St ALOYSIUS
(DEEMED TO BE UNIVERSITY)
Mangaluru-575003

Re-accredited by NAAC "A++" Grade

Course structure and syllabus of

B.Sc.
PHYSICS

(AS PER NEP 2020 SCHEME)
(2024-2025 batch onwards)

Course Structure – B.Sc. Physics (I Year)
3 Years B.Sc. Course with Physics as one of the major subjects and open Electives according to National Education Policy (2020)

Semester	Discipline Core (DC) Subject	Subject code	Theory hours/ week	Practical hours/ week	Duration of exams (Hours)	Marks and Credits			
						Exam	IA	Total	Credits
I	Mechanics and Properties of Matter	G 501 DC1.1	4		2.5	60	40	100	4
I	Practical-Lab	G 501 DC2.1P		4	4	25	25	50	2
I	Electrical Circuits and Wiring	G 501 OE1.1	3		2.5	60	40	100	3
II	Electromagnetic theory	G 501 DC1.2	4		2.5	60	40	100	4
II	Practical-Lab	G 501 DC2.2P		4	4	25	25	50	2
II	Renewable Energy and Energy Harvesting	G 501 OE1.2	3		2.5	60	40	100	3

Semester - I	
Course Title: **Mechanics and Properties of matter** Course Code: **G 501 DC1.1**	Course Credits: 4
Total Contact Hours: 56 (theory)	Duration of ESA: 2.5 hours Hrs.
Formative Assessment Marks: 60	Summative Assessment Marks: 40

Number of Theory Credits	**Number of lecture hours/semester**	**Number of practical Credits**	**Number of practical hours/semester**
4	**56**	**2**	**52**

Program Outcomes (Pos)

PO-1: Discipline Knowledge: Knowledge of science and ability to apply to relevant areas.

PO-2: Problem solving: Execute a solution process using first principles of science to solve problems related to respective discipline.

PO-3: Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
PO-4: Ethics: Apply the professional ethics and norms in respective discipline.
PO-5: Individual and teamwork: Work effectively as an individual as a team member in a multidisciplinary team.
PO-6: Communication: Communicate effectively with the stake holders, and give and receive clear instructions.

Course Articulation Matrix:
Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (Cos)	**Program Outcomes (POs)**					
	1	**2**	**3**	**4**	**5**	**6**
Co-1: will learn to deduce the dimensions of a physical quantity, will learn about accuracy of measurement and sources of errors, importance of significant figures.	**x**	**x**				**x**
Co-2: will perceive the nuances of motion in one dimension and the ideas connected with it and understand the invariance of physical laws under translations.	**x**	**x**			**x**	
Co-3. understand the basic concepts of elasticity, gain the knowledge about the properties of materials	**x**		**x**	**x**		
Co-4. study the motion of viscous fluids	x					**x**
Co-5. effectively use measuring instruments to quantify observable phenomena	x	**x**				
Co-6. understand the principles and methods used in analyzing motion of particle, verify conservation laws and gain knowledge about the rigid body mechanics.	x			**x**		
Co-7. grasp the ideas of classical theory of relativity, special theory	x	**x**			**x**	**x**

Course articulation matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

Unit 1	14 Hours

Physical World and Measurements

System of units, Dimensions of Physical Quantities. Dimensional formulae, significant figures, order of magnitude, error in measurements, combination of error, error analysis. Problems.

Fundamentals of motion in one and two dimensions

Motion in one-dimension, instantaneous velocity and acceleration, Motion in two-dimensions, derivative of a planar vector of constant magnitude but changing direction, arbitrary planar motion, radial and transverse components of velocity and acceleration, deduction of the results of uniform circular motion. Problems.

