Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme (w.e.f. 2020-21)

M. Sc. (Mathematics) **I^st year / I^st Semester**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							United Nations Sustainable Development Goals (SDGs
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	MT406	Real Analysis	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
2	MT407	Modern Algebra	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
3	MT408	Ordinary Differential Equations	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
4	MT409	Discrete Mathematics	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
5	MT410	Complex Analysis	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
6	MT411	Statistical Techniques	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
			Total	**18**	**06**	**00**	**240**	**120**	**360**	**240**	**600**	**24**	**24**								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

Integral University, Lucknow

Effective from Session: 2022 - 23							
Course Code	MT406	**Title of the Course**	Real Analysis	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	
Pre-Requisite	B. Sc. with Mathematics	**Co-requisite**					
Course Objectives	1. To familiarize students with various concepts of Real Analysis. 2. The course will help the student to understand sequence and Series of functions (convergent and uniform convergent), 3.The course will also develop an understanding of solving Riemann Stieltjes integral and Power series. 4. The course will further develop understanding the concepts of Cauchy criterion for uniform convergence.						

Course Outcomes	
CO1	Students will gain an understanding of countability of Sets, Lebesgue measure on the real line, Length of intervals. They will also learn about Cantor set, outer and inner Lebesgue measure, Lebesgue measurable sets and properties of measurable sets.
CO2	Students will be able to understand Sequence and Series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence. They will learn to define Weierstrass M test, Abel's and Dirichlet's test, for uniform convergence. Properties of uniformly convergent series of functions.
CO3	Students will create the own understanding of Weierstrass approximation theorem, some integrable functions, Definition and existence of Pointwise and uniform convergence, Properties and some important theorems on Riemann Stieltjes integral.
CO4	Students will be able to understand the concepts of Power series and radius of convergence and interval of convergence. Uniqueness theorem of power series. They will also learn about Abel's and Taylor's theorem, Riemann's theorem.
CO5	Students will create the own understanding of functions of several variables, partial derivatives and total derivatives. They will learn about Jacobian, chain rule, interchange of the order of differentiation & higher derivatives. Students will also be able to understand inverse function theorem and implicit function.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Real Numbers & measurable sets	Countability of Sets, Lebesgue measure on the real line, length of intervals, Cantor set. Outer and inner Lebesgue measure, Lebesgue measurable sets, properties of measurable sets.	8	1
2	convergence & uniform convergence	Sequence and Series of functions, pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M test, Abel's and Dirichlet's test for uniform convergence. Properties of uniformly convergent series of functions	8	2
3	Reimann Stieltjes integral	Weierstrass approximation theorem, some integrable functions. Definition and existence of Pointwise and uniform convergence, Properties and some important theorems on Riemann Stieltjes integral.	8	3
4	Power Series	Power Series, Radius of convergence and interval of convergence. Uniqueness theorem of power series, Abel's, Taylor's theorem and Riemann's theorem.	8	4
5	Partial and Total differentiations	Functions of several variables, properties of Jacobians. Partial derivatives, Total derivative, Jacobian, Chain rule, interchange of the order of differentiation, higher derivatives, inverse function theorem, implicit function theorem.	8	5

Reference Books:

1. W. Rudin: Principle of Mathematics Analysis
2. D. Somasundramand B.Choudhary: A First Course in Mathematical Analysis, Narosa, 199
3. S.C.Malik:Mathematical Analysis, Wiley Eastern, India
4. Jain,P.K. & GuptaV.P., Lebesgue measure and Integration,Willey Eastern Ltd., New Age Int. Ltd., New Delhi, (1994).

e-Learning Source:

https://www.youtube.com/watch?v=Xx7ULr79fy0&list=PLbMVogVj5nJSxFihV-ec4A3z_FOGPRCo-&index=4

https://www.youtube.com/watch?v=Xx7ULr79fy0&list=PLbMVogVj5nJSxFihV-ec4A3z_FOGPRCo-&index=4

https://www.youtube.com/watch?v=AqHxSRul-Ck

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	1	3	3	2	1	1
CO2	3	1	2	1	3	1	2	3	3	3	2	1
CO3	3	1	2	1	3	1	1	3	3	2	2	1
CO4	3	1	1	1	2	1	2	3	3	2	1	1
CO5	3	1	1	1	2	1	1	2	3	3	1	1

1. **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2015 - 16							
Course Code	MT407	**Title of the Course**	Modern Algebra	**L**	**T**	**P**	**C**
Year		**Semester**	I	**3**	**1**	**0**	
Pre-Requisite	B.Sc. with Mathematics	**Co-requisite**					
Course Objectives	The objective is to discuss the basic concept to certain classes of groups and rings. The course deals with some algebraic structures, their properties and some of the basic results related to group and ring theory. Modern algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill.						

