# Course Handout

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| Institute/School Name | Chitkara University Institute of Engineering and Technology | | |
| Department Name | Computer Sciences and Engineering | | |
| Programme Name | Bachelor of Engineering (Computer Science & Engineering) | | |
| Course Name | Modern and Computational Physics | Session | 2022-2023 |
| Course Code | 22AS015 | Semester/Batch | 2nd /2022 |
| L-T-P (Per Week) | 4-0-2 | Course Credits | 05 |
| Course Coordinators | Dr. Ridhima Gahrotra & Dr. Nidhi Bansal Garg | | |

1. **Objectives of the Course**

The course provides a wide scope of learning & understanding of the subject and the main objectives of the course are:

* Understand different types of magnetic materials, role of superconducting magnets in engineering, the need of quantum mechanics and related phenomenon and electronic behaviour of solids
* Understand engineering problems for its physical interpretation and viability.
* Develop sufficient depth in both engineering and physics and will be able to co-relate fundamental key concept of physics to engineering problems.
* Study the physical problems related to real life and find their solutions.
* Compute gradient, divergence & curl and apply these to solve problems related to vector calculus.https://ssl.gstatic.com/ui/v1/icons/mail/images/cleardot.gif

1. **Course Learning Outcomes**

Student should be able to:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Course Outcome** | **POs** | **CL** | **KC** | **Sessions** |
| **CLO01** | Analyze and solve mathematical problems relating to Gradient, Divergence and Curl of scalar and vector fields and establish their relationship with propagation of Electromagnetic waves in free space using Maxwell's equation. | PO1,PO3,PO6 | K2 | Factual  Conceptual | **05** |
| **CLO02** | Differentiate between different types of LASERs and optical fibres their operation, advantages, and disadvantages and solve related problems and their application in engineering domain. | PO1,PO3 | K3 | Fundamental  Conceptual | **10** |
| **CLO03** | Differentiate between characteristics and properties of various magnetic and superconducting materials and establish their applications in engineering disciplines. | PO1,PO3,PO12 | K3 | Conceptual  Procedural | **08** |
| **CLO04** | Describe the dual nature of waves and particles in context of Quantum Mechanics and to apply the Schrodinger Wave Equation in solving different physical systems and processes. | PO1,PO2, PO12 | K3 | Conceptual  Procedural | **05** |
| **Total Contact Hours** | | | | | **42** |

Revised Bloom’s Taxonomy Terminology

\*Cognitive Level =CL

\*Knowledge Categories = KC

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CLO01** | H | H |  |  |  | H |  |  |  |  |  |  |
| **CLO02** | H |  | H |  |  |  |  |  |  |  |  |  |
| **CLO03** | H |  | M |  |  |  |  |  |  |  |  | H |
| **CLO04** | H | H |  |  |  |  |  |  |  |  |  | M |

H=High, M=Medium, L=Low

1. **ERISE Grid Mapping**

|  |  |
| --- | --- |
| **Feature Enablement** | **Level(1-5, 5 being highest)** |
| Entrepreneurship | 2 |
| Research | 4 |
| Innovation | 2 |
| Skills | 5 |
| Employability | 3 |

