COURSE HANDOUTS

B.Sc (General) Courses in Physics under CBCS

Semester III and V, 2023-2024

Thermal Physics and Statistical Mechanics (PHSGCOR03T, PHSHGEC03T)
3rd Semester, 2023-2024

About the Course
- Name of the Course : Thermal Physics and Statistical Mechanics
- Nature of the Course : Core Course
- Code of the Course : PHSGCOR03T (Theory), PHSGCOR03P (Laboratory)
- Credit point : 4 (Theory) + 2 (Laboratory)
- Class Hours : 60 (Theory) +   60 (Laboratory)

Course Description

This course is designed to get a fundamental understanding of Heat and Thermodynamics. The laws related to behavior of a thermal system, the thermodynamic potentials and the thermodynamic variables are to be discussed. The ideas about theory of Blackbody radiation will be introduced here along with the concept of Statistical Mechanics.

Course Outcomes

On successful completion of this core course students will -

CO1 : Understand the zeroth, first and second laws of thermodynamics, the nature of thermodynamic properties of matter like internal energy, entropy, specific heats, temperature. **Understand** reversible and irreversible process, conversion between heat and work, Carnots's Theorem.

CO2 :   Understand thermodynamic potentials, Free energy, Maxwell's relations, Clausius Clapeyron equation.

CO3 :   Acquire knowledge in the kinetic theory of gases, velocity distribution laws, molecular collisions, the process of thermal conductivity, viscosity and diffusion in gases.

CO4 :   Acquire knowledge on the blackbody radiation, different laws relating to radiation, Planck's Law. **Understand** identical particles and indistinguishability, derivation of Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics and their applications in different physical systems.

CO5 :   Verify concepts learned in theoretical course through hands on experiments in the laboratory.

Relationship to other courses
- **Assumed knowledge**: Basic ideas of thermal processes
- **Prerequisite**: None.

Faculty : Mahuya Chakrabarti and Paramita Mallick

Course Schedule

PHSGCOR03T/PHSHGEC03T				
Teacher	Timetable			Google Classroom Code
Mahuya Chakrabarti	Monday	14:00 – 16:00	M-112	do6md54
	Tuesday	11:00 – 12:00	M-114	
Paramita Mallick	Wednesday	14:00 – 16:00	M-114	4d4oebe
	Saturday	13:00 – 14:00	M-114	
PHSGCOR03P/PHSHGEC03P				
Mahuya Chakrabarti	Monday	12:00 – 14:00	Physics Laboratory	do6md54
	Thursday	10:00 – 12:00	Physics Laboratory	

Course Outline

Unit 1 : Introduction to Thermodynamics
Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.
Unit 2 : Thermodynamic Potentials
Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications – Joule Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.
Unit 3 : Kinetic Theory of Gases
Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.
Unit4 : Theory of Radiation
Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.
Unit 5 : Statistical Mechanics
Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (qualitative discussion only) - Fermi-Dirac distribution law (statement only) - electron gas as an example of Fermi gas - Bose-Einstein distribution law (statement only) - photon gas as an example of Bose gas- comparison of three statistics.
Reference Books
1. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford Univ Press.
2. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
3. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
4. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications
5. Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
6. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

Course Calendar

Unit	Topic	Class Hours	Month
Paramita Mallick			
1	**Laws of Thermodynamics**	**22**	
1A	Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes.	6	September October
1B	Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes.	6	October November
	First class test	**1**	
1C	Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams.	5	November December
1D	Third law of thermodynamics, Unattainability of absolute zero.	3	December
	Second class test	1	December
2	**Thermodynamic Potentials**	**10**	
2A	Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for $(C_P - C_V)$, C_P/C_V, TdS equations.	9	January February
	Third class test	1	February

Unit	Topic	Class Hours	Month
Mahuya Chakrabarti			
3	**Kinetic Theory of Gases**	**10**	
3A	Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order)	6	September October
3B	Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case)	3	October
	1st Class Test	1	November
4	**Theory of Radiation**	**6**	
4A	Blackbody radiation, Spectral distribution, Concept of Energy Density,	3	November
4B	Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan-Boltzmann Law and Wien's displacement law from Planck's law.	2	November
	2nd class test	1	December

5	**Statistical Mechanics**	12	
5A	Phase space, Macrostates and Microstate, Entropy and Thermodynamic probability	4	December
5B	Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (qualitative discussion only)	2	December January
5C	Fermi-Dirac distribution law (statement only) electron	2	January
5D	Bose-Einstein distribution law (statement only), photon gas as an example of Bose gas- comparison of three statistics.	3	January February
	3rd Class Test	1	February

Evaluation of students :

Internal evaluation of the students will be done through class tests only.

