Program Outcomes

PO-1: Knowledge and Problem Solving: Acquire in-depth scientific knowledge of their discipline both in theory and practical, demonstrate basic skills, investigate, apply, and solve the problems in a variety of contexts related to science and technology.

PO-2: Communication and Teamwork: Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.

PO-3: Modern tools and techniques for Scientific Experiments: Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for valid conclusion with clear understanding of limitations.

PO-4: Logical thinking: Develop logical thinking and expertise with precision, analytical mind, innovative thinking, clarity of thought, and systematic approach for proving or disproving the facts after mathematical formulation. with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach

PO-5: Skill development and Employability: develop elementary computing and soft skills to prepare students for industry, entrepreneurship and higher education with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.

PO-6: Ethics and citizenship: Able to recognize different value systems and ethical principles; and commit to professional ethics, norms, and responsibilities of the science practice and act with informed awareness to participate in civic life activities.

PO-7: Society, Environment and Sustainability: Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.

PO-8: Life-long learning: Acquire fundamental knowledge for lifelong learning to participate in the extensive context of socio-technological change as a self-directed member and a leader.

Programme Specific Outcomes (PSO)

PSO1: Acquire sound knowledge in the key areas of mathematics and demonstrate basic skills in Calculus, Algebra, Geometry, Real Analysis, Differential Equations, Discrete Mathematics, Complex Analysis and Linear Programming.

PSO2: Ability to Investigate and apply mathematical problems and solutions in variety of context related to science, technology and business & industry.

PSO3: Proficiency in programming skills and practical to further mathematical understanding and solve mathematical problems.

PSO4: Acquire good knowledge of suitable tools of mathematical analysis to solve specific theoretical and applied problems in advanced areas of mathematic and related sciences.

PSO5: Ability to present mathematics clearly and precisely, describe mathematical ideas from multiple perspectives and demonstrate generic skills helpful in employment, internships and social activities.

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OPJU
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Programme:	**B. Sc.**	**Semester :**	**I Sem**
Name of the Course:	**Calculus –I**	**Course Code:**	**SOS-B-MA101**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of mathematical nature as well as practical problems. More precisely, main target of this course is to explore the different tools for higher order derivatives, to plot the various curves and to solve the problems associated with differentiation and integration of vector functions.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Apply the knowledge of concepts of real analysis in order to study theoretical development of different mathematical techniques and their applications.
CO2	Understand the nature of abstract mathematics and explore the concepts in further details.
CO3	Identify challenging problems in real variable theory and find their appropriate solutions.
CO4	Determine the existence of, estimate numerically and graphically, and find algebraically the limits of functions.
CO5	Determine continuity at a point or on intervals and distinguish between the types of discontinuities at a point.
CO6	Determine the derivative of a function using the limit definition.
CO7	Interpret the derivative as the slope of a tangent line to a graph
CO8	Determine the derivative and higher derivatives of a function explicitly using differentiation formulas

CO9	Use the first and second derivatives to analyze and sketch the graph of a function, including asymptotes, intervals on which the graph is increasing, decreasing, concave up, or concave down, and any local extrema and inflection points
CO10	Use the Fundamental Theorem of Calculus to evaluate definite integrals.
CO11	Use definite integrals to find areas of planar regions.
CO12	Uses limit definition of continuity correctly to determine whether continuous.

Syllabus:

Unit 1 : Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L' Hospitals rule, Application in business, economics and life sciences.

Unit 2 : Riemann integration as a limit of sum, integration by parts, Reduction formulae, derivations and illustrations of reduction formulae of the types $\sin^n x\,dx$, $\int\cos^n x\,dx$, $\int\tan^n x\,dx$, $\int\sec^n x\,dx$, $\int(\log x)^n dx$, $\int\sin^n x\cos^n x\,dx$, definite integral, integration by substitution.

Unit 3 : Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Unit 4 : Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration

Text Books

1. H. Anton, I. Bivens and S. Davis, Calculus, 10thEd.,John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.
3. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014

Reference Books

1. James Stewart, Single Variable Calculus, Early Transcendentals, Cengage Learning, 2016.
2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi,2005.

