GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

I &II – Semester

Course Title: **Applied Physics**

(Course Code: C4300004)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering, Ceramic Technology, Civil Engineering, Environment Engineering, Fabrication Engineering, Mechanical Engineering, Mechatronics Engineering, Mining Engineering, Chemical Engineering, Textile Manufacturing Technology, Marine Engineering, Printing Technology	First
Metallurgy Engineering, Plastic Engineering, Textile Processing Technology	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 applied 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) Solve various engineering problems by the concept of linear momentum and circular motion.
c) Apply basic concepts of properties of matter in solving engineering problems efficiently.
d) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.

e) Use the concept of waves and sound waves for various acoustics and other engineering applications involving wave dynamics.

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) 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 caliper 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 Hooke's law to determine force constant of a given spring.	III	02
4	Use Searle's method to determine Youngs modulus of the given metallic wire.	III	02*
5	Use capillary rise method and travelling microscope to determine the surface tension of a given liquid.	III	02*
6	Use Stokes' law to determine the viscosity of a given liquid (e.g., glycerin).	III	02
7	Use different types of thermometers to measure temperature of a hot bath and convert it into different scales.	IV	02*
8	Use Searle's method to measure the coefficient of thermal conductivity of a given metallic rod.	IV	02
9	Use Searle's method to determine the coefficient of linear expansion of the given metallic rod.	IV	02
10	Determine acceleration due to gravity 'g' by using simple pendulum.	V	02
11	Use sonometer to find the frequency of given tuning fork.	V	02
12	Use resonance tube to determine velocity of sound in air at room temperature.	V	02*
13	Use ultrasonic interferometer to determine the velocity of ultrasonic waves in different liquids.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
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.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Vernier caliper analog - least count 0.02 mm	1, 4
2	Micrometer screw gauge analog (0-25 mm) – least count 0.01mm	2, 4
3	Rigid support, spring, 20 g hanger, six 20 g slotted weight, fine pointer, vertical wooden scale, hook	3
4	Young modulus apparatus (Searle's pattern): two aluminum graduated scales mounted on pillar supports, two pointers with clamps for attaching to specimen, brass and steel rod, cord and hook for carrying weight.	4
5	Travelling microscope - high magnification power, stainless steel scale with Vernier least count - 0.02 mm for taking the recordings, horizontal scale graduated up to 20 cm, vertical scale graduated up to 15 cm.	5
6	One meter high and 5 cm broad glass cylindrical jar with millimeter graduations along its height, steel balls	6

S. No.	Equipment Name with Broad Specifications	PrO. No.
7	Hot water bath	7
8	Mercury filled glass thermometer 0-110 °C, Mercury filled glass thermometer 0-250 °C. digital food thermometer, bimetallic thermometer.	7
9	Searle's thermal conductivity apparatus - made up of pure copper and outer boxes are of wooden polished material, 04 thermometers, steam generator, measuring cylinder, constant water level tank, pinch cork, rubber tube	8
10	Linear expansion apparatus, steam generator, rubber tubing, metal rods of aluminum, iron, copper, brass, and steel.	9
11	A bob	10
12	A sonometer with set of tuning forks, two sharp edge wedges and a weight box.	11
13	Resonance tube apparatus, tuning forks of different frequencies, rubber pad, thermometer	12
14	Stop watch (least count = 1/100 s)	8, 10
15	Clamp with stand.	5
16	0.5 kg hanger, 0.5 kg slotted weight.	4
17	Hot plate (1800 W)	8, 9
18	Ultrasonic interferometer - gold plated quartz crystal, operating voltage - 220 Volt, display - analog, frequency - 2MHz with position control	13
19	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 method 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 **Circular motion**	2.a Apply the concept of linear momentum and its conservation to explain recoil of gun and rockets propulsion. 2.b Apply the concept of centripetal and centrifugal forces to solve given engineering problems.	2.1 Force, momentum, law of conservation of linear momentum, its applications such as recoil of gun, rocket propulsion, impulse and its applications 2.2 Circular motion, angular displacement, angular velocity, angular acceleration and their interrelation 2.3 Centripetal and centrifugal forces examples: banking of roads and bending of cyclist
Unit– III **General Properties of Matter**	3.a Explain the Hooke's law, stress-strain curve and moduli of elasticity. 3.b Explain surface tension, cohesive and adhesive forces. 3.c Apply Ascent formula to determine surface tension of	**3.1 Elasticity** 3.1.1 Deforming and restoring Force 3.1.2 Stress-Strain with their types 3.1.3 Hooke's law 3.1.4 Moduli of elasticity, Young's modulus, Bulk modulus, Shear modulus

