AC 25.04.24 ITEM NO: 23.3

Deccan Education Society's

Kirti M. Doongursee College of Arts, Science and Commerce (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Bachelor of Science
Course: T.Y.B.SC.
Subject: Mathematics

Choice Based Credit System (CBCS)
with effect from
Academic Year 2024-2025

PROGRAM OUTCOMES

PO	Description
A student completing Bachelor's Degree in **Arts/Commerce/Science** Program will be able to	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate Programme. Execute strong theoretical and practical understanding generated from the specific graduate Programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioral skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

Deccan Education Society's

Kirti M. Doongursee College (autonomous)

Proposed Curriculum as per Mumbai

University implementation- 2024-25

Name of the Department: Mathematics

Semester	Course Code	Course Title	Credit
V	KUSMAT24501	Paper I:Multivariable Calculus I	2.5
	KUSMAT24502	Paper II: Group Theory	2.5
	KUSMAT24503	Paper III:Topology of Metric Spaces	2.5
	KUSMAT24504	Paper IV:Partial Differential Equations	2.5
	KUMAT24P5	Practical Paper I:Multivariable Calculus I Paper II:Group Theory	3
	KUMAT24P6	Practical :Paper III: Topology of Metric Spaces Paper IV: Partial Differential Equations	3
	KUSMAT24505	Paper V:Computer Programming and System Analysis-I	2
	KUMAT24P5AC	Practical :Computer Programming and System Analysis-I	1
VI	KUSMAT24601	Paper I: Basic Complex Analysis	2.5
	KUSMAT24602	Paper II: Ring Theory	2.5
	KUSMAT24603	Paper III: Topology of Metric Spaces and Real Analysis	2.5
	KUSMAT24604	Paper IV:Intergral Transforms	2.5
	KUMAT24P7	Practical Paper I: Basic Complex Analysis Paper II: Ring Theory	3
	KUMAT24P8	Practical Paper III: Topology of Metric Spaces and Real Analysis Paper IV: Intergral Transforms	3
	KUSMAT24605	Paper V:Computer Programming and System Analysis-II	2
	KUMAT24P6AC	Practical :Computer Programming and System Analysis-II	1

<table>
<tr><td>Course Code</td><td>SEM – V - Multivariable Calculus I</td><td>Credits</td><td>Lectures/Week</td></tr>
<tr><td>KUSMAT24501</td><td>Paper I</td><td>2.5</td><td>3</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course Outcomes:
After successful completion of this course, students would be able to
• Define double integral , triple integral , line integral , surface integral of a function , scalar and vector fields over $\mathbb{R}^n$, Gradient ,divergence and curl of Vector fields on $\mathbb{R}^n$
• Understand and explain calculus of vector fields, line integrals and surface integrals with applications, connection between line integral, double integral, and triple integral (Green's Theorem, Stokes' Theorem, The Divergence Theorem).
• Apply multiple integrals , line integral and surface integral to solve related problems Verify vector integral theorems. state Stokes' theorem and Gauss's divergence theorem and write them in a mathematical form.
• Evaluate double and triple integrals, and learn their use to compute volume, surface area, etc. and change of variables in multiple integrals .</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Unit</td><td colspan="2">Topics</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="2">Multiple Integrals: Definition of double (resp: triple) integral of a function and bounded on a rectangle (resp:box). Geometric interpretation as area and volume. Fubini's Theorem over rectangles and any closed bounded sets, Iterated Integrals. Following basic properties of double and triple integrals proved using the Fubini's theorem:
(1) Integrability of the sums, scalar multiples, products, and (under suitable conditions) quotients of integrable functions. Formulae for the integrals of sums and scalar multiples of integrable functions.
(2) Integrability of continuous functions. More generally, Integrability of functions with a "small" set of (Here, the notion of "small sets" should include finite unions of graphs of continuous functions.)
(3) Domain additivity of the integral. Integrability and the integral over arbitrary bounded domains. Change of variables formula (Statement only).Polar, cylindrical and spherical coordinates, and integration using these coordinates. Differentiation under the integral sign. Applications to finding the center of gravity and moments of inertia.</td><td>15</td></tr>
</table>

