Syllabus

for

Semester I and II

B.Sc in Physics

w.e.f. Academic Session 2023-24

Kazi Nazrul University

Asansol, Paschim Bardhaman
West Bengal 713340

Semester-I:

MAJOR COURSE

Mechanics and General properties of Matter

Course Code: BSCPHYMJ101

Course Type: MJC -1 **(Theory and Practical)**	Course Details: **Mechanics & General Properties of Matter**			L-T-P: 3-0-4	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	20	**35**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1.Understand vector calculus, classical mechanics of single as well as system of particles within the scope the Newtonian formulation.
2. Understand the dynamics of rigid body and concept of moment of inertia. Study of moment of inertia of different bodies and its applications.
3. Examine phenomena of simple harmonic motion and the distinction between undamped, damped and forced oscillations and the concepts of resonance and quality factor in a driven system.
4. Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
5. Study the properties of matter, response of the classical systems to external forces and their elastic deformation and its applications and comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications.

Course Content

MJC-1: Mechanics & General Properties of Matter

45 Hrs

Vector Calculus : Vector triple product(review); Derivatives of vectors; Gradient, Divergence, Curl of a vector field; Vector integrations-line, surface and volume integration; Gauss' divergence theorem, Stoke's theorem, Green's theorem (statement only with simple applications); Introduction to Orthogonal curvilinear Co-ordinate systems, unit vectors, Jacobian; Special cases: plane, spherical and

cylindrical co-ordinate systems; Infinitesimal line segment, area and volume elements in them.
10L

Mechanics of Single Particle: Introduction to Inertial & Non-inertial reference frames; Velocity and Acceleration - tangential and normal components, Radial and Cross-radial components; Newton's laws, Inertial frame, Work, Energy, Impulse of a force, Freely falling bodies, Motion in a resistive medium. Projectile motion. Conservative force and concept of potential; Conservation of energy; Dissipative forces; Translation invariance and conservation of linear momentum; Central force (preliminary idea) & Conservation of angular momentum; Torque; Brief reference to fundamental forces in nature
6L

Oscillations: Oscillations: Simple Harmonic Motion and its properties, energy of a simple harmonic oscillator, Damped oscillations: under damped, over-damped, and critically damped motion, Forced Oscillations and Resonance, Q factor and Sharpness; Examples of Oscillators from various branches of physics. 8L

Gravitation: Kepler's laws, Newton's law of gravitation, Motion of satellites in circular orbit. Geosynchronous orbits. 2L

Systems of particles: Degrees of freedom, Centre of mass and Centre of gravity, Momentum, Angular momentum, Torque, Kinetic energy of a system of particles; Conservation of linear momentum, angular momentum, and Energy for a system of particles; Centre of mass motion and Centre of mass coordinate; Examples: two coupled harmonic oscillators, two-body systems with (i) gravitaional, (ii) Coulomb interaction etc. 5L

Rigid body Dynamics : Concept of rigid body, Euler's theorem, General motion of rigid bodies: Chasle's theorem, Rotational motion about an axis, Moment of inertia, Radius of gyration, Perpendicular and Parallel Axis Theorems; Moment of inertia of a uniform body-Solid and hollow cylinders, Solid and hollow spheres, Rectangular plane, thin rod; Rotational energy, Conservation of energy, Work and Power, Motion of a flywheel, Theory of compound pendulum- Bar and Kater's pendulum, Foucault Pendulum; determination of "g"; Principal axis and Product of Inertia; Rotating Cordinate & Coriolis force. 7L

General properties of matter: Elasticity: Relation between different elastic moduli and Poisson's ratio, Torsional pendulum, Bending of beam;

Surface Tension: Angle of contact, surface tension and surface energy, pressure difference across curved surface example, excess pressure inside spherical liquid drop;

Viscocity: Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poiseulle's method, Stoke's method. Bernoulli's theorem and its applications.
7L

References/ Suggested Readings

1. *Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill)*

2. *Classical Mechanics – J. C. Upadhyay, (Himalaya Publ.).*
3. *Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).*
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11. Introduction to classical Mechanics with problems and solutions by Davis Morin, Cambridge University Press
12. Feynman Lectures Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
13. Elements of properties of matter by D.S. Mathur
14. A Treatise on general properties of matter by Sengupta and Chatterjee

Students can also explore these sites for additional reading -
https://nptel.ac.in/courseshttps://ocw.mit.edu/search/?q=courses

Experiments to be performed in the first semester (At least 6 experiments have to be performed):

1. To study the Motion of Spring and calculate (a) Spring constant, (b) Acceleration due to gravity.

2. To determine the Moment of Inertia of a Flywheel / regular-shaped body.

3. To determine Coefficient of Viscosity of water by Capillary Flow (Poiseuille‟s) Method.

4. Determination of Young‟s modulus by method of flexure.

5. To determine the Young's Modulus of a Wire by Optical Lever Method.

6. To determine the elastic Constants of a wire by Searle‟s method.

7. To determine the value of acceleration due to gravity using Bar Pendulum.

8. 7. To determine the value of acceleration due to gravity using Kater’s Pendulum.