CO-PO&PSO Correlation

Course Name : Calculus –I													
	Program Outcomes								PSOs				
Course	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	1	1				1			1	1	1	**1**	**1**
CO2:				2									
CO3:		1	1			1	1		1		1	**2**	**1**
CO4:	1			1	2								
CO5:			1					1				**1**	
CO6:	**1**	**1**	**1**	**2**		**1**			**1**		**1**		
CO7:	**2**				**1**		**2**					**1**	
CO8:				**2**		**1**		**1**					**1**
CO9:						**1**			**1**		**1**		
CO10:	**1**	**1**			**1**							**1**	
CO11:		**1**		**1**					**1**		**1**	**1**	**1**
CO12:	**1**					**1**						**1**	

Note: 1: Low 2: Moderate 3: High

Programme: **B. Sc.**
Name of the Course: **Calculus –I Lab**
Credits :
Max Marks: **50**

Semester : **I Sem**
Course Code: **SOS-B-MA101**
No of Hours : **40**

Course Description:

The main emphasis of this course is to equip the student with to learn a mathematical software and use to draw graphs of different functions, curves and family of curves

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Learn the basic about a mathematical software
CO2	Learn the basics operations and function of the software
CO3	Plot the graph of exponential, trigonometric, logarithmic functions, higher degree polynomials and solving higher degree polynomials.
CO4	Plot the graph of some curves and surfaces of conic section.

Syllabus:

LIST OF PRACTICALS

(Using any software/ MATLAB to be performed on a Computer.)

1. Plotting the graphs of the functions e^{ax+b}, log|ax+b|, 1/ax+b , sin(ax+b) ,cos(ax+b) and $|ax+b|$ to illustrate the effect of a and b on the graph.
2. Plotting the graphs of the polynomial of degree 4 and 5.
3. Sketching parametric curves (E.g. Trochoid, cycloid, hypocycloid).
4. Obtaining surface of revolution of curves.
5. Tracing of conics in Cartesian coordinates /polar coordinates.
6. Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates).

Text Books

4. H. Anton, I. Bivens and S. Davis, Calculus, 10thEd.,John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
5. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.
6. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014

Reference Books

3. James Stewart, Single Variable Calculus, Early Transcendentals, Cengage Learning, 2016.
4. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi,2005.

CO-PO&PSO Correlation

Course Name : Calculus –I												
	Program Outcomes								PSOs			
Course	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	2	2	2	1		1			1	1	1	**1**	**1**
CO2:	3	1	3	2									
CO3:	3	1	2	2		1	1		1		1	**2**	**1**
CO4:	2	1	2	1	2								

Note: 1: Low 2: Moderate 3: High

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Programme:	**B. Sc. Hons.**	**Semester :**	**I Sem**
Name of the Course:	**Geometry and Algebra-I**	**Course Code:**	**SOS-B-MA102**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**150**		

Course Description

This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The geometry of two dimensions and three dimensions are introduced here.

COURSE OUTCOMES

Upon completion of this course, students should be able to:

CO Number	Course Outcome
CO1	Introduction to Analytical geometry of two dimensions
CO2	Understand Analytical geometry of three dimensions.
CO3	Understand Polar representation of complex numbers.
CO4	Understand De-Mover's theorem for rational indices and its applications.
CO5	Understand Equivalence relations, Functions, Composition of functions
CO6	Understand Well-ordering property of positive integers, Division algorithm.
CO7	Understand Principles of Mathematical Induction and Fundamental Theorem of Arithmetic.
CO8	Understand Green's function and solutions of boundary value problems.
CO9	to study further courses in mathematics like, group theory, ring theory and field theory, linear algebra and geometry
CO10	Familiarize with relations, equivalence relations and partitions. Understand the importance of roots of real and complex polynomials

	and learn various methods of obtaining roots.

Syllabus

Analytical geometry of two dimensions: Transformation of rectangular axes. General equation of second degree and its reduction to normal form. Tracing of conics, Systems of conics, Polar equation of a conic.