1. **Recommended Books:**

**B01:** Engineering Physics by H. K. Malik and A. K. Singh, McGraw Hill Education.

**B02:** Engineering Physics by Chitkara Publication 2nd Edition.

**B03:** Engineering Physics by Dr. M. N. Avadhanulu and Dr P.G. Kshirsagar, S. Chand & Company PVT. LTD.

B04: Engineering Physics by Dr S Mani Naidu, Pearson

**B04:** Engineering Physics by Dattu R Joshi, McGraw Hill Education

**B05:** Concepts of Modern Physics by Arthur Beiser

**B06:** Engineering Physics by R.K Guar, & S. L. Gupta

**B07:** Engineering Physics by Vanchna Singh and Sheetal Kumar

**B08:** Interactive Engineering Physics by Randhir Singh

1. **Other readings and relevant websites:**

|  |  |
| --- | --- |
| **S.No.** | **Link of Journals, Magazines, websites and Research Papers** |
|  | [www.apniphysics.com](http://www.apniphysics.com/) [Engineering Physics Video Lectures], <https://goo.gl/P1AqJM> |
|  | <https://onlinecourses.nptel.ac.in/noc19_ph16/preview> |
|  | <https://onlinecourses.nptel.ac.in/noc21_ph02/preview> |
|  | <http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html> |
|  | <http://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/fiberoptics-fundamentals> [Laser+Optical Fibre] |
|  | <http://www.irm.umn.edu/hg2m/hg2m_b/hg2m_b.html> [Magnetic Material] |
|  | <http://www.phys.ufl.edu/~pjh/teaching/phz7427/7427notes/ch5.pdf> [Superconductivity] |
|  | <https://onlinecourses.nptel.ac.in/noc17_ph03/preview> [Quantum Mechanics] |

