GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma in Engineering

Level: Diploma

Course / Subject Code : DI01000061

Course / Subject Name : Modern Physics

w. e. f. Academic Year:	2024
Semester:	1or **2**
Category of the Course:	BSC

Prerequisite:	**10+**
Rationale:	Physics is branch of science mainly deals with interaction of energy and matter and considered as the mother of all engineering disciplines. Diploma engineers (technologists) have to deal with various materials while using/ maintaining machines. More over the basic knowledge of principles of physics helps diploma students to lay foundations of core engineering courses. The laws and principles of physics, formulae and knowledge of physical phenomena and physical properties provides a means of estimating the behavior of things before we design and observe them. This course of modern physics has been designed as per program requirements to help students to study the relevant core engineering courses. The complicated derivations have been avoided. This course will help the diploma engineers to use/apply the basic concepts and principles of physics solve well designed engineering problems and comprehend different technology based applications.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.	R/U/A
02	Apply the concepts of electrostatics and capacitance for engineering applications.	R/U/A
03	Use the concept of waves and ultrasonic for various engineering applications.	R/U/A
04	Use the concepts of LASER and Fiber optics for various engineering applications.	R/U/A
05	Use the concepts of semiconductor devices for engineering applications.	R/U/A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

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Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content		No. of Hours	% of Weightage
1.	**Units and Measurements:** 1.a Explain physical quantities and their units. 1.b Convert unit of a given physical quantity in one system of units into another systems of units. 1.c Explain methods to measure the dimensions of given object by using relevant instruments. 1.d Estimate errors in the measurement. 1.e Apply the concept of least count, errors and significant figures to solve the given problems.	3.1 Measurement and units in engineering and science 3.2 Physical quantities: fundamental and derived quantities, 3.3 Systems of units: CGS, MKS and SI, Interco version of units MKS to CGS and vice versa, requirements of standard units and unit systems, 3.4 Principle, construction, working, applications of Vernier calipers and Micrometer screw gauge with their errors. 3.5 Accuracy, precision , error, estimation of errors: absolute error, relative error ,percentage error, rounding off, significant digits	7	19
2.	**Electrostatics:** 2.a Explain Coulomb's inverse square law and apply it on system of charges. 2.b Explain an electric field, electric flux, and electric	2.1 Charge & its unit, quantization of electric charge, conservation of electric charge, charging by friction and induction, Coulomb's law* 2.2 Electric field, Electric field	8	19

	potential and potential difference. 2.c Explain the concepts of a capacitor, capacitance and working of parallel plate capacitor. 2.d Apply the concept of series and parallel combination of capacitors to solve problems in electrical circuits.	Intensity (E=F/q), Electric field lines and its properties* 2.3 Electric flux, Electric potential V=W/q and potential difference* (No mathematical derivation), Electric potential from electric field (V = End) 2.4 Capacitor and its capacitance (C=Q/V), Working of parallel plate capacitor, formula $C = \varepsilon_0 \frac{A^*}{d}$ 2.5 Equivalent capacitance of capacitors in series and in parallel combinations. 2.6 Effect of dielectric material on the capacitance of parallel plate		
3.	**Waves and Ultrasonic:** 3.a Explain wave and wave motion with example. 3.b Explain frequency, periodic time, amplitude, wave length and wave velocity. 3.c Distinguish between longitudinal and transverse waves. 3.d Explain ultrasonic waves, production and their properties 3.e List engineering and medical applications of ultrasonic waves.	3.1 Waves, wave motion and types of waves: longitudinal and transverse waves 3.2 Frequency, periodic time, amplitude, wave length and wave velocity and their relationship 3.3 Ultrasonic : Definitions of Audible sound, Infrasonic sound, Ultrasonic Sound, 3.4 Production of ultrasonic Methods: Piezo electric & Magnetostriction (Principle, Diagram, Construction, Working, Advantages and Disadvantages),properties of ultrasonic, 3.5 SONAR and NDT (flaw detection) as an applications of ultrasonic. 3.6 List applications of ultrasonic waves in the field	9	14