Course Outcomes	
CO1	Students will be able to explain the fundamental concept of Certain classes of groups.
CO2	Students will be able to describe Sylow's theorem and their applications.
CO3	Students will be an understanding of ideals and quotient of rings.
CO4	Students will be able to describe integral domains and divisibility in integral domains.
CO5	Students will be able to explain fields, splitting fields and field extensions.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Unit-1**	Normal subgroups and Quotient groups, Permutation groups, Homomorphisms, Cayley's theorem.	8	1
2	**Unit-2**	Conjugate elements, Class equation, Cauchy theorem, Sylow's theorems and its applications.	8	2
3	**Unit-3**	Quotient of rings, Maximal and prime ideals, Homomorphisms, Polynomial rings.	8	3
4	**Unit-4**	Integral domain, Divisibility in integral domains, Unique factorization domains, Principal ideal domains, Euclidean domains, Polynomial rings over UFD.	8	4
5	**Unit-5**	Fields, Extension of fields, Splitting fields, Algebraic extensions of fields: Irreducible and reducible polynomials.	8	5

Reference Books:

1. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd.
2. Joseph A. Gallian: Contemporary Abstract Algebra, Narosa Publishing House.
3. Surjeet Singh and Qazi Zameeruddin: Modern Algebra, Vikas Publishing House.

e-Learning Source:

1. https://nptel.ac.in/courses/111/105/111105112/
2. https://nptel.ac.in/courses/111/106/111106131/
3. https://nptel.ac.in/courses/111/105/111105112/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	1	3	3	2	1	1
CO2	3	1	2	1	3	1	2	3	3	3	2	1
CO3	3	1	2	1	3	1	1	3	3	2	2	1
CO4	3	1	1	1	2	1	2	3	3	2	1	1
CO5	3	1	1	1	2	1	1	2	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2015 - 16							
Course Code	MT408	**Title of the Course**	Ordinary Differential Equations	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	**3**	**1**	**0**	
Pre-Requisite	B.Sc (Mathematics)	**Co-requisite**					
Course Objectives	To put it briefly, the point of this class is to take your existing knowledge of calculus and apply it towards the construction and solution of mathematical models in the form of differential equations.						

Course Outcomes	
CO1	Student will be able to find the complete solution of a non homogeneous differential equation as a linear combination of the complementary function and a particular solution.
CO2	Student will be introduced to the complete solution of a non homogeneous differential equation with constant coefficients by the method of undetermined coefficients
CO3	Students will be able to Use power series to solve first-order and second-order differential equations.
CO4	Successful students in Boundary Value Problems and Differential Equations will be knowledgeable about and will be able to analyze solutions to two-point boundary value problems
CO5	Students will gain an understanding of Stability of dynamical systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit-1**	Linear differential equations of nth order, fundamental sets of solutions, Wronskian Abel's identity, theorem on linear dependence of solutions, adjoint, self-adjoint linear operator, Green's formula	8	1
2	**Unit-2**	Adjoint equations, the nth order non homogeneous linear equations, Variation of parameters, zeros of solutions, comparison and separation theorems.	8	2
3	**Unit-3**	Power series, solution of linear differential equations, ordinary and singular points of differential equations, Classification into regular and irregular singular points, series solution about an ordinary point and regular singular point.	8	3
4	**Unit-4**	Existence and uniqueness of solutions: Lipschitz Condition, Successive Approximation, Picard's theorem for initial value problem, Homogeneous BVP, Non-Homogeneous BVP , Sturm Liouville's problem , Green's function, non-existence of solutions , Picard's theorem for BVP.	8	4
5	**Unit-5**	Stability of Linear system, Stability of Quasi-linear system, Stability of autonomous system, Stability of non-autonomous system, a particular Lyapunav Function.	8	5

Reference Books:

1. M. D. Rai Singhania, Advance differential equations – S. Chand , 1995.
2. M. D. Rai Singhania, Ordinary differential equations – S. Chand . 1995
3. P. Haitman: Ordinary Differential Equations, Wiley, New York, 1964.
4. E.A. Coddington and H. Davinson: Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.

e-Learning Source:

1. https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/
2. https://nptel.ac.in/courses/111/106/111106100/
3. http://www.math.iitb.ac.in/~siva/afs07.pdf

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	1	3	3	2	1	1
CO2	3	1	2	1	3	1	2	3	3	3	2	1
CO3	3	1	2	1	3	1	1	3	3	2	2	1
CO4	3	1	1	1	2	1	2	3	3	2	1	1
CO5	3	1	1	1	2	1	1	2	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2015 - 16							
Course Code	MT409	**Title of the Course**	Discrete Mathematics	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	**3**	**1**	**0**	
Pre-Requisite	B. Sc. with Mathematics	**Co-requisite**					
Course Objectives	1. To familiarize students with various concepts of Discrete mathematics. 2. The course will help the student to understand propositions and their truth values. 3.The course will also develop an understanding of the elements of Boolean algebra and its various aspects. 4. The course will further develop understanding of graphs & trees with its applications.						

