GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I– Semester

CourseTitle: **Mathematics**
(Course Code: 4300001)

Diploma program in which this course is offered	Semester in which offered
Automobile Engineering, Architecture Assistantship, Biomedical Engineering, Ceramic, Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Electronics &Communication Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Marine Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Power Electronics Engineering, Printing Technology, Textile Designing, Textile Manufacturing Technology, Textile Processing Technology, Transportation Engineering (All branches except CACD & DM)	First

1.   RATIONALE

This course of Mathematics is being introduced as a foundation which will help students in developing competency and the requisite course outcomes in most of the Diploma Engineering programs. Components of Mathematics like Algebra, Geometry, Calculus, Computer computation work as a tool to describe physical phenomena and to evaluate the merit of different possible solutions. This course is an attempt to initiate the multi-dimensional logical thinking and reasoning capabilities. It will help the students to apply the basic principles of Mathematics to solve related technology problems. The course will give the students an insight to apply and analyse the Engineering problems scientifically based on the subject of Trigonometry, Differential Calculus and Basic elements of algebra and coordinate geometry to give a comprehensive coverage at an introductory level.

2.   COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
       Solve broad-based technology problems using the principles of mathematics.

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) Interpret the function graphically, numerically and analytically**.**

b) Demonstrate the ability to algebraically analyse basic functions used in Trigonometry.

c) Demonstrate the ability to Crack engineering related problems based on concepts of Vectors**.**

d) Solve basic engineering problems under given conditions of straight lines and circle.

e) Demonstrate the ability to analyze and illustrate the Functions using the concept of Limit.

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	1	-	4	30*	70	-	-	100

(*):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 (During Tutorial Hours)
The following practical outcomes (PrOs) are the sub-components of the COs. *These PrOs need to be attained to achieve the Cos.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Solve given problems of Determinant up to order 3*3.	I	1
2	Use Open source mathematical software to demonstrate the graphs of given functions with its geometrical interpretation.	I	1
3	Use Open source mathematical software to display given logarithmic functions showing basic laws.	I	1
4	Solve the given examples based on conversion of units of Angles explaining the allied angles.	II	1
5	Crack given problems based on the concept of Compound Angles, Multiple and Submultiples angles.	II	1
6	Plot the graph of sine and cosine functions with help of Open source mathematical software and justify problems related to sum and factor formulae.	II	1
7	Use the concepts of Algebra to Solve given engineering related problems based on Magnitude of a vector.	III	1
8	Apply the concept of Dot Product to solve given engineering	III	1

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	related problems.		
9	Explain the physical significance of the Cross Product and apply the concept to solve given engineering related problems.	III	1
10	Apply the concept of various forms of line, slope, intercept to solve simple problems.	IV	1
11	Use the concepts of equations of Parallel lines and Perpendicular lines to solve specified problems.	IV	1
12	Use the concept of Tangent and Normal to solve related engineering problems.	IV	1
13	Explain Limit of a function graphically and solve the specified problems.	V	1
14	Apply the Standard Formulae of Limit and crack the specified problems.	V	1
	Total		**14**

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 %
	Geometric Thinking: Comprehend geometric concepts to prove theorems by applying apt results to solve well defined Engineering problems.	
1.	Experiment with transformations in the plane.	30
2.	Define trigonometric ratios and solve problems involving right triangles.	30
3.	Apply theorems about circles.	40
	Total	**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	Algebraic Thinking: Create, interpret, use, and analyze expressions, equations, and inequalities in a variety of contexts.	
1.	Represent, interpret, and solve variable expressions, equations, and inequalities.	60
2.	Write expressions in equivalent forms to solve problems.	40
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	Computer System & LCD Projector	2,3,6,10,13
2	Scientific Calculator (Display type: Natural Display Algebraic input logic: Natural V.P.A.M. Significand function: 10+2.	1,5,10

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 fulfill the development of this course competency.

   a) Work as a leader/a team member.
   b) Follow ethical practices.
   c) 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 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 **Determinant and Function**	1a. Solve simple problems of Determinant up to order 3*3. 1b. Explain graphically the given functions. 1c. Solve simple problems using concepts of Logarithms	1.1 Determinant and its value up to 3rd order (Without properties) 1.2 Function and simple examples. 1.3 Logarithm as a function 1.4 Laws of Logarithm and related Simple examples
Unit– II **Trigonometry**	2a. Apply the concept of Compound angle, Allied angle, and Multiple angles to solve the given simple engineering problem(s) 2b. Explain the concept of Sub-Multiple and solve related problem(s). 2c. Invoke the concept of Sum and Factor formulae to solve the given simple problem(s) 2d. Investigate given simple problems using inverse Trigonometric functions.	2.1 Units of Angles (degree and radian) 2.2 Trigonometric Functions 2.3 Allied & Compound Angles, Multiple –Submultiples angles 2.4 Graph of Sine and Cosine, 2.5 Periodic Trigonometric function 2.6 Sum and factor formulae 2.7 Inverse Trigonometric function
Unit– III **Vectors**	3a. Apply the concept of algebraic operations of Vectors to solve given simple engineering problem(s) 3b. Apply the concept of Scalar and Vector product to solve specified simple problem(s) 3c. Solve problems of work done and moment of force using the concept of Vectors.	3.1 Vector, Addition, Subtraction, Magnitude and direction. 3.2 Scalar and Vector Product and it's properties 3.3 Angle between two Vectors 3.4 Applications of Scalar and Vector Product (Work Done and Moment of Force)
Unit– IV **Coordinate Geometry**	4a. Employ the equation of straight line to solve given simple problems. 4b. Apply the concept of slope and its consequences to	4.1 Straight line (Two-point form) and slope of straight line 4.2 Slope point form, Intercept form, General form of line 4.3 Condition of parallel and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	solve the given problems. 4c. Find the angle between two lines using the concept of Parallel and Perpendicular lines. 4d. Apply the concept of equation of circle with center and radius to solve the given problems. 4e. Solve problems related to general equation of circle based on tangent and normal.	perpendicular lines 4.4 Equations of Parallel lines and Perpendicular lines to the given lines 4.5 Angle between two lines. 4.6 Equation of circle with center and Radius. 4.7 General equation of circle. 4.8 Tangent and normal to a circle.
Unit– V **Limit**	5a. Analyse the characteristic of functions using the concept of Limit. 5b. Solve the given problems using standard formulae of Limit	5.1 Limit of a Function. 5.2 Standard formulae of Limit and related simple examples.

