0GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

I &II – Semester

Course Title: **Physics**

(Course Code: 4300005)

Diploma programme in which this course is offered	Semester in which offered
Biomedical Engineering, Electronics and Communication Engineering, Instrumentation & Control, Printing Technology	First
Computer Engineering, Electrical Engineering, Information Technology, Power Electronics	Second

1. 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 engineering physics has been designed as per program requirements to help students to study the relevant core engineering courses. The complicated derivations have been avoided and micro projects are introduced. 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.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use principles of physics to solve broadly defined engineering problems.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.
b) Apply the concepts of electrostatics and capacitance for engineering applications.
c) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.
d) Use the concept of waves and sound waves for various engineering applications involving wave dynamics.
e) Use the concepts of LASER and Fiber optics for various engineering applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
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	Use a parallel plate capacitor to investigate the dependence of capacitance of a parallel plate capacitor on various factors.	II	02*
4	Use principles of series and parallel combinations of capacitance in solving various electrical circuits.	II	02
5	Use different types of thermometers to measure temperature of a hot bath and convert it into different scales.	III	02*
6	Use Searle's method to measure the coefficient of thermal conductivity of a given metallic rod.	III	02
7	Use Searle's method to determine the coefficient of linear expansion of the given metallic rod.	III	02
8	Use sonometer to find the frequency of given tuning fork.	IV	02*
9	Use resonance tube to determine velocity of sound in air at room temperature.	IV	02
10	Determine the refractive index of given semi-circular glass block using TIR.	V	02*
11	Determine refractive index of liquid by concave mirror.	V	02
12	Determine the value of the numerical aperture (NA) of given optical fibre.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
13	Use ultrasonic interferometer to determine the velocity of ultrasonic waves in different liquids.	V	02
14	Use electrical vibrator to find the frequency of AC mains.	V	02
	Total		28

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

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	Parallel plate capacitor (variable plate distance and area)	3
4	Digital capacitance meter	3, 4
5	Hot water bath	5
6	Mercury filled glass thermometer 0-110 °C, Mercury filled glass thermometer 0-250 °C., digital food thermometer, bimetallic thermometer.	5

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
7	Clamp with stand.	5
8	Searle's thermal conductivity apparatus - made up of pure copper and outer boxes are of wooden polished material, 04 thermometers, steam boiler, measuring cylinder, constant water level tank, pinch cork, stop watch (1/100 s), rubber tube.	6
9	Linear expansion apparatus, steam generator, rubber tubing, metal rods of aluminum, iron, copper, brass, and steel.	7
10	A Sonometer with a tuning fork set and two sharp edge wedges and a weight box.	8
11	Resonance tube apparatus, tuning forks of different frequencies, rubber pad, thermometer	9
12	Semi-circular glass block	10
13	Laser light pen	10
14	A concave mirror, stand, pointer	11
15	Complete set up to determine numerical aperture (NA) of optical fiber with LASER source.	12
16	Hot plate (1800 W)	6, 7
17	Ultrasonic interferometer - gold plated quartz crystal, operating voltage - 220 Volt, display - analog, frequency - 2MHz with position control	13
18	Electrical Vibrator, uniform cord, weight pan, weight box, pulley, meter scale, sensitive balance	14