II	**Line Integrals:** Review of Scalar and Vector fields on $\mathbb{R}^n$, Vector Differential Operators, Gradient, Curl, Divergence. Paths (parametrized curves) in $\mathbb{R}^n$ (emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$), Smooth and piecewise smooth paths. Closed paths. Equivalence and orientation preserving equivalence of paths. Definition of the line integral of a vector field over a piecewise smooth path. Basic properties of line integrals including linearity, path-additivity and behaviour under a change of parameters. Examples. Line integrals of the gradient vector field, Fundamental Theorem of Calculus for Line Integrals, Necessary and sufficient conditions for a vector field to be conservative. Green's Theorem (proof in the case of rectangular domains). Applications to evaluation of line integrals.	**15**
III	**Surface Integrals:** Parameterized surfaces. Smoothly equivalent parameterizations. Area of such surfaces. Definition of surface integrals of scalar-valued functions as well as of vector fields defined on a surface. Curl and divergence of a vector field. Elementary identities involving gradient, curl and divergence. Stoke's Theorem (proof assuming the general from of Green's Theorem). Examples. Gauss' Divergence Theorem (proof only in the case of cubical domains). Examples.	**15**

Reference Books:

1. Apostol, Calculus, Vol. 2, Second Ed., John Wiley, New York, 1969 Section 1.1 to 11.8
2. James Stewart, Calculus with early transcendental Functions - Section 16.5 to 16.9 12
3. Marsden and Jerrold E. Tromba, Vector Calculus, Fourth Ed., W.H. Freeman and Co., New York, 1996 Section 6.2 to 6.4.

Other References :

1. T. Apostol, Mathematical Analysis, Second Ed., Narosa, New Delhi. 1947.
2. R. Courant and F.John, Introduction to Calculus and Analysis, Vol.2, Springer Verlag, New York, 1989.
3. W. Fleming, Functions of Several Variables, Second Ed., Springer-Verlag, New York, 1977.
4. M. H. Protter and C.B.Morrey Jr., Intermediate Calculus, Second Ed., Springer-Verlag, New York, 1995.
5. G. B. Thomas and R.L Finney, Calculus and Analytic Geometry, Ninth Ed. (ISE Reprint), Addison- Wesley, Reading Mass, 1998.
6. D. V. Widder, Advanced Calculus, Second Ed., Dover Pub., New York. 1989.

Course Code	SEM – V- Group Theory	Credits	Lectures/Week
KUSMAT24502	Paper II	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- Define Groups , Subgroups, Normal subgroup, Direct product of Groups, Cyclic groups and Cyclic Subgroups.
- Identify subgroups, normal subgroups, orders of elements, Cosets of a subgroup in a group and prove that the identification is correct
- Apply the properties of groups to check whether the group is commutative, non- commutative, cyclic, noncyclic, finite, infinite etc.
- Examine Groups ,subgroups, Normal subgroups, Direct products, Cyclic groups and cyclic subgroups and use it in applications.

Unit	Topics	No of Lectures
I	Groups and Subgroups 1. Definition and elementary properties of a group. Order of a group. Subgroups. Criterion for a subset to be a subgroup. Abelian groups. Center of a group. Homomorphisms and isomorphisms. 2. Examples of groups including $\mathbb{Z}, \mathbb{Q}, \mathbb{R}, \mathbb{C}$, Klein 4-group, symmetric and alternating groups, S^1 (= the unit circle in $\mathbb{C}$), GLn($\mathbb{R}$), SLn($\mathbb{R}$), On (= the group of n × n nonsingular upper triangular matrices), Bn (= the group of n × n nonsingular upper triangular matrices), and groups of symmetries of plane figures. 3. Order of an element. Subgroup generated by a subset of the group.	**15**
II	Normal subgroups, Direct products and Cayley's Theorem 1. Cosets of a subgroup in a group. Lagrange's Theorem. Normal subgroups. Alternating group A_nAn. Listing normal subgroups of A_4, S_3. Quotient (or Factor) groups. Fundamental Theorem of homomorphisms of groups. 2. External direct products of groups. Examples. Relation with internal products such as HK of subgroups H, K of a group. 3. Cayley's Theorem for finite groups.	**15**
III	Cyclic groups and cyclic subgroups (1) Examples of cyclic groups such as $\mathbb{Z}$ and the group μ_n of the n−th roots of unity. Properties of cyclic groups	

	and cyclic subgroups. (2) Finite cyclic groups, infinite cyclic groups and their generators. Properties of generators. (3) The group $\mathbb{Z}/n\mathbb{Z}$ of residue classes (mod n). Characterization of cyclic groups (as being isomorphic to $\mathbb{Z}$ or $\mathbb{Z}/n\mathbb{Z}$ for some $n \in \mathbb{N}$).	

