Simple applications.	12
4	**Hamilton's Formulation** Configuration space, Basics of Variational principle, Hamilton's Principle, Hamilton's equations of motion (qualitative) and some applications, Phase space. Canonical transformation, Condition for transformation to be canonical, Poisson Brackets, Canonical equations in terms of Poisson Bracket notation, Hamiltonian-Jacobi equations, Numericals.	12
5	**Two body Collisions and Small Oscillations** Elastic Scattering: Laboratory and centre of mass systems (quantitative), Kinematics of elastic scattering in laboratory systems, Inelastic Scattering, Cross section (quantitative), Rutherford formula (quantitative). Theory of small oscillations, General case of coupled oscillations, Eigenvectors and Eigen frequencies, The orthogonality of eigenvectors, Normal coordinates, Small oscillations of particles on string.	12

References:

1. Classical Mechanics by H Goldstein, Third Edition, Pearson India, 2011.
2. Introduction to Classical Mechanics by R G Takwale and P S Puranik, Tata McGraw-Hill, 1979.
3. Classical Mechanics by N C Rana and P S Joag, Tata McGraw, 1991.
4. Classical Mechanics by J. C. Upadhyaya, Himalaya Publishing House, 2014.
5. Classical Dynamics of particles and systems by J. B. Marian, Academic Press, New York, 1965.

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Department Name: Physics

Semester - I

Course Title: Atomic, Molecular & Optical Physics	**Course Code:** 23PHHCT13
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Apply the concepts of atomic physics to analyse and interpret spectra of atoms.
2. Apply the concepts of molecular physics to analyse and interpret spectra of molecules.
3. Apply the concepts of laser physics to understand the laser systems and their applications.

Unit	Description	Hours
1	**Atomic Physics I** Brief review of early atomic models of Bohr and Sommerfeld, Spectrum of hydrogen, Rydberg atoms (brief treatment), Quantum states of an electron in an atom, Spin orbit interaction – Expression for term shift, Quantum mechanical relativity correction for term shift, Hydrogen fine structure, Spectrum of helium – ortho and para states, Fine structure in alkali spectra, Calculation of level splitting due to spin-orbit interaction in alkali spectra, Sodium doublet, Intensity ratio for doublets, Hyperfine structure – Isotope and nuclear spin effects, Width of spectral lines- Natural, Doppler and External effects. (Ref. 1, 2, 3 & 4)	12
2	**Atomic Physics II** Magnetic moment of a bound electron, Zeeman effect – Types, Magnetic interaction energy, Zeeman splitting in Sodium D-lines, Paschen-Back effect – Magnetic interaction energy, Paschen-Back splitting in Sodium D-lies, Stark effect – Types, Stark effect in hydrogen – weak and strong fields, Coupling schemes: LS and jj coupling – Expression for interaction energy, multiplet splitting and Lande interval rule, Electron Spin Resonance (ESR), Nuclear	12

	Magnetic Resonance (NMR), Chemical Shift in NMR (qualitative). Working Principle of Constant Deviation Spectrometer (CDS) and its uses. Talbot bands, Hartman's formula. (Ref. 1, 2, 3 & 4)	
3	**Rotational and Vibrational spectroscopy** Rotational/microwave Spectra: Types of molecules based on rotation, Rotational spectra of rigid diatomic molecule, Intensities of spectral lines, Effect of isotopic substitution, Spectrum of non-rigid rotator, Instrumentation for rotational spectroscopy – Microwave spectrometer, Chemical analysis by microwave spectroscopy, Microwave radiation for microwave oven (qualitative). Vibrational/infrared spectra: Vibrating molecule as a simple harmonic oscillator, Anharmonic oscillator, Diatomic vibrating rotator, Analysis by infrared techniques, Instrumentation for Vibrational spectroscopy – infrared spectrometer. (Ref. 2, 5 & 6)	12
4	**Raman and Electronic Spectroscopy** Raman Spectra: Classical and Quantum Theories of Raman effect, experimental technique, Pure rotational Raman spectra of linear & symmetric top molecules, Raman activity of vibrations, Rule of mutual exclusion, Vibrational Raman spectra. Comparison of infrared and Raman spectroscopy. Applications of Raman spectroscopy (qualitative). Electronic Spectra: Born-Oppenheir approximation, Vibrational coarse structure: progressions, Intensity of Vibrational-Electronic spectra : Franck-Condon principle, Rotational fine structure of Electronic-Vibration transitions, Dissociation and predissociation, Chemical analysis by electronic spectroscopy, Instrumentation for electronic spectroscopy : UV-Vis spectrometer (single and double beam). Jablonski diagram - fluorescence and phosphorescence, Selection rules. (Ref. 2, 5 & 6)	12
5	**Optical Physics** Coherence of light - spatial and temporal coherence, Characteristics of a laser beam, Laser light versus ordinary light, Induced absorption, spontaneous and stimulated emissions, Einstein's coefficients, Population inversion and methods, Metastable states, Beer's law – attenuation of light, Theory of amplification of	12