Perspective of Modern Physics (PHSGDSE02T)
5th semester, 2023-2024

About the Course
- Name of the Course : Perspectives of Modern Physics
- Nature of the Course : Department Specific Elective
- Code of the Course : PHSGDSE02T
- Credit point : 6
- Class hours : 75 hours

Course description

Elements of Modern Physics is an introductory course to give students an understanding of relativistic dynamics, quantum theory of light, wave function description, wave particle duality, atomic and nuclear Physics.

Course Outcomes

On successful completion of this core course students will :

CO1 : **Acquire** knowledge on Lorentz transformation, velocity addition; **know** the concept of relativistic mass, and momentum, two body elastic collisions.

CO2 : **Understand** limitations of classical theory of electromagnetic radiation, Planck's law of black body radiation, Photoelectric effect, Compton's scattering, Rutherford's model of atomic structure. Bohr's model

CO3 : **Acquire** knowledge on De Broglie's hypothesis Wave particle duality, Davisson-Germer experiment, Bohr's quantization postulate for stationary orbits, Heisenberg Uncertainty principles.

CO4 : **Acquire** knowledge on wave functions, linear superposition principle of wave functions, Schrödinger equation for non-relativistic particles, momentum and energy operators, stationary states, probability and probability current densities in one dimension.

CO5 : **Understand** application of Schrödinger equation in one dimensional infinitely rigid box and a rectangular potential barrier, energy eigenvalues and eigenfunctions, quantum dot, quantum mechanical scattering and tunneling across a step potential and across a potential barrier.

CO6 : **Understand** energy and orbital angular momentum of hydrogen and hydrogen like atoms, space quantization, orbital magnetic moment, spin Magnetic moment, Zeeman effect, Larmour Precession, spin-orbit interaction and fine-structure splitting Pauli's Exclusion Principle and Aufbau principle

CO7 : **Understand** structure of atomic nucleus, nuclear force, binding energy curve, mass formula, radioactivity, alpha and beta decay, gamma ray emission, nuclear Fission and fusion, nuclear reactor.

CO8 : **Develop** elementary concept of Bohr's model of atomic structure and generation of X-ray, Mosley's law, amorphous and crystalline solids, concept of Lattice, unit cell and basis vectors, diffraction of X-ray by crystalline solid and Bragg's law.

Course Schedule

Faculty	Timetable			Google Classroom Code
Priyanka Chowdhury	Wednesday	13:00 – 14:00	M-114	wrgbej4
	Thursday	14:00 – 15:00	M-114	
	Friday	14:00 – 15:00	M-114	
Purnendu Chakraborty	Thursday	10:00 – 12:00	M-114	o3qrg4b
	Friday	15:00 – 16:00	M-114	

Course Outline

Unit 1 – Relativistic Dynamics

Brief summary of Lorentz transformation and time dilation, length contraction, velocity addition etc. (no derivation required). Elastic collision between two particles as observed from two inertial frames with relative velocity, idea of relativistic momentum and relativistic mass. Mass-energy equivalence.

Unit 2 – Quantum Theory of Light

Review on the limitations of classical theory of electromagnetic radiation within a cavity and its solution by Planck's quantum hypothesis (no derivation required). Statement of Planck's law of black body radiation. Photoelectric effect. Einstein's postulate on light as a stream of photons. Compton's scattering and its explanation.

Unit 3 - Bohr's model

Limitations of Ruherford's model of atomic structure. Bohr's model, its successes and limitations.

Unit 4 - Wave-particle Duality

De Broglie's hypothesis – wave particle duality. Davisson-Germer experiment. Connection with Einstein'spostulate on photons and with Bohr's quantization postulate for stationary orbits. Heisenberg's uncertainty relation as a consequence of wave-particle duality. Demonstration by γ-ray microscope thought experiment. Estimating minimum energy of a confined particle using uncertainty principle.

Unit 5 - Wave-function Description

Two slit interference experiment with photons, atoms & particles; linear superposition principle of associated wave functions as a consequence; Departure from matter wave interpretation and probabilistic interpretation of wave function; Schroedinger equation for non-relativistic particles; Momentum and Energy operators; stationary states. Properties of wave function. Probability and probability current densities in one dimension.

Unit 6 - Stationary State Problems

One Dimensional infinitely rigid box, energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example. Quantum mechanical scattering and tunneling in one dimension – across a step potential and

across a rectangular potential barrier.