Analytical geometry of three dimensions: Direction cosines. Straight line, Plane, Sphere, Cone, Cylinder, Central conicoids, paraboloids, plane sections of conicoids. Generating lines. Reduction of second degree equations to normal form; classification of quadrics.

Polar representation of complex numbers, nth roots of unity, De-Moivre's theorem for rational indices and its applications.

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Reference Books

1. Birkhoff G., and S. Mac Lane, A Survey of Modern Algebra, 4th ed.
2. John B. Fraleigh, A First Course in Abstract Algebra,7th Ed., Pearson, 2002.
3. R. J. T. Bell: An Elementary Treatise on Coordinate Geometry, MacMillon& Co Ltd, 1994.
4. P.K. Jain and Khalil Ahmad, A Text Book of Analytical Geometry of two Dimensions, Wiley Eastern Ltd., 1994.
5. Ram Ballabh: A Textbook of Coordinate Geometry, Prakashan Kendra, Lucknow, 13th Revised Ed.
6. Gorakh Prasad and H.C. Gupta, Text Book on Coordinate Geometry, Pothishala Pvt. Ltd., Allahabad.
7. S.L. Loney, The Elements of Coordinate Geometry, Macmillan and Company, london.
8. P.K. Jain and Khalil Ahmad, A Text Book of Analytical Geometry of three Dimensions, Wiley Eastern Ltd., 1999.
9. N. Saran and R.S. Gupta, Analytical Geometry of three Dimensions, Pothishala Pvt. Ltd. Allahabad.

CO-PO & PSO Correlation

Course Name : Geometry and Algebra-I													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1		1						1				1
CO2:		2		1	1	1					2		
CO3:	1			1		1			1				1
CO4:			2		1					2		1	
CO5:		1			1				1				
CO6:		2				2				2		1	
CO7:	1		1		2				1		1		
CO8:	1			1		1			1				1
CO9:			2		1					2		1	
CO10:		1			1				1				

Note: 1: Low 2: Moderate 3: High

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Programme:	**B.Sc.**	**Semester :**	**II Sem**
Name of the Course:	**Real Analysis (Analysis I)**	**Course Code:**	**SOS-B-MA201**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**150**		

Course Description:

This course enables the students to understand Real number system and their properties, Open and closed sets, sequences and series and Convergence and Divergence criteria for sequence and series of functions.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
CO2	Understand the Algebraic and Order Properties of R, d-neighborhood of a point in R.
CO3	Identify the idea of countability of R, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.
CO4	Determine the Completeness Property of *R,* The Archimedean Property, Density of Rational (and Irrational) numbers in *R,* Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.
CO5	Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
CO6	Use the limit theorems on sequence to evaluate the limit of sequence.
CO7	Understand the Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence:
CO8	Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Syllabus:

Unit 1 : Algebraic and Order Properties of *R,* d-neighborhood of a point in *R,* Idea of countable sets, uncountable sets and uncountability of *R.* Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.

Unit 2 : The Completeness Property of *R,* The Archimedean Property, Density of Rational (and Irrational) numbers in *R,* Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Unit 3: Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Unit 4 : Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Text Books

1. T. M. Apostol, Calculus (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, Introduction to Real Analysis, John Wiley and Sons (Asia), Ltd., 2000.

Reference Books

1. E. Fischer, Intermediate Real Analysis, Springer Verlag, 1983.
2. K.A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts inMathematics, Springer Verlag, 2003.

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CO-PO & PSO Correlation

Course Name : Real Analysis (Analysis I)													
	Program Outcomes								PSOs				
Course	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	1									2	2	1	1
CO2:	1		1			1		1					
CO3:		1	1		1				1		2	1	1
CO4:		1	1	1			1	1		1			
CO5:	1	1				2					1	1	
CO6:		1			1					1	1		
CO7:			2		1	1	1			1			
CO8:	1				1			1		1		1	1

Note: 1: Low 2: Moderate 3: High

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UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B. Sc. Hons.**	**Semester :**	**II Sem**
Name of the Course:	**Ordinary Differential Equations**	**Course Code:**	**SOS-B-MA202**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

Ordinary differential equations (ODE) are a fundamental part of the mathematical vocabulary used to describe natural phenomena. The course emphasizes classical methods for finding exact solution formulas. We will also study numerical methods which yield precise but approximate quantitative information, and qualitative methods which provide a rich geometric understanding of ODE.