Textbooks:

- I. N. Herstein, Topics in Algebra, Wiley Eastern Limied, Second edition.
- P. B. Bhattacharya, S.K. Jain, S. Nagpaul. Abstract Algebra, Second edition, Foundation Books, New Delhi, 1995.
- N. S. Gopalkrishnan, University Algebra, Wiley Eastern Limited.
- M. Artin, Algebra, Prentice Hall of India, New Delhi
- J. B. Fraleigh, A first course in Abstract Algebra, Third edition, Narosa, New Delhi.
- J. Gallian. Contemporary Abstract Algebra. Narosa, New Delhi

Additional References:

- T. W. Hungerford. Algebra, Springer.
- D. Dummit, R. Foote. Abstract Algebra, John Wiley & Sons, Inc.
- I. S. Luther, I.B.S. Passi. Algebra. Vol. I and II.

Course Code	SEM – V - Topology of Metric Spaces	Credits	Lectures/Week
KUSMAT24503	Paper III	2.5	3
Course Outcomes: After successful completion of this course, students would be able to • Define metric spaces, open set, closed set, interior points, limit points, boundary points, isolated points, various sequences in metric space, complete metric space and compact metric space. • Explain various types of metrics, properties of open sets, closed sets, complete and compact metric spaces and concept of sequences in metric spaces. • Apply the idea of metric space, complete metric space and compact metric space to construct various results and properties. • Examine the properties of metric spaces, sequences in metric spaces, complete and compact metric space to solve related problems.			

Unit	Topics	No of Lectures
I	**Metric spaces:** Definition and examples of metric spaces such as $\mathbb{R}, \mathbb{R}^2, \mathbb{R}^n$ with its Euclidean, sup and sum metrics. $\mathbb{C}$ (complex numbers). l_1 and l_2 spaces of sequences. C[a, b] the space of real valued continuous functions on [a, b]. Discrete metric space. Metric induced by the norm. Translation invariance of the metric induced by the norm. Metric subspaces. Product of two metric spaces. Open balls and open sets in a metric space. Examples of open sets in various metric spaces. Hausdorff property. Interior of a set. Properties of open sets. Structure of an open set in $\mathbb{R}$. Equivalent metrics. Distance of a point from a set, Distance between sets. Diameter of a set. Bounded sets. Closed balls. Closed sets. Examples. Limit point of a set. Isolated point. Closure of a set. Boundary of a set.	15
II	**Sequences and Complete metric spaces** Sequences in a metric space. Convergent sequence in metric space. Cauchy sequence in a metric space. Subsequences. Examples of convergent and Cauchy sequences in different metric spaces. Characterization of limit points and closure points in terms of sequences. Definition and examples of relative openness/closeness in subspaces. Dense subsets in a metric space and Separability. Definition of complete metric	**15**

	spaces. Examples of complete metric spaces. Completeness property in subspaces. Nested Interval theorem in $\mathbb{R}$. Cantor's Intersection Theorem. Applications of Cantors Intersection Theorem: (i) The set of real Numbers is uncountable. (ii) Density of rational Numbers. (iii) Intermediate Value theorem.	
III	**Compact spaces** Definition of a compact metric space using open cover. Examples of compact sets in different metric spaces such as $\mathbb{R}, \mathbb{R}^2, \mathbb{R}^n$ with Euclidean metric. Properties of compact sets: A compact set is closed and bounded, (Converse is not true). Every infinite bounded subset of compact metric space has a limit point. A closed subset of a compact set is compact. Union and Intersection of Compact sets. Equivalent statements for compact sets in R with usual metric: (i) Sequentially compactness property. (ii) Heine-Borel property. (iii) Closed and boundedness property. (iv) Bolzano-Weierstrass property.	**15**

Textbooks:

- S. Kumaresan; Topology of Metric spaces.
- E. T. Copson; Metric Spaces; Universal Book Stall, New Delhi, 1996.
- P. K. Jain, K. Ahmed; Metric Spaces; Narosa, New Delhi, 1996.

Additional References:

- T. Apostol; Mathematical Analysis, Second edition, Narosa, New Delhi, 1974
- R. R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi 1970.
- D. Gopal, A. Deshmukh, A. S. Ranadive and S. Yadav; An Introduction to Metric Spaces, Chapman and Hall/CRC, New York, 2020.
- W. Rudin; Principles of Mathematical Analysis; Third Ed, McGraw-Hill, Auckland, 1976.
- D. Somasundaram; B. Choudhary; A first Course in Mathematical Analysis. Narosa, New Delhi.
- G. F. Simmons; Introduction to Topology and Modern Analysis; McGraw-Hi, New York, 1963.
- Expository articles of MTTS programme.