Unit 7 – Atomic Physics

Quantization rules energy and orbital angular momentum from Hydrogen and Hydrogen like atoms (no derivation); s, p, d,shells-subshells. Space quantization. Orbital Magnetic Moment and Magnetic Energy of electron, Gyromagnetic Ratio and Bohr magneton. Zeeman effect.

Electron Spin as relativistic quantum effect (qualitative discussion only), Spin Angular Momentum. Spin Magnetic Moment. Stern-Gerlach Experiment. Larmor Precession. Spin-orbit interaction. Addition of angular momentum (statement only). Energy correction due to relativistic effect and spin-orbit ineraction (statement only). Fine-structure splitting.

Multi-electron atoms. Pauli's Exclusion Principle (statement only). Spectral Notations for atomic States. Aufbau principle, n+l rule (qualitative discussion only). Periodic table.

Unit 8 – Nuclear Physics

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph. Binding energy curve.

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay, beta decay, gamma emission – basic characteristics.

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Basic principle of a nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and basic principle of thermonuclear reactions

Unit 9 - X-ray and Crystal Structure of Solids

Generation of X-ray. Mosley's law, explanation from Bohr's theory. Amorphous and crystalline solids.

Lattice structure of crystalline (no categorisation required). Unit cell and basis vectors of a lattice. Diffraction of X-ray by crystalline solid. Bragg's law.

Reference Books

1. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles. R. Eisberg and R. Resnick, 1985, Wiley.
2. Perspectives of Modern Physics. A. Beiser, 1969, McGraw-Hill.
3. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
4. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
5. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
6. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill

Course Calendar

Unit	Topic	Class Hour	Month
Priyanka Chowdhury		
1	**Relativistic Dynamics**	**8**	
1A	Brief summary of Lorentz transformation and time dilation, length contraction, velocity addition etc. (no derivation required).	3	September
1B	Elastic collision between two particles as observed from two inertial frames with relative velocity, idea of relativistic momentum and relativistic mass. Mass-energy equivalence.	5	September October
3	**Bohr's model**	**4**	
	Limitations of Rutherford's model of atomic structure. Bohr's model, its successes and limitations.	3	October
	1st Class Test	1	November
8	**Nuclear Physics**	**15**	
8A	Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph. Binding energy curve.	5	November
8B	Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay, beta decay, gamma emission – basic characteristics.	5	December
8C	Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Basic principle of a nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and basic principle of thermonuclear reactions.	5	December
9	**X-ray and Crystal Structure of Solids**	**10**	
9A	Generation of X-ray. Mosley's law, explanation from Bohr's theory.	2	January
9B	Amorphous and crystalline solids. Lattice structure of crystalline (no categorisation required). Unit cell and basis vectors of a lattice.	4	January
9C	Diffraction of X-ray by crystalline solid. Bragg's law.	3	January
	2nd Class Test	1	January

Purnendu Chakraborty			
Unit	Topic	Class Hour	Month
2	**Quantum Theory of Light**	**5**	
2A	Review on the limitations of classical theory of electromagnetic radiation within a cavity and its solution by Planck's quantum hypothesis. Statement of Planck's law of black body radiation.	2	September
2B	Photoelectric effect. Einstein's postulate on light as a stream of photons.	1	September
2C	Compton's scattering and its explanation.	2	October
4	**Wave Particle Duality**	**6**	
4A	De Broglie's hypothesis – wave particle duality. Davisson-Germer experiment. Connection with Einstein's postulate on photons and with Bohr's quantization postulate for stationary orbits.	3	October
4B	Heisenberg's uncertainty relation as a consequence of wave-particle duality. Demonstration by γ-ray microscope thought experiment. Estimating minimum energy of a confined particle using uncertainty principle.	3	October November
5	**Wave-function Description**	**7**	
5A	Two slit interference experiment with photons, atoms & particles; linear superposition principle of associated wave functions as a consequence; Departure from matter wave interpretation and probabilistic interpretation of wave function.	3	November
5B	Schroedinger equation for non-relativistic particles; Momentum and Energy operators; stationary states. Properties of wave function. Probability and probability current densities in one dimension.	4	November December
6	**Stationary State Problems**	**5**	
6A	One dimensional infinitely rigid box, energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example.	2	December
	Quantum mechanical scattering and tunneling in one dimension – across a step potential and across a rectangular potential barrier.	2	December
	First Class Test	1	December
7	**Atomic Physics**	**15**	
7A	Quantization rules energy and orbital angular momentum from Hydrogen and Hydrogen like atoms; s, p, d shells-subshells. Space quantization. Orbital	8	December January

