Enclosure-BMTII

SHREE MANIBHAI VIRANI & SMT. NAVALBEN VIRANI SCIENCE COLLEGE (AUTONOMOUS)

Department of Mathematics

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – II		
Course Code	Course Title	Course Credit and Hours
21UMTCC201	**Core 3**: **Differential Equations (Ap)**	**4 Credits - 4 hrs/wk** (4 Th)

Course Description:

Differential equation is a basic course designated for second semester students those majoring Mathematics. This covers different methods for obtaining solutions to first order and higher orders ordinary differential equations which serves as very useful mathematical tools in solving problems in engineering and sciences. This begins with the basic concepts and classification of differential equations and then goes on with the techniques of solving first order first degree ordinary differential equations and the methods of solving higher order linear differential equations with constant coefficients as well as linear differential equation with variable coefficient. Lastly, it gives introductory discussions on partial differential equation.

Course Purpose:

Ordinary differential equations have important applications and are a powerful tool in the study of many problems in the natural sciences and in technology; they are extensively employed in mechanics, astronomy, physics, and in many problems of chemistry and biology. This course aims to provide basic understanding of differential equation. This is designed in such a way that students will able to solve the first order and first degree as well as higher order and higher degree differential equation. Students will also understand and solve linear differential equation with constant as well as variable coefficient.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Classify differential equations by order, linearity, and homogeneity. Apply the proper method to find the general solution of a given differential equation.	K_2, K_3

CO_2	Use the suitable method to obtain the solution of a given first order and higher degree differential equation.	K_3
CO_3	Identify the suitable method to obtain the solution of a linear differential equation with constant coefficient	K_3
CO_4	Obtain the solution of a linear differential equation with variable coefficient.	K_3
CO_5	Define and derive the partial differential equation and find the order and degree of the given partial differential equation.	K_1, K_3

Course Contents	**Hours**
Unit-I: Differential Equations of First Order and First Degree	**10 hrs**
• Introduction, definition, order, degree • Formation of a differential equation. • Methods to solve separable equations, homogenous equations, Bernoulli's differential equations, exact differential equations.	
Unit-II: Differential equations of first order and higher degree	**10 hrs**
• Differential equations of first order and first degree solve by method, ▪ Solvable for x ▪ Solvable for y ▪ Solvable for p • Lagrange's form of differential equations. • Clairaut's form of differential equations.	
Unit- III: Linear differential equations of higher order with constant coefficients.	**10 hrs**
• Solution of auxiliary equation $f(D)y = 0$ for real roots and complex roots. • Solution of differential equations of the type $f(D)y = X$. • Meaning of complimentary function (C.F.) and Particular integral (P.I.). • Methods to obtain Particular integral (P.I.) when $X = e^{ax}$, $X = sin(ax+b), X = cos(ax+b), X = x^m, X = e^{ax}V$ where V is exponential/ linear/ trigonometric functions.	
Unit- IV: Linear Differential Equations with Variable Coefficients	**10 hrs**

• Method of solution of homogeneous linear differential equations, equations reducible to homogeneous linear form, Legendre's linear equations. • Working rule to solve homogeneous linear differential equations. • Working rule to solve Legendre's linear equations.	
Unit- V: Basics concept of partial differential equations	**10 hrs**
• Definition, order and degree of partial differential equation. • Derivation of a partial differential equation by the elimination of constant. • Derivation of a partial differential equation by the elimination of an arbitrary function.	

Pedagogic tools:

- Chalk and Board.
- Power point presentation
- Seminar

Text books:

- Nita. H. Shah, (2015), Ordinary and Partial Differential Equations - Theory and Applications, 2nd edition, Prentice Hall of India Pvt. Ltd. (Units:1 to 5).
- M. D. Raisinghania, (2017), Ordinary and Partial Differential Equations,19th edition, S. Chand and Company Ltd. (Units:1 to 5).

Reference books:

- Daniel A. Murray, (2012), Introductory Course in Differential Equations, University Press.
- G. F. Simmons, (2017), Differential Equations with Applications and Historical Notes, 3rd edition, Tata McGraw-Hill Publishing Co. Ltd.

Suggested reading / E-resources:

- https://simiode.org/resources/onlinetexts
- http://www.math.lamar.edu/faculty/maesumi/ODE33011.html

Suggested MOOCs:

- https://www.openlearning.com/courses/introduction-to-ordinary-differential-equations/
- https://www.mooc-list.com/course/introduction-ordinary-differential-equations-coursera

Methods of Assessment & Tools:

Components of CIA: 30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 60)	
B	Assignment			5	10
C	Class activity			5	
				Grand Total	**30**

Assignment	• Solution of problem set • Student's handbook
Class activity	• Surprise Quiz • Quiz • Seminar • Problem solving sessions.