	light – Gain coefficient, Threshold condition for light amplification, Requisites of laser system – active medium, energy source & optical resonant cavity, Three level lasers versus Four Level lasers with examples, Laser Systems: (a) Nd-YAG Laser (b) Carbon Dioxide Laser (c) Excimer Laser (d) Dye Lasers (e) Free-Electron Laser, Applications of Laser (qualitative): (a) Holography (b) Defense – Ranging (c) Laser Cooling (d) Isotope separation (e) Eye Surgery: LASIK. (Ref. 1, 2 & 7)	

References:

1. Concepts of Modern Physics by Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, McGraw Hill Education, 7th Edition, 2015.
2. Atomic and Molecular Spectra by Raj Kumar, Kedar Nath Ram Nath (KNRN) Publishers, 5th Edition – Reprint 2019.
3. Introduction to Atomic Spectra by H.C. White, McGraw-Hill Education / Asia, 1963.
4. Concepts of Atomic Physics by S.P. Kuila, New Central Book Agency (P) Ltd. (NCBA), Kolkata, January 2018.
5. Fundamentals of Molecular Spectroscopic by C N. Banwell and E. M. McCash, Tata McGraw-Hill Publishing Co., Ltd., New Delhi, 5th Edition, 2008.
6. Molecular Spectra by Herzberg Gerhard, D.Van Nostrand Company Inc., Vol.I, 2005.
7. Laser Fundamentals by William T. Silfvast, Cambridge University Press, 2nd Edition, 2004.

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Department Name: Physics

Semester - I

Course Title: Electronics	**Course Code:** 23PHHCT14
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain basic working principles and governing equations of electronic devices.
2. Design and analyse the electronic circuits.
3. Apply the knowledge for the development and design of new methods to determine semiconductor parameters and devices.

Unit	Description	Hours
1	**Transistor** Transistor action, configurations (CE, CB & CC) and relation between α& β. BJT transistor modelling, Hybrid equivalent model, Voltage divider bias, CE and Emitter follower configurations, Frequency response. Hybrid model equivalent circuit concept. Concept of feedback criteria for oscillation. Oscillator operation, Phase shift oscillator, Wein-bridge oscillator, FET amplifiers: FET small signal model, Biasing of FET, Common drain common gate configurations, Operational characteristics of MOSFET.	12
2	**Operational Amplifier:** Basic Information of Op-Amp, Characteristics of an ideal operational amplifier - comparison with 741, IC Op-Amp 741, open loop Op-Amp configurations – Differential, inverting and non-inverting amplifiers (qualitative). Op-Amp as a feedback amplifier – negative feedback, feedback configurations, voltageseries feedback amplifiers – closed loop voltage gain, input & output impedance, bandwidth and voltage follower, differential amplifiers.	12
3	Applications of an Operational Amplifier: Linear Applications – DC & AC amplifiers, Summing, Scaling, Averaging amplifiers, Ideal and Practical	12