Course Code	SEM – V - Partial Differential Equations	Credits	Lectures/Week
KUSMAT24504	Paper IV	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- Define first order partial differential equation, compatibility condition , linear , quasi-linear and non-linear partial differential equations.
- Understand different types of methods to solve first order partial differential equations.
- Apply the various methods to solve first order partial differential equation.
- Analyze the ideas of partial differential equation to solve initial value and boundary value problems.

Unit	Topics	No of Lectures
I	**First Order Partial Differential Equations.** Curves and Surfaces, Genesis of first order PDE, Classification of first order PDE, Classification of integrals, The Cauchy problem, Linear Equation of first order, Lagrange's equation, Pfaffian differential equations. (Ref Book: An Elementary Course in Partial Differential Equations by T. Amaranath, 2nd edition, Chapter 1: 1.1, 1.2, 1.3, Lemma 1.3.1, 1.3.2, 1.3.3, 1.4, Theorem 1.4.1, 1.4.2, 1.5, Theorem 1.5.1, Lemma 1.5.1, Theorem 1.5.2, Lemma 1.5.2 and related examples).	**15**
II	**Compatible system of first order Partial Differential Equations.** Definition, Necessary and sufficient condition for integrability, Charpit's method, Some standard types, Jacobi's method, The Cauchy problem. (Ref Book: An Elementary Course in Partial Differential Equations by T. Amaranath, 2nd edition, Chapter 1: 1.6, Theorem 1.6.1, 1.7, 1.8 Theorem 1.8.1, 1.9 and related examples)	**15**
III	**Quasi-Linear Partial Differential Equations.** Semi linear equations, Quasi-linear equations, first order quasi-linear PDE, Initial value problem for quasi-linear equation, Non linear first order PDE, Monge cone, Analytic expression for Monge's cone, Characteristics strip, Initial strip. (Ref Book: An Elementary Course in Partial Differential Equations by T. Amaranath, 2nd edition, Chapter 1: 1.10, Theorem 1.10.1, 1.11, Theorem 1.11.1, Preposition 1.11.1, 1.11.2 and related examples).	**15**

Textbooks:

- T. Amaranath; An Elementary Course in Partial Differential Equations; 2nd edition, Narosa Publishing house.
- M.D. Raisinghania; Ordinary and Partial Differential Equations; S. Chand.
- Ian Sneddon; Elements of Partial Differential Equations; McGraw Hill book.

Additional References:

- K. Atkinson, W.Han and D Stewart, Numerical Solution of Ordinary Differential Equations, Wiley.
- G.F. Simmons; Differential Equations with Applications and Historical Notes; Taylor's and Francis.
- W. E. Williams; Partial Differential Equations; Clarendon Press, Oxford, (1980).
- Ravi P. Agarwal and Donal O'Regan; Ordinary and Partial Differential Equations; Springer, First Edition (2009).
- K. Sankara Rao; Introduction to Partial Differential Equations; Third Edition, PHI.

Course Code	SEM V- Practical 1 (Paper 1 + Paper 2)	Credits	Lectures/ Week
KUMAT24P5	Paper I: Multivariable Calculus I Paper II: Group Theory	3	6

Course Outcomes:

After successful completion of this course, students would be able to

- Analyze and solve the problems based on the syllabus.
- Relate mathematics and its applications in pure and applied sciences.

Paper 1: Multivariable Calculus I

1	Evaluation of double and triple integrals.
2	Change of variables in double and triple integrals and applications
3	Line integrals of scalar and vector fields
4	Green’s theorem, conservative field and applications
5	Evaluation of surface integrals
6	Stoke’s and Gauss divergence theorem
7	Miscellaneous theory questions on units 1, 2 and 3.

Paper 2: Group Theory

1	Examples of groups and groups of symmetries of equilateral triangle, square and rectangle.
2	Examples of determining centers of different groups. Examples of subgroups of various groups and orders of elements in a group.
3	Left and right cosets of a group and Lagrange’s theorem.
4	Normal subgroups and quotient groups. Direct products of groups.
5	Finite cyclic groups and their generators
6	Infinite cyclic groups and their properties.
7	Miscellaneous Theory Questions

Course Code	SEM V- Practical 2 (Paper 3 + Paper 4)	Credits	Lectures/ Week
KUMAT24P6	Paper 3: Topology of Metric Spaces Paper 4: Partial Differential Equations	3	6

Course Outcomes:

After successful completion of this course, students would be able to

- Analyze and solve the problems based on the syllabus.
- Relate mathematics and its applications in pure and applied sciences.

