Scheme of B. Sc. Mathematics

Year	Course Code	Subject Name	Theory/ Practical	Total Credit	Total Marks	
					Max	Min
First year	MATH-1T	Calculus	Theory	4	50	33
	MATH-2T	Algebra	Theory	4	50	
	MATH-1P **(Any One)**	Lab 1 : Calculus and Algebra	Practical	2	50	17
		Project 1 : History of Mathematicians	Project	2	50	17
Second year	MATH-3T	Differential Equations	Theory	4	50	33
	MATH-4T	Real Analysis	Theory	4	50	
	MATH-2P **(Any One)**	Lab 2 : Differential Equations and Real Analysis	Practical	2	50	17
		Project 2 : History of Mathematicians	Project	2	50	17
Third year	MATH-5T **Optional I (Any One)**	Mechanics	Theory	4	50	33
		Numerical Methods	Theory	4	50	
		Linear Algebra	Theory	4	50	
		Integral Transforms and Fourier Analysis	Theory	4	50	
	MATH-6T **Optional II (Any One)**	Discrete Mathematics	Theory	4	50	
		Tensors and Differential Geometry	Theory	4	50	
		Number Theory	Theory	4	50	
		Probability and Statistics	Theory	4	50	
	MATH-3P **(Any One)**	Lab 3 : Mathematics Paper 1 and Paper 2	Practical	2	50	17
		Project 3 : History of Mathematicians	Project	2	50	17

Note: There shall be four extra credits in all the years of under graduation for internship/apprenticeship. The certificate of extra credits would be provided by the concern university and is not mandatory.

Part A: Introduction				
Program: **Diploma Course**		Class: **B.A/ B.Sc. II Year**	Year: **2022**	Session: **2023-2024**
1	Course Code	**MATH-2P (I)**		
2	Course Title	I - Lab 02 - Differential Equations and Real Analysis		
3	Course Type	**Practical**		
4	Pre-requisite (if any)	No		
5	Course Learning Outcomes (CLO)	This course will enable the students to • Learn Free and Open Source Software (FOSS) tools for computer programming • Solve problem on differential equations and real analysis theory studied in Mathematics Paper 1 and 2 by using FOSS software's. • Acquire knowledge of applications of Differential Equations and Real Analysisthrough FOSS.		
6	**Credit Value**	**2**		
7	**Total Marks**	**Max. Marks: 50**	**Min Passing Marks : 17**	

Part B: Content of the Course	
	Total Periods: 30
Tentative Practical List	Mathematics practical with Free and Open Source Software (FOSS) tools for computer programs, such as GeoGebra/Maxima/Scilab/ Octave /Python/R. **Course Objectives:** • To learn Free and Open Source Software (FOSS) tool for computerprogramming • Acquire knowledge of applications of differential equations and real analysisthrough FOSS **List of Practicals**: (At least 10 practicals) • Solution of differential equation and plotting the graph of the solution:Variable separable. • Solution of differential equation and plotting the graph of the solutionHomogeneous equations. • Solution of differential equation and plotting the graph of the solution:Linear differential equations.

	• Solution of differential equation and plotting the solution: Bernoulli'sequations • Solution of second and higher order ordinary differential equations withconstant coefficients • Solution of second order ordinary differential equations with variable coefficients by i) Method of variation of parameters ii) When the equationis exact. • Finding complementary function and particular integral of constantcoefficient second and higher order ordinary differential equations. • Solving second order linear partial differential equations in two variableswith constant coefficient. • Solutions to the problems on total and simultaneous differential equations. • Solutions to the problems on different types of Partial differentialequations. • Illustration of convergent, divergent and oscillatory sequences. • Using Cauchy's criterion to determine convergence of a sequence(simple examples). • Illustration of convergent, divergent and oscillatory series. • Programs to find the sum of the series and its radius of convergence. • Using Cauchy's criterion on the sequence of partial sums of the series todetermine convergence of series. • Testing the convergence of binomial, exponential and logarithmic seriesand finding the sum. • To verify the given function is Riemann integrable or not over arbitraryclosed interval [a, b].

Part C - Learning Resource		
Text Books, Reference Books, Other Resources		
SUPPORT FROM THE GOVT FOR STUDENTS AND TEACHERS IN UNDERSTANDING AND LEARNING FOSS TOOLS: As a national level initiative towards learning FOSS tools, IIT Bombay for MHRD, government of India is giving free training to teachers interested in learning open source software's like scilab, maxima, octave, geogebra and others. (Website: http://spoken-tutorial.org;) (email: info@spokentutorial.org; contact@spoken-tutorial.org)		
Part D: Assessment and Evaluation		
Suggested Continuous Evaluation Methods: Maximum Marks: 50 Continuous Comprehensive Evaluation (CCE): Not Applicable University Exam(UE): 50 Marks		
Internal Assessment: Continuous Comprehensive Evaluation (CCE)	Class Test/Assignment/Presentation	Not Applicable