	Differentiator, Integrator, V-I and I-V convertors. Non- Linear Applications- Comparators, Wave generators, 555 timer - Astable & Monostable Multivibrator, Schmitt Trigger – IC 741 & 555 timer, Positive and negative clippers, Positive and negative clampers. Active and Passive Filters, Types. (qualitative)	
4	**Digital Electronics** Boolean operations and expressions, Boolean analysis of logic gates, simplification of Boolean expression. Karnaugh map: two, three and four variable map, product of sums (POS) and sum of products (SOP) simplification. Families of logic gates, implementation of Boolean expressions. Logic gates: AND, OR, NAND and NOR gates, AND-OR and NAND-NOR implementation of Boolean expression, Logic gate operation with pulse waveforms.	12
5	**Sequential and Conversion circuit** Latches flip flop, RS and JK flip-flops, The Master-Slave JK Flip-Flop, D and T flipflops. Counters - Binary Ripple Counters, Synchronous Binary counters, counters based on Shift Registers, introduction to A/D and D/A conversion circuits, filtering and sampling, quantisation, quantization error, flash converter and dual slop converter, conversion errors. Binary weighted converter, R-2R ladder converter, characteristic properties. Introduction to microprocessor.	12

References:

1. Physics of Semiconductor Devices by S M Sze, Kwok K Ng John Wiley 3rd Ed. 2007.
2. Microelectronics, J Millman and Arvin Grabel, Mc Graw Hill 2nd Edition 1987.
3. Introduction to electronics, K J M. Rao. Oxford 1976.
4. Integrated electronics, Milmann and Halkias. Mc Graw Hill 1991.
5. Electronic Fundamentals and Application, J D Ryder. Ed. Rev 1966.
6. Basic Electronics B L Theraja S Chand 1st Ed. 1985.
7. Op-Amps and Linear Integrated Circuits, R Gayakwad, PHI Publications, 2000.
8. Operational Amplifiers and Linear IC's, F Robert Coughlin, F Frederick, PHI, 1994.
9. Digital Principles and Applications, A P Malvino and D Leach, TMH 1991.
10. Digital fundamentals, Thomas L Floyd, 8th edition, Pearson Education 2003.

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Department Name: Physics

Semester - I

Course Title: Atomic, Molecular & Optical Physics Lab	**Course Code:** 23PHHCP11
Total Contact Hours: 60 Hours	**No. of Credits:** 02
Internal Assessment Marks: 20	**Duration of SEE :** 04 Hours
SEE Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Design experiments to study atomic spectra of atoms.
2. Analyse spectra of molecules.
3. Use laser light to determine properties of light.

List of Experiments

1. Wavelength of sodium light using Michelson's Interferometer.
2. Determination of doublet separation by using Michelson's Interferometer.
3. Determination of Rydbereg constant using diffraction grating and hydrogen discharge tube.
4. Study of absorption spectrum of iodine vapour and determination of force constant.
5. Talbot bands.
6. Constant deviation Spectrometer.
7. Verification of Hartman's formula.
8. Study of Zeeman effect
9. Study of Stark effect
10. Analysis of rotational spectrum
11. Analysis of Vibrational spectrum
12. Verification of Beer's law.
13. Temporal and spatial coherence of laser light.
14. Wavelength of Laser light by single slit diffraction method.
15. Wavelength of Laser light by double slit interference method.
16. Diffraction halos (Lycopodium powder particle size determination).

17. Ultrasonic velocity in liquids using Spectrometer / spectral shift.

Note:

1. Minimum of EIGHT experiments must be carried out.
2. Experiments may be added as and when required with the approval of BoS.

References:

1. University Practical Physics by D.C. Tayal, Himalaya Publishing House, First Millenium Edition, 2000.
2. Advanced Practical Physics for students by B.L. Flint and H.T. Worsnop, Asia Publishing House, 1971.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, Kitab Mahal, 11th Edition, 2011.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, Heinemann Educational Publishers, 4th Edition, 1985.