COURSE OUTCOMES

Upon completion of this course, students should be able to:

CO Number	Course Outcome
CO1	Introduction to General, Particular, explicit, implicit and singular solutions of a differential equation
CO2	Understand linear equations and Bernoulli's equation, special integrating factors and transformations.
CO3	Introduction to compartmental models, Exponential decay radioactivity
CO4	Understand exponential growth of population, Density dependent growth
CO5	Understand General solution of homogeneous equation of second order
CO6	Understand Method of variation of parameters
CO7	Understand Applications of second order differential equations to mechanical vibrations
CO8	predator-prey model and its analysis, competing species and its analysis

CO9	Understand Series Solutions of linear differential equations
CO10	Understand method of Frobeinus, Bessel's equation and Bessel functions.

Syllabus

Differential equations and mathematical models, order and degree of a differential equation, General, Particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equations and Bernoulli's equation, special integrating factors and transformations.

Introduction to compartmental models, Exponential decay radioactivity (case study of detecting art forgeries), lake pollution model (with case study of Lake Burley Griffin), drug assimilation into the blood (case study of dull, dizzy and dead), exponential growth of population, Density dependent growth, Limited growth with harvesting.

General solution of homogeneous equation of second order, principle of superposition, Wronskian, its properties and applications, method of undetermined coefficients, Method of variation of parameters, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation.

Applications of second order differential equations to mechanical vibrations. Equilibrium points, interpretation of the phase plane, predator-prey model and its analysis, competing species and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Series Solutions of linear differential equations: Power series solutions about an ordinary point, solutions about singular points; method of Frobenius, Bessel's equation and Bessel functions.

Text Books

1. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and MATLAB, 2ndEd., Taylor and Francis group, London and New York,2009.

Reference Books

1. Simmons G F, Differential equation, Tata Mc Graw Hill, 1991.
2. Martin Braun, Differential Equations and their Applications, Springer International, Student Ed.
3. S. L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons, India.
4. C.Y. Lin, Theory and Examples of Ordinary Differential Equations, World Scientific, 2011.
5. C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
6. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

CO-PO & PSO Correlation

Course Name : Ordinary Differential Equations													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1				1				2			1	
CO2:		2		1						1			
CO3:			1		2				1			1	
CO4:	1	1		1						2			
CO5:			2		1						1		
CO6:	1	1		2					1			1	
CO7:		1	1		1						2		
CO8:	2		1		2				1			1	
CO9:	1	1		1						2			
CO10:	2		2		1						1		

Note: 1: Low 2.: Moderate 3:High

Programme: B. Sc. Hons.
Name of the Course: Ordinary Differential Equations Lab
Semester : II Sem
Course Code: SOS-B-MA202

Credits :
Max Marks: 50
No of Hours : 40

Course Description:
The course emphasizes to study numerical solution of 1st order, 2nd order differential equation. Students will able to learn about the population growth and decay model.

COURSE OUTCOMES

Upon completion of this course, students should be able to:

CO Number	Course Outcome
CO1	Student will able to solve first order differential equation
CO2	Student will able to solve second and third order differential equation
CO3	Understand the Growth and Decay model by plotting the graphs
CO4	Use second order differential equation to solve vibration problems

Syllabus

List of Practical (Using any Software/MATLAB)

Practical/Lab work to be performed on a Computer

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Economic problems.
6. Mixture problems.
7. Vibration problems.
8. Oxygen debt model.
9. Falling body problems.
   Frictional forces problems

Text Books

2. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and MATLAB, 2ndEd., Taylor and Francis group, London and New York,2009.

