Mithesh Ramachandran
UW MSDS 2023 Fall

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: B. Tech. (I.T., Computer, EXTC, Mechanical, Civil, Mechatronics & Data Science)					**Semester:** II	
Course/Module: Mathematics-II					**Module Code:** BTIT02008, BTCO02008, BTET02008, BTME02008, BTCI02008, BTMA02008, BTDS02008	
Teaching Scheme					**Evaluation Scheme**	
Classroom Session	**Lecture (Hours per week)**	**Tutorial (Hours per week)**	**Practical/ Group work (Hours per week)**	**Credit**	**Continuous Evaluation (Marks-50)**	**Term End Examinations (TEE) (Marks - 100 in Question Paper)**
42	**3**	**1**	**0**	**4**	**Marks Scaled to 50**	**Marks Scaled to 50**

Course Rationale:

This course is designed to develop the concepts and methods related to Multivariate Integration, Ordinary Differential Equations and Functions of Complex Variables. Double Integrals, Triple Integrals, Line and Surface Integrals are all powerful tools for real world applications. Mathematical models of real world problems often involve Differential Equations. Approach to the solution of such equations is discussed in the course. The course also explores Analytic and Harmonic Functions, Conformal Mappings, Contour Integration, Cauchy Integral Formula and evaluation of Definite and Improper Integrals.

Course Objectives:

1. To familiarize prospective engineers with techniques in Multivariate Integration, Ordinary Differential Equations and Complex Variables.
2. To enable students to deal with advanced levels of Mathematics and applications that would be essential for their disciplines.

Course Outcomes:

After completion of the course, students would be able to :

1. employ appropriate mathematical techniques in evaluating Multiple Integrals, Differentiation and Integration of Functions of Complex Variables.
2. use effective mathematical tools for the solutions of ordinary differential equations that model physical processes.
3. apply various techniques of Multiple Integration and Calculus of Complex Functions in solving engineering problems

Pedagogy:

Lectures, tutorials, presentations, application-based videos and use of mathematical software.

Textbooks:

TB1. *Advanced Engineering Mathematics*, 10 e, Erwin Kreyszig, Wiley India, 2017.
TB2. *Engineering Mathematics – I*, 1 e, Veerarajan T, McGraw-Hill Education, 2017.
TB3. *Higher Engineering Mathematics*, 44 e, B.S. Grewal, Khanna Publishers, 2017.
TB4. *Engineering Mathematics – II*, 1 e, Veerarajan T, McGraw-Hill Education, 2017.

Reference Books:

RB1. *Calculus and Analytic geometry,* 9 e, G. B. Thomas and R. L. Finney, Pearson, 2006.

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RB2. *Elementary Differential Equations and Boundary Value Problems*, 9 e, W. E. Boyce and R. C. DiPrima, Wiley India, 2015.

RB3. *Differential Equations*, 3 e, S.L. Ross, Wiley India, 2016.

RB4. *Complex Variables and Applications*, 8 e, J.W. Brown and R.V. Churchill, Mc- Graw Hill Education, 2014.

RB5. *A text book of Engineering Mathematics*, 9 e, N. P. Bali and Manish Goyal, Laxmi Publications (P) LTD., 2017.

Links to websites:

- http://mathworld.wolfram.com
- http://www.math.com
- https://ocw.mit.edu/index.htm

Evaluation Scheme:

• Tutorial Test/Presentation/viva/quiz	20%
• Mid Term	30%
• Term End Exam	50%
Total	**100%**

Session Plan:

Session	Topics	Session/Course Outcomes	Pedagogical Tool	Textbook Chapters & Readings
Unit 1	**Multivariate Integration**	**CO1,CO3**	--	--
1.	**Multiple Integration** • Double integrals (Cartesian)	evaluate Multiple Integrals	• Lecture • Problem Solving	**TB2:** Chapter 4: Multiple Integrals **TB3:** Chapter 7: Multiple Integrals and Beta and Gamma functions
2.	**Multiple Integration** • Change of order of integration in double integrals • Change of variables (Cartesian to polar).	evaluate Multiple Integrals		
3.	**Applications** • areas and volumes	• Evaluate Multiple Integrals • apply various techniques of Multiple Integration in engineering problems		
4.	**Applications** • Centre of mass and Gravity (constant and variable densities).	• Evaluate Multiple Integrals • apply various techniques of Multiple		

