DIGITAL ELECTRONICS

Course Code: PAS 7203A Course Type: Major
Credit: 02

Course objective:
This course aims at imparting the basic concepts of digital logic and digital circuits. The mathematical formulations are used to describe number systems, algebra and codes used in digital electronics.

Course outcome:
After completing this course the student will able to understand digital logic and digital circuits. He/she will acquire in-depth knowledge of number systems, algebra and codes used in digital electronics. The basic and fundamental digital circuits will be covered in this course.

Course Contents

Unit-1: Introduction
Digital and Analogue quantities, Digital signals, Digital waveforms, Logic levels, Digital Logic, Digital logic that carries binary information. (02 Lectures)

Unit-2: Number System and Codes:
Decimal and Binary number systems, Weighted Structure, 1's complement form, 2's complement of Binary number, Base conversions: Decimal to Binary & Binary to Decimal Conversion, BCD, Digital Codes: Grey Code, Alphanumeric Codes, ASCII, Representation of Signed numbers: Sign magnitude form, 1's complement form, 2's complement form, Floating point numbers, Binary arithmetic; addition, subtraction, multiplication, division, Arithmetic operations with signed numbers: addition, subtraction, multiplication, division. (10 Lectures)

Unit-3: Logic Gates and Boolean algebra:
The inverter: NOT Gate, Symbol, Truth Table, Operation, Timing diagrams, AND Gate: Symbol, Truth Table, Operation, Timing diagrams, Bubbled AND Gate, OR Gate: Symbol, Truth Table, Operation, Timing diagrams, NAND Gate: Symbol, Truth Table, Operation, Timing diagrams, NOR Gate: Symbol, Truth Table, Operation, Timing diagrams, XOR Gate: Symbol, Truth Table, Operation, Timing diagrams, XNOR Gate: Symbol, Truth Table, Operation, Timing diagrams, Universal property of NAND & NOR Gates
Boolean operation & expression, Boolean addition, Boolean multiplication, Laws & rules of Boolean algebra, DeMorgans theorems, Boolean analysis of logic circuits
Standard forms of Boolean expressions: SOP, POS, Converting standard SOP to standard POS, Converting SOP & POS to truth table format, Karnaugh map and minimization method.
(10 Lectures)

Unit-4: Functions of Combinational logic:
Basic Adders: The Half adder, The Full Adder, Parallel Adders, Comparators: Equality, Inequality, Decoders, Encoders, Multiplexers: Demultiplexers, Parity Checkers (08 Lectures)

Unit-5: Flip-Flops:
Latches, Clocked (Level and Edge Triggered) Flip-Flops, Edge Triggered Flip-Flops: S-R, D, and J-K Flip-Flops, J-K Master-Slave Flip-Flops. (06 hours)

Text/Reference Books:

1. W. H. Gothman, Digital Electronics: An Introduction to theory & practice, Prentice Hall India (PHI), (2/e), (1982).

2. D. P. Leach, A. P. Malvino & G. Saha, Digital Principles & Applications, Mc Graw Hill, (8/e), (2014)

3. R. P. Jain & K. Sarawadekar, Modern Digital Electronics, McGraw Hill (2022).

4. G. K. Kharate, Digital Electronics, Oxford (2010).

5. A. K. Saxena, Digital Electronics, CBS Publishers (2020).

6. A. Anand Kumar, Fundamentals of Digital Circuits, Prentice Hall India (PHI) (2022)

Classical Electrodynamics

Course Code: PAS7201
Course Type: Major
Course Credit: 4
Course Objectives:
Maxwell's theory of electromagnetic phenomenon is a basic component of all modern courses of theoretical physics and all students of physics must have a thorough knowledge of its principles and working. The basic ingredient of this theory is the concept of a field and the equations which govern the space and time evolution of these fields. These fields are called electromagnetic fields and the equations are known as the Maxwell equations. Moreover, these fields show a wave behaviour and are termed as electromagnetic waves. Visible light is an example of electromagnetic wave. In this course, we shall learn about the working and applications of the Maxwell equations and how it is consistent with the theory of relativity.
Course Outcomes:
After successful completion of this course, students shall be able to
CO1: Evaluate the electrostatic fields and potential in free space and in a dielectric media.
CO2: Evaluate configuration energy of an electrostatic system.
CO3: Understand the production of magnetic field due to steady current and calculate magnetic fields using Boit Savart and Amperes law.
CO4: Understand the Maxwell's equation of electrodynamics and its applications to propagation of electromagnetic waves.
CO5: Understand the concept of wave guide and basic concept of plasma and confinement.