Course Outcomes	
CO1	Students will gain an understanding of Statements, connectives, Truth tables, Tautologies & Contradictions, Equivalences & Implications. They will be able to understand and implement Normal forms. along with Quantifier, Predicates, Posets & Lattices and also about Lattices on Algebraic systems, Sub-lattices. Understand the formation of Hasse diagram
CO2	Students will be able to understand Boolean identities, the switching algebra, sub-algebra, Direct product & homomorphism. Boolean forms & their equivalences. They will learn to form Sum of products & Product of sums form, Normal form, Canonical form, Boolean expression & Boolean functions with the help of Karnaugh map method.
CO3	Students will create the own understanding of Permutations & combinations, Pigeon hole principle. They will learn about Recurrence relation and also about their solution by characteristic roots and Generating function.
CO4	Students will be able to understand degree of a vertex different types of graphs including Eulerian & Hamiltonian graphs. They will also learn about representation of graphs with the help of matrix. and Graph colouring. They will be able to know about Trees, Binary tree, their types and their properties. They also learn about spanning tree and their formation by Kruskal's algorithm.
CO5	Students will create the own understanding of relations and their representation by matrix & Digraph. They will learn about Paths & connectivity, composition of relations. Students will also be able to understand Function, their Classification, their types & their composition, growth of functions, Recursive function.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Mathematical logic & Lattices	Statements, connectives, Truth tables, Tautologies & Contradictions. Equivalences & Implications. Normal forms, Quantifier & Predicates. Posets & Lattices, Hasse diagram, Lattices on Algebraic systems, Sub-lattices.	8	1
2	Boolean Algebra	Boolean identities, the switching algebra, sub-algebra, Direct product & homomorphism. Boolean forms & their equivalences. Sum of products & Product of sums form, Normal form, Canonical form, Boolean expression & Boolean functions-the Karnaugh map method.	8	2
3	Combinatorics	Permutations & combinations, Pigeon hole principle, Recurrence relation, solution by characteristic roots, Generating function	8	3
4	Graphs & Trees	Degree of a vertex, types of graphs, Eulerian & Hamiltonian graphs, Matrix representation of graphs, Graph coloring. Trees: Properties, spanning tree, Kruskal's algorithm, Binary tree, tree reversal.	8	4
5	Relation & Functions	Properties, matrix & Digraph representation of relation, Paths & connectivity, composition of relations. Functions: Classification, types & composition of functions, growth of functions, Recursive function.	8	5

Reference Books:

1. Elements of Discrete Mathematics, C.L.Liu, Tata McGraw-Hill Publishing Company Ltd, New Delhi.
2. Discrete Mathematical Structures, Kolman, Busby & Ross, 4e, Prentice Hall of India.
3. Discrete Mathematics with Graph theory, Goodaire & Parmenter, 2e, Pearson.
4. Discrete Mathematical Structures, J.P.Tremblay & R.Manohar, McGraw-Hill Book co.

e-Learning Source:

1. https://freevideolectures.com/course/3517/discrete-mathematics
2. http://home.iitk.ac.in/~arlal/book/mth202.pdf
3. https://www.cis.upenn.edu/~jean/discmath-root-b.pdf

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	1	3	3	2	1	1
CO2	3	1	2	1	3	1	2	3	3	3	2	1
CO3	3	1	2	1	3	1	1	3	3	2	2	1
CO4	3	1	1	1	2	1	2	3	3	2	1	1
CO5	3	1	1	1	2	1	1	2	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlatio

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2015 - 16							
Course Code	MT410	**Title of the Course**	Complex Analysis	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	**3**	**1**	**0**	
Pre-Requisite	B.Sc. with Maths	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart basic and key knowledge of complex analysis. By using the principal of pure and applied mathematics to obtain quantitative relations which are very important for higher studies. After successfully completion of course, the student will able explore subject into their respective dimensions						

Course Outcomes	
CO1	Find and interpret Analytic functions, Cauchy Riemann Equations, Harmonic function, velocity potential, Cauchy Integral Theorem and Cauchy integral formula
CO2	Evaluate and Interpret the Power series, Uniform convergence, Taylor's series, zeros of analytic functions, Laurent's series, Integration and differentiation of power series, multiplication and division of power series.
CO3	Describe and evaluate the Cauchy residue theorem, evaluation of real definite integration when function has no pole on real axis and pole lies on real axis, Integral involving many valued functions, contour
CO4	State and explain Conformal bilinear exponential and trigonometric transformations, special bilinear and Schwarz,-Christoffel transformations
CO5	State and explain the Weierstrass's theorem, principle of maximum modulus, Schwarz's lemma, Picard's theorem, Jensen inequality and formula, Hadamard's three circle theorem and as a convexity