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Follow safe practices
d) Handle equipment carefully
e) Practice energy saving processes.
f) Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I: **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.	1.1 Measurement and units in engineering and science 1.2 Physical quantities; fundamental and derived quantities, 1.3 Systems of units: CGS, MKS and SI, definition of units (only for information and not to be asked in examination), Interconversion of units MKS to CGS and vice versa, requirements of standard unit, 1.4 Vernier caliper, Micrometer screw gauge 1.5 Accuracy, precision and error, estimation of errors - absolute error, relative error and percentage error, error propagation, significant figures
Unit – II: **Electrostatics**	2.a Explain Coulomb's inverse square law and apply it on system of charges. 2.b Explain an electric field, electric flux, electric 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.	2.1 Charge, unit of charge, Coulomb's law 2.2 Electric field, electric field lines and its properties 2.3 Electric flux, electric potential and potential difference (point charge only) 2.4 Capacitor and its capacitance. $(C = Q/V)$, Working of the parallel capacitor, formula $\left(C = \varepsilon_0 \frac{A}{d}\right)$, types of capacitors: Plane, spherical & cylindrical (Information only) 2.5 Equivalent capacitance of capacitors in series and in parallel combinations. 2.6 Effect of dielectric material on the capacitance of parallel plate capacitor. (No Derivation)
Unit – III: **Heat and**	3.a Distinguish between Heat and Temperature. 3.b Explain modes of heat	3.1 Heat and Temperature 3.2 Modes of Heat transfer: Conduction, Convection and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Thermometry	transmission. 3.c Explain various temperature scales and conversion between them. 3.d Explain Heat Capacity and Specific Heat. 3.e Explain types of thermometers and their uses. 3.f Apply the concept of co-efficient of thermal conductivity to solve engineering problems. 3.g Explain expansion in solids and coefficient of linear expansions in solids.	Radiation 3.3 Temperature measurement scales: Kelvin, Celsius and Fahrenheit and interconversion between them 3.4 Heat Capacity and Specific Heat 3.5 Types of thermometers (Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer) and their uses 3.6 Coefficient of thermal conductivity and its engineering applications 3.7 Expansion of solids, coefficient of linear expansion
Unit – IV: **Wave motion and its applications**	4.a Explain wave and wave motion with example. 4.b Distinguish between longitudinal and transverse waves. 4.c Explain frequency, periodic time, amplitude, wave length and wave velocity. 4.d Explain sound waves, light waves and their properties 4.e Explain amplitude, phase, phase difference and wave equation. 4.f Explain principle of superposition of waves, interference and beat formation. 4.g Explain ultrasonic waves, production and their properties. 4.h Explain engineering and medical applications of ultrasonic waves.	4.1 Waves, wave motion, and types of waves: longitudinal and transverse waves 4.2 Frequency, periodic time, amplitude, wave length and wave velocity and their relationship 4.3 Properties of sound and light waves 4.4 phase, phase difference and various terms of wave equation ($y = Asin(\omega t + \varphi)$) [NO equations of velocity and acceleration] 4.5 Superposition of waves, Interference: constructive and destructive interference , condition for stationary interference pattern, beat formation 4.6 Ultrasonic waves, production of ultrasonic waves – magnetostriction and piezoelectric method, their properties, applications of ultrasonic waves in the field of engineering and medical
Unit – V: **Optics and Modern Physics**	5.a Apply Snell's law to calculate refractive index of given medium 5.b Explain the phenomenon of total internal reflection 5.c Explain LASER and it's in	5.1 Refraction, refractive index and Snell's law 5.2 Total internal reflection, critical angle and necessary conditions for total internal reflection 5.3 Application of total internal

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	engineering and medical applications. 5.d Explain construction and working principle of step index and graded index optical fibers. 5.e Comprehend engineering and medical applications of optical fiber.	reflection in optical fire 5.4 LASER, characteristics of LASER, differences between LASER and ordinary light 5.5 Applications of LASER in engineering and medical field. 5.6 Optical fiber and light propagation through optical fiber, acceptance angle and numerical aperture 5.7 Step index and graded index 5.8 Applications of optical fiber in engineering and medical. 5.9 Advantages of optical fiber over coaxial cable.