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

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Department of Mathematics

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Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – II		
Course Code	Course Title	Course Credit and Hours
21UMTCC202	**Core 4: Advanced Calculus (Ad)**	**4 Credits - 4 hrs/wk (4 Th)**

Course Description:

This course provides the students with the advanced mathematical skills necessary to understand analytical methods. The main part of this course covers mathematical analysis with multivariable functions, with applications for theories of consumption and production. Advanced calculus seems to be like a bridge between calculus and real analysis. This course introduces Beta and Gamma Functions and how to evaluate them. Students will learn how these two functions complement each other. Learners will able these methods of integration to solve problems.

Course Purpose:

Course helps the learners to understand the existence of limit and continuity of function of several variables. It is applied when the given integral cannot be obtained by usual methods. The repeated application of reduction formulae helps us to evaluate the given integrals easily. This course helps the leaner to deal with the problems of extreme values of the function of the several variable which makes the subject more interesting for learners.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Bloom's taxonomy Level (K_1 to K_6)**
CO_1	Determine the existence of limits and calculate the limit of the function of several variable at a given point. (if exists)	K1, K3
CO_2	Utilize the concept of limit to verify the continuity of function of several variables.	K1, K3
CO_3	Verify the differentiability of function of several variables.	K2
CO_4	Illustrate the partial derivatives of given function of several variables.	K2

CO_5	Implement and verify the Euler's Theorem to solve the problems related to partial derivative.	K2, K3
CO_6	Utilize the relation between Beta and Gamma function.	K2, K5
CO_7	Apply Duplication formula and Reduction formulae to solve problems of integration.	K3

Course Contents	**Hrs**
Unit-I: Limit, Continuity of function of several variable	**10**
• Introduction to function of several variables. • Rectangular and spherical neighborhood of a point in R^n . • Limit of function of several variables. • Concept of iterated limit, limit and path. • Continuity of function of several variables.	
Unit -II: Differentiability of function of several variables-I	**9**
• Introduction to partial derivatives. • Higher order partial derivatives and problems. • Differentiability of function of two variables. • Theorems on differentiability conditions and converses.	
Unit -III: Differentiability of function of several variables-II	**10**
• Chain rule for differentiability. • Homogeneous functions, Euler's theorem for homogeneous functions of two variables. • Directional derivatives. • Extreme values of functions of two variables and its theorems. • Taylor's theorem for function of two variables.	
Unit -IV: Beta & Gamma Functions	**9**
• Beta and Gamma functions and relation between them.	

• Value $\int_{-\infty}^{\infty} e^{-x^2} dx$ as gamma function. • Statement of Legendre's Duplication formula (without proof.)	
Unit -V: Reduction formulae	**10**
• Reduction formulae $\int_0^{\frac{\pi}{2}} \sin^m x dx, \int_0^{\frac{\pi}{2}} \cos^m x dx, \int_0^{\frac{\pi}{2}} \sin^m x \cos^n x dx \ (m,n \in N)$. • Reduction formulae for $\int_0^{\pi/4} \tan^n x dx, \int_{\pi/4}^{\pi/2} \cot^n x dx$	

Pedagogic Tools:

- Chalk and Talk
- PPT and Videos.
- Assignment
- Group discussion

Text Books:

- James J. Callahan, (2010), Advanced Calculus A Geometric View, Springer.
- Carlos Polanco, (2019), Advanced Calculus - Fundamentals of Mathematics, Bentham Books.

Reference Books:

- John Srdjan Petrovic (2020), Advanced Calculus: Theory and Practice, Second edition Chapman and Hall/CRC.
- Michael E. Taylor (2020), Introduction to analysis in several variables (Advanced calculus), Math. Dept., UNC.