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit-1**	Analytic functions, Cauchy Riemann Equations, Harmonic function, velocity potential, Milne's Thomson method, Cauchy Integral Theorem and Cauchy integral formula	8	1
2	**Unit-2**	Power series, Uniform convergence, Taylor's series, zeros of analytic functions, Laurent's series, Integration and differentiation of power series, multiplication and division of power series.	8	2
3	**Unit-3**	Cauchy residue theorem, evaluation of real definite integration when function has no pole on real axis and pole lies on real axis, Integral involving many valued function, rectangular contours	8	3
4	**Unit-4**	Conformal bilinear exponential and trigonometric transformations, special bilinear and Schwarz, -Christoffel transformations.	8	4
5	**Unit-5**	Weierstrass's theorem, principle of maximum modulus, Schwarz's lemma, Picard's theorem, Jensen inequality and formula, Hadamard's three circle theorem and as a convexity	8	5

Reference Books:

1. L. V. Alforse, Complex Analysis, McGraw-Hill Book Company
2. B. Chaudhary, The elements of Complex Analysis, Wiley Eastern
3. Shanti Narayan, Theory of Functions of a complex variable, S. Chand & Co.

e-Learning Source:

1. http://www.bhojvirtualuniversity.com/slm/mscmath1p4.pdf
2. http://web.math.ku.dk/noter/filer/koman-12.pdf
3. https://www.youtube.com/watch?v=YORGYJKDDN0

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	1	3	3	2	1	1
CO2	3	1	2	1	3	1	2	3	3	3	2	1
CO3	3	1	2	1	3	1	1	3	3	2	2	1
CO4	3	1	1	1	2	1	2	3	3	2	1	1
CO5	3	1	1	1	2	1	1	2	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2018 – 19							
Course Code	MT411	**Title of the Course**	Statistical Techniques	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	**3**	**1**	**0**	
Pre-Requisite	B.Sc. with Mathematics	**Co-requisite**					
Course Objectives	To teach the basic concepts used to describe data. Probability theory and testing of hypothesis. This is a great beginner course for those interested in Data Science, Economics, Psychology, Machine Learning, Sports analytics and just about any other related field.						

Course Outcomes	
CO1	Understand of data, scales of measurement, presentation of data with the help of diagrams and graphs.
CO2	Description of data through its central value, variability and shape.
CO3	Understanding of bi-variate data, degree of its relationship and functional relationship between variables. Prediction of future values.
CO4	Explain the concept of weighted and unweighted index numbers, its applications to real life. Consumer Index number.
CO5	Understand the theory of attributes. Contingency tables, class frequencies and ultimate class frequencies, consistency of attributes, association of attributes, independence of attribute

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Unit-1**	Discrete and continuous data, Frequency and non-frequency data, primary and secondary data, diagrammatic and graphical representation of grouped data, frequency and cumulative frequency distribution and their applications, histogram, frequency polygon, ogives. Concept of central tendency and its measures, partition values, dispersion and relative dispersion, moments, Sheppard's	8	1
2	**Unit-2**	Scatter diagram, Karl Pearson's and spearman's rank correlation coefficients, coefficient of determination, correlation ratio, principle of least squares, fitting of linear regression and related results, partial and multiple correlations of three variables, their measures and related results.	8	2
3	**Unit-3**	Random experiment, trial, sample point, sample space, definitions of equally likely, mutually exclusive and exhaustive events, definition of probability, classical, relative frequency and axiomatic approaches to probability, conditional probability, independence of events, Bayes theorem and its applications.	8	3
4	**Unit-4**	Discrete and continuous random variable, expectation and variance of random variables, Probability mass/ density function, distribution function, joint density function of two continuous variables, marginal and conditional probability density functions, uniform, binomial, Poisson, geometric, negative binomial, hyper geometric and normal distributions.	8	4
5	**Unit-5**	null and alternative hypotheses, critical region, types of error, level of significance, p-value, size and power of a test, Z, t, chi-square & F tests, analysis of variance: one way and two-way classifications.	8	5

Reference Books:

1. Spiegel M.R. (1967): Theory and problem of Statistics, Schaum's Publishing Series
2. Goon A.M., Gupta M.K. and Das Gupta B. (1991): Fundamental of Statistics, Vol. I, World Press, Calcutta.
3. Meyer P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
4. Hogg R.V. and Craig A.T. (1972): Introduction to mathematical Statistics, Amerind Publishing Co.

e-Learning Source:

