# JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE

## (Autonomous)

## OOTY ROAD, MYSURU- 570 025

# DEPARTMENT OF PHYSICS

## Syllabus

## CHOICE BASED CREDIT SYSTEM

## For B.Sc. Programmes

- **Physics, Mathematics, Chemistry**
- **Physics, Mathematics, Computer Science**
- **Physics, Mathematics, Electronics**
- **Physics, Mathematics, Computer Maintenance**

## 2017-18

## Department of Physics

## PROGRAMME: BSc PCM, PROGRAMME CODE: BSc-01 (2017-18)

| Semester | Course Code | Course Title | Course type | No. of credits | | | |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Total |
| I | CMA29001 | Mechanics | **DSC-1** | 04 | - | 02 | 06 |
| II | CMB29001 | Electricity and Magnetism | **DSC-2** | 04 | - | 02 | 06 |
| III | CMC29001 | Thermal physics and Statistical mechanics | **DSC-3** | 04 | - | 02 | 06 |
| IV | CMD29001 | Waves and Optics | **DSC-4** | 04 | - | 02 | 06 |
| **Discipline Specific Elective papers (DSE 1): Choose any 1** | | | | | | | |
| V | CME29001 | Digital, Analog circuits and Instrumentation | **DSE-1A** | 04 | - | 01 | 05 |
| | CME29201 | Solid State Physics | **DSE-1B** | 04 | - | 01 | 05 |
| | CME29601 | Mathematical Physics | **DSE-1D** | 04 | - | 01 | 05 |
| **Discipline Specific Elective papers ( DSE 2): Choose any 1** | | | | | | | |
| VI | CMF29001 | Elements of Modern Physics | **DSE-1A** | 04 | - | 01 | 05 |
| | CMF29201 | Nuclear and particle physics | **DSE-1B** | 05 | - | - | 05 |
| | CMF29401 | Quantum Mechanics | **DSE-1C** | 04 | - | 01 | 05 |
| **Skill Enhancement Course (SEC)** | | | | | | | |
| V | CME69001 | Renewable Energy and Energy harvesting | **SEC-1A** | 2 | - | - | 2 |
| | CME69201 | Radiation Safety | **SEC-1B** | 2 | - | - | 2 |
| | CME69401 | Basic Instrumentation Skills | **SEC-1C** | 2 | - | - | 2 |
| | CME70601 | Applied Optics | **SEC-1I** | 2 | - | - | 2 |

**PROGRAMME: BSc PMCS, PROGRAMME CODE: BSc-02 (2017-18)**

| Semester | Course Code | Course Title | Course type | No. of credits | | | |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Total |
| I | CMA29002 | Mechanics | **DSC-1** | 04 | - | 02 | 06 |
| II | CMB29002 | Electricity and Magnetism | **DSC-2** | 04 | - | 02 | 06 |
| III | CMC29002 | Thermal physics and Statistical mechanics | **DSC-3** | 04 | - | 02 | 06 |
| IV | CMD29002 | Waves and Optics | **DSC-4** | 04 | - | 02 | 06 |
| **Discipline Specific Elective papers (DSE 1): Choose any 1** | | | | | | | |
| V | CME29002 | Digital, Analog circuits and Instrumentation | **DSE-1A** | 04 | - | 01 | 05 |
| | CME29202 | Solid State Physics | **DSE-1B** | 04 | - | 01 | 05 |
| | CME29602 | Mathematical Physics | **DSE-1D** | 04 | - | 01 | 05 |
| **Discipline Specific Elective papers (DSE 2): Choose any 1** | | | | | | | |
| VI | CMF29002 | Elements of Modern Physics | **DSE-1A** | 04 | - | 01 | 05 |
| | CMF29202 | Nuclear and particle physics | **DSE-1B** | 05 | - | - | 05 |
| | CMF29402 | Quantum Mechanics | **DSE-1C** | 04 | - | 01 | 05 |
| **Skill Enhancement Course (SEC)** | | | | | | | |
| V | CME69002 | Renewable Energy and Energy harvesting | **SEC-1A** | 2 | - | - | 2 |
| | CME69202 | Radiation Safety | **SEC-1B** | 2 | - | - | 2 |
| | CME69402 | Basic Instrumentation Skills | **SEC-1C** | 2 | - | - | 2 |
| | CME70602 | Applied Optics | **SEC-1I** | 2 | - | - | 2 |

**PROGRAMME: BSc PMCM, PROGRAMME CODE: BSc-03 (2017-18)**

| Semester | Course Code | Course Title | Course type | No. of credits | | | |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Total |
| I | CMA29003 | Mechanics | **DSC-1** | 04 | - | 02 | 06 |
| II | CMB29003 | Electricity and Magnetism | **DSC-2** | 04 | - | 02 | 06 |
| III | CMC29003 | Thermal physics and Statistical mechanics | **DSC-3** | 04 | - | 02 | 06 |
| IV | CMD29003 | Waves and Optics | **DSC-4** | 04 | - | 02 | 06 |
| **Discipline Specific Elective papers (DSE 1): Choose any 1** | | | | | | | |
| V | CME29003 | Digital, Analog circuits and Instrumentation | DSE-1A | 04 | - | 01 | 05 |
| | CME29203 | Solid State Physics | DSE-1B | 04 | - | 01 | 05 |
| | CME29603 | Mathematical Physics | DSE-1D | 04 | - | 01 | 05 |
| **Discipline Specific Elective papers (DSE 2): Choose any 1** | | | | | | | |
| VI | CMF29003 | Elements of Modern Physics | DSE-1A | 04 | - | 01 | 05 |
| | CMF29203 | Nuclear and particle physics | DSE-1B | 05 | - | - | 05 |
| | CMF29403 | Quantum Mechanics | DSE-1C | 04 | - | 01 | 05 |
| **Skill Enhancement Course (SEC)** | | | | | | | |
| V | CME69003 | Renewable Energy and Energy harvesting | **SEC-1A** | 2 | - | - | 2 |
| | CME69203 | Radiation Safety | **SEC-1B** | 2 | - | - | 2 |
| | CME69403 | Basic Instrumentation Skills | **SEC-1C** | 2 | - | - | 2 |
| | CME70603 | Applied Optics | **SEC-1I** | 2 | - | - | 2 |

**PROGRAMME: BSc PME, PROGRAMME CODE: BSc-04 (2017-18)**

| Semester | Course Code | Course Title | Course type | No. of credits L | T | P | Total |
|---|---|---|---|---|---|---|---|
| I | CMA29004 | Mechanics | **DSC-1** | 04 | - | 02 | 06 |
| II | CMB29004 | Electricity and Magnetism | **DSC-2** | 04 | - | 02 | 06 |
| III | CMC29004 | Thermal physics and Statistical mechanics | **DSC-3** | 04 | - | 02 | 06 |
| IV | CMD29004 | Waves and Optics | **DSC-4** | 04 | - | 02 | 06 |
| **Discipline Specific Elective papers (DSE 1): Choose any 1** | | | | | | | |
| V | CME29004 | Digital, Analog circuits and Instrumentation | **DSE-1A** | 04 | - | 01 | 05 |
| | CME29204 | Solid State Physics | **DSE-1B** | 04 | - | 01 | 05 |
| | CME29604 | Mathematical Physics | **DSE-1D** | 04 | - | 01 | 05 |
| **Discipline Specific Elective papers (DSE 2): Choose any 1** | | | | | | | |
| VI | CMF29004 | Elements of Modern Physics | **DSE-1A** | 04 | - | 01 | 05 |
| | CMF29204 | Nuclear and particle physics | **DSE-1B** | 05 | - | - | 05 |
| | CMF29404 | Quantum Mechanics | **DSE-1C** | 04 | - | 01 | 05 |
| **Skill Enhancement Course (SEC)** | | | | | | | |
| V | CME69004 | Renewable Energy and Energy harvesting | **SEC-1A** | 2 | - | - | 2 |
| | CME69204 | Radiation Safety | **SEC-1B** | 2 | - | - | 2 |
| | CME69404 | Basic Instrumentation Skills | **SEC-1C** | 2 | - | - | 2 |
| | CME70604 | Applied Optics | **SEC-1I** | 2 | - | - | 2 |