Paper 3	: Topology of Metric Spaces
1	Examples of Metric Spaces, Normed Linear Spaces,
2	Sketching of Open Balls in R 2 , Open and Closed sets, Equivalent Metrics
3	Subspaces, Interior points, Limit Points, Dense Sets and Separability, Diameter of a set, Closure.
4	Limit Points ,Sequences , Bounded , Convergent and Cauchy Sequences in a Metric Space.
5	Complete Metric Spaces and Applications.
6	Examples of Compact Sets.
7	Miscellaneous Theory Questions
Paper 4	- Partial Differential Equations
1	Find general solution of Langrange’s equation.
2	Show that Pfaffian differential equation are exact and find corresponding integrals.
3	Find complete integral of first order PDE using Charpit’s Method.
4	Find complete integral using Jacobi’s Method.
5	Solve initial value problem for quasi-linear PDE
6	Find the integral surface by the method of characteristics.
7	Miscellaneous Theory Questions.

Course Code	SEM – VI - BASIC COMPLEX ANALYSIS	Credits	Lectures/Week
KUSMAT24601	Paper I	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- Define and Understand limits ,continuity, differentiability, Cauchy-Riemann equations, Linear fractional transformation, Complex power series, Laurent series and isolated singularities..
- Understand and explain basic concepts involved in calculus of functions of complex variables.
- Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra,
- Analyze and make use of the techniques regarding power series to solve the integrals, Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues , evaluate complex integrals using the residue theorem.

Unit	Topics	No of Lectures
I	Introduction to Complex Analysis: Review of complex numbers: Complex plane, polar coordinates, exponential map, powers and roots of complex numbers, De Moivre's formula, C as a metric space, bounded and unbounded sets, point at infinity-extended complex plane, sketching of set in complex plane (No questions to be asked) convergence of sequences of complex numbers and related results. Limit of a function $f : C \longrightarrow C$, real and imaginary part of functions, continuity at a point and algebra of continuous functions. Derivative of $f : C \longrightarrow C$, comparison between differentiability in real and complex sense, Cauchy-Riemann equations, sufficient conditions for differentiability, analytic function, if f, g analytic then $f + g$, $f - g$, fg and f/g are analytic, chain rule. Theorem: If f(z) = 0 everywhere in a domain D, then f(z) must be constant throughout D. Harmonic functions and harmonic conjugate.	**15**
II	Cauchy Integral Formula: Evaluation the line integral $\int f(z)dz$ over $\|z - z0\| = r$ and Cauchy integral formula. 21 Taylor's theorem for analytic function. Linear fractional transformation: definition and examples. Exponential function, its properties. trigonometric functions and hyperbolic functions.	**15**

III	Complex power series, Laurent series and isolated singularities. Power series of complex numbers and related results. Radius of convergences, disc of convergence, uniqueness of series representation, examples. Definition of Laurent series , Definition of isolated singularity, statement (without proof) of existence of Laurent series expansion in neighbourhood of an isolated singularity, type of isolated singularities viz. removable, pole and essential defined using Laurent series expansion, examples Statement of Residue theorem and calculation of residue.	**15**

Textbooks:
J.W. Brown and R.V. Churchill, Eighth Edition, Complex variables and Applications :
Sections 18, 19, 20, 21, 23, 24, 25, 28, 33, 34, 47, 48, 53, 54, 55 , Chapter 5, page 231 section 65, define residue of a function at a pole using Theorem in section 66 page 234, Statement of Cauchy's residue theorem on page 225, section 71 and 72 from chapter 7.
Additional References:

- COMPLEX VARIABLES: THEORY AND APPLICATIONS. By H. S. KASANA
- Robert E. Greene and Steven G. Krantz, Function theory of one complex variable
- T.W. Gamelin, Complex analysis.
- Functions of One Complex Variable by John B. Conway, Sringer-Verlag, New York, Heidelberg, Barlin.
- Complex Variables with Applications by S. Ponnusamy, Herb Silverman.

Course Code	SEM – VI - Ring Theory	Credits	Lectures/Week
KUSMAT24602	Paper II	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- Define ring , commutative ring, Integral domain , fiels , units in ring , Ideals etc
- Describe the fundamental concepts in ring theory such as elementary properties of rings, ideals, quotient rings, integral domains ,fields;
- Apply fundamental concept of Rings, Fields, subrings, integral domains and the corresponding morphisms to solve related problems.
- Examine Integral domains, Ideals , homomorphism , isomorphisms of rings and irreducibility of higher degree polynomials over rings.