1. **Recommended Tools and Platforms**

Google classroom

1. **Course Plan:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Session Number** | **Topics** | **Recommended Book / Other reading material** | | **Page numbers**  **of Text Book(s)** |
| 1-2 | **Electrodynamics:**  Vector and scalar fields, [Gradient, divergence, curl and their physical interpretation](http://www.apniphysics.com/electrodynamics-basics-gradient-divergence-and-curl-operators-part-3/)  Determination of planck’s constant. | **B02**  **B01** | | **1**  **10.2-10.5** |
| 3 | [Gauss’s theorem and Stoke’s theorem](http://www.apniphysics.com/electrodynamics-basics-gauss-divergence-and-stokes-theorem-part-4/) (Statement only), [Equation of continuity](http://www.apniphysics.com/electrodynamics-basics-the-continuity-equation-part-6/), Green’s theorm | **B01** | | **10.6, 10.7, 10.14** |
| 4-5 | [Maxwell’s equations](http://www.apniphysics.com/electrodynamics-basics-maxwells-equation-in-integral-and-differential-form-part-5/) (differential and integral form), Maxwell’s equations in free space, [Propagation of electromagnetic waves in free space](http://www.apniphysics.com/proof-of-transverse-nature-of-electromagnetic-wave/) and its applications in daily life. | **B01** | | **10.15-10.22** |
| 6-8 | **Laser:**  Introduction, Laser characteristics such as coherence, monochromaticity, collimated and directionality, laser action, [stimulated absorption, spontaneous emission, stimulated emission](http://www.apniphysics.com/absorption-spontaneous-stimulated-emission-concepts-of-laser/), [Population inversion and pumping](http://www.apniphysics.com/population-inversion-in-laser/). Derivation of Einstein’s coefficient relation  To find out the wavelength of laser light using diffraction grating. | **B01** | | **4.1-4.5** |
| 9 | Various level lasers, two level, three level, four level[, Ruby laser](http://www.apniphysics.com/ruby-laser-its-construction-and-working/), [Helium-Neon laser](http://www.apniphysics.com/he-ne-gas-laser-its-principle-construction-and-working/) | **B01** | | **4.6, 4.7** |
| 10 | [Semiconductor laser](http://www.apniphysics.com/basics-of-semiconductor-laser-part-2/), concepts of Holography, LASER Applications in engineering | **B01** | | **4.13-4.21** |
| **ST1** |
| 11 | **Fibre Optics:** [Basic principle of optical fibre, step index and graded index fibres](http://www.apniphysics.com/classification-of-optical-fibers-step-and-graded-index-optical-fibers-apniphysics/) | **B01** | | **5.3** |
| 12-13 | [Parameters of optical fibres, acceptance angle,](http://www.apniphysics.com/acceptance-angle-and-numerical-aperture-of-fiber-optics/) [numerical aperture](http://www.apniphysics.com/numerical-aperture-of-optical-fiber-apniphysics-com/), [normalized frequency](http://www.apniphysics.com/v-number-or-normalized-frequency-of-optical-fiber-apniphysics-com/), No. of modes, [normalized frequency](http://www.apniphysics.com/v-number-or-normalized-frequency-of-optical-fiber-apniphysics-com/)  Determination of angular divergence using laser. | **B01** | | **5.5** |