**Assessment Maximum marks - 100**

| Course type | C1 | | C2 | | C3 Exam Marks | | Assigned Marks (Percentage) | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Theory | Lab | Theory | Lab | Theory | Lab | Theory | Lab | IA | |
| **DSC** | **10** | **05** | **10** | **05** | **70** | **70** | **50** | **20** | **30** | **100** |
| **DSE** | **10** | **05** | **10** | **05** | **70** | **70** | **50** | **20** | **30** | **100** |
| **DSE (non practical)** | **15** | **-** | **15** | **-** | **70** | **-** | **70** | **--** | **30** | **100** |
| **SEC** | **15** | **-** | **15** | **-** | **50** | **-** | **70** | **--** | **30** | **100** |

Note:

1. **C1 will be conducted for 20 Marks (Theory) with one hour duration - 10 Marks (Lab) with continuous assessment and it will be reduced to assigned marks.**
2. **C2 will be conducted for 20 Marks (Theory) with one hour duration - 10 Marks (Lab) with continuous assessment and it will be reduced to assigned marks.**
3. **C3 will be conducted for 70 Marks (Theory) with three hours duration - 70 Marks (Lab) with 3 hours duration and to be reduced to assigned marks.**
4. **For non-practical course C3 will be conducted for 70 Marks (Theory) with three hours duration.**
5. **In case of SEC, C1 and C2 will be conducted for 15 Marks each with one hour duration and C3 will be conducted for 50 Marks with 2 hours duration.**

## Programme Outcome for Bachelor of Science in Physics, Chemistry, Mathematics:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate proficiency in Mathematics and the Mathematical concepts needed for a proper understanding of Physics.

PO2. Demonstrate the ability to justify and explain their thinking and/or approach

PO3. Develop state-of-the-art laboratory and professional communication skills

PO4. Apply the scientific method to design, execute, and analyze an experiment

PO5. Explain scientific procedures and experimental observations

PO6. Appreciate the role of chemistry in the society

PO7. Use this as a basis for ethical behaviour in issues facing chemists /drugs

PO8. Understand chemistry as an integral part for addressing social, economic, and environmental problems

PO9. Understand the value of Mathematical proof

PO10. Demonstrate proficiency in writing and understanding proofs

PO11. Apply mathematical problems and solution in aspects of science and technology

PO12. Gain experience to investigate the real world problems

PO13. Apply mathematical ideas and models to those problems

# Programme Specific Outcome

## Bachelor of Science in Physics, Chemistry, Mathematics

After completing the graduation in the Bachelor of Science the students are able to:

PSO1. Find career opportunities

PSO2. Develop competence to write competitive examinations

PSO3. Develop proficiency in the analysis of complex physical problems

PSO4. Use of mathematical or other appropriate techniques to solve problems

PSO5. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries

PSO6. Create a hypothesis and appreciate how it relates to broader theories

PSO7. Demonstrate skills in the use of computers

## Programme Outcome for Bachelor of Science in Physics, Mathematics, Computer Science:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate proficiency in Mathematics and the Mathematical concepts needed for a proper understanding of Physics

PO2. Demonstrate the ability to justify and explain their thinking and/or approach

PO3. Develop state-of-the-art laboratory and professional communication skills

PO4. Apply the scientific method to design, execute, and analyze an experiment

PO5. Explain scientific procedure and experimental observations

PO6. Understand the value of Mathematical proof

PO7. Demonstrate proficiency in writing an understanding proofs

PO8. Apply mathematical problems and solutions in aspects of science and technology.

PO9. Gain experience to investigate the real world problems

PO10. Apply mathematical ideas and models to those problems.

PO11. Apply Mathematical principles for computing and logical design.

PO12.Design, implements, and evaluates a computational system to meet desired needs within realistic constraints

PO13. Use the System principles in the design and development of software for systems of varying complexity.

# Programme Specific Outcome

## Bachelor of Science in Physics, Mathematics, Computer Science

After completing the graduation in the Bachelor of Science the students are able to:

PSO1. Find career opportunities

PSO2. Develop competence to write competitive examinations.

PSO3. Develop proficiency in the analysis of complex physical problems

PSO4. Use of mathematical or other appropriate techniques to solve problems

PSO5. Create a hypothesis and appreciate how it relates to broader theories.

PSO6. Demonstrate skills in the use of Computers

PSO7. Join as Entry level Technical job role for an IT Industry

PSO8. Build small database ERP software/ web applications.

## Programme Outcome for Bachelor of Science in Physics, Mathematics, Computer Maintenance:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate proficiency in Mathematics and the Mathematical concepts needed for a proper understanding of Physics

PO2. Demonstrate the ability to justify and explain their thinking and/or approach

PO3. Develop state-of-the-art laboratory and professional communication skills

PO4. Apply the scientific method to design, execute, and analyze an experiment

PO5. Explain scientific procedure and experimental observations

PO6. Understand the value of Mathematical proof

PO7. Demonstrate proficiency in writing and understanding proofs

PO8. Apply mathematical problems and solutions in aspects of science and technology.

PO9. Gain experience to investigate the real world problems

PO10. Apply mathematical ideas and models to those problems

PO11. Design, implement and evaluate a computational system to meet desired needs within realistic constraints

PO12. Apply system design and development principals in the construction of software systems of varying complexity

PO13. Apply the knowledge techniques , skills and modern tools in computer maintenance

PO14. Understand networking applications to include basic electronics, programming, operation and computer network

# Programme Specific Outcome

## Bachelor of Science in Physics, Mathematics, Computer Maintenance

After completing the graduation in the Bachelor of Science the students are able to:

PSO1. Find career opportunities

PSO2. Develop competence to write competitive examinations

PSO3. Develop proficiency in the analysis of complex physical problems

PSO4. Use of mathematical or other appropriate techniques to solve them

PSO5. Create a hypothesis and appreciate how it relates to broader theories.

PSO6. Demonstrate skills in the use of Computers

PSO7. Start small enterprise in PC Maintenance/ Networking field.

PSO8. Join organizations related to Computer Hardware and Networking Maintenance.

## Programme Outcome for Bachelor of Science in Physics, Mathematics, Electronics:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.

PO2. Demonstrate the ability to justify and explain their thinking and/or approach

PO3. Develop state-of-the-art laboratory skills and professional communication skills.

PO4. Apply the scientific method to design, execute, and analyze an experiment

PO5. Understand the value of Mathematical proof

PO6. Gain experience to investigate the real world problems

PO7. Explain scientific procedures and their experimental observations

PO8. Demonstrate proficiency in writing and understanding proofs.

PO9. Apply mathematical problems and solutions in aspects of science and technology

PO10. Apply mathematical ideas and models to problems.

PO11. Apply appropriate troubleshooting techniques to electronic circuits / systems and perform test procedures

PO12. Assist, Assemble, modify and test electronic circuits in accordance with job requirements.