***Note**: The UOs need to be formulated at the 'Applcation Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

- 'Definition of units' is only for information and not to be asked in examination.
- Students can be introduced to system of units other than SI, MKS, CGS unit systems.
- Application level based numerical should be given at the time of instruction and assessment in each unit.
- Only scalar treatment is to be given to Coulomb's law (No Vector Treatment)
- Concept of electric potential and potential difference is constrained to Point charge only.
- Types of capacitors: parallel plate, spherical & cylindrical are for information point of view only.
- Types of Optical Fiber: Step index and Graded index (Only Single mode)

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Units and Measurements	8	4	4	5	13
II	Electrostatics	8	4	4	5	13
III	Heat and Thermometry	8	2	5	6	13
IV	Wave motion and its applications	9	4	6	5	15
V	Optics and Modern Physics	9	4	7	5	16
Total		42	**18**	**26**	**26**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at*

different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare small reports of about 5 pages for each activity. They should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare model to demonstrate concepts of physics
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Measure physical quantities using smart phone.
e) Prepare showcase portfolios.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability using the knowledge of this course

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course.The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Measurement: Measure physical quantities using smart phone applications.
b) Prepare proto type Vernier calipers of given least count.
c) 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.
d) Paper Capacitor: Aluminum foil and tissue paper can be used to make cylindrical capacitor.
e) Variable capacitor: Two copper cylinders and plastic pipe can be used to make variable capacitor.
f) Sugar and bending of light: prepare a solution of sugar and water to demonstrate bending of light (using semiconductor LASER).
g) Fiber optics: prepare an optical fiber cable using transparent flexible plastic tube, laser and water to demonstrate the property of optical fiber cable.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	SEARS and ZEMANSKY'S University Physics with modern Physics	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)
2	Physics for Scientists and Engineers with Modern Physics	John W. Jewett & Raymond A. Serway	CENGAGE Learning, 2010, Boston, 10th edition, ISBN-10: 1337553298
3	University Physics (Volume I, II & III) (Open-source Material)	William Moebs, Samuel J. Ling & Jeff Sanny	OPENSTAX, 2016, Houston, Texas ISBN-13: 1-947172-20-4
4	PHYSICS for SCIENTISTS & ENGINEERS with Modern Physics	Douglas C. Giancoli	Pearson, 2015, 7th edition, Delhi, ISBN-13: 978-1292057125
5	Principles of Physics	Jearl Ealker, David Halliday, Robert Resnick	Wiley India, 2015, Navi Mumbai 10th edition, ISBN-13: 978-8126552566
6	Physics in Daily Life With illustrations	L.J.F. Hermans & Wiebke Drenckhan	EDP Sciences, 2012, France ISBN: 978-2-7598-0705-5
7	Introductory Physics: Building Models to Describe Our World (Open-Source Material)	Ryan Martin, Emma Neary, Joshua Rinaldo & Olivia Woodman	Creative Commons license, 2019, GitHub
8	Concept of Physics (volume I & II)	H.C. Verma	Bharati Bhavan Publishers, 2017, 1st edition, New Delhi, ISSBN-13: 978-8177091878

S. No.	Title of Book	Author	Publication with place, year and ISBN
9	Introduction to Fiber optics	Ajoy Ghatak & K. Thyagarajan	Cambridge University Press India Pvt. Ltd., New Delhi, ISBN: 9780521577854

14. SUGGESTED LEARNING WEBSITES

a) www.williamson-labs.com
b) www.cadsoft.io
c) www.nptel.iitm.ac.in
d) www.khanacademy
e) www.olabs.edu.in
f) www.vlab.co.in
g) www.vlabs.iitb.ac.in
h) www.vlab.amrita.edu
i) www.praxilabs.com
j) www.compadre.org/osp/
k) www.datasheetcafe.com

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Physics (Course Code: 4300005)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency ***Use Principles of Physics to solve broadly defined engineering problems*.**	3	1	1	2	1	-	1
Course Outcomes CO a) Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.	3	1	1	2	-	-	1
CO b) Apply the concepts of electrostatics and capacitance for engineering applications	3	1	1	2	-	-	1
CO c) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.	3	1	1	2	1	-	1
CO d) Use the concept of waves and sound waves for various engineering applications involving wave -dynamics.	3	1	1	2	1	-	1
CO e) Use the concepts of LASER and Fiber optics for various engineering applications.	3	-	1	2	1	-	1

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for no correlation with CO and PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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