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	the given liquid. 3.d Explain viscosity, coefficient of viscosity, terminal velocity and Stokes' law. 3.e Apply the concept of viscosity in explaining hydraulic system. 3.f Explain types of fluid motion and Reynold number	3.1.5 Stress-Strain curve **3.2 Surface Tension** 3.2.1 Surface tension; concept and units 3.2.2 Cohesive and adhesive forces 3.2.3 Molecular range and sphere of Influence 3.2.4 Laplace's molecular theory 3.2.5 Angle of contact, Ascent Formula (No derivation) 3.2.6 Surface energy 3.2.7 Applications of surface tension 3.2.8 Effect of temperature and impurity on surface tension **3.3 Viscosity** 3.3.1 Viscosity and its SI units 3.3.2 Newton's law of Viscosity 3.3.3 Viscous force, velocity gradient and coefficient of viscosity and its SI units, free fall of an object through viscous medium and terminal velocity 3.3.4 Types of fluid motion, stream line and turbulent flow, critical velocity, Reynold's number 3.3.5 Stokes' law 3.3.6 Effect of temperature on viscosity 3.3.7 Applications of viscosity in hydraulic systems
Unit– IV **Heat and Thermometry**	4.a Distinguish between heat and temperature. 4.b Explain modes of heat transmission. 4.c Explain various temperature scales and conversion between them. 4.d Explain heat capacity and specific heat. 4.e Explain types of thermometers and their uses. 4.f Apply the concept of coefficient of thermal conductivity to solve	4.1 Heat and temperature 4.2 Modes of Heat transfer: Conduction, Convection and Radiation 4.3 Temperature measurement scales: Kelvin, Celsius and Fahrenheit and interconversion between them 4.4 Heat capacity and specific heat 4.5 Types of thermometers: Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer and their uses.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	Engineering problems. 4.g Explain expansion in solids and coefficient of linear expansions in solids.	4.6 Coefficient of thermal conductivity and its engineering applications. 4.7 Expansion of solids, coefficient of linear expansion
Unit– V **Wave motion and its applications**	5.a Explain wave and wave motion with example. 5.b Distinguish between longitudinal and transverse waves. 5.c Explain frequency, periodic time, amplitude, wave length and wave velocity 5.d Explain sound waves, light waves and their properties 5.e Explain amplitude, phase, phase difference and wave equation. 5.f Explain principle of superposition of waves, interference and beat formation. 5.g Explain reverberation, reverberation time, echo, noise and coefficient of absorption of sound. 5.h Apply Sabine's formula to calculate reverberation time. 5.i Explain ultrasonic waves and their properties. 5.j Explain engineering and medical applications of ultrasonic waves.	5.1 Waves, wave motion, and types of waves: longitudinal and transverse waves 5.2 Frequency, periodic time, amplitude, wave length and wave velocity and their relationship 5.3 Properties of sound and light waves. 5.4 Phase, phase difference and various terms of wave equation $(y = Asin(\omega t + \varphi))$ [derivation of equations of velocity and acceleration is not required] 5.5 Superposition of waves, Interference: constructive and destructive interference ,conditions for stationary interference pattern, beat formation 5.6 Reverberation, reverberation time, echo, noise and coefficient of absorption of sound 5.7 Sabine's formula (derivation not required) for reverberation time, methods to control reverberation time and their applications 5.8 Ultrasonic waves and their properties, applications of ultrasonic waves in the field of engineering and medical

***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 instructions and assessment in each unit
- Derivation of Ascent formula is not required only statement and related terms have to be explained at the time of instruction and assessment.