PO13. Communicate effectively in technical and non-technical environments

# Programme Specific Outcome

## Bachelor of Science in Physics, Mathematics, Electronics

After completing the graduation in the Bachelor of Science the students are able to:

PSO1. Find career opportunities

PSO2. Develop competence to write competitive examinations.

PSO3. Develop proficiency in the analysis of complex physical problems.

PSO4. Use mathematical or other appropriate techniques to solve complex physical problems.

PSO5. Create a hypothesis and appreciate how it relates to broader theories.

PSO6. Demonstrate skills in the use of Computers for control, data acquisition, and data analysis in experimental investigations

PSO7. Apply knowledge of Physics, Mathematics and Electronics fundamentals to the solve problems in electronic circuits & communication systems

PSO8. Apply appropriate troubleshooting techniques to Electronic circuits / systems and perform test procedures

# SEMESTER I

**Course code:** CMA29001/ CMA29002/ CMA29003/ CMA29004
**Credits: Theory – 04, Practical – 02** **Theories: 60 Lectures**

## COURSE OUTCOME:

After successful completion of the course, the student is able to

CO1.Learn the details of Elasticity

CO2.Understand the classification and characteristics of motion of a point particle

CO3.Understand in details with examples Frames of reference and relative motion

CO4.Deliberate the classification and characteristics of Dynamics of particle in conservative field

CO5.Specify the classification and characteristics of Special theory of relativity and gravitation

CO6.Write down the characteristics of Surface tension and viscosity

# MECHANICS: DSC1

### Unit-1

**Vectors:** Vector algebra (with special reference to the rules of addition and multiplication), Scalar and vector products with specific examples.

**Motion of a point particle:** The position vector *r(t)* of a moving point particle and its Cartesian components. Velocity and acceleration as the vector derivatives. Derivatives of a vector with respect to a parameter; Derivation of planar vector of a constant magnitude. Radial and transverse components of velocity and acceleration for arbitrary planar motion, deduction of results for uniform circular motion-centripetal force. **(05 Lectures)**

**Frames of references and relative motion:**
Newton's laws of motion and inertial mass. Galilean transformation; Galilean principle of relativity, Plumb line accelerometer and a freely falling elevator, Non-inertial frames and fictitious force, uniformly rotating frame of reference and coriolis force. Effect of rotation of earth on acceleration due to gravity. **(07Lectures)**

**Dynamics of a particle in conservative fields:**

Work done by force acting on a particle, work-energy theorem. Conservative and non conservative force field. Conservation of energy. Conservative force as a negative gradient of potential, central force as an example of conservative force field. **(05 Lectures)**

**Conservation of momentum:** Conservation of linear momentum, centre of mass, rocket equation. Angular momentum and torque, law of conservation of angular momentum, angular momentum of a system taking centre of mass of the system. **(06 Lectures)**

**Dynamics of rigid bodies:** Moment of inertia, radius of gyration, calculation of momentum of inertia of rectangular plate, circular plate and solid sphere, kinetic energy of rotation. **(04 Lectures)**

**Oscillations:** Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. (**03 Lectures)**

**Unit-2**

**Gravitation:** Newton's Law of gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws, derivations of Kepler's law, satellite in circular orbit and applications, geosynchronous orbits, weightlessness, basic idea of global positioning system (GPS). **(08Lectures)**

**Special Theory of Relativity:** Postulates of Special Theory of Relativity. Lorentz transformation equations, Length contraction, time dilation, relativistic addition of velocities. Mass-Energy relation, energy-momentum relation**.** **(06 Lectures)**

**Elasticity:**

Review of concepts of modulii of elasticity, Hooke's Law and Poisson's ratio(σ). Relation between the elastic constants $q$, $k$, $n$ and $\sigma$, limiting values for **σ.** Work done in stretching. Elastic potential energy. Bending moment. Theory of light single cantilever. I-section girders. Torsion; calculation of couple per unit twist. The Torsional pendulum, Static torsion, Searle's double bar experiment.

**Surface Tension:** Review of basic concepts. Pressure inside curved liquid surface. Surface tension and interfacial tension by drop-weight method. Surface tension and angle of contact of mercury by Quincke's method.

**Viscosity:** Review of basic concepts; Variation of Viscosity of liquids with temperature and pressure.

**(16 Lectures)**

**Reference Books:**


- Halliday, Resnick, Jearl Walker, "Principles of Physics" 9th edition, Wiley, 2013.
- Berkeley Physics Course, Vol-1 "Mechanics", 2nd edition, Charles Kittle, Walter D Knight, Malvin A
- D S Mathur, "Elements of properties of matter", S Chand and company, New Delhi, Reprint-2007.
- D S Mathur, "Mechanics", S Chand and company, New Delhi, Reprint-2001.
- Brij Lal and N Subrahmanyam, "Properties of matter", 6th edition, Eurasia publishing house Ltd. New Delhi, Reprint-1993.
- Mechanics by Shankara Narayana & Chopra.
- Mechanics by Bhargava and Sharma.


## PHYSICS LAB: DSC 1A LAB: MECHANICS
**(Minimum of eight is to be conducted)**

1. To determine the Moment of Inertia of a Flywheel.
2. Young's modulus by the single cantilever method.
3. Determination of the Young's modulus by Dynamic method (graphical and calculation method).
4. Drop weight method; Determination of surface tension of liquid and the interfacial tension between two liquids
5. Torsional pendulum; Determination of the rigidity modulus
6. To determine the Elastic Constants of a Wire by Searle's method.
7. Oscillations of a spiral Spring and calculate a) Spring Constant b) Value of g
8. Bar pendulum: Determination of the acceleration due to gravity and radius of gyration (Both graphical and calculation methods).
9. Determination of young's modulus by the method of uniform bending.
10. Determination of rigidity modulus by the static torsion method.

11. To determine the Height of a Building using a Sextant.
12. To determine g by Kater's Pendulum
13. To determine the Modulus of Rigidity of a Wire by Maxwell's needle
14. To determine **g** and velocity for a freely falling body using Digital Timing Technique

**Reference Books:**


- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, $4^{th}$ Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, $11^{th}$ Edition, 2011, Kitab Mahal, New Delhi.

# SEMESTER II

**Course code:** CMB29001/ CMB29002/ CMB29003/ CMB29004
**Credits: Theory – 04, Practical – 02** **Theories: 60 Lectures**

## COURSE OUTCOME:

After successful completion of the course, the student is able to

CO1.Deliberate in detail with examples vector analysis

CO2.Write down in detail with application, electrostatics and magnetostatic

CO3.Write down the classification and characteristics of AC Circuits

CO4.Specify in details with application, if applicable, properties of magnet material

CO5.Understand the characteristics of electromagnetic theory

CO6.Write down the characteristic of galvanometer

# ELECTRICITY AND MAGNETISM: DSC 2

**Unit-1**

**Vector Analysis**: Review of vector algebra (Scalar and Vector product), Scalar and vector fields, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). **(07 Lectures)**

**Electrostatics:** Electrostatic Field, electric flux, Gauss's theorem of electrostatics and applications; 1) infinite line of charge and 2) plane charged sheet. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field.

Dielectric medium, Polarization, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

**Galvanometers**: Construction, theory and working of Helmholtz galvanometer. **(15Lectures)**

**Alternating current:** R M S values, Response of LR, CR and LCR circuits to sinusoidal voltages (discussion using the j symbol), Series and parallel resonance, Half-power frequencies, bandwidth and Q-factor, Power in electrical circuits, power factor and Maximum power transfer theorem.