Conservation Laws(For single particle system)

Conservation of linear momentum, motion of a rocket, conservation of angular momentum, conservative and non-conservative forces. Work, Law of conservation of energy, conservation of energy in a central force field, illustrations. Vertical oscillations of a light-loaded spring, force constant. Determination of acceleration due to gravity. Problems

Gravitation

Newtonian Law of Universal Gravitation, (gravitational force is a central force), Motion of a particle in a central force field, Kepler's laws of planetary motion, dynamics of satellites in circular orbits. Gravitation potential and gravitational potential energy (Qualitative). Problems

Topics for self-study

Concept of gradient and curl. The relationship of space and time symmetry to conservation laws. The Universal and Fundamental nature of Conservation Laws. The practical value of Conservation laws. Energy transformation in the pole- vault. Uses of springs in vehicles. Internal forces and momentum conservation, Collision. General elastic collision of particle of different mass. Ultracentrifuge. Kepler's 2nd law: the Law of conservation of the Angular momentum of a planet. Ventures into space and the use of satellites. Coding of Kepler's laws.

Suggested Activities

Activity 1	Design innovative experiments to determine the density of liquids using a limited number of items provided and determine the possible sources of error in the measurement.

Activity 2	Design innovative experiments to determine the surface area of objects of irregular shape and determine the possible sources of error in the measurement
Activity 3	Design a throwing weapon based on the conservation of angular momentum.
Activity 4	Play a Hoop rolling game and compete with your peers.

Unit 2	**14 Hours**

Rigid Body mechanics

Rigid Body mechanics: Rotational motion, relation between torque and angular momentum, moment of inertia, radius of gyration, rotational kinetic energy. Theorem of perpendicular axes, Theorem of parallel axes.

Moment of Inertia of: a) rectangular lamina b) circular disc c) ring d) solid cylinder Flywheel, Compound pendulum, Centre of mass, reduced mass. Problems.

Motion in an Inertial frame

Newton's Concept of space, time, and matter. Inertial and non-inertial frames of reference. Galilean transformation equations, Galilean principle of relativity, classical velocity addition theorem. Velocity of light and Galilean transformation, absolute frame of reference. Michelson-Morley experiment, consequences of Michelson-Morley experiment, Null result of Michelson-Morley experiment. Problems.

Theory of Special relativity

Need for a new-theory of relativity. Postulates of theory of special relativity, Lorentz transformation equations. Consequences of Lorentz transformation (a) Relativity of space: Length contraction (b) Relativity of time: Time-dilation.

Explanation of Null-result of Michelson-Morley experiment. Relativity and simultaneity, relativistic addition of velocities, Constancy of the speed of light, variation of mass with velocity, Mass Energy relation: $E = mc^2$, relation between energy and momentum. Photon-Box thought experiment. Problems.

Topics for self-study

Practical uses of Fly wheel and Compound pendulum. Gyroscope. Rolling without slipping. Moments and products of inertia: Principle axes and Euler's equation. Tyrannosaurus Rex and the Physical pendulum. Earth as reference frame, Fixed star as standard unaccelerated frame of reference, Derivation of Lorentz transform

equations. Speed of light in inertial frames in relative motion. The recessional red shift. Life time of π^+ meson. Aberration of light. Doppler effect. Twin paradox Recoilless emission of gamma rays.	
Suggested Activities	
Activity 1	Construct a compound pendulum using any stationary item and measure its moment of inertia.
Activity 2	Design a simple radio telescope.
Activity 3	Find the center of mass of everyday objects.
Activity 4	Launch a bottle rocket.

Unit 3	**14 Hours**
Elasticity Introduction. Hooke's law - Stress-strain diagram, I- section girders (Qualitative), elastic moduli, Poisson's Ratio, Elastic after effect, elastic fatigue. Relation between shear and longitudinal strains. Relation between elastic moduli. Bending moment, uniform and non-uniform bending, Cantilever bending. Torsion- Couple per unit twist. Torsional pendulum. Searle's double bar - Determination of rigidity modulus and moment of inertia - q, η and σ. Advantages. Problems.	
Topics for self-study	
Factors affecting elasticity of various materials, strain hardening and strain softening. Work done in stretching and work done in twisting a wire, twisting couple on a cylinder.	
Suggested Activities	
Activity 1	Stretching of a sock when loaded.
Activity 2	Interaction with a Non- Newtonian Fluid.
Activity 3	Strength of paper and string.
Activity 4	Design and test the limits of a spaghetti bridge.