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	08	4	4	5	13
II	Circular motion	06	3	3	4	10
III	General Properties of Matter	12	4	7	9	20
IV	Heat and Thermometry	08	3	4	6	13
V	Wave motion and its applications	08	4	5	5	14
Total		**42**	**18**	**23**	**29**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist students 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-projects 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) Collect wires and sheets of different gauges from market and estimate errors in measurements using analog and digital Vernier Calipers.
d) Elasticity: Prepare working model to demonstrate the stress – strain behavior of different wires of different thickness and material.
e) Viscosity: Collect 3 to 5 liquids and prepare a working model to differentiate liquids based on viscosity and demonstrate their applications.
f) Motion: Prepare model of ball rolling down on inclined plane to demonstrate the conservation of energy and motion of an object in inclined plane.
g) Waves in string**:** standing waves in string using woofer loudspeaker.
h) Noise Level measurement**:** measure noise Level at different places in campus.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Text Book of Physics for Class XI (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN 81-7450-508-3(Part-I) & ISBN 81-7450-566-0 (Part-II)
2	Text Book of Physics for Class XII (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN 81-7450-631-4 (Part-I) & ISBN 81-7450-671-3 (Part II)
3	Applied Physics, Vol. I and Vol. II	TTTI Publications	Tata McGraw Hill, Delhi, 2019
4	Concepts in Physics Vol. I and Vol. II	H C Verma	Bharti Bhawan Ltd. New Delhi, 2019 ISBN-13: 978-8177091878 ISBN-13: 978-8177092325
5	Engineering Physics	DK Bhattacharya	Oxford University Press, New

S. No.	Title of Book	Author	Publication with place, year and ISBN
		& Poonam Tandon	Delhi, ISBN:9781680158687
6	B. Sc. Practical Physics	C. L. Arora	S. Chand Publication, New Delhi, ISBN: 9788121909099
7	A Textbook of Engineering Physics	M.N. Avadhanulu, P.G. Kshirsagar, TVS Arun Murthy	S. Chand Publication, 11th edition ,New Delhi, 2018 ISBN-13: 978-9352833993
8	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)
9	Physics for Scientists and Engineers with Modern Physics	John W. Jewett & Raymond A. Serway	CENGAGE Learning, 10th edition, Boston, 2010, ISBN-10: 1337553298
10	University Physics (Volume I, II & III) (Open-source Material)	William Moebs, Samuel J. Ling & Jeff Sanny	OPENSTAX, Houston, Texas, 2016, ISBN-13: 1-947172-20-4
11	PHYSICS for SCIENTISTS & ENGINEERS with Modern Physics	Douglas C. Giancoli	Pearson, 7th edition, Delhi, 2015, ISBN-13: 978-1292057125
12	Principles of Physics	Jearl Ealker, David Halliday, Robert Resnick	Wiley India, Navi Mumbai 10th edition, 2015, ISBN-13: 978-8126552566
13	NCERT Physics	NCERT	NCERT Physics
14	Physics in Daily Life With illustrations	L.J.F. Hermans & Wiebke Drenckhan	EDP Sciences, France, 2012, ISBN: 978-2-7598-0705-5
15	Introductory Physics: Building Models to Describe Our World (Open-Source Material)	Ryan Martin, Emma Neary, Joshua Rinaldo & Olivia Woodman	Creative Commons license, 2019, GitHub

14. SUGGESTED LEARNING WEBSITES

a) https://ocw.mit.edu/courses/physics/
b) https://www.einstein-online.info/en/category/elementary/
c) https://academicearth.org/physics/
d) www.nptel.iitm.ac.in
e) http://phys23p.sl.psu.edu/phys_anim/Phys_anim.htm
f) http://www.atoptics.co.uk/
g) https://www.khanacademy.org/science/physics
h) http://www.olabs.edu.in/

i) http://vlabs.iitb.ac.in/vlab/
j) https://phet.colorado.edu/
k) http://physics.bu.edu/~duffy/vlabs.html
l) https://virtuallabs.merlot.org/vl_physics.html
m) www.datasheetcafe.com

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Applied Physics (Course Code: C4300004)						
	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) Solve various engineering problems by the concept of linear and circular motion.	3	1	-	-	1	-	1
CO c) Apply basic concepts of properties of matter in solving engineering problems efficiently	3	1	-	2	-	-	1
CO d) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.	3	1	1	2	1	-	1
CO e) Use the concept of waves and sound waves for various acoustics and other engineering applications involving wave dynamics	3	1	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

S. No.	Name and Designation	Institute	Contact No.	Email
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5	Late Dr. Gaurang S. Patel Lecturer in Physics	Dr. S. & S. S. Ghandhy College of Engineering & Technology, Surat	9909986859	goru16686@gmail.com

NITTTR Resource Person

S. No.	Name and Designation	Department	Contact No.	Email
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