		of engineering and medical		
4.	**LASER and Fiber optics:** 4.a Apply Snell's law to calculate refractive index of given medium 4.b Explain the phenomenon of total internal reflection 4.c Explain LASER and it's in engineering and medical applications. 4.d Explain construction and working principle of step index and graded index optical fibers. 4.e Comprehend engineering and medical applications of optical fiber.	4.1 Refraction, Refractive index , Absolute Refractive index, Relative Refractive index and Snell's law 4.2 Total internal reflection, critical angle and necessary conditions for total internal reflection 4.3 Application of total internal reflection in optical fiber 4.4 LASER*: characteristics of LASER, differences between LASER and ordinary light 4.5 List applications of LASER in engineering and medical field 4.6 Structure of Optical fiber, light propagation through optical fiber, acceptance angle and numerical aperture*(only formula) 4.7 Step index* and graded index* 4.8 List applications of optical fiber in engineering and medical field 4.9 Advantages of optical fiber over coaxial cable	9	22
5.	**Semiconductor devices:** 5.a Apply the concept of energy band gap to classify Conductor, Semiconductor and insulator 5.b Apply the concept impurity doping to the semiconductors 5.c Explain the P-N junction	5.1 Conductor, Semiconductor and insulator in reference to Energy band gap* 5.2 Intrinsic Semiconductors 5.3 Extrinsic Semiconductors: P & N type, electric conduction in N-type and P-type semiconductor, temperature dependence of	12	26

	diode and its characteristics 5.d Apply the concept of PN junction diode to the rectifiers. 5.e Apply the concept of reverse bias of Zener diode to the voltage regulator. 5.f Explain LED, Photo Diode and Solar cell 5.g Explain the logic Gates and Boolean algebra.	conductivity of semiconductor. 5.4 P -N Junction formation, Depletion Region 5.5 P-N Junction diode, forward and reverse bias characteristics 5.6 Application of Junction diode as rectifier: half wave, Full wave and Bridge rectifier 5.7 Zener diode as a voltage regulator 5.8 Principle, Construction, working and applications of LED, Photo diode, Solar cell* (FF) 5.9 Logic gates and its types: AND, OR, NOT, NAND, NOR, XOR and XNOR, De Morgan's first and second law, Boolean Algebra and Truth table		
	Total		**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
26	**37**	**37**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Physics by NCERT, ISBN 81-7450-631-4
2. SEARS and ZEMANSKY'S University Physics with modern Physics by Hugh D. Young & Roger A. Freedman, Person Publication 14th Edition, USA, ISBN 10: 0-321-97361-5; ISBN 13: 978-0-321-97361-0, (Student edition)

3. Physics for Scientists and Engineers with Modern Physics by John W. Jewett & Raymond A. Serway, CENGAGE Learning, 2010, Boston, 10th edition, ISBN-10: 1337553298
4. University Physics (Volume I, II & III) (Open- source Material) by William Moebs, Samuel J. Ling & Jeff Sanny, OPENSTAX, 2016, Houston, Texas ISBN-13: 1-947172-20-4
5. PHYSICS for SCIENTISTS & ENGINEERS with Modern Physics by Douglas C. Giancoli, Pearson, 2015, 7th edition, Delhi, ISBN-13: 978-1292057125
6. Fundamentals of Physics by David Halliday, Robert Greensick, Jearl Walker, 12th Edition, Willey Publication, ISBN – 1119801141
7. The Physics in our Daily Lives by Umme Ammara, 1st edition, ISBN-10: 9388435214, ISBN-13: 978-9388435215
8. Physics in Daily Life With illustrations by JO HERMANS With illustrations by Wiebke Drenckhan, EDP Science Publication, 2012, ISBN: 978-2-7598-0705-5
9. Introductory Physics: Building Models to Describe Our World (Open-Source Material) by Ryan Martin, Emma Neary, Joshua Rinaldo & Olivia Woodman, Creative Commons license, 2019, GitHub
10. Concept of Physics (volume I & II) by H.C. Verma, Bharati Bhavan Publishers, 2017, 1st edition, New Delhi, ISSBN-13: 978- 8177091878
11. Introduction to Fiber optics by Ajoy Ghatak & K. Thyagarajan, Cambridge University Press India Pvt. Ltd., New Delhi, ISBN: 9780521577854
12. Semiconductor Physics and devices – Basic Principles by Donald A. Neamen, 4th edition, McGraw Hill, SBN 978-0-07-352958-5
13. The Feynman Lectures on Physics - Vol. I, II & III, by Feynman Richard P., Pearson Education, 2012, ISBN-10 : 9332580952, ISBN-13 : 978-9332580954
14. Conceptual Physics by Paul G. Hewitt, Pearson Education, 12 edition, ISBN-10: 9352861779 ISBN-13: 978-9352861774.