**(08 Lectures)**

## Unit-2

**Applications of ac circuits -** ac bridges**;** Anderson's bridge and De-Sauty's bridge

**(02 Lectures)**

**Magneto statics:** Biot-Savart's law & its applications; long straight conductor, circular coil and solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.

**Magnetic properties of materials:** Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-magnetic, para-magnetic and ferro-magnetic materials.

**(10Lectures)**

**Electromagnetic Induction:** Faraday's laws of electromagnetic induction, Lenz's law, self Inductance (L) and mutual inductance (M), L of single coil, M of two coils. Energy stored in magnetic field. **(06 Lectures)**

**Electromagnetic Theory:** Equation of continuity, Displacement current, Setting up of Maxwell's equations, wave equation in free space, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through free space and isotropic dielectric medium, Transverse nature of electromagnetic waves, polarization. **(12 Lectures)**

**Reference Books:**


- D. C. Tayal, Electricity and Magnetism, 1988, Himalaya Publishing House.
- K. K. Tewari: Electricity and magnetism, S. Chand Co. Ltd., New Delhi, Reprint 2007.
- B. B. Laud: Electrodynamics, Wiley Eastern Limited, New Delhi.
- David. J. Griffiths: Introduction to Electrodynamics, 3rd edition, Prentice-Hall of India Private limited, New Delhi.
- BrijLal and N. Subramanian: Electricity and Magnetism, 19th edition-Ratan Prakashan Mandir, Educational and University Publishers, Agra.

- D.N. Vasudeva: Fundamentals of Magnetism and Electricity, 12th edition-S.Chand and Co. Ltd., New Delhi


**PHYSICS LAB- DSC 2A LAB: ELECTRICITY AND MAGNETISM**
**(Minimum of eight is to be conducted)**

1. To verify the Thevinin's theorem
2. Maximum Power Transfer Theorem
3. Black box – Identification of L,C & R
4. LCR series circuits – Determination of L & Q factor
5. LCR parallel circuits – Determination of L & Q factor
6. Anderson's Bridge – Determination of the self-inductance of the coil.
7. De-Sauty's bridge – Verification of laws of combination of capacitances, unknown capacitance.
8. $B_H$ using Helmholtz double coil galvanometer
9. Maxwell's bridge-determination of mutual inductance
10. Low resistance-determination of the resistivity of the material.
11. Determination of capacitance by measuring impedance of RC circuit.
12. Determination of inductance by measuring impedance of RL circuit.
13. Measurement of Magnetic field strength B and its gradient in a Solenoid (Determine dB/dx).
14. To determine a Low Resistance by Carey Foster's Bridge.

**Reference Books**


- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Edition, reprinted 1985, Heinemann Educational Publishers

# SEMESTER III

**Course code:** CMC29001/ CMC29002/ CMC29003/ CMC29004
**Credits: Theory – 04, Practical – 02** **Theories: 60 Lectures**

**COURSE OUTCOME:**

After successful completion of the course, the student is able to

CO1.Specify in details with examples kinetic theory of gases

CO2.Specify in depth low temperature physics

CO3.Identify in detail with application thermal conductivity and theory of radiation

CO4.write down the classification and characteristics of laws of thermodynamics

CO5.Have a clear understanding about reversible and irreversible process

CO6.Understand the classification and characteristics of entropy and thermodynamic potential

# THERMAL PHYSICS AND STATISTICAL MECHANICS: DSC 3

**Unit-1**

**Laws of Thermodynamics:** Thermodynamic description of system, Zeroth Law of thermodynamics and temperature. Applications of First Law; General Relation between $C_P$ & $C_V$. Work Done during Isothermal and Adiabatic Processes. Compressibility & Expansion Coefficient. Reversible & irreversible processes; Carnot's theorem. Thermodynamic scale of temperature and its identity with perfect gas scale.

**Entropy:** The concept of entropy. Change of entropy in reversible and irreversible cycles. Entropy and non-available energy. Principle of increase of entropy; Clausius inequality. Second law of thermodynamics in terms of Entropy. Entropy of ideal gas, T-S diagram. Probability and entropy, Boltzmann relation. Concept of absolute zero and the third law of thermodynamics.

**(15 Lectures)**

**Thermodynamic Potentials:** Internal energy, Enthalpy, Helmholtz and Gibbs functions, Maxwell's thermodynamic relations & applications; Joule-Thompson Effect. Clausius-Clapeyron first Latent heat equation, effect of pressure on melting point of a solid, effect of pressure on boiling point of a liquid, Expression for ($C_P - C_V$), $C_P/C_V$, TdS equations. **(08 Lectures)**

**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. **(07 Lectures)**

## Unit-2

**Thermal conductivity:** Equation of flow of heat through solid bar, determination of thermal conductivity of a bad conductor by Lee and Charlton method. **(03 Lectures)**

**Theory of Radiation:** Induced and spontaneous emission of radiation. Derivation of Planck's law of radiation using Einstein's A and B coefficients. Deduction of Rayleigh-Jeans law, Stefan's law and Wien's displacement law from Planck's law, Wien's formula. **(08 Lectures)**

**Low temperature Physics:** Ideal gas and real gas. Van-der Waals equation of state. Porous-plug experiment and its theory. Joule-Thomson expansion - expression for the temperature of inversion, inversion curve. Relation between Boyle temperature, temperature of inversion and critical temperature of a gas. Principle of regenerative cooling. Liquefaction of air by Linde's methods. Adiabatic demagnetization**.** **(07 Lectures)**

**Statistical Mechanics:** Probability concept, Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law- distribution of velocity. Quantum statistics: Bose-Einstein, Maxwell-Boltzmann and Fermi-Dirac distribution law – electron gas-Bose-Einstein distribution law - photon gas - comparison of three statistics. **(12 Lectures)**

**Reference Books:**


- BrijLal, N. Subramanyam P.S. Hemne: Heat Thermodynamics and Statistical Physics, 1$^{st}$ edition. S Chand Publishing, 2007.
- S C Gupta: Thermodynamics, 1$^{st}$ edition, Pearson, 2005.
- C. L. Arora: Refresher Course in Physics Vol I, S Chand publishing, 2011.

- S. R. Shankara Narayana: Heat and Thermodynamics, 2nd edition, Sulthan Chand and Sons, 1990.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill


## PHYSICS LAB-DSC 3A LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS
**(Minimum of eight is to be conducted)**

1. Measurement of Planck's constant using black body radiation.
2. Verification of Stefan's-Boltzmann law.
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
4. Verification of distribution law using Monte-Carlo Method
5. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
6. Specific heat of a liquid by cooling – graphical method
7. To determine Stefan's Constant
8. To determine Mechanical Equivalent of Heat, J, by Callender and Berne's constant flow method.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
11. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus
12. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
13. To study the variation of thermo emf across two junctions of a thermocouple with temperature
14. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

**Reference Books:**

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

# SEMESTER IV

**Course code:** CMD29001/ CMD29002/ CMD29003/ CMD29004
**Credits: Theory – 04, Practical – 02** **Theories: 60 Lectures**

## COURSE OUTCOME:

After the completion of the course, Students will be able to

CO1.Specify the classification and characteristics of Fourier theorem

CO2.Learn in detail with application, superposition of simple harmonic motion

CO3.Understand in detail with application of wave motion

CO4.Deliberate in detail with examples Sound, wave optics and transducers

CO5.Learn the details of Interference, diffraction and polarization

CO6.Learn in detail with application of acoustics

# WAVES AND OPTICS: DSC 4

**Unit-1**

**Analysis of Complex Waves:** Fourier's Theorem - Application to saw tooth wave and square wave. **(03 Lectures)**

**Superposition of simple harmonic motion:**

Superposition of two simple harmonic motion; Lissajous' figures. Damped vibration; Equation for damped vibrations. Forced vibration; solution in exponential form, Resonance, Expression for amplitude and phase at resonance.