Note: The Unit Outcomes (UOs) need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	R Level	U Level	A Level	Total Marks
I	Determinant and Function	9	4	7	5	16
II	Trigonometry	12	4	5	5	14
III	Vectors	7	4	6	4	14
IV	Coordinate Geometry	8	4	5	5	14
V	Limit	6	3	4	5	12
	Total	42	**19**	**27**	**24**	**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 perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Identify engineering problems based on real world problems relevant to content of the unit and solve these problems in the light of free tutorials available on the internet.
b) Explore the opportunity to visit Science city, ISRO or nearby Science centres.
c) Explore the opportunity to visit Mathematics Lab Virtually.
d) Prepare charts showing formulas of multiple and sub multiple trigonometric functions.
e) Use Graphing calculator to plot the graph of functions showing Engineering applications.
f) Collect set of problems based on concept of limit with real world applications and make a presentation.
g) Communicate mathematical thinking coherently and clearly to other students, peers, and others.

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) Explore the possibility for understanding the Biosphere through Mathematics
g) Guide students for using data manuals.

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) Draw graphs of given Functions like $2x-1, x^2, \sin x, \cos x$ etc and verify using suitable Open-source software like GeoGebra, DPLOT and GRAPH.
b) Prepare the Charts of formulae for limit, Vector, Trigonometry, Co-ordinate Geometry, and Logarithm.
c) Prepare the cardboard models based on Mathematical concepts.
d) Draw various lines, circles using GeoGebra software.
e) Prepare projects on height and distance using Trigonometry.
f) Use PHET website for simulation of Vector Algebra.
g) Prepare a presentation/seminar on any relevant topic of interdisciplinary nature.
h) Prepare a write up on the Historical path of Calculus.
i) Prepare models of graphical representation for the existence of limits of given functions.
j) Prepare charts showing formulas of multiple and sub multiple trigonometric functions and its usefulness.
k) Formulate models to describe mathematical relationships and analyze data.

13.SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Mathematics (Third edition).	Croft, Anthony	Pearson Education, New Delhi, 2014. ISBN 978-81-317-2605-1
2	A Text Book of Vector Analysis	Narayan Shanti and Mittal P.K	S. Chand Publication, ISBN 978-8121922432
3	Calculus and Analytic Geometry	G. B. Thomas, R. L. Finney	Addison Wesley, 9th Edition, 1995. ISBN 978-8174906168
4	Understanding Engineering Mathematics	John Bird	Routledge; 1st edition ISBN 978-0415662840
5	Advanced Engineering Mathematics	Krezig, Ervin	Wiley Publ., New Delhi,2014, ISBN: 978-0-470-45836-5

14. SUGGESTED LEARNING WEBSITES

a. https://www.youtube.com/channel/UCLJVrQyPYsseCf78QWCDsvA/featured

(YouTube Channel of DTEGUJ)

b. https://www.geogebra.org/?lang=en

c. https://phet.colorado.edu/

d. www.dplot.com/ - DPlot

e. www.wolfram.com/mathematica/

f. https://www.khanacademy.org/

g. www.easycalculation.com

i. www.scilab.org/ - SCI Lab

j. https://cnx.org/contents/cCXsMC7-@3.2:rOtjgdjI@5/Trigonometry

k. https://www.embibe.com/exams/real-life-applications-of-trigonometry

l. https://opentextbc.ca/calculusv1openstax/chapter/the-limit-of-a-function

m. https://www.accessengineeringlibrary.com/?implicit-login=true

15. PO-COMPETENCY-CO MAPPING

Semester I	Mathematics (Course Code: 4300001)						
	POs and PSOs						
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 ***Solve broad-based technology problems using the principles of mathematics.***	3	2	1	-	-	-	1
Course Outcomes CO a) Interpret the function graphically, numerically and analytically.	3	2	1	-	-	-	-
CO b) Demonstrate the ability to algebraically analyze basic functions used in Trigonometry.	3	1	1	-	-	-	1
CO c) Demonstrate the ability to Crack engineering related problems based on concepts of Vectors.	3	1	1	-	-	-	1
CO d) Solve basic engineering problems under given conditions of straight lines and circle.	3	1	-	-	-	-	-
CO e) Demonstrate the ability to analyze and illustrate the Function using the concept of Limit.	3	-	-	-	-	-	-

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

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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NITTTR Resource Person

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