1.https://www.youtube.com/watch?v=PWbOq-Inmck

2. https://www.youtube.com/watch?v=KIBZUk39ncI

3.https://www.youtube.com/watch?v=jBQCwbHfKoM

4. https://www.youtube.com/channel/UCGT0pirandEMtvu-3JwePSw

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PO03	PO4
CO1	3	1	1	1	2	1	1	3	3	2	1	1
CO2	3	1	2	1	3	1	2	3	3	3	2	1
CO3	3	1	2	1	3	1	1	3	3	2	2	1
CO4	3	1	1	1	2	1	2	3	3	2	1	1
CO5	3	1	1	1	2	1	1	2	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow
Department of Mathematics & Statistics
Study and Evaluation Scheme (w.e.f. 2020-21)

M. Sc. (Mathematics) **Ist year / IInd Semester**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Total	Credit	Total Credits	Attributes							United Nation Sustainable Development Goals (SDGs
				L	T	P	CT	TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
THEORIES																					
1	MT413	Differential Geometry I	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
2	MT414	Partial Differential Equations	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
3	MT415	Numerical Analysis	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
4	MT416	Linear Algebra	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
5	MT417	Problem Solving and Computer Programming through C	**Core**	03	01	00	40	20	60	40	100	3:1:0	4	√		√					
PRACTICAL																					
6	MT418	Numerical Analysis Lab through C/MATLAB	**Core**	00	00	04	40	20	60	40	100	0:0:2	2	√		√					
			Total	**15**	**05**	**04**	**240**	**120**	**360**	**240**	**600**	**22**	**22**								

CT = Class Test; **TA** = Teacher's Assessment,; **ESE** = End Semester Examination; **Sessional** = CT + TA; **Subject Total** = Sessional + ESE

Integral University, Lucknow

Effective from Session: 2022 - 23							
Course Code	MT413	**Title of the Course**	Differential Geometry I	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	
Prerequisite	B.Sc. with Mathematics	**Co-requisite**					
Course Objectives	1. This is an introductory course on curves and surfaces. The aim of this course is to introduce and develop basic analytic concepts of osculating plane, curvature and torsion of the space curves. 2. This course is aimed to provide an understanding of the first and second fundamental forms of a smooth surface and the concepts of various different types of curvature associated to a surface.						

Course Outcomes	
CO1	Understand the mathematical tools of tensor calculus and apply it to the geometry of curves and surfaces.
CO2	Able to calculate the curvature and torsion of a space curves and how they suffice to determine the shape of the curve.
CO3	Make logical arguments on fundamental forms, Gaussian and mean curvatures to determine the shape of the curve.
CO4	Characterize the surfaces to totally umbilical and minimal surfaces and efficiently compute the fundamental equations to the surface.
CO5	Demonstrate the basic concepts of Riemannian manifolds and its submanifolds.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Tensor Analysis**	Coordinate transformation, Dummy index, Kronecker delta, Covariant, Contravariant and Mixed tensors, Tensors of higher rank, Symmetric and Skew-symmetric tensors, Tensor algebra, Contraction, Inner product, Metric tensor, Christoffel symbols.	8	1
2	**Space curves**	Space curves, parametric representation of curves, Arc length, Tangent line, order of contact, Osculating plane (or curvature plane), Principal normal, Binormal, The unit vectors t, n, b, Curvature and torsion, Serret-Frenet formula.	8	2
3	**Surface Theory**	Concept and definition of surfaces, Regular point and singular point on a surface, Regular point and singular point on a surface, Tangent plane and normal plane, First fundamental form or metric, geometrical representation of metric, Element of area, Second fundamental form, Geometrical representation of second fundamental form, Intrinsic properties of surface, Normal curvature, Normal section, Principal direction.	8	3
4	**Fundamental Equations**	Principal curvatures, Gaussian curvature, Mean curvature, Gaussian equations, Weingarten equation, Codazzi-Mainardi equations, Minimal surfaces, Geodesic on surface.	8	4
5	**Riemannian Manifolds**	Riemannian manifolds, Riemannian metric, Riemannian connection, Riemannian curvature tensor, First Bianchi identity, Second Bianchi identity, Geodesic in a Riemannian manifold, Basic concepts of submanifolds of a manifold.	8	5

Reference Books:

1. Zafar Ahsan Tensor Calculus, , Anamaya Publications, New Delhi.
2. T.J. Wilmore An Introduction to Differential Geometry, Oxford University Press, New Delhi, 1993.
3. U.C. De & A.A. Shaikh Differential Geometry of Manifolds, Narosa Publishing House Pvt. Ltd, 2007.
4. Barret O' Neill Elementary Differential Geometry, Academic Press, 2006.

e-Learning Source:

1. https://www.youtube.com/watch?v=6xgtMQ7WSzQ
2. https://www.youtube.com/watch?v=-iOcBqxTkx0
3. https://www.youtube.com/watch?v=6js84WA8f58&list=PLq-Gm0yRYwTiFb-dfmrz4E8g6v6tg-x3j
4. https://www.youtube.com/watch?v=ImIQP9szMGs

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	1	3	3	2	1	1
CO2	3	1	2	1	3	1	2	3	3	3	2	1
CO3	3	1	2	1	3	1	1	3	3	2	2	1
CO4	3	1	1	1	2	1	2	3	3	2	1	1
CO5	3	1	1	1	2	1	1	2	3	3	1	1

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2015 - 16							
Course Code	MT414	**Title of the Course**	Partial Differential Equations	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**3**	**1**	**0**	
Pre-Requisite	B.Sc. with Mathematics	**Co-requisite**					
Course Objectives	The objective of this course is to form partial differential equations occurring in the various fields of science and engineering and to provide their analytic solutions.						

Course Outcomes	
CO1	Understanding of some modern methods for studying linear and nonlinear partial differential equations.
CO2	Students will be able to solve linear partial differential equations of both first and second order
CO3	Students will be able to apply partial derivative equation techniques to predict the behavior of certain phenomena.
CO4	Students will be able to extract information from partial derivative models in order to interpret reality
CO5	Students will be able to apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit 1**	First order partial differential equation, Formulation of first order partial equations, compatibility of first order partial differential equation, classification of the solutions of first order partial differential equation, solutions of Non-linear partial differential equation of first kind.	8	1
2	**Unit 2**	Second order partial differential equation, origin of second order partial differential equations, linear partial differential equations with constant coefficients, methods of solving linear partial differential equations, classification of partial differential equations, Riemann's method.	8	2
3	**Unit 3**	Wave equation, solution by the method of separation of variables and integral transforms, The Cauchy problem, Wave equation in cylindrical and spherical polar coordinates.	8	3
4	**Unit 4**	Laplace equation, solution by the method of separation of variables and transforms. Dirichlets, Neumann's and Churchills problems, Dirichlets problem for a rectangle, half plane and circle, solution of Laplace equation in cylindrical and spherical polar coordinates.	8	4
5	**Unit 5**	Solutions of boundary value problems: Green's function method for Hyperbolic, Parabolic and Elliptic equations...	8	5

Reference Books:

1. I. N. Sneddon, Elements of Partial Differential Equations, Tata McGraw Hill, New Delhi, 1983.
2. Lolenath Debnath, Nonlinear Partial Differential Equations for Scientists and Engineers, Birkhauser , Boston, 2007.
3. Robert C. McQwen, Partial Differential Equations, Pearson Education, 2004.
4. Shankar Rao, Partial Differential Equations, PHI, 2006.

e-Learning Source:

1. https://ocw.mit.edu/courses/mathematics/18-152-introduction-to-partial-differential-equations-fall-2011/
2. https://nptel.ac.in/courses/111/103/111103021/
3. https://online.stanford.edu/courses/me300b-partial-differential-equations-engineering

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1		2	1	1	3	3	2	1	1
CO2	3	1	2		3	1	1	3	3	3	2	1
CO3	3	1	2		3	1	1	3	3	2	2	1
CO4	3	1	1		2	1	1	3	3	2	1	1
CO5	3	1	1		2	1	1	3	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2022 - 23							
Course Code	MT415	**Title of the Course**	Numerical Analysis	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**3**	**1**	**0**	
Pre-Requisite	B.Sc. with Mathematics	**Co-requisite**					
Course Objectives	The course is aimed to develop the skills in numerical analysis which is necessary for grooming them into successful science graduate. The topics introduced will serve as basic tools for specialized studies in science field.						

Course Outcomes	
CO1	Apply Numerical analysis which has enormous application in the field of science and some fields of Engineering.
CO2	Familiar with numerical solutions of nonlinear equations in a single variable.
CO3	Familiar with finite difference and different type interpolation technique.
CO4	Familiar with calculation and interpretation of errors in numerical method.
CO5	Familiar with programming with numerical packages like C++ and MATLAB

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit 1**	Solution of algebraic and transcendental equations by Newton-Raphson's method, Stephenson method, Muller's method, Chebyshev method, Rate of convergence of Newton-Raphson's and Stephenson method. Eigen value Problem: Power method, Jacobi method and QR method	8	1
2	**Unit 2**	Various polynomial forms for approximating a given function by Newton's, Gauss's and Stirling's Interpolation formula, Lagrange and Newton's divided difference interpolation, Hermite interpolation, quadratic spline, piecewise, cubic spline and multidimensional interpolation.	8	2
3	**Unit 3**	Numerical differentiation using different interpolation formula, Euler Maclaurin's formula, Newton's Cote formula, Simpson's, Gauss' , Gaussian and Romberg formula for numerical integration and their error estimation, double integrals using trapezoidal and Simpson's rule.	8	3
4	**Unit 4**	Solution of initial value problems of first and second order by Runge Kutta method, Solution of initial value problems by finite difference equations and Adam's interpolation method Two points boundary value problems for second order linear and non-homogeneous differential equations, Shooting method with least square convergence criterion, finite element method.	8	4
5	**Unit 5**	Solution of Laplace and Poisson's equations by Liebman's method, solution of one-dimensional heat equation by Bender-Schmidt method, solution of one-dimensional wave equation by Crank-Nicholson's method, Laplace equation by relaxation method.	8	5