Superposition of two collinear harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **(11Lectures)**

**Wave Motion:**

Progressive waves; Differential equation of wave motion; Relation between amplitude and intensity. Expression for velocity of progressive waves in a medium; Newton's formula, Laplace's correction.

Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string.

Expression for frequency of vibration of a stretched string, harmonics. Group velocity, Phase velocity. Longitudinal vibrations in a rod; Kundt's tube experiment. **(10 Lectures)**

**Sound:** Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation, Absorption coefficient, Sabine's formula, measurement of reverberation time. Acoustic aspects of halls and auditoria.

**(06 Lectures)**

**Unit-2**

**Transducers:** Types of transducers, dynamic microphone and loudspeaker - construction, working and their characteristics, Piezo electrical transducer. **(03 Lectures)**

**Wave Optics:** Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **(03 Lectures)**

**Interference:** Interference: Review of basic concepts, Coherent sources, conditions for constructive and destructive interference.

Coherent source by division of amplitude: Interference in Thin Films: – reflected and transmitted light, color of thin films, theory of air wedge, theory of Newton's rings; measurement of wavelength and refractive index.

Coherent source by division of division of wave front: Lloyd's Mirror and Fresnel's Biprism. Michelson's interferometer; Measurement of $\lambda$ and $d\lambda$. **(11 Lectures)**

**Diffraction:** Fresnel and Fraunhoffer diffraction. Explanation of rectilinear propagation of light. Theory of the zone plate and comparison with convex lens. Fresnel diffraction at a straight edge. Fraunhoffer diffraction at a single slit. Transmission grating: theory for the case of normal incidence. **(06 Lectures)**

**Polarization:** Double refraction in uniaxial crystals. Huygens's theory. Positive and negative crystal. Principal refractive indices. Huygens's constructions of ordinary and extraordinary wave fronts in a uniaxial crystal, retarding plates. Production and analysis of linearly, circularly and elliptically polarized light. Optical activity, Fresnel's theory, Lorentz half shade polarimeter.

**(07 Lectures)**

**Reference Books:**


- Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
- Brij lal and N Subramanyam: Waves and Oscillations, 2nd edition, Vikas publishing house Pvt. Ltd., New Delhi.
- S K Gupta, O P Varma: Waves and Oscillations, 3rd edition, R.Chand & Co., New Delhi.
- R.L. Saihgal, A Text Book of Sound, S.Chand & Company Ltd. New Delhi, Reprint 1990.


**PHYSICS LAB-DSC 4A LAB: WAVES AND OPTICS**
**(Minimum of eight is to be conducted)**

1. To study Lissajous Figures
2. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
3. To determine wavelength of sodium light using Fresnel Biprism.
4. To determine wavelength of sodium light using Newton's Rings.
5. To determine wavelength of Sodium light using plane diffraction Grating
6. Air wedge – Determination of thickness of a thin paper/diameter of a thin wire.
7. Helmholtz resonator-determination of frequency of tuning fork.
8. Cauchy's constants using spectrometer
9. Polarization – Determination of unknown concentration of sugar solution by graphical method using a polarimeter.
10. Diffraction at a Straight wire -To determine the diameter of the Straight wire
11. To investigate the motion of coupled oscillators
12. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $\lambda^2$ – T Law
13. Familiarization with Schuster`s focusing; determination of angle of prism
14. To measure the intensity using photo sensor and laser in diffraction patterns of single and double slits.

**Reference Books:**


- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4$^{th}$ Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11$^{th}$ Edition, 2011, Kitab Mahal, New Delhi.

**Discipline Specific Elective papers: Choose 1**

# SEMESTER V

**Course code:** CME29001/ CME29001/ CME29003/ CME29004
**Credits: Theory – 04, Practical – 01** **Theories: 60 Lectures**

**COURSE OUTCOME:**

After the completion of the course, Students will be able to

CO1.Deliberate in detail with examples Digital Circuits

CO2.Specify the details of Operational amplifier

CO3.Learn the characteristics of sinusoidal oscillator

CO4.Identify in detail with application Instrumentation

CO5.Deliberate the classification and characteristics of gates

CO6.Identify in detail with application of semiconductor devices

## DIGITAL AND ANALOG CIRCUITS AND INSTRUMENTATION: DSE 1A

**Unit-1**

**Digital Circuits**

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. **(04 Lectures)**

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(05 Lectures)**

Binary Addition. Binary Subtraction using 2's Complement Method).Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor. **(04 Lectures)**

**Semiconductor Devices and Amplifiers:**

***Semiconductor Diodes:*** p and n type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs (2) Photodiode (3) Solar Cell. **(05 Lectures)**

**Bipolar Junction transistors*:*** n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff, and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Voltage Divider Bias Circuit for CE Amplifier. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Class A, B, and C Amplifiers. Two stage RC coupled amplifier. **(12 Lectures)**

## Unit-2

**Operational Amplifiers (Black Box approach):**

Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop& Closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and Non-inverting Amplifiers (2) Adder (3) Subtractor (4) Differentiator (5) Integrator (6) Zero Crossing Detector

**(13 Lectures)**

**Sinusoidal Oscillators:** Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator **(05Lectures)**

**Instrumentations:**

Introduction to CRO: Construction and Working of CRO Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **(03 Lectures)**

Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation. **(06 Lectures)**

Timer IC: IC 555 Pin diagram and its application as Astable & Monostable Multivibrator.

**(03 Lectures)**

**Reference Books:**


- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic devices and circuits, S. Salivahanan and N. Suresh Kumar, 2012, Tata Mc-Graw Hill.
- Microelectronic Circuits, M.H. Rashid, 2ndEdn. 2011, Cengage Learning.
- Modern Electronic Instrumentation & Measurement Tech., Helfrick&Cooper,1990, PHI Learning
- Digital Principles & Applications, A.P. Malvino, D.P. Leach & Saha, 7th Ed.,2011, Tata McGraw Hill
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.
- OP-AMP and Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.


**PRACTICALS - DSE LAB: DIGITAL AND ANALOG CIRCUITS AND INSTRUMENTS (Minimum of eight is to be conducted)**

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. Zener diode as a voltage regulator.
3. Half adder and Full adder
4. FET-characteristics
5. To study the characteristics of a Transistor in CE configuration.
6. To study the characteristics of a Transistor in CB configuration.
7. Phase shift oscillator
8. Op-amp has inverting and non-inverting amplifier
9. Wien Bridge Oscillator
10. Hartley oscillator
11. CE-amplifier and negative feedback amplifier
12. To minimize a given logic circuit.
13. To design an astable multivibrator of given specifications using 555 Timer.