Course Contents

Unit 1: Electrostatics and Magnetostatics , Scalar and vector potentials. Multipole expansion of
Scalar potential due to a static charge distribution, Vector potential due to a stationary current distribution. (5 hours)

Unit 2: Maxwell's theory and conservation laws, Maxwell's equations; charge, energy and momentum conservation (Poynting's vector and Maxwell's stress tensor)
Electromagnetic fields and wave solution. **(10 hours)**

Unit 3: Electromagnetic waves, Electromagnetic waves in vacuum and matter, Linear media, Reflection and transmission, Absorption and dispersion, Electromagnetic waves in conductors, frequency dependence of permitivity. (10 hours)

Unit 4: The potential formulation of fields, Gauge transformations, Retarted potentials, Lienard-Wiechert potentials, Radiation from time-dependent sources of charges and currents Inhomogeneous wave equations and their solutions; Radiation from localised sources and multipole expansion in the radiation zone. **(10 hours)**

Unit 5: Relativistic formulation of electrodynamics
Introduction to special relativity: Postulates of Einstein,Geometry of relativity, Lorentz transformations.Relativistic mechanics: Proper time, proper velocity, Kinematics

and dynamics. Four vector notation Electromagnetic field tensor, covariance of Maxwell's equations. **(5 hours)**

Prescribed Textbooks:

1. D. J. Griffiths: Introduction to electrodynamics, Prentice Hall.
2. J. Marion and M. Heald: Classical electromagnetic radiation, Saunders college publishing.
3. W. Panofsky and M. Phillips: Classical electricity and magnetism, Addison Wesley.

Other Resources/Reference books:

1 L. Landau and E. Lifshitz: Classical theory of fields, Pergamon Press.
2 J. Jackson: Classical electrodynamics, Wiley international.
3 M. Schwartz: Classical electromagnetic theory, Dover publication

List of examiners

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Mathematical Physics III

Course Code: PAS7202 **Course Type: Major**
Credit: 4

Course Objectives: Mathematical physics and basic mathematics is an essential tool required for understanding physics. The main objective of the course is to introduce you to some techniques of

- Algebra of complex functions
- Calculus of complex functions a single variable.
- introduce some techniques of integral equations.
- Fourier integrals of functions of single variables.
- Laplace integrals of functions of single variables.

Course Outcomes: The student shall be able to :

CO1: Develop techniques to solve complex variables to solve equations of physics.
CO2: Understand poles and singularities of various functions.
CO3: Solve integrals having complicated functions and singularities.
CO4: Differential equations of functions with a definite boundedness.
CO5: Equations of physics involving boundary conditions of Dirichlet and Neumann type.
CO6: Various equations useful in electrical circuits and wave theory.

Course Contents

Unit 1: Complex numbers and their properties:

Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. **(3 Lectures)**

Unit 2: Analytic functions of complex variables:

Functions, limits, continuity, derivatives.Cauchy- Riemann equations, Analytic functions, Hamonic functions. Elementary functions of complex variables: Exponential, Logarithmic, Trigonometric, Contours, and contour integrals, Cauchy and Cauchy- Goursat theorems, Simply and multiply connected domains, Cauchy integral formula. Liouville and maximum modulus theorems. **(12 Lectures)**

Unit 3: Classification of singularities and Residue Theorem:

Series and their convergence, Taylor’s theorem, Laurent’s theorem. Power series, Classification of singularities, isolated singularities, poles and branch points, order of singularity, branch cuts, Residue theorem, Jordan’s lemma, Evaluation of improper and definite integrals. Indented paths around a branch point, integrals along branch cuts. **(5 Lectures)**

Unit 4: Fourier Integrals:

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric,Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. **(15 Lectures)**

Unit 5: Laplace integrals

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits. **(10 Lectures)**

Text books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley.
3. A first course in Complex Analysis with Applications, Dennis G. Zill and Patrick D. Shanahan, Jones and Bartlett Publisher.
4. Complex Variables, A. S. Fokas & M. J. Ablowitz, 8th Ed., 2011, Cambridge University Press
5. Complex analysis: M. R. Speigel, Schaum, McGraw Hill.