Reference Books:

1. Numerical Methods for Scientific and Engineering computation by M.K.
2. Jain, S.R.K. Iyengar, R.K. Jain, New Age Int. Ltd., New Delhi.
3. Numerical Methods by P. Kandasamy, S. Chand Publ. New Delhi.
4. Introduction to Numerical Analysis, by S.S. Sastry Prentice Hall Flied

e-Learning Source:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/111107105/lec6.pdf
2. https://nptel.ac.in/content/storage2/courses/122104018/node114.html
3. https://nptel.ac.in/courses/111107062/
4. https://www.yumpu.com/en/document/view/8662778/derivation-of-runge-kutta-method-nptel

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	2	1	1	3	2	1	1
CO2	3	2	2	1	1	3	2	1	3	3	2	1
CO3	3	2	3	1	1	3	1	1	3	2	2	1
CO4	3	2	3	1	1	2	2	1	3	2	1	1
CO5	3	2	1	1	1	3	1	1	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2018 - 19							
Course Code	MT416	**Title of the Course**	Linear algebra	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**3**	**1**	**0**	
Pre-Requisite	B.Sc. with Mathematics	**Co-requisite**					
Course Objectives	This course enables the students to understand the basic ideas of vector algebra, linear dependent and independent set and basis. Students of the course should master properties of matrices including how to use them to solve linear systems of equations and how they are used in linear transformations between vector spaces.						

Course Outcomes	
CO1	Students will be able to explain the concept of vector spaces and linear dependency of vectors.
CO2	Students will be able to describe basis, rank of matrices and direct sum of vector spaces.
CO3	Students will be an understanding of linear operators, their properties and algebra of transformations.
CO4	Students will be able to describe Matrix representation of a linear transformation and their applications.
CO5	Students will be able to explain eigen values, change of basis and diagonalization.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit 1**	Vector spaces, subspaces, examples, Linear dependence and independence, Spanning set, Linear span, Row space of matrix.	8	1
2	**Unit 2**	Basis and dimension, Application to matrices, Rank of matrices, Direct sums and complements, Quotient spaces.	8	2
3	**Unit 3**	Students will be an understanding of linear operators, their properties and algebra of transformations.	8	3
4	**Unit 4**	Students will be able to describe Matrix representation of a linear transformation and their applications.	8	4
5	**Unit 5**	Students will be able to explain eigen values, change of basis and diagonalization.	8	5

Reference Books:

1. Hoffman & Kunze: Linear Algebra
2. V Krishnamurthy: An introduction to linear algebra
3. Schaum's Outline Series: Linear Algebra

e-Learning Source:

1. https://nptel.ac.in/courses/111/105/111105112/
2. https://nptel.ac.in/courses/111/101/111101115/
3. https://nptel.ac.in/courses/111/106/111106135/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	3	1	2	3	3	2	1	1
CO2	3	2	2	2	2	1	3	3	3	3	2	1
CO3	3	2	2	2	2	1	2	2	3	2	2	1
CO4	3	2	2	2	2	1	2	3	3	2	1	1
CO5	3	2	1	2	3	1	2	3	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2018 - 19							
Course Code	MT417	**Title of the Course**	Problem solving and computer Programming through c	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**3**	**1**	**0**	
Pre-Requisite	B.Sc. with Mathematics	**Co-requisite**					
Course Objectives	Students will be able to understand the concepts of programming Language and design principles along with understanding of C programming in detail so that they can independently create their own program to solve the mathematical problems. Learning the basic programming constructs, they can easily switch over to any other language in future.						