(b) Open source software and website:

1. https://phet.colorado.edu/
2. https://www.iitm.ac.in/academics/learning-for-all/national-programme
3. https://www.khanacademy.org/
4. https://vlab.amrita.edu/
5. https://www.amrita.edu/project/online-labs/
6. https://www.vlab.co.in/
7. https://iitb.vlabs.co.in/
8. https://vlab.amrita.edu/
9. https://praxilabs.com/
10. https://www.compadre.org/osp/
11. https://www.instructables.com/
12. https://www.labster.com/simulation-courses
13. https://lab4u.co/en/home/
14. https://www.labxchange.org/

15. https://virtuallabs.merlot.org/vl_physics.html
16. https://www.ncbionetwork.org/iet/labsafety/
17. https://www.thephysicsaviary.com/Physics/Programs/Labs/find.php
18. https://sites.google.com/view/thephysicsaviary/all-labs?authuser=0
19. https://sciencelessonsthatrock.com/secondary-science-virtual-labs-html/
20. https://www.mheducation.com/highered/virtual-labs.html#virtuallabs
21. https://roqed.com/product-physics/

Android/iOS Applications:

1. Physics Lab: https://play.google.com/store/apps/details?id=com.civitas.quantumphysics&pli=1
2. Lab4u: https://play.google.com/store/apps/details?id=com.lab4u.lab4physics
3. Phet: https://play.google.com/store/apps/details?id=edu.colorado.phet.androidApp
4. Every Circuit: https://play.google.com/store/apps/details?id=com.everycircuit.free
5. Logic Circuit Simulator Pro: https://play.google.com/store/apps/details?id=com.duracodefactory.logiccircuitsimulatorpro
6. Micrometer screw: https://play.google.com/store/apps/details?id=com.priantos.micrometersimulator
7. Vernier Callipers: https://play.google.com/store/apps/details?id=com.vernier.tavifom

Suggested Course Practical List: If any

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs.
1	Use Vernier calipers to measure the dimensions of a given object.	I	02
2	Use micrometer screw gauge to measure diameter of a given wire and determine volume of a given metallic piece.	I	02
3	Study the series-parallel connections of resistors.	II	02
4	Study parallel plate capacitor and its series-parallel combinations.	II	02
5	Use ultrasonic interferometer to determine the velocity of ultrasonic waves in different liquids.	III	02
6	Use electrical vibrator to find the frequency of AC mains.	III	02
7	Determine the refractive index of given semi-circular glass block using TIR.	IV	02
8	Determine the value of the numerical aperture (NA) of given optical fiber.	IV	02
9	Study the I – V characteristics of PN junction diode.	V	02
10	Use PN junction diode to determine the energy band gap of a semiconductor.	V	02

11	Determine the breakdown voltage of Zener diode in reverse bias.	V	02
12	Use PN junction diode as a half wave, full wave and Bridge rectifier.	V	02
13	Determine the Fill factor (FF) of given solar cell.	V	02
14	Verify the truth table of logic gates OR, AND, NOT, NAND, NOR, XOR and XNOR gates.	V	02

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Vernier caliper analog - least count- 0.02 mm	1
2	Micrometer screw gauge analog (0-25 mm) – least count 0.01mm	2
3	Resistors, Digital Multimeter, DC Ameter, Power supply (0-5 V DC)	3
4	Parallel plate capacitor (variable plate distance and area), Digital capacitance meter, capacitors of various capacities	4
5	Ultrasonic interferometer - gold plated quartz crystal, operating voltage - 220 Volt, display - analog, frequency - 2MHz with position control	5
6	Electrical Vibrator, uniform cord, weight pan, weight box, pulley, meter scale, sensitive balance	6
7	Semi-circular glass block, Laser light pen	7
8	Numerical aperture apparatus with optical fiber & LASER source.	8
9	PN Junction Diode Characteristics Apparatus	9
10	Energy band gap apparatus	10
11	Zener Diode Characteristics Apparatus	11
12	Diode Rectifier kit	12
13	Solar Cell kit	13
14	Logic Gate Trainer kit	14