14. To design a monostable multivibrator of given specifications using 555 Timer

**Reference Books:**


- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, $4^{th}$ edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill

# SEMESTER V

**Course code:** CME29201/ CME29202/ CME29203/ CME29204
**Credits: Theory – 04, Practical – 01** **Theories: 60 Lectures**

## COURSE OUTCOME:

After the completion of the course, Students will be able to

CO1.Write down in detail with application of crystal structure

CO2.Write down the details of Elementary lattice dynamics

CO3.Deliberate in detail with examples Magnetic properties of matter

CO4.Identify the characteristics of elementary band theory

CO5.Learn the classification and characteristics of superconductivity

CO6.Understand the elastic properties of solids and lattice vibrations

# SOLID STATE PHYSICS: DSE 1B

### Unit-1

**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Bragg spectrometer. Continuous x-ray spectra, Duane and Hunt limit. Characteristic x-ray spectra. Mosley law and its significance. **(10 Lectures)**

**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. **(09 Lectures)**

**Magnetic Properties of Matter:** Dia, Para, Ferri and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **(11 Lectures)**

**Unit-2**

**Electrical Properties of metals:** Free electron theory, Quantum theory, Conductivity of metals on the basis of free electron theory- Ohm's law. **(04 Lectures)**

**Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmon's. **(10 Lectures)**

**Elementary band theory:** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors, carrier concentration in intrinsic semiconductor, Fermi energy, effect of temperature and concentration on Fermi energy, Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient. **(10 Lectures)**

**Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field.
Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.BCS theory, application of Superconductors.

**(06 Lectures)**

**Reference Books:**


- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid State Physics, Rita John, 2014, McGraw Hill
- Solid-state Physics, H. Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

## PRACTICALS-DSE LAB: SOLID STATE PHYSICS

### (Minimum of eight is to be conducted)

1. Determination of energy gap of a semiconductor using Meter Bridge.
2. Determination Fermi energy of metal(copper)
3. Study of powder X-ray photograph-the determination of inter planar distances.
4. Study of hall effect
5. To measure the Dielectric Constant of a given solid Materials
6. To determine value of Boltzmann constant using V-I characteristic of PN diode.
7. To determine value of Planck's constant using LEDs of at least 4 different colors.
8. Study of LDR characteristics.
9. Verification of Inverse square law for light Intensity using a Photo-diode.
10. To determine the refractive index of a dielectric layer using SPR
11. To study the PE Hysteresis loop of a Ferroelectric Crystal.
12. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (from room temperature to 150 $^{o}$C) and to determine its band gap
13. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
14. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)

**Reference Books**


- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4$^{th}$ Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11$^{th}$ Ed., 2011, Kitab Mahal, New Delhi
- Elements of Solid State Physics, J.P. Srivastava, 2$^{nd}$ Ed., 2006, Prentice-Hall of India

# SEMESTER V

**Course code: CME29601/CME29602/CME29603/CME29604**
**Credits: Theory – 04, Practical – 01** **Theories: 60 Lectures**

## COURSE OUTCOME:

After successful completion of the course, the student is able to:

CO1.Learn in detail with examples calculus of functions of more than one variable

CO2.Specify the details of fourier series

CO3.Specify in depth integrals

CO4.Deliberate in detail with application of partial differential equations

CO5.Understand in depth complex analysis

CO6.Deliberate in detail with examples of beta and gamma function

## MATHEMATICAL PHYSICS: DSE 1D

**Unit-1**

**Calculus of functions of more than one variable**: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **(06 Lectures)**

**Fourier series**: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. **(10 Lectures)**

**Frobenius Method and Special Functions**: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations. **(14 Lectures)**

## Unit-2

**Some Special Integrals:** Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(06 Lectures)**

**Partial Differential Equations**: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry.

**(10 Lectures)**

**Complex Analysis**: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula.

**(14 Lectures)**

**Reference Books:**

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- An Introduction to Ordinary Differential Equations, Earl A Coddington, 1961, PHI Learning.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Essential Mathematical Methods, K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
- Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Books.

## PRACTICALS -DSE LAB: MATHEMATICAL PHYSICS

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- Use of computer language as a tool in solving physics problems (applications)
- The course will consist of lectures (both theory and practical) in the ComputerLab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- Students can use anyone operating system Linux or Microsoft Windows

| **Topics Description with Applications** | Introduction and Overview |
|---|---|
| Introduction and Overview | Computer architecture and organization, memory and Input/output devices |
| Basics of scientific computing | Binary and decimal 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 |
| Errors and error Analysis | Truncation and round off errors, Absolute and relative errors, Floating point computations. |
| Review of C & C++ Programming fundamentals | Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. 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, Structures and Unions, Idea of classes and objects |
| Programs: using C/C++ language | Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending-descending order, Binary search |
| Random number generation | Area of circle, area of square, volume of sphere, value of pi (**$\pi$**) |

| | |
|---|---|
| Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson<br>and Secant methods | Solution of linear and quadratic equation, solving $\alpha = \tan\alpha; I = I_0\left(\frac{\sin\alpha}{\alpha}\right)^2$ in optics |
| Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation | Evaluation of trigonometric functions e.g. *sin θ, cos θ, tanθ, etc.* |
| Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal a n d Simpson rules), Monte Carlo method | Given Position with equidistant time data to calculate velocity and acceleration and vice-versa.<br>Find the area of B-H Hysteresis loop |
| Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods | First order differential equation<br>• Radioactive decay<br>• Current in RC, LC circuits with DC source<br>• Newton's law of cooling<br>• Classical equations of motion<br>Attempt following problems using RK 4 order method:<br>• Solve the coupled differential equations<br>$\frac{dx}{dt} = y + x - \frac{x^3}{3}; \frac{dy}{dx} = -x$<br><br>for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$<br>The differential equation describing the motion of a Pendulum is $\frac{d^2\theta}{dt^2} = -\sin(\theta)$. The pendulum is released from rest at an angular displacement α, i. e. $\theta(0) = \alpha, and \theta^1(0) = 0.$ Solve the equation for α= 0.1, 0.5 and 1.0 and plot θ as a function of time in the range 0 ≤ t ≤8Π. Also plot the analytic solution valid for small θsin(θ)=θ |

**Reference Books:**


- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publications.
- Numerical Recipes in C++: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn., 2007, Cambridge University Press.
- A first course in Numerical Methods, Uri M. Ascher and Chen Greif, 2012, PHI Learning
- Elementary Numerical Analysis, K.E. Atkinson, 3 r dEdn. , 2007, Wiley India Edition.
- Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to Computational Physics, T. Pang, 2ndEdn., 2006, Cambridge Univ. Press

**Discipline Specific Elective papers: Choose 1**

# SEMESTER VI

**Course code:** CMF29001/ CMF29002/ CMF29003/ CMF29004
**Credits: Theory – 04, Practical – 01** **Theories: 60 Lectures**

## COURSE OUTCOME:

After successful completion of the course, the student is able to:

CO1.Understand in detail with examples planks quantum

CO2.Identify the classification and characteristics of Planck's quantum

CO3.Learn the classification and characteristics of fission and fusion reaction

CO4.Write down the characteristics of matter waves

CO5.Understand the classification and characteristics of radioactivity

CO6.Specify in depth Eigen values

# ELEMENTS OF MODERN PHYSICS: DSE 1A

**Unit-1**

Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. **(08 Lectures)**

Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra. **(04 Lectures)**

Position measurement-gamma ray microscope thought experiment; wave-particle duality, Heisenberg uncertainty principle-impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle **(04 lectures)**

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension. **(10 Lectures)**

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions. **(04 Lectures)**

## Unit-2

One dimensional infinitely rigid box- energy eigenvalues and Eigen functions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier. **(12 Lectures)**

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, semi-empirical mass formula and binding energy. **(07 Lectures)**

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; Alpha decay; Beta decay - energy released, spectrum and Pauli's prediction of neutrino; gamma-ray emission.