Course Articulation Matrix of PAS7202- Mathematical Physics-III

COs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	3	1	2	3	1
CO2	3	1	2	3	1	3	1	1
CO3	2	1	2	3	2	3	2	1
CO4	3	1	2	3	3	3	1	1
CO5	3	1	2	3	3	3	2	1
CO6	3	1	2	3	3	2	2	1

1: Partially related
2: Moderately related
3: Strongly related

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Course Code: PAS 7204
Credits: 02
Course Name: Vedic Physics
Course Duration: 01 Semester
Class: BSc Vth Semester

Credits Equivalent:

One credit of theory is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.).

Course Aims and Objectives:

Bhārata has a very rich and versatile knowledge system and cultural heritage. The Bhāratīya knowledge system was developed during the Vedic period, the Saraswatī-Sindhu Civilization, the Middle ages and practiced till the conditions of modern times. In this course, a special attention is given to the concepts of physics developed during the Vedic period or later post-Vedic era.

There are some interesting thoughts, which were later developed by the modern scientists.The main objectives of this course are as follows:

- Creating awareness amongst the youths about the scientific concepts developed in the ancient Bharata;
- Understanding the scientific value of the sutras given in the ancient texts;
- Teaching the physics concepts developed by the ancient Vedic scholars;
- Promoting the youths to explore connections and dimensions of physics in Bhāratīya knowledge system.

Learning Outcomes:

It is expected that after completing this course the students would be quite aware of the rich and versatile knowledge system of physics in ancient Bhārata. They will be clear about the following points:

- The great knowledge system was developed during the Vedic period;
- Bhārata was quite developed in all spheres of life, art and science including physics;
- The youths will be self-motivated to do research in the field Vedic physics;
- The students would be able to connect Bhāratīya wisdom into the applied aspect of the modern physics;

It is also expected that after completion of this course the students will have a holistic insight into the understanding of matter and universe.

Attendance Requirements:

A minimum of 75% attendance is a must failing which a student may not be permitted to appear in the examination.

Course Contents Credits: 2(20 Hours)

UNIT-I: Concepts of Vedic Physics **(4 hours)**
Prakriti, Purusha, Mahat, Ahnkara, Rta, Satya, Triguna system, Brahma, Tanmatra, Padaratha, Dravya, and Panch-Mahabhuta.

UNIT-II: Units and Measurements **(4 hours)**
Introduction to measurements of Length, Mass, Time, Solar Day, Week, Month and Year, Yuga and Measure of Temperature.

UNIT-III: Laws of Motion **(4 hours)**
Space, Time, Three Laws of Motion, Types of Motion, Relativity, Concept of Gravity and Mystery of Light.

UNIT-IV: Electricity and Magnetism **(4 hours)**
Types of Electricity, Agastya Battery, Electrolysis, Electroplating, Magnetism, Types of Magnets.

UNIT-V: Vedanta and Modern Physics **(4 hours)**
Concept of Maya and Brahma, Vivekananda interpretation of Vedanta to the West, Conversation with Nicola Tesla, Ultimate Constituent of Matter, Whither Physics Today.

Text books:

1. Textbook on The Knowledge System of Bhārata, Bhag Chand Chauhan, Garuda Prakashan (2023).
2. Physics in Ancient India, Narayan Gopal Dongre and Shankar Gopal Nene; National Book Trust, India (2016).
3. Vedic Physics– Towards Unification of Quantum Mechanics & General Relativity, Keshav Dev Verma; Motilal Banarsidas, Jwāhar Nagar Delhi–110007 (2008).
4. Modern Physics and Vedanta, Swāmī Jitatmananda; Bhārtiya Vidya Bhavan, Mumbai–400007 (2012).

Reference Books:

1. History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata (2014).
2. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).
3. Matter and Mind– The Vaiśeṣika Sūtra of Kaṇāda by Subhash Kak; Mount Meru Publishing, Canada L4Z 0B6 (2016).
4. India's Glorious Scientific Tradition by Suresh Soni; Ocean Books Pvt. Ltd. New Delhi–110002 (2010).