Suggested Project List:

a) Measurement: Measure physical quantities using smart phone applications.
b) Arduino: Physical quantities such as Voltage, Magnetic field, Temperature, Light, Sound and distance can be measured with the help of low-cost sensors and Arduino.

c) Prepare proto type Vernier calipers of given least count.
d) Unit Systems: Charts/Models of conversion from MKS to CGS and vice versa.
e) Electroscope: To detect presence of static charges, to determine the nature of electric charges, to compare the magnitudes of two different charges.
f) Coulomb's Torsion Balance: Conceptualize the relation of electrostatic force with distance and charge.
g) Electrostatic pom-pom set: A cheap demonstrator for electrostatic force made up of a metal rod mounted on an insulated plastic stand carries a round metal plate at its top and a fringe of colored nylon cords. These can even be used as a make shift charge sensor as long as you know the charge on one of your objects.
h) Paper Capacitor: Aluminum foil and tissue paper can be used to make cylindrical capacitor.
i) Variable capacitor: Two copper cylinders and plastic pipe can be used to make variable capacitor.
j) Dry Field Mapping Kit: Easily visualize electric fields generated by electrodes of your own design. Simply draw your electrodes, hook up a battery to generate the electric fields, and use a Multimeter or voltmeter to map out the equipotential surfaces.
k) Domino model: A model showing fundamental idea about wave and how it travels.
l) Shive Wave Machine: For demonstration of Frequency, Wavelength, wave velocity.
m) Wave Generator: model for generating transverse wave.
n) Powell's Wave machine: For demonstration of Frequency, Wavelength, wave velocity
o) Chladni's Plates: A model which provides a nice way to visualize the effects of vibrations on mechanical surfaces like flat sheet of metal mounted on a central stalk to a sturdy base. When the plate is made to vibrate, set up form complex but symmetrical patterns over its surface.
p) Slinky: A nice way to demonstrate transverse and longitudinal waves.
q) Mirascope: to demonstrate the Holographic effect using simple concept of reflection.
r) Paraxial Ray Optics Cloaking: A combination of four converging lenses creates an illusional 3D cloaking effect.
s) Hartle's Optical Disk: To demonstrate refraction and total internal reflection using LASER and 360° protractor.
t) Sugar and bending of light: prepare a solution of sugar and water to demonstrate bending of light (using semiconductor LASER).
u) Fiber optics: prepare an optical fiber cable using transparent flexible plastic tube, laser and water to demonstrate the property of optical fiber cable.
v) Semiconductor: Prepare the logic gate circuits.

APPENDIX

a. Application level based numerical should be given at the time of instruction and assessment in each unit.
b. 'Definition' of units of fundamental physical quantities are only for information and not to be

asked in examination in any form.

c. Students can be introduced to system of units other than SI, MKS, CGS unit systems but not to be asked in examinations.
d. Only scalar treatment is to be given to Coulomb's law. (No Vector Treatment)
e. Properties of electric field lines are constrained to only dipole (two charge) system of charges and must not be asked in exam.
f. Concept of Electric potential and potential difference requires no mathematical derivation. It can be explained with formula, units and applications.
g. For LASER, Principle, Construction and working must not be asked in exam..
h. For optical fiber, mathematical derivation of Numerical aperture and acceptance angle must not be asked in exam.
i. Types of Optical Fiber: Step index and Graded index (Only Single mode transmission)
j. Energy band Gap theory can be introduced only as tool to classify the conductors, semiconductors and insulators with the help of conduction and valance band. Energy band theory must not be asked in exams. Hybridization of orbitals must not be introduced.
k. For solar cell, the derivation of Fill factor is not required.
l. For logic gates, Karnaugh maps must not be asked in exam.

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