| 14-15 | [Attenuation in optical fibres](http://www.apniphysics.com/attenuation-in-optical-fiber-a-numerical-problem/), intermodal and intramodal dispersion (no derivation), optical fibres in communication, Applications of optical fibre in engineering | **B01** | | **5.8, 5.13** |
| **Lab Evaluation 1** |
| 16-17 | **Magnetic Materials:** Types of Magnetic Materials, the domain structure, super paramagnetic materials, Ferrites, Anti ferromagnetic, ferrimagnetic materials  Determination of susceptibility using quinke’s method. | **B01** | | **18.1-18.12** |
| 18 | [Ferromagnetism and related phenomena](http://www.apniphysics.com/the-magnetic-susceptibility-and-its-mathematical-formulation/), [The hysteresis loop](http://www.apniphysics.com/b-h-curve-hysteresis-loss-explained/) | **B01** | | **18.13,18.14** |
| 19 | [Types of magnetic materials](http://www.apniphysics.com/basics-of-b-h-curve-and-hysteresis-loop-with-supporting-physical-concepts/), soft magnetic materials, hard magnetic materials , applications of magnetic materials in engineering Superparamagnetism | **B02**  **B01** | | **7.15**  **18.18** |
| **ST 2** | | | | |
| 20 | **Superconductivity:** [Introduction](http://www.apniphysics.com/superconductivity-basics-critical-magnetic-field-and-critical-temperature-part1/), [Meissner effect, critical field, critical current](http://www.apniphysics.com/superconductivitycritical-temperature-and-current-part-2/) | **B01** | | **19.1, 19.2** |
| 21-22 | Isotope effect , Types of superconductors: type I superconductors, type II superconductors, Isotope Effect, London equations  To find the hall coefficient and carrier concentration using hall effect. | **B01** | | **19.3 - 19.5** |
| 23 | Penetration depth, Cooper pair and BCS theory (Qualitative only),  high temperature superconductors, applications | **B01** | | **19.5-19.10** |
| **Lab evaluation -II** | | | | |
| 24-25 | **Quantum Mechanics**[**:** Heisenberg Uncertainty Principle, Introduction to Quantum Mechanics, Group velocity and phase velocity](http://www.apniphysics.com/concept-of-wave-packet-phase-velocity-group-velocity-for-de-broglie-waves/) (No relation) | **B01**  **B02** | | **15.1**  **5.4-5.8** |
| 26 | [Wave function and its significance, Normalized wave](http://www.apniphysics.com/how-to-find-normalization-constant-of-a-wave-function-physical-meaning/)  function, [Time Dependent and Independent Schrodinger wave equations](http://www.apniphysics.com/schrodingers-time-dependent-and-time-independent-wave-equations/) | **B01** | | **15.7-15.10** |
| 27-28 | [Particle in a one dimensional box](http://www.apniphysics.com/particle-in-a-one-dimensional-box-quantum-mechanics/)  To find out the , charge by mass ration using Thomson method. | | **B01** | **15.11** |
| **Final Lab Evaluation** | | | | |
| **ETE** | | | | |