Unit	Topics	No of Lectures
I	(1)Definition and elementary properties of rings (where the definition should include the existence of unity), commutative rings, integral domains and fields. Examples, including Z, Q, R, Z/nZ, C, Mn(R), Z[i], Z[$\sqrt{2}$], Z[$\sqrt{-5}$], Z[X], R[X], C[X],(Z/nZ)[X]. (2) Units in a ring. The multiplicative group of units in a ring R [and, in particular, the multiplicative group $F*$ of nonzero elemets of a field F]. Description of the units in Z/nZ. Results such as: A finite integral domain is a field. Z/pZ, where p is a prime, as an example of a finite field. (3) Characteristic of a ring. Examples. Elementary facts such as: the characteristic of an itegral domain is either 0 or a prime number. (Note: From here on all rings are assumed to be commutative with unity).	**15**
II	Ideals and special rings (1) Ideals in a ring. Sums and products of ideals. Quotient rings. Examples. Prime ideals and maximal ideals. Characterization of prime ideals and maximal ideals in a commutative ring in terms of their quotient rings. Description of the ideals and the prime ideals in Z, R[X] and C[X]. (2) Homomorphisms and isomorphism of rings. Kernel and the image of a homomorphism. Fundamental Theorem of homomorphism of a ring. (3) Construction of the quotient field of an integral	**15**

	domain (Emphasis on Z, Q). A field contains a subfield isomorphic to Z/pZ or Q. (4) (4) Notions of euclidean domain (ED), principal ideal domain (PID). Examples such as Z, Z[i], and polynomial rings. Relation between these two notions (ED =⇒ PID).	
III	Factorization (1) Divisibility in a ring. Irreducible and prime elements. Examples (2) Division algorithm in F[X] (where F is a field). Monic polynomials, greatest common divisor of f(x), g(x) ∈ F[X] (not both 0). Theorem: Given f(x) and g(x) 6= 0, in F[X] then their greatest common divisor d(x) ∈ F[X] exists; moreover, d(x) = a(x)f(x) + b(x)g(x) for some a(x), b(x) ∈ F[X]. Relatively prime polynomials in F[X], irreducible polynomial in F[X]. Examples of irreducible polynomials in (Z/pZ)[X] (p prime), Eisenstein Criterion (without proof). (3) Notion of unique factorization domain (UFD). Elementary properties. Example of a nonUFD is Z[√ −5] (without proof). Theorem (without proof). Relation between the three notions (ED =⇒ PID =⇒ UFD). Examples such as Z[X] of UFD that are not PID. Theorem (without proof): If R is a UFD, then R[X] is a UFD.	**15**

Textbooks:

1.N. Herstein; Topics in Algebra; Wiley Eastern Limited, Second edition
2.P. B. Bhattacharya, S. K. Jain, and S. R. Nagpaul; Abstract Algebra; Second edition, Foundation Books, New Delhi, 1995.
3.N. S. Gopalakrishnan; University Algebra; Wiley Eastern Limited.
4.M. Artin; Algebra; Prentice Hall of India, New Delhi.
5. J. B. Fraleigh; A First course in Abstract Algebra; Third edition, Narosa, New Delhi.
6.J. Gallian; Contemporary Abstract Algebra; Narosa, New Delhi.

Additional References:

1. S. Adhikari; An Introduction to Commutative Algebra and Number theory; Narosa Publishing House.
2. T.W. Hungerford; Algebra; Springer.
3. D. Dummit, R. Foote; Abstract Algebra; John Wiley & Sons, Inc.
4. I.S. Luthar, I.B.S. Passi; Algebra; Vol. I and II.
5. U. M. Swamy, A. V. S. N. Murthy; Algebra Abstract and Modern; Pearson.
6. Charles Lanski; Concepts Abstract Algebra; American Mathematical Society.
7. Sen, Ghosh and Mukhopadhyay; Topics in Abstract Algebra; Universities press.

Course Code	SEM – VI - Topology of Metric Spaces and Real Analysis	Credits	Lectures/Week
KUSMAT24603	Paper III	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- Define continuity and uniform continuity in metric space, connected, disconnected and path connected set, sequence and series of functions.
- Explain continuity, uniform continuity, connected and disconnected metric spaces, pointwise and uniform convergence of sequence and series of functions.
- Apply the idea of continuity, uniform continuity to discuss the images of compact sets and connected set and their properties and various test to discuss pointwise and uniform convergence of sequence and series of functions.
- Analyse continuity, uniform continuity, compact set, connected set, path connected set, sequence and series of functions to solve related problems.