Suggested reading / E-resources:

- https://nptel.ac.in/courses/111/104/111104125/
- https://onlinecourses.nptel.ac.in/noc22_ma08/preview

Suggested MOOCs:

- https://www.classcentral.com/course/swayam-calculus-of-several-real-variables-13936

- https://www.classcentral.com/course/swayam-engineering-mathematics-ii-17592

Methods of Assessment & Tools:

Components of CIA: 30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 60)	
B	Assignment			5	10
C	Class activity			5	
				Grand Total	**30**
Assignment	• Solution of problem set • Student's handbook				
Class activity	• Surprise Quiz • Quiz • Seminar • Problem Solving				

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

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Department of Mathematics

Core Practical 2 For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – II		
Course Code	Course Title	Course Credit and Hours
21UMTCC203	**Core Practical 2: Practical on Differential Equations and Advanced Calculus (including Mathematical Software.)**	**4 Credits- 8 hrs/wk**

Course Description:

This course is an introduction to the use of mathematical software in advanced calculus and differential equations. Although mathematics is still largely taught as a pen-and-paper subject, this approach ignores the fundamental role played by computing technology in the process of mathematical discovery. This course will introduce students to a broad but coherent collection of open-source software tools, and to diverse examples of their use in mathematical study. In this course students will visualize function of multivariable and its property through mathematical software and learn to solve ordinary differential equation using computer algebraic system.

Course Purpose:

This course aims to provide basic understanding of Advanced Calculus and Differential Equation using Open-source mathematical software. In this course learners will be able to visualize various concepts of advanced calculus and solutions of differential equations, it also provides the learner with the computer skills required to use the mathematical software.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Explain the nature of solution curve using computer algebra system	S_1
CO_2	Interpret the differentiability and visualize the concept of limit and continuity of function of several variables.	S_1, S_3
CO_3	Utilize the different tools of mathematical software to understand the mathematical concepts with graphical interpretation.	S_3

CO_4	Utilize the computer algebra system to solve the differential equations.	S_3
CO_5	Calculate general solution of ordinary differential equation	S_3

List of Practical		
Sr.	**Experiments**	**Hrs**
1	Examples based on a line perpendicular to the surface. (Normal Line)	4
2	Examples based on a plane that is tangent to the surface. Any line in this plane through will also be tangent to the surface. (Tangent Plane)	4
3	Problems based on a line in a constant x plane that is tangent to the surface. (Tangent Line ($x=x_A$))	4
4	Problems based on a line in a constant y plane that is tangent to the surface. (Tangent Line ($Y=Y_A$))	4
5	Problems based on a contour curve where the function value is constant. (Contour Line)	4
6	Problems based on Directional derivatives.	4
7	Problems based on partial derivative.	4
8	Problems based on Extreme values of functions of two variables.	4
9	Problems based on Beta function.	4
10	Problems based on Gamma function.	4
11	Problems based on differentiation and integration in Computer Algebraic System (CAS).	4
12	Problems based on how to enter differential equation in CAS.	4
13	Problems based on general solution of ordinary differential equation in CAS.	4
14	Problems based on solution of first order ordinary differential equation in CAS.	4
15	Problems based on solution of higher order ordinary differential equation in CAS.	4
16	Problems based on solution of first order homogeneous differential equation in CAS.	4
17	Problems based on solution of higher order homogeneous differential equation in CAS.	4

18	Problems based on partial fraction for finding complementary function in CAS.	4
19	Problems based on solution curve in CAS.	4
20	Problems based on how to enter partial differential equation in CAS.	4

Pedagogic Tools:

- Computer
- Chalk and Board
- Power point presentation
- Handouts
- Video

Text books:

- Hohenwarter J. and Hohenwarter M., (2011), Introduction to GeoGebra, International GeoGebra Institute.
- Das V. (2008), Programming in Scilab, New Age International (P) Limited.
- Baudin M. (2010), Introduction to Scilab, Consortium Scilab.

Reference books:

- M. D. Raisinghania, (2017), Ordinary and Partial Differential Equations, 19th edition, S. Chand and Company Ltd.
- Dr. Nita. H. Shah, (2015), Ordinary and Partial Differential Equations - Theory and
- Applications, 2nd edition, Prentice Hall of India Pvt. Ltd.

Suggested reading / E-resources:

- https://help.scilab.org/doc/5.5.2/en_US/ode.html
- https://www.geogebra.org/m/m9hvRWKQ

Suggested MOOCs:

- https://www.openlearning.com/courses/introduction-to-ordinary-differential-equations/?cl=1
- https://www.mooc-list.com/course/introduction-ordinary-differential-equations-coursera
- https://onlinecourses.swayam2.ac.in/aic20_sp03/preview

Methods of Assessment & Tools:

Components of CIA: 40 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1-10 Experiments	$1\frac{1}{2}$hours	15	30
	Test 2	11-20 Experiments	$1\frac{1}{2}$hours	15	
B	Attendance and Regularity			5	10
C	Record book			5	
				Grand Total	**40**
Class activity	• Surprise Quiz • Quiz • Situation based question				

Note: Any other assessment tools or methods can be adopted as per requirement of the course.