9. Determination of surface tension of a liquid by Jaeger‟s method.

10. Determination of surface tension of a liquid by capillary-rise method.

11. Determination of the rigidity modulus of a wire by statical /dynamical method

Reference Books for Laboratory Experiments:

1. Physics through experiments	B. Saraf	Vikas Publications
2. A laboratory manual of Physics for undergraduate classes, 1st Edition,	D P Khandelwal	Vikas Publications.
3. B.Sc. Practical Physics (Revised Edition)		S.Chand& Co.
	C. L Arora	
4. An advanced course in practical physics.	D. Chatopadhyay, PC Rakshit, B. Saha	New Central Book Agency Pvt Ltd.

MINOR COURSE

Mechanics and General properties of Matter

Course Code: BSCPHYMN101

Course Type: MNC-1 **(Theory and Practical)**	Course Details: **Mechanics & General Properties of Matter**			L-T-P: 3-0-4	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
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4. An advanced course in practical physics.	D. Chatopadhyay, PC Rakshit, B. Saha	New Central Book Agency Pvt Ltd.

MD COURSE

PHYSICAL SCIENCE

COURSE CODE: MDC101

Course Type: **MDC-1**	Course Details: Physical Science			L-T-P: **3-0-0**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		**35**

Learning objectives:

1) *On completion of this course students should be able to demonstrate a comprehensive understanding of the fundamental concepts of matter, energy, gravity, and space, as well as their applications in various fields including medicine, communication, and modern storage technology.*

2) Students will also be able to critically analyze the universe's structure and evolution based on the Big Bang theory.

3) Additionally, they should have an awareness of the role of physics in everyday life and technological advancements.

Course Content
MDC-1: Physical Science

Matter and Energy

What is matter? Constituents of matter (upto elementary particles), States of Matter, Fundamental forces in Nature

What is energy?, Types of energy, Conservation of energy dissipation of energy, Conversion of one form of energy to another, Equivalence of matter and energy, energy generation and distribution in our daily life (Nuclear reactors, electrical energy), Renewable and Non-renewable sources of energy; Solar energy, tidal energy, hydro energy

Gravity, Force and Space:

The force of Gravity; Planetary motion, Newton's third law; Weightlessness; Low earth orbit; Geosynchronous satellites; Spy satellites; Medium Earth Orbit satellite; Circular Acceleration; momentum; Rockets; Airplanes, helicopters and fans; Hot air and helium balloons;

Structure of the Universe (Milkyway, solar system, planets, comets), Evolution of the Universe (Big Bang theory)

Applications of Physics

Medical Physics: stethoscope, x-ray, Ultrasound, Laser, Endoscopy, Colonoscopy, NMR, Pet-scan, Radiation- radiation hazards and safety

Communication: optical communication, radars, broad-band, mobile communication

Modern storage system: magnetic storage, solid state devices, holography

SEC COURSE

Computer Programming in C / FORTRAN/ Python/ SciLab

Course Code: BSCPHYSE101

<table>
<tr><td>Course Type: SEC-1</td><td colspan="2">Course Details: Computer Programming in C / FORTRAN/ Python/ SciLab</td><td colspan="2">L-T-P: 0-0-6</td></tr>
<tr><td rowspan="3">Credit: 3</td><td rowspan="3">Full Marks: 50</td><td colspan="2">CA Marks</td><td colspan="2">ESE Marks</td></tr>
<tr><td>Practical</td><td>Theoretical</td><td>Practical</td><td>Theoretical</td></tr>
<tr><td>15</td><td></td><td>35</td><td></td></tr>
</table>

Course Content

SEC-1: Computer Programming in C / FORTRAN/ Python/ SciLab

1. **Introduction and Overview**: Computer architecture and organization, memory and Input/output devices.

2. **Basics of scientific computing:** Decimal, Binary, octal and hexadecimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

3. **Errors and error Analysis**: Truncation and round off errors, Absolute and relative errors, Floating point computations.

4. **Programming fundamentals:** Introduction to Programming, constants, variables and data types, simple and logical operators and Expressions, I/O statements, Input and output statements. Reading Input and sending output from/to files., Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops*), Arrays (*1D & 2D*) and strings. user defined functions, Pointers, Structures and Unions, Idea of classes and objects (for C/C++).