Course Outcomes	
CO1	Students will Understand the problem-solving strategy and programming environment
CO2	Students will be able to describe basis, rank of matrices and direct sum of vector spaces.
CO3	Apply different algorithm and identify the way to write the effective program.
CO4	Able to manipulate arrays and strings in the programming. Analyze the use of functions and concept of function call for modular programming along with effective use of pointers.
CO5	Create complete program independently to solve the mathematical problems

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Unit 1**	Problem Identification, Problem Definition, Goal and Objective, Program Design and Implementation issue: Algorithm, Algorithm Generalization, Algorithm representation, Flow Chart. Program writing: sequence, iterative and selection logic. Type of Programming language: Machine level, assembly level, high level and scripting Languages. Programming language tools: Compiler, Interpreter, Linker, Editor.	8	1
2	**Unit 2**	C fundamentals: Character set, Constants, Identifiers, keywords, basic data types, Variables, Operators, Expressions, Statements, Input and Output statements – Structure of a C program – simple programs. Control statements: if, if-else, nested if, switch, while, do-while, for, break & continue. Nested loops.	8	2
3	**Unit 3**	Single dimensional arrays: defining an array, array initialization, accessing array elements. Programs for sequential search, binary search and bubble sort. Multidimensional arrays: defining a two-dimensional array, array initialization, accessing elements. Programs for matrix additions and multiplications.	8	3
4	**Unit 4**	Strings: declaring a string variable, reading and displaying strings, Programs for string matching and sorting. Functions: Function definition, function call, function prototype, parameter passing, void function Recursion of function.	8	4
5	**Unit 5**	Pointers: declaration, operations on pointers, accessing array elements using pointers, processing strings using pointers, pointer to pointer, array of pointers, pointer to function. Files: Different types of files in C. Opening & closing a file. Writing to and reading from a file. Dynamic memory allocation. Storage class associated with variables: automatic, static, and external and register.	8	5

Reference Books:

1. Programming in C (5e) – E. Balaguruswamy , Mc Graw Hill
2. Let us C – Yashwant Kanetkar, BPB.
3. How to Programme C Deitel & Deitel, Addison Wesley, Pearson Education Asia
4. Programming with C - Byron S. Gottfried, Tata McGraw Hill.

e-Learning Source:

1. https://nptel.ac.in/courses/106105171/
2. http://www.vssut.ac.in/lecture_notes/lecture1424354156.pdf
3. http://www2.cs.uregina.ca/~hilder/cs833/Other%20Reference%20Materials/The%20C%20Programming%20Language.pdf

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	2	2	2	3	2	1	1
CO2	3	2	1	1	1	1	1	2	3	3	2	1
CO3	3	2	1	1	1	1	1	1	3	2	2	1
CO4	3	2	1	1	1	2	1	1	3	2	1	1
CO5	3	2	1	1	1	2	2	2	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2015 - 16							
Course Code	MT418	**Title of the Course**	Numerical analysis Lab through Matlab/C	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**3**	**1**	**0**	
Pre-Requisite	B.Sc with Mathematics	**Co-requisite**					
Course Objectives	1.To familiarize students with numerical techniques needed in problem-solving and industrial applications by using C++. 2. The course will develop numerical methods aided by technology to solve algebraic, transcendental, and differential equations, and to calculate derivatives and integrals by using C++. 3.The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs. 4. The course will further develop problem solving skills.						

Course Outcomes	
CO1	Apply numerical methods to find our solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations.
CO2	Apply various interpolation methods and finite difference concepts
CO3	Work out numerical differentiation whenever and wherever routine methods are not applicable
CO4	Work out numerical integration whenever and wherever routine methods are not applicable
CO5	Work numerically on the ordinary differential equations using different methods through the theory of finite differences.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit 1**	Algebraic and transcendental equations using False Position method, Newton Raphson's method and Mullar's method, also give rate of convergence of roots in tabular form for each method	8	1
2	**Unit 2**	Interpolation by Newton's, cubic spline and Lagrange's formulae.	8	2
3	**Unit 3**	Numerical integration using Simpson's 1/3, Simpson's 3/8 and Romberg formulae.	8	3
4	**Unit 4**	Numerical solution of O.D.E. using Runge-KuttaI Vth order method.	8	4
5	**Unit 5**	Matrix addition, multiplication & inverse. Determinant of matrices. Algebraic and transcendental equations	8	5

Reference Books:

1.Programming in C (5e) – E. Balaguruswamy

2.Computer Based Numerical Techniques by Santosh Kumar

3.CBNT by Dr. Manish Goyal

e-Learning Source:

1.https://www.youtube.com/watch?v=zT83sJ5IrEE&list=PLyqSpQzTE6M-QT7PvEBHV0iNMvZk9mocO

2.https://www.youtube.com/watch?v=IuEOMyGuuIg&list=PLRWKj4sFG7-6_Xr9yqg6SMr_F80KdFVhN

3.https://www.youtube.com/watch?v=zjyR9e-N1D4&list=PL1A70C686CB3C95FC

4.https://www.youtube.com/watch?v=7Mg0b9Gc_mc

		Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1		2	1	2		3	2	1	1
CO2	3	1	1		1	2	2		3	3	2	1
CO3	3	1	1		1		2		3	2	2	1
CO4	3	1	1		1		2		3	2	1	1
CO5	3	1	1		1	2	2		3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**