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Part A: Introduction				
Program: **Diploma Course**		Class: **B.A./ B.Sc. II Year**	Year: **2022**	Session: **2023-2024**
1	Course Code	**MATH-2P (II)**		
2	Course Title	II - Project 02 - History of Mathematician		
3	Course Type	**Project**		
4	Pre-requisite (if any)	No		
5	Course Learning Outcomes (CLO)	Studying history of mathematicians help students: • Develop a deeper understanding of the mathematics they hare already studied by seeing how it was developed over time and in various places. • Know the rich intellectual heritage of the country. • Develop an appreciation of mathematics and build positive attitude towards mathematics increasing student's motivation decreasing anxiety related the subject. • To acquire knowledge about development of mathematics in ancient , medieval and modern period of history.		
6	**Credit Value**	**2**		
7	**Total Marks**	**Max. Marks: 50**	**Min Passing Marks : 17**	

Part B: Content of the Course	
Total Periods: 30	
Project List	**Course Objectives:** An elective course designed to acquire special / advance knowledge, such as supplement study / support study to a project work and a candidate study such a course on his own with an advisory support by a teacher / faculty member. **Project** Contributions and biographies of Indian Mathematicians Aryabhatta , Varahmihir , and Bhaskar I ,Shreedharacharya , Shreepati and Parmeshwar and contribution involved in contents of the paper of Differential Equations and Real Analysis. (Any 10 Mathematicians)

Part C - Learning Resource		
Text Books, Reference Books, Other Resources		
Part D: Assessment and Evaluation		
Suggested Continuous Evaluation Methods: Maximum Marks: 50 Continuous Comprehensive Evaluation (CCE): Not Applicable University Exam(UE): 50 Marks		
Internal Assessment: Continuous Comprehensive Evaluation (CCE)	Class Test/Assignment/Presentation	Not Applicable

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Part A: Introduction				
Program: Diploma Course		Class: B. A / B.Sc. Part II	Year: 2022	Session:2023-2024
1	Course Code	Paper – MATH-3T		
2	Course Title	Differential Equations		
3	Course Type	Theory		
4	Pre-requisite (if any)	No		
5	Course Learning Outcome (CLO)	**This Course will enable the students to:** • Understand the genesis of ordinary as well as partial differential equations. • Learn various techniques of getting exact solutions of certain solvable first order differential equations and linear differential equations of second order. • Know Picard's method of obtaining successive approximations of solutions of first order ordinary differential equations, passing through a given point in the plane. • Learn about solution of first order linear partial differential equations using Lagrange's method. • Know how to solve second order linear partial differential equations with constant coefficients. • Formulate mathematical models in the form of ordinary and partial differential equations to problems arising in physical, chemical and biological disciplines.		
6	Credit Value	4		
7	Total Marks	Maximum Marks : 50	Minimum Passing Marks :	

Part B: Content of the Course Total Periods: 60		
Unit	Topics	No. of Periods
I	**First Order Differential Equations:** Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p, Clairaut's form and singular solutions; Picard's	12

	method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.	
II	**Second Order Linear Differential Equations:** Statement of existence and uniqueness theorem for the solution of linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Euler-Cauchy equations, Coupled linear differential equations with constant coefficients.	12
III	**First Order Partial Differential Equations:** Genesis of Partial differential equations (PDE), Concept of linear and non-linear PDEs, Methods of solution of Simultaneous differential equations of the form: $dx/P(x,y,z) = dy/Q(x,y,z) = dz/R(x,y,z)$, Lagrange's method for PDEs of the form: $P(x,y,z)p+Q(x,y,z)q=R(x,y,z)$, where $p=\partial z/\partial x$ and $q=\partial z/\partial y$; Solutions passing through a given curve.	12
IV	**Second order Partial differential equations:** Principle of superposition for homogeneous linear PDEs, Relation between solution sets of non-homogeneous linear PDEs and their corresponding homogeneous equations, Reducible and irreducible homogeneous equations and their solutions in various possible cases, Solution of non-homogeneous reducible equations using Lagrange's method for first order equations.	12
V	**Applications:** Orthogonal trajectories of one-parameter families of curves in a plane, Minimum velocity of escape from Earth's gravitational field, Newton's law of cooling, Malthusian and logistic population models, Radioactive decay, Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits, Surfaces orthogonal to a given system of surfaces.	12

Part C - Learning Resource

Text Books and Reference Books:

1. Erwin Kreyszig . *Advanced Engineering Mathematics* (10th edition). J. Wiley &Sons 2011
2. B. Rai & D. P. Choudhury. *Ordinary Differential Equations - An Introduction*.Narosa Publishing House Pvt. Ltd. New Delhi. 2006
3. Shepley L. Ross. *Differential Equations* (3rd edition). Wiley. 2007
4. George F. Simmons. *Differential Equations with Applications and HistoricalNotes* (3rd edition). CRC Press. Taylor & Francis. 2017