Unit 4	14 Hours
Surface tension Definition of surface tension. Molecular theory of surface tension. Surface energy, relation between surface tension and surface energy, pressure changes due to surface tension, pressure difference across curved liquid surface, excess pressure inside	

spherical liquid drop, angle of contact, capillarity, surface tension by drop weight method, Interfacial tension. Problems. **Viscosity** Streamline flow, turbulent flow, equation of continuity. Coefficient of viscosity, effect of temperature and pressure. Reynolds number. Poiseuille's formula, terminal velocity, Stoke's formula, determination of coefficient of viscosity by Poiseuille's method, Stoke's method. Problems.

Topics for self-study
Testing the aerodynamics of vehicles using wind tunnel. Role of viscosity in drawing of optical fibers. Physics of Hydrophobic fluids.

Suggested Activities	
Activity 1	Determination of flow properties of oils of different viscosity using Poiseulle's and Stoke's method.
Activity 2	Study of temperature dependence of viscosity of oils.
Activity 3	Magnus effect
Activity 4	Blowing soap bubbles, Floating needle

References Books:

1. Charles Kittel, Walter Knight, Malvin Ruderman and Carl Helmholtz, Mechanics: Vol- 1 of Berkeley Physics course.
2. D S Mathur, Mechanics, (S.Chand, 2007)
3. Hugh D Young and Roger A. Freedman, Sears and Zemansky's University Physics with Modern Physics (Pearson Education Limited, Fourteenth edition., 2016)
4. Robert Resnick, Introduction to Special Relativity, (Wiley)
5. DS Mathur, Elements of Properties of matter, (S. Chand, 2008)
6. Brijlal & Subramanyam, Properties of Matter, (S.Chand, 2014)
7. C L Arora, Physics for Degree students B.Sc. (S. Chand, 2010)
8. J C Upadhyaya, Classical Mechanics, (Himalaya Publishing House, 2016)
9. Paul G Hewit, Conceptual Physics, (Pearson, Tenth edition, 2012)
10. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, (Cengage Learning, 2012)
11. Richard P Feynman, Robert B Leighton, Mathew Sands, The Feynman Lectures on Physics – Vol 1
12. Marcelo Alonso, Edward J. Finn, Physics (Addison – Wesley, 1999)
13. Arthur Beiser, Concepts of Modern Physics, (Tata Mcgraw Hill, 1998)
14. Kenneth S. Krane, Modern Physics, (Wiley, 2012)

15. AP French, Newtonian Mechanics, (Viva Books, 2017)
16. G Aruldhas & P Rajgopal, Modern Physics, (PHI Learning, 2009)

List of Experiments to be performed in the Laboratory:

Sl. No	Experiment
1	Determination of g using bar pendulum (two-hole method and L versus T graphs).
2	Determination of moment of inertia of a Fly Wheel.
3	Determination of rigidity modulus using torsional pendulum.
4	Modulus of rigidity of a rod – Static torsion method
5	Determination of elastic constants of a wire by Searle's method
6	Young's modulus by Koenig's method.
7	Viscosity by Stokes' method
8	Verification of Hooke's law by stretching and determination of Young's Modulus.
9	Determination of surface tension of a liquid by drop weight method.
10	Study of motion of spring and to calculate the spring constant, g and unknown mass.
11	Determination of Young's modulus of a bar by the single cantilever method
12	Determination of Young's modulus of a bar by uniform bending method.
13	Radius of capillary tube by mercury pellet method.
14	Verification of parallel and perpendicular axis theorems.
15	Determination of interfacial tension between two liquids using drop weight method
16	Determination of viscosity of liquids by Poiseuille's method.