1. **Delivery/Instructional Resources**

|  |  |  |  |
| --- | --- | --- | --- |
| **SessionNo.** | **Topics** | **Web References** | **Audio-Video** |
| 1-5 | Vector and scalar fields, [Gradient, divergence, curl and their physical interpretation](http://www.apniphysics.com/electrodynamics-basics-gradient-divergence-and-curl-operators-part-3/)  [Gauss’s theorem and Stoke’s theorem](http://www.apniphysics.com/electrodynamics-basics-gauss-divergence-and-stokes-theorem-part-4/) (Statement only), [Equation of continuity](http://www.apniphysics.com/electrodynamics-basics-the-continuity-equation-part-6/), Green’s theorm, [Maxwell’s equations](http://www.apniphysics.com/electrodynamics-basics-maxwells-equation-in-integral-and-differential-form-part-5/) (differential and integral form), Maxwell’s equations in free space, [Propagation of electromagnetic waves in free space](http://www.apniphysics.com/proof-of-transverse-nature-of-electromagnetic-wave/) and its applications in daily life. | [www.apniphysics.com](http://www.apniphysics.com/) [Engineering Physics Video Lectures], <https://goo.gl/P1AqJM> | [www.apniphysics.com](http://www.apniphysics.com/) [Engineering Physics Video Lectures], <https://goo.gl/P1AqJM> |
| 6-10 | Introduction, Laser characteristics such as coherence, monochromaticity, collimated and directionality, laser action, [stimulated absorption, spontaneous emission, stimulated emission](http://www.apniphysics.com/absorption-spontaneous-stimulated-emission-concepts-of-laser/), [Population inversion and pumping](http://www.apniphysics.com/population-inversion-in-laser/). Derivation of Einstein’s coefficient relation, Various level lasers, two level, three level, four level[, Ruby laser](http://www.apniphysics.com/ruby-laser-its-construction-and-working/), [Helium-Neon laser](http://www.apniphysics.com/he-ne-gas-laser-its-principle-construction-and-working/)  [Semiconductor laser](http://www.apniphysics.com/basics-of-semiconductor-laser-part-2/), concepts of Holography, LASER Applications in engineering | <http://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/fiberoptics-fundamentals> [Laser+Optical Fibre] | <http://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/fiberoptics-fundamentals> [Laser+Optical Fibre] |
| 11-15 | [Basic principle of optical fibre, step index and graded index fibres](http://www.apniphysics.com/classification-of-optical-fibers-step-and-graded-index-optical-fibers-apniphysics/)  [Parameters of optical fibres, acceptance angle,](http://www.apniphysics.com/acceptance-angle-and-numerical-aperture-of-fiber-optics/) [numerical aperture](http://www.apniphysics.com/numerical-aperture-of-optical-fiber-apniphysics-com/), [normalized frequency](http://www.apniphysics.com/v-number-or-normalized-frequency-of-optical-fiber-apniphysics-com/), No. of modes, [normalized frequency](http://www.apniphysics.com/v-number-or-normalized-frequency-of-optical-fiber-apniphysics-com/), [Attenuation in optical fibres](http://www.apniphysics.com/attenuation-in-optical-fiber-a-numerical-problem/), intermodal and intramodal dispersion (no derivation), optical fibres in communication, Applications of optical fibre in  engineering | https://classroom.codingninjas.com/app/classroom/me/20926/content/430931/offering/6231280 | <https://nptel.ac.in/courses/106106182> |
| 16-19 | Types of Magnetic Materials, the domain structure, super paramagnetic materials, Ferrites, Anti ferromagnetic, ferrimagnetic materials, [Ferromagnetism and related phenomena](http://www.apniphysics.com/the-magnetic-susceptibility-and-its-mathematical-formulation/), [The hysteresis loop](http://www.apniphysics.com/b-h-curve-hysteresis-loss-explained/)  [Types of magnetic materials](http://www.apniphysics.com/basics-of-b-h-curve-and-hysteresis-loop-with-supporting-physical-concepts/), soft magnetic materials, hard magnetic materials , applications of magnetic materials in engineering Superparamagnetism | <http://www.irm.umn.edu/hg2m/hg2m_b/hg2m_b.html> [Magnetic Material] | <http://www.irm.umn.edu/hg2m/hg2m_b/hg2m_b.html> [Magnetic Material] |
| 20-23 | [Introduction](http://www.apniphysics.com/superconductivity-basics-critical-magnetic-field-and-critical-temperature-part1/), [Meissner effect, critical field, critical current](http://www.apniphysics.com/superconductivitycritical-temperature-and-current-part-2/), Isotope effect , Types of superconductors: type I superconductors, type II superconductors, Isotope Effect, London equations, Penetration depth, Cooper pair and BCS theory (Qualitative only), high temperature superconductors, applications | <http://www.phys.ufl.edu/~pjh/teaching/phz7427/7427notes/ch5.pdf> [Superconductivity] | <http://www.phys.ufl.edu/~pjh/teaching/phz7427/7427notes/ch5.pdf> [Superconductivity] |
| 24-28 | [Heisenberg Uncertainty Principle, Introduction to Quantum Mechanics, Group velocity and phase velocity](http://www.apniphysics.com/concept-of-wave-packet-phase-velocity-group-velocity-for-de-broglie-waves/), [Wave function and its significance, Normalized wave](http://www.apniphysics.com/how-to-find-normalization-constant-of-a-wave-function-physical-meaning/)  function, [Time Dependent and Independent Schrodinger wave equations](http://www.apniphysics.com/schrodingers-time-dependent-and-time-independent-wave-equations/), [Particle in a one dimensional box](http://www.apniphysics.com/particle-in-a-one-dimensional-box-quantum-mechanics/), concept of quantum computing. | <https://onlinecourses.nptel.ac.in/noc17_ph03/preview> [Quantum Mechanics], https://www.digimat.in/nptel/courses/video/115101092/L45.html | <https://onlinecourses.nptel.ac.in/noc17_ph03/preview> [Quantum Mechanics], https://www.digimat.in/nptel/courses/video/115101092/L45.html |