5. Ian N. Sneddon. *Elements of Partial Differential Equations*. Dover Publications. 2006

E-Resources:

1. Suggested Equivalent **online courses:** Web link NPTEL/ SWAYAM/ MOOCs
2. Differential equation
   https://www.youtube.com/watch?v=NBcGLLU90fM&list=PLbMVogVj5nJSGlf9sluucwobyr_zz6glD
3. Partial Differential equation
   https://www.youtube.com/watch?v=Kk5SEzASkZU&list=PL9m2Lkh6odgKbfY03TFRhwjOqW79UdzK8

Part D: Assessment and Evaluation	
Suggested Continuous Evaluation Methods:	
Maximum Marks:	50 Marks

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Part A: Introduction				
Program: Diploma Course		Class: B. A. / B.Sc. Part II	Year: 2022	Session:2023-2024
1	Course Code	Paper – MATH-4T		
2	Course Title	Real Analysis		
3	Course Type	Theory		
4	Pre-requisite (if any)	No		
5	Course Learning Outcome (CLO)	**This Course will enable the students to:** • Understand basic properties of real number system such as least upper bound propertyand order property. • Realize importance of bounded, convergent, Cauchy and monotonic sequences of real l numbers, find their limit superior and limit inferior. • Apply various tests to determine convergence and absolute convergence of a series of real numbers. • Learn about Riemann integrability of bounded functions and algebra of R- integrable functions. • Determine various applications of the fundamental theorem of integral calculus. • Relate concepts of uniform continuity, differentiation, integration and uniformconvergence.		
6	Credit Value	4		
7	Total Marks	Maximum Marks : 50	Minimum Passing Marks :	

Part B: Content of the Course Total Periods: 60		
Unit	Topics	No. of Periods
I	**Real Numbers:** The set of real numbers $\mathbb{R}$ as an ordered field, Least upper bound properties of $\mathbb{R}$, Metric property and completeness of $\mathbb{R}$, Archimedean property of $\mathbb{R}$, Dense subsets of $\mathbb{R}$, Nested intervals property; Neighbourhood of a point in $\mathbb{R}$, Open sets, limit point of a set, closed and perfect sets in $\mathbb{R}$, connected and compact subsets of $\mathbb{R}$, Heine-Borel theorem.	12
II	**Convergence of Sequences in $\mathbb{R}$:** Bounded and monotonic sequences, Convergent sequence and its limit, Limit theorems, Monotone convergence	12

	theorem, Subsequences, Bolzano-Weierstrass theorem, Limit superior and limit inferior, Cauchy sequence, Cauchy's convergence criterion.	
III	**Infinite Series:** Convergence of a series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence: Comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Abel's test, Integral test; Alternating series, Absolute and conditional convergence, Leibniz theorem, Rearrangements of series, Riemann's rearrangement theorem.	12
IV	**Riemann Integration:** Riemann integrability of bounded functions, Examples of R-integrable and non-integrable functions, Algebra of Riemann integrable functions, Integrability of continuous and monotonic functions, Darboux theorems, Fundamental theorem of integral calculus, First mean value theorem and second mean value theorems (Bonnet and Weierstrass forms). Necessary and sufficient condition for Riemann integrable function (Statement only).	12
V	**Uniform Convergence, Continuity and Improper Integrals:** Pointwise and uniform convergence of sequence and series of functions, Uniform continuity, Weierstrass's M-test, Uniform convergence and continuity, Uniform convergence and differentiability, Improper integrals and tests for improper integrals, Beta and Gamma functions.	12

Part C - Learning Resource

Text Books, Reference Books:

1. T. M. Apostol. *Mathematical Analysis: A Modern Approach to AdvancedCalculus*. Pearson Education. 2008
2. Charalambos D. Aliprantis &) Owen Burkinshaw. *Principles of Real Analysis* (3rd edition). Academic Press. 1998
3. Robert G. Bartle & Donald R. Sherbert. *Introduction to Real Analysis* (4thedition).Wiley India. 2015
4. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough. *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd. 2015
5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis.* Springer-Verlag.
6. K. A. Ross. *Elementary Analysis*: *The Theory of Calculus* (2nd edition).Springer. 2013

7 Walter Rudin. *Principles of Mathematical Analysis* (3rd edition), Tata McGraw Hill.

E-Resources:

1. Suggested Equivalent **online courses:** Web link NPTEL/ SWAYAM/ MOOCs
2. https://www.youtube.com/watch?v=Bef8QjIjCy0&list=PLbMVogVj5nJQ1UXrOm7KqTg9UKk6eXRp_
3. https://www.youtube.com/watch?v=C2qIoHkhEuM&list=PLOzRYVm0a65cpVtcdj_5SBEh6VQvC_BvR

Part D: Assessment and Evaluation

Suggested Continuous Evaluation Methods:
Maximum Marks: 50 Marks

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