Sample Programming (suggested atleast eight):

1. (a) Conversion of components of a vector among cartesian, polar and cylindrical coordinate systems. (b) Conversion of list of temperatures from celsius to fahrenheit scale. (c) Calculating the positions, velocities of a particle from given mass, acceleration. (d) Finding the real / complex roots of a quadratic equation using Sridharacharya method.
2. To check the divisibility of an integer and find a set of prime numbers.
3. Conversion of a number between decimal, binary, octal, hexadecimal number systems.
4. Find the area / perimeter of circle / square /ellipse, volume of sphere / cube etc. using userdefined functions.
5. Generation of terms, sum, ratios for arithmatic, geometric and Fibonacci / series.
6. To evaluate an infinite series with pre-assigned accuracy.
7. To find the largest/second largest/smallest of a given list of numbers. Find their locations in a sequence.
8. Sorting of numbers in ascending / descending order.
9. To generate a frequency distribution, mean, mode, median (from formula), standard deviation , correlation functions etc from a given data.
10. Fitting an experimental data with linear least-square method.
11. To find the trace of a square matrix. Find the sum, difference and product of two square matrices.
12. Generation of pseudo-random numbers and test their auto-correlations.
13. To write in and read from an external file in a program.

References/ Suggested Readings:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
3. LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
4. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
5. Schaum"s Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
6. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi (1999)
7. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
8. Elementary Numerical Analysis, K.E. Atkinson, 3 rd Edn. , 2007, Wiley India.

Semester-II:

MAJOR COURSE

Electricity and Magnetism

Course Code: BSCPHYMJ201

Course Type: MJC -2 **(Theory and Practical)**	Course Details: **Electricity and Magnetism**			L-T-P: 3-0-4	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	20	**35**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Explain the properties of (i) the electric field produced due to charges at rest; (ii) the magnetic field produced due to steady current, both in free-space and inside matter.*
2. *Develop an understanding on the unification of electric and magnetic fields and Maxwell's eqution governing electromagnetic waves.*
3. *Understand the phenomenon of resonance in LCR AC-circuits, sharpness of resonance, Q- factor, Power factor and the comparative study of series and parallel resonant circuits.*

Course Content

MJC-2: Electricity and Magnetism

45 Hours

Electric Field for a point charge : Concept of charge, Conservation and quantization of charge, Coulomb's law, Electric field strength, electric field lines, point charge in an electric field; Electric dipole. work done by a charge (derivation of the expression for potential energy). 2L

Electrostatic potential for a point charge : Electric potential, line integral, gradient of a scalar function, relation between field and potential. Potential due to point charge and Constant potential surfaces.

Poisson's and Laplace's equations. Uniqueness Theorem. 3L

Multipole expansion of potential : Potential and electric field due to a dipole. Multipole expansion – monopole, dipole, quadrupole. 2L

Gauss law in Electrostatics : Electric Flux, Gauss's law, Continuous Charge distribution, Calculation of Electric fields of a (i) spherical charge distribution, (ii) line charge and (iii) an infinite flat sheet of charge. Calculation of Potential. 3L

Concept of Voltage and current Sources : Concept of Voltage and Current Sources, Kirchhoff's Laws, Network Theorems- Thevenin's, Norton's, Maximum Power Transfer Theorem, Reciprocity Theorem. 4L

Electrostatics in Conductors and Dielectrics : Electric field and surface charge density for conductors, Electric Polarisation (atomic view) and bound charge densities for Dielectric materials, Displacement Vector and Gauss's law in dielectrics. Capacitors-parallel plate capacitor with dielectric inside, Electrostatic Energy stored in a capacitor. 5L

DC steady currents : Electric currents and current density. Lorentz Force on a moving charge. Electrical conductivity and Ohm's law. Physics of electrical conduction, conduction in metals and semiconductors, circuit elements and circuits: Transient currents in RC, LR and LCR circuits. 4L

Magnetostatics : Definition of magnetic field, Ampere's law and Biot-Savart law (magnetic force and magnetic flux), Magnetic force on a current carrying conductor. Magnetic moment of a current-carrying circular loop, electric current in atoms, electron spin and magnetic moment, Hall effect in a conductor. 5L

Magnetic materials : Magnetic intensity and magnetic induction, Intensity of magnetization, Susceptibility, Permeability, Types of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials. Magnetization and magnetic susceptibility. 3L

Electromagnetic Induction : Electromagnetic induction, conducting rod moving in a magnetic field, Faraday's laws of induction, Lenz's Law, expression for self-inductance and energy stored in a magnetic field. Mutual inductance**.** 4L

AC circuits : RMS and average value of AC, Response of RL, RC, LC, LCR circuits using j-operator method, quality factor, admittance and impedance, power and energy in series and parallel resonance AC circuits.