Unit	Topics	No of Lectures
I	**Continuous functions on metric spaces** Epsilon-delta definition of continuity of a function at a point from one metric space to another. Characterization of continuity at a point in terms of sequences, open sets and closed sets and examples. Algebra of continuous real valued functions on a metric space. Continuity of composite function. Continuous image of compact set is compact, Uniform continuity in a metric space, examples (emphasis on $\mathbb{R}$). Results such as: every continuous functions from a compact metric space is uniformly continuous. Contraction mapping and fixed point theorem. Applications.	**15**
II	**Connected spaces** Separated sets- Definition and examples. Connected and disconnected sets. Connected and disconnected metric spaces. Results such as: A subset of $\mathbb{R}$ is connected if and only if it is an interval. A continuous image of a connected set is connected. Characterization of a connected space, viz. a metric space is connected if and only if every continuous function from X to $\{1, -1\}$ is a constant function. Path connectedness in $\mathbb{R}^n$, definition and examples. A path connected subset of $\mathbb{R}^n$ is connected, convex sets are path connected. Connected components. An example of a connected subset of $\mathbb{R}^n$ which is not path connected.	**15**
III	**Sequence and series of functions**	**15**

	Sequence of functions - pointwise and uniform convergence of sequences of real- valued functions, examples. Uniform convergence implies pointwise convergence, example to show converse not true, series of functions, convergence of series of functions, Weierstrass M-test (statement only). Examples. Properties of uniform convergence: Continuity of the uniform limit of a sequence of continuous function, conditions under which integral and the derivative of sequence of functions converge to the integral and derivative of uniform limit on a closed and bounded interval (statements only). Examples. Consequences of these properties for series of functions, term by term differentiation and integration(statements only). Power series in $\mathbb{R}$ centered at origin and at some point in $\mathbb{R}$, radius of convergence, region (interval) of convergence, uniform convergence, term by-term differentiation and integration of power series, Examples. Uniqueness of series representation, functions represented by power series, classical functions defined by power series such as exponential, cosine and sine functions, the basic properties of these functions.	

Textbooks:

- R. R. Goldberg; Methods of Real Analysis; Oxford and International Book House (IBH) Publishers, New Delhi.
- S. Kumaresan; Topology of Metric spaces.
- E. T. Copson; Metric Spaces; Universal Book Stall, New Delhi, 1996.
- Robert Bartle and Donald R. Sherbert; Introduction to Real Analysis; Second Edition, John Wiley and Sons.

Additional References:

- W. Rudin, Principles of Mathematical Analysis; Third Ed, McGraw-Hill, Auckland, 1976.
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- P. K. Jain. K. Ahmed, Metric Spaces. Narosa, New Delhi, 1996.
- D. Somasundaram, B. Choudhary; A first Course in Mathematical Analysis. Narosa, New Delhi
- G. F. Simmons; Introduction to Topology and Modern Analysis, McGraw-Hi, New York, 1963.

Course Code	SEM – VI - Intergral Transforms	Credits	Lectures/ Week
KUSMAT24604	Paper IV	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- Define Laplace, Fourier transform and their various properties.
- Describe the relationship between the Laplace, Fourier transform and their various properties.
- Apply the concepts of Laplace transform to solve one dimensional heat and wave equation, Fourier transform to solve initial and boundary value problem.
- Analyse Laplace and Fourier transform to solve related problems.

Unit	Topics	No of Lectures
I	**Laplace Transform** Definition of Laplace Transform, theorem, Laplace transforms of some elementary functions, Properties of Laplace transform, Laplace Transform of derivatives and integrals, Initial and final value theorem, Inverse Laplace Transform, Properties of Inverse Laplace Transform, Convolution Theorem, Inverse Laplace Transform by partial fraction method, Laplace transform of special functions: Heaviside unit step function, Dirac-delta function and Periodic function.	15
II	**Fourier Transform** Fourier integral representation, Fourier integral theorem, Fourier Sine & Cosine integral representation, Fourier Sine & Cosine transform pairs, Fourier transform of elementary functions, Properties of Fourier Transform, Convolution Theorem, Parseval's Identity.	**15**
III	**Applications of Integral Transforms** Relation between the Fourier and Laplace Transform. Application of Laplace transform to evaluation of integrals and solutions of higher order linear ODE. Applications of Laplace Transform to solution of one dimensional heat equation & wave equation. Application of Fourier transforms to the solution of initial and boundary value problems, Heat conduction in solids (one dimensional problems in infinite & semi infinite domain).	**15**