**(11 Lectures)**

**Reference Books:**


- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
- Modern Physics, John R. Taylor, Chris D. Zafiratos, Michael A.Dubson,2009, PHI Learning
- Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
- Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill

Co.

- Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning
- Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

**PRACTICALS –DSE LAB: ELEMENTS OF MODERN PHYSICS**
**(Minimum of eight is to be conducted)**

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine value of Planck's constant using LEDs of at least 4 different colors.
4. To determine the ionization potential of mercury.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the absorption lines in the rotational spectrum of Iodine vapor. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photo sensor and compare with incoherent source – Na light.
7. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
8. To determine the value of e/m by magnetic focusing.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photo sensor and compare with incoherent source – Na light.
11. To determine work function of material of filament of directly heated vacuum diode.
12. To study the Divergence of laser
13. Spectral response of solar cell
14. Bridge rectifier with and without filters
15. Clipping and clamping circuits using diodes
16. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
17. Study of counting statistics using background radiation using GM counter.
18. Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
19. Study of absorption of beta particles in Aluminum using GM counter.

20. Half life of k-40
21. To determine the ionization potential of xenon.
22. Cockcroft-Walton Voltage multiplier.
23. Determination of range of electron in aluminum using GM counter

**References:**


- Physics of Radiation Therapy: F M Khan Williams and Wilkins, Third edition (2003)
- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
- A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4$^{th}$ Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11$^{th}$ Edition, 2011, Kitab Mahal, New Delhi.

# SEMESTER VI

**Course code:** CMF29201/ CMF29202/ CMF29203/ CMF29204
**Credits: Theory – 05** **Theories: 75 Lectures**

**COURSE OUTCOME:**

After the completion of the course, Students will be able to

CO1.Write down in detail with application and properties of nuclei

CO2.Learn in detail with application and nuclear models

CO3.Understand in detail with examples radioactivity

CO4.Identify the details of particle physics

CO5.Write down the details of particle accelerators

CO6.Write down the details of detector for nuclear radiator

## Nuclear & Particle Physics: DSE 1B

**Unit-1**

**General Properties of Nuclei**: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

**(10 Lectures)**

**Nuclear Models**: Liquid drop model approach, semi empirical mass formula and binding energy, significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **(12 Lectures)**

**Nuclear Reactions:** Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(08 Lectures)**

## Unit-2

**Radioactivity decay** :(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) beta-decay: energy kinematics for beta-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

**(10 Lectures)**

**Interaction of Nuclear Radiation with matter**: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

**(08 Lectures)**

**Detector for Nuclear Radiations:** Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation. Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility)

**(08 Lectures)**

**Particle Accelerators:** Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

**(04 Lectures)**

## Unit-3

**Particle physics:** Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. **(15 Lectures)**

**Reference Books**:


- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-

Institute of Physics Publishing, 2004).

- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

# SEMESTER VI

**Course code: CMF29401/CMF29402/CMF29403/CMF29404**
**Credits: Theory – 04, Practical – 01** **Theories: 60 Lectures**

## COURSE OUTCOME:

After successful completion of the course, the student is able to:

CO1.Understand the classification and characteristics of time dependent Schrodinger equation

CO2.Understand in depth time independent Schrodinger equation

CO3.Understand the classification and characteristics of quantum theory of hydrogen like atoms

CO4.Specify the details of atoms in external magnetic field

CO5.Write down the characteristics of many electron atoms

## QUANTUM MECHANICS: DSE 1C

**Unit-1**

**Time dependent Schrodinger equation**: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(08 Lectures)**

**Time independent Schrodinger equation**-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wavepacket for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle. **(10 Lectures)**

**General discussion of bound states in an arbitrary potential**- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method. **(12 Lectures)**

**Unit-2**

**Quantum theory of hydrogen-like atoms**: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wave functions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d,.. Shells (idea only) **(10 Lectures)**

**Atoms in Electric and Magnetic Fields**:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(08 Lectures)**

**Atoms in External Magnetic Fields**:- Normal and Anomalous Zeeman Effect. **(02 Lectures)**

**Many electron atoms**:- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings.

**(10 Lectures)**

**Reference Books:**


- A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn. 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.

- Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4thEdn., 2001, Springer


## PRACTICAL-DSE LAB: QUANTUM MECHANICS

**Use C/C++/Scilab for solving the following problems based on Quantum Mechanics Like**

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}[V(r) - E] where V(r) = \frac{-e^2}{r}$$

   Here, m is the reduced mass of the electron. Obtain the energy Eigen values and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e=3.795 $(eVÅ)^{1/2}$, $\hbar c$ = 1973 (eVÅ) and m = $0.511 \times 10^6 eV/c^2$

2. Solve the s-wave radial Schrodinger equation for an atom

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

   Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = \frac{-e^2}{r} e^{\frac{-r}{a}}$$

   Find the energy (in eV) of the ground state of the atom to an accuracy of three Significant digits. Also, plot the corresponding wave function. Take e = 3.795 $(eVÅ)^{1/2}$, m = $0.511 \times 10^6 eV/c^2$ , and a = 3 Å, 5 Å, 7 Å. In these units $\hbar c$ = 1973(eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/$c^2$, k = 100 MeV $fm^{-2}$, b = 0, 10, 30 MeV $fm^{-3}$ In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$$

where µ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D\left(e^{-2\alpha r^1} - e^{-\alpha r^1}\right), r^1 = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: m = 940x$10^6$eV/$C^2$, D = 0.755501 eV, α = 1.44, $r_o$ = 0.131349 Å

**Laboratory based experiments:**

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency

6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting

7. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode.

**Reference Books:**


- Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publications.
- Numerical Recipes in C: The Art of Scientific Computing, W.H.Press et al., 3rdEdn., 2007, Cambridge University Press.
- Elementary Numerical Analysis, K.E.Atkinson, 3 r dEdn. , 2007, Wiley India Edition.

- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB:
- Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf2012ISBN: 978-1479203444
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand and Company, New Delhi ISBN: 978-8121939706
- Scilab Image Processing: Lambert M. Surhone. 2010Betascript Publishing ISBN: 978-6133459274A
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

## Skill Enhancement Course (SEC) (Credit: 02 each)

# SEMESTER V

**Course code:** CME69001/ CME69002/ CME69003/ CME69004
**Credits: Theory – 02** **Theories: 30 Lectures**

### COURSE OUTCOME:

After the completion of the course, Students will be able to

CO1.Understand the characteristics of fossil fuel

CO2.Learn in detail with application of wind energy

CO3.Specify in detail with application of ocean energy and hydro energy

CO4.Identify the characteristics of geothermal energy

CO5.Deliberate the characteristics of electromagnetic energy

CO6.Deliberate the characteristics of piezoelectric energy harvesting

## RENEWABLE ENERGY AND ENERGY HARVESTING: SEC 1A

**Fossil fuels and Alternate Sources of energy:** Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **(03 Lectures)**

**Solar energy**: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(06 Lectures)**

**Wind Energy harvesting**: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. **(03 Lectures)**

**Ocean Energy**: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. **(03 Lectures)**

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(02 Lectures)**

**Geothermal Energy**: Geothermal Resources, Geothermal Technologies. **(02 Lectures)**

**Hydro Energy**: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(02 Lectures)**

**Piezoelectric Energy harvesting**: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power **(04 Lectures)**

**Electromagnetic Energy Harvesting**: Linear generators, physics mathematical models, recent applications **(02 Lectures)**

Carbon captured technologies, cell, batteries, power consumption **(02 Lectures)**

Environmental issues and Renewable sources of energy, sustainability. **(01 Lecture)**