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Department Name: Physics

Semester - I

Course Title: Electronics Lab	**Course Code:** 23PHHCP12
Total Contact Hours: 60 Hours	**No. of Credits:** 02
Internal Assessment Marks: 20	**Duration of SEE :** 04 Hours
SEE Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Use Cathode Ray Oscilloscope for electrical measurements.
2. Design electrical/electronic devices using diodes/transistors and analyse their characteristics.
3. Design electronic circuits using OP-AMP and analyse their characteristics.
4. Design electronic circuits using logic gates/ICs and analyse their characteristics.

List of Experiments

1. Studies on Cathode Ray Oscilloscope: DC/AC voltages and frequencies of sine and square signals, Unknown frequencies using Lissageous figures.
2. Full-wave bridge rectifier using diodes: Design and study the performance of CR, L and π type filters.
3. Study of Fixed Bias and Voltage divider bias configuration for CE transistor.
4. Study of Astable multivibrator using transistors: Frequency studies.
5. To design inverting amplifier using Op-amp (741, 351) & to study its mathematical operations.
6. To design non-inverting amplifier using Op-amp (741, 351) & study frequency response.
7. Design and study frequency response Weinbridge Oscillator using Op-Amp.
8. Design and construction of Logic gates using diodes and transistor and verify their truth table.
9. Construction of Karnaugh map for three and four variables.
10. (a) To convert Boolean expression into logic circuit & design it using logic gate ICs.
    (b) To minimize a given logic circuit.
11. Flip-Flop: Design of JK and RS flip flop circuit using IC 7412and study the truth table.
12. Study of A/D and D/A conversion circuits.

Note:

1. Minimum of EIGHT experiments must be carried out.
2. Experiments may be added as and when required with the approval of BoS.

Reference Books:

1. Electronic devices and circuit Theory by R.Boylstead and Nashalsky, Pearson, 10th Edition, 2009.
2. Digital Principles and Applications, A P Malvino and D Leach, TMH 1991.
3. Operational amplifiers and linear IC's by F.Robert Coughlin and Frederick F Driscoll.
4. Instrumental Methods of Analysis : (6th Edition) H.H. Willard, L.L.Merrit, J.A. Dean & F.A. Settle, J.K. Jain for CBS Publishers (1986).

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Department Name: Physics

Semester - I

Course Title: Design of Electrical & Electronics Circuits	**Course Code:** 23PHSEC11
Total Contact Hours: 30 Hours	**No. of Credits:** 02
Internal Assessment Marks: 50	**Duration of SEE :** - No SEE
SEE Marks: - No SEE	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain how to model, simulate, and analyze an electric circuits.
2. Explore effect of parametric variation on the performance of a circuit.
3. Perform simple multi-domain simulation of a physical system.
4. Explain the solution process and customize existing models to suit specific requirements.
5. Explain the importance of virtual lab
6. Model and simulate circuits using interface.

Unit	Description	Hours
1	**Measurement and Principles of Electricity** Instruments accuracy, precision, sensitivity, resolution range. Errors in measurements and loading effects. AC, DC, Voltage, Current, Resistance, Capacitance, Inductance, fundamentals and applications, **Hands on Sessions:** Analysis of R, RC, LC and RLC and its application as passive filters.	10
2	**Electric Motors** AC & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. **Hands on Sessions:** Modelling and control of a DC motor (PWM Controlled DC Motor).	10
3	**Introduction of Virtual Lab** Introduction to Python, Matlab and ExpEyes Kit, components, Sources and connectors with ExpEyes Kit. **Hands on Sessions:** Producing Sinusoidal	10

	Waves, Study of V-I characteristic curve of Diode, Study of LDR, Charging and discharging of capacitor in RC and LCR circuit.	

References:

1. Electric Circuits, S. A. Nasar, Schaum's outline series, Tata McGraw Hill (2004)
2. Electrical Circuits, M. Nahvi& J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
3. Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
4. Electronic Devices and Circuits, David A. Bell, 5th Edition 2015, Oxford University Press.
5. Lab Manual prepared by IUAC, New Delhi

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