	Magnetic Moment and Magnetic Energy of electron, Gyromagnetic Ratio and Bohr magneton. Zeeman effect.		
	Electron Spin as relativistic quantum effect, Spin Angular Momentum. Spin Magnetic Moment. Stern-Gerlach Experiment. Larmor Precession. Spin-orbit interaction.	3	January
	Multi-electron atoms. Pauli's Exclusion Principle (statement only). Spectral Notations for atomic States. Aufbau principle, n+1 rule (qualitative discussion only). Periodic table.	3	January February
	Second Class Test	**1**	February

Mode of Evaluation : The internal assessment in the paper PHSGDSE02T will be through class tests.

Basic Instrumentation Skills (PHSSSEC01M)
3rd and 5th Semester, 2023-2024

About the Course

- Name of the Course : Basic Instrumentation skills
- Nature of the Course : Skill Enhancement Course
- Code of the Course : PHSSEC01M
- Credit point : 2 (Theory + Laboratory)
- Class Hours : 30 (Theory + Laboratory)

Course Description

The course is designed to develop basic instrumental skill among students.

Course Outcomes

CO1 : Develop fundamental skill to handle basic measuring instruments.

CO2 : Learn about electronic voltmeter and will be able to use it efficiently.

CO3 : Understand about CRO and its efficient use.

CO4 : Acquire knowledge about signal generators, impedance bridge and Q-meter.

CO5 : Develop knowledge about digital instruments and will be able to handle digital meters

Relationship to other courses

This course will help students to perform laboratory class more confidently.

Course Coordinator : Raghu Nath Bera

Course Schedule (PHSSSEC01M)

Faculty	Timetable			Google Classroom Code
Raghunath Bera	Tuesday	12:00-14:00	Physics Laboratory	b3cghy7

Course Outline (Theory)

Unit 1 : Basic of Measurement
Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter : Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Unit 2 : Electronic Voltmeter
Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier-rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

Unit 3 : 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. Front panel 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.

Unit 4 : 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

Unit 5 : 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.

Unit 6 : Digital Instruments
Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter

Unit 7 : 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

Reference Books
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, 3rd 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

Course calendar (Theory)

Unit	Topic	Class Hour	Month
1.Basic of Measurement	Basic idea about measuring instruments: Accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of DC & AC voltage, current and resistance. Specifications of a multimeter and their significance.	2	September
2.Electronic Voltmeter	Advantage of electronic voltmeter over conventional multimeter. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier-rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.	2	October
3.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. Front panel 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. Signal a) Electronic components and measuring devices and their general characteristics	3	October / November
4.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	2	December
5. 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.	2	January
6.Digital Instruments	Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter	2	January
7.Digital Multimeter	Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement	2	February

	using universal counter/ frequency counter, time- base stability, accuracy and resolution		

Course Outline (Laboratory)

The test of lab skills will be of the following test items :

1. Use of an oscilloscope.

2. CRO as a versatile measuring device.

3. Circuit tracing of Laboratory electronic equipment,

4. Use of Digital multimeter/VTVM for measuring voltages

5. Circuit tracing of Laboratory electronic equipment,

6. Winding a coil / transformer.

7. Study the layout of receiver circuit.

8. Trouble shooting a circuit

9. Balancing of bridges

Laboratory Exercises

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.

Open Ended Experiments

1. Using a Dual Trace Oscilloscope

2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Plan of Laboratory sessions

Expt No	Description of the Experiment	Time allotted (Hours)*
1	To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.	1
2	To observe the limitations of a multimeter for measuring high frequency voltage and currents.	1
3	To measure Q of a coil and its dependence on frequency, using a Q-meter.	1
4	Measurement of voltage, frequency, time period and phase angle using CRO.	1

5	Measurement of time period, frequency, average period using universal counter/ frequency counter.	2
6	Measurement of rise, fall and delay times using a CRO.	2
7	Measurement of distortion of a RF signal generator using distortion factor meter.	2
8	Measurement of R, L and C using a LCR bridge/ universal bridge.	1
9	Converting the range of a given measuring instrument (voltmeter, ammeter)	4

*This is tentative time allocation. Students have to carry out the experiment by their own under the supervision of the teacher. Some students may complete it in shorter time and some may need longer time. Unavoidable circumstances like power cut and/or instrumental problem may also arise during experiment leading to delay.