**Demonstrations and Experiments**

1. Demonstration of Training modules on solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

**Reference Books:**


- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- Solar energy - M P Agarwal - S Chand and Co. Ltd.
- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

# SEMESTER V

**Course code:** CME69201/ CME69202/ CME69203/ CME69204
**Credits: Theory – 02** **Theories: 30 Lectures**

**COURSE OUTCOME:**

After the completion of the course, Students will be able to

CO1.Deliberate the details of photons

CO2.Understand the classification and characteristics of Atomic and nuclear physics

CO3.Write down the classification and characteristics of nuclear techniques

CO4.Write down the characteristics of radiation safety management

CO5.Identify in detail with application of radiation detection

# RADIATION SAFETY: SEC 2A

**Basics of Atomic and Nuclear Physics:** Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission. **(06 Lectures)**

**Interaction of Radiation with matter: Types of Radiation:** Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, **Interaction of Photons** – Photoelectric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, **Interaction of Charged Particles:** Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), **Interaction of Neutrons-** Collision, slowing down and Moderation. **(07 Lectures)**

**Radiation detection and monitoring devices: Radiation Quantities and Units:** Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). **Radiation detection:** Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors **(**Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry. **(07 Lectures)**

**Radiation safety management:** Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. **(05 Lectures)**

**Application of nuclear techniques:** Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. *Industrial Uses:* Tracing, Gauging, Material Modification, Sterization, Food preservation.

**(05 Lectures)**

**Experiments:**

1. Study the background radiation levels using Radiation meter

**Characteristics of Geiger Muller (GM) Counter:**

2) Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).

3) Study of counting statistics using background radiation using GM counter.

4) Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.

5) Study of absorption of beta particles in Aluminum using GM counter.

6) Detection of α particles using reference source & determining its half life using spark counter

7) Gamma spectrum of Gas Light mantle (Source of Thorium)

**Reference Books:**

1. W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)

2. G.F.Knoll, Radiation detection and measurements

3. Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)

4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.

5. J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.

6. Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001

7. W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981

# SEMESTER V

**Course code:** CME69401/ CME69402/ CME69403/ CME69404
**Credits: Theory – 02** **Theories: 30 Lectures**

## COURSE OUTCOME:

After completion of the course the student is able to

CO1.Deliberate in details with examples basic of measurement

CO2.Specify in depth electronic voltmeter

CO3.Understand in depth Cathode ray oscilloscope

CO4.Specify the characteristics of Impedance Bridge

CO5.Specify the classification and characteristics of digital multimetre

CO6.Identify the characteristics of signal generator

## BASIC INSTRUMENTATION SKILLS: SEC 1C

**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.

**(04 Lectures)**

**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. **(04 Lectures)**

**Cathode** Ray **Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– nonmathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

**(06 Lectures)**

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. **(03 Lectures)**

**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. **(04 Lectures)**

**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. **(03 Lectures)**

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

**(03 Lectures)**

**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. **(03 Lectures)**

**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)

**Reference Books:**


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

# SEMESTER V

**Course code:** CME70601/ CME70602/ CME70603/ CME70604
**Credits: Theory – 02** **Theories: 30 Lectures**

**COURSE OUTCOME:**

After the completion of the course, Students will be able to

CO1.Specify the details of sources and detector

CO2.Deliberate the classification and characteristics of experiments on lasers

CO3.Specify the details of experiments on semiconductor sources

CO4.Write down in details with examples Fourier optics

CO5.Specify the classification and characteristics of photonic and holography

CO6.Specify the characteristics of photonic

# APPLIED OPTICS: SEC 1I

**(i) Sources and Detectors** **(09 Lectures)**

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

**Experiments on Lasers:**

a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.

b. To find the width of the wire or width of the slit using diffraction pattern Obtained by a He-Ne or solid state laser.

c. To find the polarization angle of laser light using polarizer and analyzer

d. Thermal expansion of quartz using laser

**Experiments on Semiconductor Sources and Detectors:**

a. V-I characteristics of LED

b. Study the characteristics of solid state laser

c. Study the characteristics of LDR

d. Photovoltaic Cell

e. Characteristics of IR sensor

**(ii) Fourier Optics** **(06 Lectures)**

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens

**Experiments on Fourier Optics:**

**a. Fourier optic and image processing**

1. Optical image addition/subtraction
2. Optical image differentiation
3. Fourier optical filtering
4. Construction of an optical 4f system

**b. Fourier Transform Spectroscopy**

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

**Experiment:**

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

**(iii) Holography** **(06 Lectures)**

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

**Experiments on Holography and interferometry:**

1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air

4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

**(iv) Photonics: Fibre Optics** **(09 Lectures)**

Optical fibers and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

**Experiments on Photonics: Fibre Optics**

a. To measure the numerical aperture of an optical fibre

b. To study the variation of the bending loss in a multimode fibre

c. To determine the mode field diameter (MFD) of fundamental mode in a Single-mode fibre by measurements of its far field Gaussian pattern

d. To measure the near field intensity profile of a fibre and study its refractive Index profile

e. To determine the power loss at a splice between two multimode fibre

**Reference Books:**


- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments,M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

**The marks distribution for the final practical examination is as follows:**

| | |
|---|---|
| Formula/Formulae with explanation of symbols | **05 marks** |
| Diagram/Circuit diagram and tabular column | **08 marks** |
| Experimental setup+ taking readings | **18 marks** |
| Accuracy of readings | **05 marks** |
| Graph and Calculations | **10 marks** |
| Final result and units | **04 marks** |
| Viva | **10 marks** |
| Record | **10 marks** |
| Total for the practical examination | **70 marks** |

## Question Paper Pattern for DSC and DSE theory papers of 04 credits

## From the academic year 2017-2018 onwards

**Time: 3 hours** **Max. Marks: 70**

**Part A:**

**I. Answer all the questions ( Multiple choice questions) 1 x 4 = 4 marks**

(One question should be selected from 15 lectures)

**Part B:**

**II. Answer any seven questions. 2 x 7 =14 marks**

**Ten questions should be set**

(At least two questions should be selected from 15 lectures)

**Part C:**

**III. Answer all the questions. 4 x 10 = 40 marks**

(Two questions should be set out of fifteen lectures of internal choice of ten marks each)

**Part D:**

**IV. Answer any three out of four questions 4 x 3 = 12 marks**

(One problem should be selected from 15 lecturers)

## Question Paper Pattern for DSE theory papers of 05 credits

**From the academic year 2017-2018 0nwards**

**Time: 3 hours** **Max. Marks: 70**

**Part A:**

**I. Answer all the questions (Multiple choice questions)** **1 x 5 = 5 marks**

(One question should be selected from 15 lectures)

**Part B:**

**II. Answer any five questions.** **2 x 5 =10 marks**

**Eight questions should be set**

(At least two questions should be selected from 15 lectures)

**Part C:**

**III. Answer the following questions.** **8 x 5 = 40 marks**

(Two questions should be set out of fifteen lectures of internal choice of eight marks each)

**Part D:**

**IV. Answer any three out of five questions** **5 x 3 = 15 marks**

(One problem should be selected from 15 lecturers)

## Question Paper Pattern for SEC theory paper of 02 credits

**Time: 2 hours** **Max. Marks: 50**

**Part A:**

**I. Ten Questions out of twelve.** **2 x 10 = 20 marks**

(Five questions from15 lectures.)

**Part B:**

**II. Answer all the questions** **10 x 03 = 30 marks**

(Two questions should be set out of ten lectures of internal choice of ten marks each)