1. **Action plan for different types of learners**

|  |  |  |
| --- | --- | --- |
| **Slow Learners** | **Average Learners** | **Fast Learners** |
| Remedial Classes, Doubt Sessions, Guided Tutorials | Doubt Session | Students will be motivated/offered to participate in competitions and research. |

1. **Evaluation Scheme & Components:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Evaluation Component** | **Type of Component** | **No. of Assessments** | **Weightage of Component** | **Mode of Assessment** |
| Component 1 | Lab Evaluations | 03\* | 30% | Offline |
| Component 2 | Sessional Tests (STs) | 02\*\* | 20% | Offline |
| Component 3 | End Term Examination | 01\*\*\* | 50% | Offline |
| **Total** | | **100%** | | |

\* Lab Evaluation is mandatory evaluation taken thrice in a semester, one will be considered as mid term evaluation (ERP automatically picks the best 01) and another one will be final evaluation.

\*\*Out of 02 STs, the ERP system automatically picks the best 01 ST.

\*\*\* Further, as per Academic Guidelines minimum 75% attendance is required to become eligible for appearing in the End Semester Examination.

1. **Syllabus of the Course:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Subject:**  **Modern and Computational Physics** | | | |
| **S.No.** | **Topics** | **No. of Sessions** | **Weightage %** |
| 1 | Vector and scalar fields, [Gradient, divergence, curl and their physical interpretation](http://www.apniphysics.com/electrodynamics-basics-gradient-divergence-and-curl-operators-part-3/)  [Gauss’s theorem and Stoke’s theorem](http://www.apniphysics.com/electrodynamics-basics-gauss-divergence-and-stokes-theorem-part-4/) (Statement only), [Equation of continuity](http://www.apniphysics.com/electrodynamics-basics-the-continuity-equation-part-6/), Green’s theorm, [Maxwell’s equations](http://www.apniphysics.com/electrodynamics-basics-maxwells-equation-in-integral-and-differential-form-part-5/) (differential and integral form), Maxwell’s equations in free space, [Propagation of electromagnetic waves in free space](http://www.apniphysics.com/proof-of-transverse-nature-of-electromagnetic-wave/) and its applications in daily life. | 5 | 18 |
| 2 | Introduction, Laser characteristics such as coherence, monochromaticity, collimated and directionality, laser action, [stimulated absorption, spontaneous emission, stimulated emission](http://www.apniphysics.com/absorption-spontaneous-stimulated-emission-concepts-of-laser/), [Population inversion and pumping](http://www.apniphysics.com/population-inversion-in-laser/). Derivation of Einstein’s coefficient relation, Various level lasers, two level, three level, four level[, Ruby laser](http://www.apniphysics.com/ruby-laser-its-construction-and-working/), [Helium-Neon laser](http://www.apniphysics.com/he-ne-gas-laser-its-principle-construction-and-working/)  [Semiconductor laser](http://www.apniphysics.com/basics-of-semiconductor-laser-part-2/), concepts of Holography, LASER Applications in engineering | 5 | 18 |
| 3 | [Basic principle of optical fibre, step index and graded index fibres](http://www.apniphysics.com/classification-of-optical-fibers-step-and-graded-index-optical-fibers-apniphysics/)  [Parameters of optical fibres, acceptance angle,](http://www.apniphysics.com/acceptance-angle-and-numerical-aperture-of-fiber-optics/) [numerical aperture](http://www.apniphysics.com/numerical-aperture-of-optical-fiber-apniphysics-com/), [normalized frequency](http://www.apniphysics.com/v-number-or-normalized-frequency-of-optical-fiber-apniphysics-com/), No. of modes, [normalized frequency](http://www.apniphysics.com/v-number-or-normalized-frequency-of-optical-fiber-apniphysics-com/), [Attenuation in optical fibres](http://www.apniphysics.com/attenuation-in-optical-fiber-a-numerical-problem/), intermodal and intramodal dispersion (no derivation), optical fibres in communication, Applications of optical fibre in  engineering | 5 | 18 |
| 4 | Types of Magnetic Materials, the domain structure, super paramagnetic materials, Ferrites, Anti ferromagnetic, ferrimagnetic materials, [Ferromagnetism and related phenomena](http://www.apniphysics.com/the-magnetic-susceptibility-and-its-mathematical-formulation/), [The hysteresis loop](http://www.apniphysics.com/b-h-curve-hysteresis-loss-explained/)  [Types of magnetic materials](http://www.apniphysics.com/basics-of-b-h-curve-and-hysteresis-loop-with-supporting-physical-concepts/), soft magnetic materials, hard magnetic materials , applications of magnetic materials in engineering Superparamagnetism | 4 | 14 |
| 5 | [Introduction](http://www.apniphysics.com/superconductivity-basics-critical-magnetic-field-and-critical-temperature-part1/), [Meissner effect, critical field, critical current](http://www.apniphysics.com/superconductivitycritical-temperature-and-current-part-2/), Isotope effect , Types of superconductors: type I superconductors, type II superconductors, Isotope Effect, London equations, Penetration depth, Cooper pair and BCS theory (Qualitative only), high temperature superconductors, applications | 4 | 14 |
| 6 | [Heisenberg Uncertainty Principle, Introduction to Quantum Mechanics, Group velocity and phase velocity](http://www.apniphysics.com/concept-of-wave-packet-phase-velocity-group-velocity-for-de-broglie-waves/), [Wave function and its significance, Normalized wave](http://www.apniphysics.com/how-to-find-normalization-constant-of-a-wave-function-physical-meaning/)  function, [Time Dependent and Independent Schrodinger wave equations](http://www.apniphysics.com/schrodingers-time-dependent-and-time-independent-wave-equations/), [Particle in a one dimensional box](http://www.apniphysics.com/particle-in-a-one-dimensional-box-quantum-mechanics/), concept of quantum computing. | 5 | 18 |

**This Document is approved by:**

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| --- | --- | --- |
| **Designation** | **Name** | **Signature** |
| **Course Coordinators** | Dr. Ridhima Gahrotra & Dr. Nidhi Bansal Garg |  |
| **Head-Academic Delivery** | Dr Reetu Malhotra |  |
| **Dean** | Dr. Mohit Kumar Kakkar |  |
| **Date (DD/MM/YYYY)** | 27/12/2022 | |