(Minimum EIGHT experiments have to be carried out).

Reference Book for Laboratory Experiments:

1. B.L. Flint and H.T. Worsnop, Advanced Practical Physics for students, (Asia Publishing House,1971)
2. Prakash and Ramakrishna, A Text Book of Practical Physics, (Kitab Mahal, 11th edition, 2011)
3. Michael Nelson and Jon M. Ogborn, Advanced level Physics Practicals, (Heinemann Educational Publishers, 4th edition, 1985)
4. D. P. Khandelwal, A Laboratory Manual of Physics for undergraduate classes, (Vani Publications, 1985)
5. CL Arora, BSc Practical Physics, (S. Chand, 2007)

6. D. Chatopadhyay, PC Rakshit, B. Saha, An advanced course in practical physics, (New Central Book Agency, 20

Semester – II

Course Title: **Electromagnetic theory** Course Code**: G 501 DC1.2**	Course Credits: 4
Total Contact Hours: 56 (theory)	Duration of ESA: 2.5 Hrs.
Formative Assessment Marks: 60	Summative Assessment Marks: 40

Number of Theory Credits	**Number of lecture hours/semester**	**Number of practical Credits**	**Number of practical hours/semester**
4	**56**	**2**	**52**

Programme Outcomes

PO - 1 Discipline Knowledge: Knowledge of science and ability to apply to relevant areas.

PO - 2 Problem solving: Execute a solution process using first principles of science to solve problems related to respective discipline.

PO - 3 Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.

PO - 4 Ethics: Apply the professional ethics and norms in respective discipline.

PO - 5 Individual and teamwork: Work effectively as an individual as a team member in a multidisciplinary team.

PO - 6 Communication: Communicate effectively with the stake holders, and give and receive clearinstructions.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	**1**	**2**	**3**	**4**	**5**	**6**
CO-1: Will learn the requires mathematical skills to understand concepts of electricity, magnetism and electromagnetism.	**x**	**x**		**x**	**x**	

CO-2: Will gain the needed knowledge of the fundamental laws of electrostatics and their application in electrostatics	**x**	**x**			**x**	
CO-3: Will acquire the ability to differentiate between the effect of steady and variable currents in electrical circuits.	**x**	**x**		**x**		**x**
CO-4: Will understand the intimate connection between electricity and magnetism	**x**	**x**	**x**		**x**	
CO-5: Using the ideas obtained from variable currents will comprehend the concepts of converting other forms of energy into electrical energy	**x**	**x**			**x**	
CO-6: Will realise that light waves are electromagnetic waves	**X**	**x**	**x**	**x**		**x**

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

Unit 1	**14 Hours**

Scalar and vector fields

Concept of scalar and vector fields, gradient of a scalar function,
vector integration: a) Line integral, line integral independent of a path, conservative force. b) Surface integral c) Volume integralGauss theorem, Stoke's theorem, Dirac delta function, curvilinear co-ordinates. Divergence of a vector, expression for divergence in Cartesian co-ordinates, physical significance of divergence. The curl of a vector function, expression for curl in cartesian co-ordinates, Physical significance of curl. Problems

Electrostatics

Coulomb's law, electric field, charge distributions: discrete and continuous charge distributions, linear, surface and volume charge densities, field lines, flux, and Gauss's law. Applications of Gauss's law, Electric potential, the potential of a localized Charge distribution, potential of an electric monopole, potential of a collection of charges for a continuous charge distribution: linear, surface and volume charge, electric dipole,

potential of an electric dipole and electric Quadrupole, the work done to move a charge, potential energy, expression for potential energy of a point charge. The divergence of E. Problems	
Topics for self-study	
Understanding lightning: Faraday cage, Electrostatic shielding, Thunderstorm Electrification (Physics of lightning)	
Suggested Activities	
Activity 1	Charge a metal sphere by conduction.
Activity 2	Test Gauss law experimentally: Faraday's ice pail.
Activity 3	Construct a lightning arrestor
Activity 4	Design a torsion balance to measure electric force.