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		Integration in engineering problems		
5.	**Triple Integration** • Triple integrals (Cartesian), orthogonal curvilinear coordinates.	Evaluate Multiple Integrals	• Lecture • Problem Solving • Presentations involving videos	
6.	**Triple Integration** • (contd.) Triple integrals (Cartesian), orthogonal curvilinear coordinates.	Evaluate Multiple Integrals		
7.	**Applications** • Simple applications involving cubes, sphere and rectangular parallelopipeds.	• Evaluate Multiple Integrals • apply various techniques of Multiple Integration in engineering problems		
8.	**Applications** • (contd.) Simple applications involving cubes, sphere and rectangular parallelopipeds.	• Evaluate Multiple Integrals • apply various techniques of Multiple Integration in engineering problems		
9.	**Scalar line integrals** • Definition and examples of scalar line integrals	evaluate Multiple Integrals	• Lecture • Problem Solving	**TB3:** Chapter 8: Vector Calculus and its Applications
10.	**Vector surface integrals** • Definition and examples of vector surface integrals	• Evaluate Multiple Integrals • apply various techniques of Multiple Integration in engineering problems	• Lecture • Problem Solving • Presentations involving videos	
11.	**Theorems on Integrals** • Theorems of Green, Gauss and Stokes.	• Evaluate Multiple Integrals • apply various techniques of Multiple Integration in engineering		

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		problems		
Unit 2	**First order ordinary differential equations**	**CO2**	--	--
12.	**Exact and linear differential equations** • Solving Exact and linear differential equations.	solving ordinary differential equations	• Lecture • Problem Solving	**TB1:** Chapter 1: First order ODEs **TB2:** Chapter 5: Differential Equations **TB3:** Chapter 11: Differential Equations of first order
13.	**Euler's equations** • Solving Euler's equations.	solving ordinary differential equations		
14.	**Euler's equations** • Solving Euler's equations.	solving ordinary differential equations		
15.	**Equations not of first degree** • Equations solvable for p	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		
16.	**Equations not of first degree** • Equations solvable for y, equations solvable for x and Clairaut's type.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		
17.	**Equations not of first degree** • (contd.) Equations solvable for y, equations solvable for x and Clairaut's type.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		
Unit 3	**Ordinary differential equations of Higher order**	**CO2**	--	--
18.	**Second order linear differential equations** • Solving second order linear differential equations with variable coefficients.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes	• Lecture • Problem Solving	**TB1:** Chapter 2: Second Order Linear ODEs Chapter 3: Higher Order Linear ODEs **TB2:** Chapter 5:

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				Differential Equations **TB3:** Chapter 13: Linear Differential Equations
19.	**Second order linear differential equations** • (contd.) Second order linear differential equations with variable coefficients.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		**TB1:** Chapter 2: Second Order Linear ODEs Chapter 3: Higher Order Linear ODEs **TB2:** Chapter 5: Differential Equations **TB3:** Chapter 13: Linear Differential Equations
20.	**Higher order linear differential equations** • Method of variation of parameters.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		**TB1:** Chapter 2: Second Order Linear ODEs Chapter 3: Higher Order Linear ODEs **TB3:** Chapter 13: Linear Differential Equations
21.	**Higher order linear differential equations** • Cauchy-Euler equation	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		
22.	**Higher order linear differential equations** • Power series solutions.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		**TB1:** Chapter 5: Series solution of ODEs and Special Functions **TB3:** Chapter 16: Series solutions of differential equations and special functions
23.	**Higher order linear differential equations** • Legendre polynomials.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		
24.	**Bessel functions**	use effective		

	• Bessel functions of the first kind and their properties.	mathematical tools for the solutions of ordinary differential equations that model physical processes		
25.	• **Bessel functions** (contd.) Bessel functions of the first kind and their properties.	use effective mathematical tools for the solutions of ordinary differential equations that model physical processes		
Unit 4	**Complex Variables: Differentiation**	**CO1, CO3**	--	--
26.	**Complex Differentiation** • Differentiation • Cauchy-Riemann equations	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables	• Lecture • Problem Solving	**TB1:** Chapter 3: Complex Numbers and functions and Complex Differentiation **TB3:** Chapter 20: Calculus of Complex functions **TB4:** Chapter 3: Analytic Functions
27.	**Complex Differentiation** • analytic functions	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables		
28.	**Complex Differentiation** • Harmonic functions • finding harmonic conjugate	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables		
29.	**Elementary analytic functions** • Elementary analytic functions (exponential, trigonometric, logarithm)and their properties	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables		