Course Code	SEM VI - Practical I (Paper 1 + Paper 2)	Credits	Lectures/ Week
KUMAT24P7	Paper I: Basic Complex Analysis Paper II: Ring Theory	3	6
Course Outcomes: After successful completion of this course, students would be able to • Analyze and solve the problems based on the syllabus. • Relate mathematics and its applications in pure and applied sciences.			
Paper 1: Basic Complex Analysis			
1	Limit continuity and derivatives of functions of complex variables.		
2	Steriographic Projection , Analytic function, finding harmonic conjugate.		
3	Contour Integral, Cauchy Integral Formula ,Mobius transformations.		
4	Taylors Theorem , Exponential , Trigonometric, Hyperbolic functions.		
5	Power Series , Radius of Convergence, Laurents Series.		
6	Finding isolated singularities- removable, pole and essential, Cauchy Residue theorem.		
7	Miscellaneous theory questions.		
Paper 2: Ring Theory			
1	Examples of rings (commutative and non-commutative), integral domains and fields		
2	Units in various rings. Determining characteristics of rings.		
3	Prime Ideals and Maximal Ideals, examples on various rings		
4	Euclidean domains and principal ideal domains (examples and non-examples)		
5	Examples if irreducible and prime elements.		
6	Applications of division algorithm and Eisenstein’s criterion.		
7	Miscellaneous Theoretical questions on Unit 1, 2 and 3.		

Course Code	SEM V- Practical 2 (Paper 3 + Paper 4)	Credits	Lectures/ Week
KUMAT24P8	Paper III: Topology of Metric Spaces and Real Analysis Paper IV: Intergral Transforms	3	6

Course Outcomes:

After successful completion of this course, students would be able to

- Analyze and solve the problems based on the syllabus.
- Relate mathematics and its applications in pure and applied sciences.

Paper III: Topology of Metric Spaces and Real Analysis	
1	Continuity in a Metric Spaces
2	Uniform Continuity, Contraction maps, Fixed point theorem
3	Connected Sets , Connected Metric Spaces
4	Path Connectedness, Convex sets, Continuity and Connectedness
5	Pointwise and uniform convergence of sequence functions, properties
6	Point wise and uniform convergence of series of functions and properties
7	Miscellaneous Theory Questions.
Paper IV	Intergral Transforms
1	Find the Laplace transform of differential and integral equations.
2	Find the inverse Laplace transform by the partial fraction method.
3	Find the Fourier integral representation of given functions.
4	Find the Fourier Sine / Cosine integral representation of given functions
5	Solve higher order ODE using Laplace transform
6	Solve one dimensional heat and wave equation using Laplace transform. Solve initial and boundary value problems using Fourier transform.
7	Miscellaneous Theory Questions.

Evaluation Scheme for Third Year (UG) under AUTONOMY

I. Internal Evaluation for Theory Courses – 40 Marks

(i) Continuous Internal Assessment 1 (Assignment-Tutorial) – 20 Marks

(ii) Continuous Internal Assessment 2 – 20 Marks (Class Test with Fill in the Blanks, True or False & Answer the following)

II. External Evaluation for Theory Courses – 60 Marks

Duration: 2 Hours

Theory question paper pattern:

All questions are compulsory.

Qn.	Based on	Type		Options	Marks
Q.1	Unit I, II & III	Objective	MCQs	*Attempt all 6*	12
Q.2	Unit I	Descriptive		*Any 2 out of 4*	12
Q.3	Unit II	Descriptive		*Any 2 out of 4*	12
Q.4	Unit III	Descriptive		*Any 2 out of 4*	12
Q.5	Unit I, II & III	Descriptive		*Any 3 out of 6*	12

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be sub-divided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.

III. Practical Examination

- Each core subject carries 50 Marks (30 marks External + 20 marks Internal)

Sr. No.	Undergraduate Practical Internal Evaluation:	Marks
1	Short Experiment/Field Trip/Excursion/Industrial Visit Report (MCQ questions 3 mks each attempt any 5 out of 9….15 mks Duration 1hr)	15
2	Viva	5

Sr. No.	Undergraduate Practical External Evaluation:	Marks
1	Experiment/s (problems 5 marks each Attempt any 5 out of 9)	25
2	Journal	5

- Duration: 3 Hours for each practical course.
- Minimum 80% practical from each core subjects are required to be completed.
- Certified Journal is compulsory for appearing at the time of Practical Exam.

Note:
Two short field excursions for habitat studies are compulsory. Field work of not less than eight hours duration is equivalent to one period per week for a batch of 15 students.

- A candidate will be allowed to appear for the practical examinations only if he/she submits a certified journal of T.Y.B.Sc. or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of T.Y.B.Sc. as per the minimum requirements. In case of loss of journal, a candidate must produce a certificate from the Head of the department/Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal will not be granted.

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