Unit 2	**14 Hours**
Conductors and dielectrics in electrostatic field Basic properties of conductors. Conductors in an external electric field, electric field inside a conductor, net charge density: inside a conductor, surface of a conductor. A conductor as an equipotential surface, nature of the electric field just outside a (charged) conductor, induced charges, surface charge and the force on a conductor, di-electric and di-electric polarisation, Capacitors, Capacitance, Capacitance of a parallel plate capacitor- with and without a di-electric medium between the plates, Electric displacement, Gauss's law in the presence of di-electrics, Energy in di-electric systems, energy stored in a parallel plate capacitor. Problems **Electric current** Electric current in conductors. Ohm's law, current density, conductivity, drift of electrons and the origin of resistivity. Variable Currents: Transient response of a circuit containing: a resistor, a capacitor, an inductor, and their series combinations, charging and discharging of a capacitor.	
Topics for self-study	
Applications of capacitors as motor starters, as energy storing devices. Pulsed power and weapons.	
Suggested Activities	
Activity 1	Construct a parallel plate capacitor and find its capacitance with different dielectric material
Activity 2	Fabricate resistors and print their colour codes
Activity 3	Water hydrolysis using a battery and pencil electrodes

Activity 4	Construct an electric stud finder

Unit 3	**14 Hours**
Magnetostatics Magnetic field, magnetic flux, magnetic forces: Lorentz force law, steady currents. The magnetic field of a steady line current : Biot-Savart law, Divergence of magnetic field, Ampere's circuital Law. Problems **Magnetism** Circular current loop as a magnetic dipole, magnetic moment of a circular current loop, the magnetic dipole moment of a revolving electron. Magnetic properties of materials: Magnetization and magnetic intensity, magnetic susceptibility. Magnetic permeability. Diamagnetism, Paramagnetism and ferromagnetism, ferromagnetic domains, B-H curves, hysteresis. Problems **Alternating Current** Alternating Voltage and Alternating current, sinusoidal AC. AC voltage applied to : a resistor, an inductor, a capacitor, RL, RC, LC and LCR circuits, impedance, admittance(Discussions using j operators), sharpness of resonance, quality factor, power in AC circuits. Filters: Low pass, High pass, and Band pass filters. (Qualitative) Problems.	
Topics for self-study	
Absence of magnetic charge. Force on a magnetic dipole in an external field. Magnetic materials used as transformer cores. Filter circuits in sound system.	
Suggested Activities	
Activity 1	Design an electromagnet
Activity 2	Design a simple DC motor
Activity 3	Visualising magnetic field lines
Activity 4	Generate waves on a string using an electromagnet

Unit 4	**14 Hours**
Electromagnetic Induction Faraday's Law. Lenz's Law, Motional emf, self-induction, back emf, forward emf, self-inductance, mutual induction, mutual inductance, eddy currents, energy (stored) in magnetic fields. Problems.	

Electrodynamics

Equation of continuity, Maxwell's field equations in vacuum and matter, displacement current, electromagnetic waves, wave equations, electromagnetic waves in vacuum and matter, radiation pressure, Poynting Vector, conservation of energy, Electromagnetic waves in different frames of reference, Maxwell's equations are valid in all frames of reference.