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30.	**Elementary analytic functions** • (contd.) Elementary analytic functions (exponential, trigonometric, logarithm)and their properties	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables		
31.	**Conformal Mapping** • Conformal mappings: Definition and problems	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables		**TB3:** Chapter 20: Calculus of Complex functions
32.	**Mobius transformation** • Mobius transformation and their properties.	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables		
33.	**Mobius transformation** • (contd.) Mobius transformations and their properties.	employ appropriate mathematical techniques in evaluating Differentiation of Functions of Complex Variables	• Lecture • Problem Solving	
Unit 5	**Complex Variables: Integration**	**CO1, CO3**	--	--
34.	**Contour Integrals** • Definition and problems on Contour integrals	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	**TB1:** Chapter 14: Complex Integration **TB3:** Chapter 20: Calculus of Complex functions **TB4:** Chapter 4: Complex Integration
35.	**Contour Integrals** • Cauchy-Goursat theorem (without proof).	employ appropriate mathematical techniques in evaluating Integration of Functions of	• Lecture • Problem Solving	

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		Complex Variables		
36.	**Contour Integrals** • Cauchy Integral formula (without proof)	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	
37.	**Contour Integrals** • Liouville's theorem and Maximum-Modulus theorem (without proof).	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	
38.	**Taylor's and Laurent's series** • Taylor's series, zeros of analytic functions	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	**TB1:** Chapter 15: Power Series, Taylor Series Chapter 16: Laurent Series, Residue Integration
39.	**Taylor's and Laurent's series** • singularities • Laurent's series.	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	
40.	**Residues** • Residues • Cauchy Residue theorem (without proof)	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	**TB1:** Chapter 16: Laurent Series, Residue Integration
41.	**Evaluation of definite integrals** • Evaluation of definite integral involving sine and cosine.	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	

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42.	**Evaluation of improper integrals** • Evaluation of certain improper integrals using the Bromwich contour.	employ appropriate mathematical techniques in evaluating Integration of Functions of Complex Variables	• Lecture • Problem Solving	

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Signature
(Approved by Dean)

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Mukesh Patel School of Technology Management & Engineering

Program: B. Tech Data Science (Business Analytics)				**Semester: V**	
Course/Module : Applied Mathematics – IV				**Module Code: BTDS05005**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
3	**2**	**0**	**4**	**Marks Scaled to 50**	**Marks Scaled to 50**

Pre-requisite: Nil

Objectives:

- To provide an understanding of various Mathematical Concepts such as Vector Integration, Matrices, Analytic functions and Mapping which forms basics for data science to solve engineering problems.
- Impart knowledge of Laplace Transform and generalization for the fundamental theorem of calculus like Greens, Stokes and Gauss Diversion.

Outcomes:

After completion of the course, students would be able to:

- Solve problems using Matrices, Laplace and apply it to engineering problems.
- Solve and Apply applications of Greens Theorems to find relationship between a line integral around a simple closed curve C and a double integral over the plane region D bounded by C in real life engineering problems.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Analytic Function, Analytic Function Equations, Harmonic functions, Relation between Analytic and Harmonic functions, Milne Thompson method, function u given with another function v not given and derive function of w, Either addition or subtraction of two variables u and v given and derive function of w, Cauchy Reiman equations in Cartesian and polar coordinates, Mapping – Determining the image in the plane, bilinear transformation and fixed points of Bilinear transformations, cross ratio formula.	09
2	Integration solution for Equation along the path of unit circle, parabola, Cauchy Integral Theorem, Cauchy Integral Formula, Simple pole, Multiple Pole, Repeated Poles, Function of Single random variable, Taylors and Laurentz Series, Residues, Contour integration.	08
3	Vector Integration – Line Integral, Boundary over square, over straight line segments joining points, moving particle along circle, ellipse, conservative and irrational field, Scalar Potentials, Multivariable calculus Greens Theorem, Stokes Theorem, Gauss Diversion Theorem.	09

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4	Matrices – Eigen values, Eigen vectors, Quadratic form over real field, Reduction of Quadratic form to a diagonal canonical form, Rank, Index and Signature of quadratic form, Functions of square matrix, Derogatory and non-Derogatory Matrices, Cayley-Hamilton theorem (without proof), similar Matrices, Linear dependence and Independence using matrix equations, orthogonally similar Matrices, Single Vector Decomposition.	07
5	Laplace Transform – Introduction, Derivatives and Integrals, Definition, Linearity property, Laplace transform of standard functions, first shifting theorem, second shifting theorem, Effect of multiplication by t, Effect of division by t, Laplace Transform of Derivatives and Integrals, Inverse Laplace Transforms, Laplace Transform of special functions, Application of Laplace.	12
	Total	**45**

Text Books:

1. Michael Greenberg (2017), Advanced Mathematics, Pearson new International

Reference Books:

1. 1 - P.P.G. Dyke(2015), An introduction to Laplace Transform and Fourier series, Springer
2. 2 - Elements of the Differential, and Integral Calculus (Revised: Edition) (Classic Reprint) Paperback – 19 Apr 2018 by William Anthony Granville

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Two class tests.
2. Minimum two assignments
3. Any other assessment as per institute norms

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