AC bridges- Anderson bridge, Wien bridge, De'Sauty's bridge**.** 5L

Electromagnetic waves : Equation of continuity, Maxwell's equations, Brief reference to Magnetic Monopole; Introduction to Gauges; displacement current, equation for propagation of electro-magnetic wave, transverse nature of electromagnetic wave, energy transported by electromagnetic waves. Poynting vector. 5L

References/ Suggested Readings

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

2. Electricity and Magnetism, By Rakshit and Chatterjee

3. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

4. Electricity and Magnetism, J. H. Fewkes& J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

5. Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

6. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw-Hill Education

Experiments to be performed in the Second semester (At least 6 experiments has to be performed):

1. To study the characteristics of a series RC Circuit.

2. To determine an unknown low resistance using Potentiometer.

3. To determine an unknown low resistance using Carey Foster's Bridge.

4. To compare capacitances using De' Sauty's bridge.

5. To determine self inductance of a coil by Anderson's bridge.

6. Measurement of magnetic field strength B and its variation in a solenoid (determinination of dB/dx).

7. To verify the Thevenin and Norton theorems in a wheatstone bridge.

8. To verify the superposition, and maximum power transfer theorems in a wheatstone bridge.

9. To study response curve of a Series LCR circuit and determine its (a) Resonant

frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

10. To study the response curve of a parallel LCR circuit and determine its (a) anti-resonant frequency and (b) Quality factor Q.

11. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer

12. Determine a high resistance by leakage method using Ballistic Galvanometer.

13. To determine self-inductance of a coil by Rayleigh's method.

14. To determine temperature co-efficient of resistance of a metal / semiconductor by a meter-bridge.

MINOR COURSE

Electricity and Magnetism

Course Code: BSCPHYMN201

Course Type: MNC-2 **(Theory and Practical)**	Course Details: **Electricity and Magnetism**			L-T-P: 3-0-4	
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14. To determine temperature co-efficient of resistance of a metal / semiconductor by a meter-bridge.

SEC Course

(Any one from the two listed below will be provided)

Electrical Circuits and Network Skill

Course Code: BSCPHYSE201

Course Type: SEC-2	Course Details: **Electrical Circuits and Network Skill**			L-T-P: 0-0-6	
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		15		35	

Course Content

SEC-2: Electrical Circuits and Network Skill

1. Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law, Series, parallel, and series-parallel combinations of resistances, capacitor and inductor. AC Electricity and DC Electricity. Response of resistor, inductors and capacitors in DC or AC circuits., Familiarization with voltmeter, ammeter and multimeter.

2. Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

3. Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

4. Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Basic operation of transformers.

5. Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

6. Solid-State Devices: Identification of resistors, inductors, capacitors, diode, transistor and ICs. Colour code reading and value determination of carbon resistances.

7. Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device).

8. Electrical Wiring: Different types of conductors and cables. Voltage drop and losses across cables and conductors. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Joining cables, Basics of House wiring, preparation of extension board.

Suggested Experiments (atleast five):

1. Determine the values of resistors from their colour code and their effect on series and parallel connection.
2. Designing equivalent star and delta network.
3. Preparation of extension board for use in house wiring (220 V AC).
4. Two-way Switch connections.
5. Drawing of lay out for a prototype connections in domestic purposes.
6. Pin identification of a 741 IC and design an inverting amplifier.
7. Using multimeter determine the values of resistance, capacitor, inductor and construct a series LCR circuit with a known frequency ac voltage source. Draw the phrasor diagram by determining the voltages across each components.
8. Using multimeter determine the values of resistance, capacitor, inductor and construct a parallel LCR circuit with a known frequency ac voltage source. Draw the phrasor diagram by determining the voltages across each components.
    1. Fabrication of tank circuit and study of signal generation of particular frequency.
    2.

References/ Suggested Readings:

1. A text book in Electrical Technology - B L Theraja - S Chand & Co.
2. A text book of Electrical Technology - A K Theraja
3. Performance and design of AC machines - M G Say ELBS Edn.

Basic Instrumentation Skills

Course Code: BSCPHYSE202

Course Type: SEC-2	Course Details: **Basic Instrumentation Skills**			L-T-P: 0-0-6	
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		15		35	

Course Content

SEC-2: Basic Instrumentation Skills

1. Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

2. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. specifications of a multimeter and their significance.

3. Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specification of an electronic Voltmeter/Multimeter and their significance.

4. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifieramplifier. Block diagram ac millivoltmeter, specifications and their significance.

5. Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Frontpanel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

6. Signal Generators and Analysis Instruments: Block diagram, explanation and

specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

7. Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

8. Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.
9. Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time- base stability, accuracy and resolution.

Suggested Experiments (atleast five):

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.
9. Converting the range of a given measuring instrument (voltmeter, ammeter).

References/ Suggested Readings:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and □ design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3 rd Ed., 2012, Tata Mc-Graw Hill.
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer.
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.