Topics for self-study	
Working of AC and DC induction motors, BLDC Motors	
Suggested Activities	
Activity 1	Demonstrating the phenomenon of induced current
Activity 2	Charge a metal sphere by induction
Activity 3	Measuring absorbance using colour filters, measuring the speed of light in various optical media, determination of absorption co-efficient of materials at different optical frequencies.
Activity 4	Design a volume gauge

References Books:

1. Hugh D Young and Roger A. Freedman, Sears and Zemansky's University Physics with Modern Physics (Pearson Education Limited, Fourteenth edition., 2016)
2. Halliday, Resnick and Walker, Fundamentals of Physics (Wiley, 6th edition)
3. David J Griffiths, Introduction to Electrodynamics. (Cambridge University Press,2017)
4. R Murugeshan, Electricity and Magnetism, (S Chand & Co, 2019)
5. D C Tayal, Electricity and Magnetism (Himalaya publications,1989)
6. Edward M Purcell, Edward Purcell, Electricity and Magnetism: Berkeley Physics Course - Vol.2, (Tata Mc Graw-Hill Publishing, 2008)
7. Richard P Feynman, Robert B Leighton, Mathew Sands, The Feynman Lectures on Physics – Vol 2, (Narosa Publishing House, 1986)
8. Jewett & Serway, Physics for Scientists and Engineers, (Cengage learning India Pvt Ltd, Delhi, 2012)
9. Marcelo Alonso & Edward J Finn, Physics (International Student Edition), Addison – Wesley, 1999)

List of Experiments to be performed in the Laboratory
(Minimum EIGHT experiments have to be carried out)

1.	Experiments on tracing of electric and magnetic flux lines for standard configuration.
2.	Verification of Maximum Power Transfer Theorem.
3.	Analysis of Phasor diagram.
4.	Determination of capacitance of a condenser using B.G.
5.	Determination of mutual inductance using BG.
6.	Charging and discharging of a capacitor (energy dissipated during charging and time constant measurements.
7.	Series and parallel resonance circuits (LCR circuits).
8.	Impedance of series RC circuits- determination of frequency of AC.
9.	Study the characteristics of a series RC and RL Circuit.
10.	Determination of self-inductance of a coil.
11.	Verification of laws of combination of capacitances and determination of unknown capacitance using de - Sauty bridge.
12.	Determination of BH using Helmholtz double coil galvanometer and potentiometer.
13.	Low pass and high pass filters.
14.	Charge sensitiveness of BG.
15.	Field along the axis of a coil.
16.	Low resistance by potentiometer.

Reference Book for Laboratory Experiments

1. B.L. Flint and H.T. Worsnop, Advanced Practical Physics for students,(Asia Publishing House, 1971)
2. Prakash & Ramakrishna, A Text Book of Practical Physics,(Kitab Mahal, 11th edition, 2011)
3. Michael Nelson and Jon M. Ogborn, Advanced level Physics Practicals, (Heinemann Educational Publishers, 4th edition, 1985)
4. D.P.Khandelwal, A Laboratory Manual of Physics for undergraduate classes, (Vani Publications, 1985)
5. CL Arora, BSc Practical Physics, (S.Chand, 2007)
6. D. Chatopadhyay, PC Rakshit, B.Saha An advanced course in practical physics, (New Central Book Agency, 2002)

Weightage for the formative and summative components

	Summative	Formative
Theory	40 (TS)	60(TF)
Practical's	50(PS)	50(PF)

Outline for the summative component (Internal assessment) of theory paper

Activities	C1	C2	Total marks
Session test	10	10	20
Assignment	10		10
Project		10	10
Total	20	20	40

Outline of the formative component of theory paper

Duration	Type of Question	Total number of questions	Number of Questions to be answered	Marks for each Question	Marks
2.5 Hours	Short Answer type	6 (Minimum of one question from each unit)	4	2	8
	Long answer type	8 (Two questions from each unit)	4 (Answer one question from each unit)	10	40
	Numerical Problems	4	3	4	12
Total Marks					**60**

Scheme of Practical Examination
(Minimum 8 experiments are to be carried out)

Allotment of Marks	
Record Book	8
Formula	3
Diagram/Circuit, Experimental set up	3
Observations & Trials	6

Knowledge about the experiment	3
Result & Accuracy	2
Total	**25**

Regularity	15
Test	10
Total	**25**

Outline for the summative component of practical paper