Reference Books

7. Simmons G F, Differential equation, Tata Mc Graw Hill, 1991.
8. Martin Braun, Differential Equations and their Applications, Springer International, Student Ed.
9. S. L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons, India.
10. C.Y. Lin, Theory and Examples of Ordinary Differential Equations, World Scientific, 2011.
11. C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
12. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

CO-PO & PSO Correlation

Course Name : Ordinary Differential Equations													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1				1				2			1	
CO2:		2		1						1			
CO3:			1		2				1			1	
CO4:	1	1		1						2			

Note: 1: Low 2.: Moderate 3:High

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Programme:	**B.Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Group Theory (Algebra II)**	**Course Code:**	**SOS-B-MA301**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**150**		

Course Description:

Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of group theory and examples of groups and their properties. This course will lead to future basic courses in advanced mathematics, such as Group theory-II and ring theory.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	A student learning this course gets idea on concept and examples of groups and their properties.
CO2	He understands cyclic groups, permutation groups, normal subgroups and related results.
CO3	After this course he can opt for courses in ring theory, field theory, commutative algebras, linear classical groups etc.
CO4	Apply this knowledge to problems in physics, computer science, economics and engineering.
CO5	Understand the Symmetries of a square, dihedral groups, definition and examples of groups including
CO6	Permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.
CO7	Define Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.
CO8	Understand the properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets.
CO9	Use the Lagrange's theorem and consequences including Fermat's Little theorem.
CO10	Understand the External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups

Syllabus:

Unit 1 : Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

Unit 2 : Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Unit 3 : Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Unit 4 : External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit 5 : Group homomorphism, properties of homomorphism, Cayley's theorem, properties of isomorphism, First, Second and Third isomorphism theorems.

Text Books

1. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi, 1999 (IX Edition 2010).
2. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

CO-PO & PSO Correlation

Course Name : Group Theory (Algebra II)													
	Program Outcomes								PSOs				
Course	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	1		1	2	1		1			1	1	1	1
CO2:	1			1	1			1	1		1		
CO3:		1			1	1	1			1			
CO4:	1		1	1		1			1				1
CO5:	2			2				2			1		
CO6:	1	1		1		1							
CO7:			1		1	1			1		1		
CO8:		1		2			2	2			1	2	2
CO9:		1	1			1	1		1		1	1	
CO10:		1	1			1	1	1		1			

Note: 1: Low 2: Moderate 3: High.

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Programme:	**B.Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Theory of Real Function (Analysis –II)**	**Course Code:**	**SOS-B-MA302**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**150**		

Course Description:

This course enables the students to understand Limit and continuity of functions, concepts of Uniform continuity and Differentiability, Taylor's and Maclaurin's series expansion

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Students will be able to Basic concepts of Limit, continuity of the functions.
CO2	Define limits of functions (epsilon-delta approach), sequential criterion for limits, divergence criteria.
CO3	Use the limits of functions (epsilon-delta approach), sequential criterion for limits, divergence criteria sequential criterion for continuity & discontinuity. Algebra of continuous functions.
CO4	Understand the continuous functions on an interval, intermediate value theorem, location of roots theorem.
CO5	Use preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.
CO6	Applying differentiability of a function at a point & in an interval, Caratheodory's theorem, algebra of differentiable functions
CO7	Use relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorem, intermediate value property of derivatives.
CO8	Define the Darboux's theorem. Applications of mean value theorem to inequalities & approximation of polynomials Taylor's theorem to inequalities.
CO9	Student will learn Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema.
CO10	Understand the Taylor's series & Maclaurin's series expansions of exponential & trigonometric functions.

Syllabus:

Unit 1 : Limits of functions (epsilon-delta approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits & limits at infinity. Continuous functions, sequential criterion for continuity & discontinuity. Algebra of continuous functions.

Unit 2 : Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Unit 3 : Differentiability of a function at a point & in an interval, Caratheodory's theorem, algebra of differentiable functions.

Unit 4 : Relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorem, intermediate value property of derivatives - Darboux's theorem. Applications of mean value theorem to inequalities & approximation of polynomials Taylor's theorem to inequalities.

Unit 5 : Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series & Maclaurin's series expansions of exponential & trigonometric functions.

Text Books

1. R. G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons (2003)
2. K. A. Ross, Elementary Analysis: The Theory of Calculus, Springer (2004).

Reference Books

1. A. Mattuck, Introduction to Analysis, Prentice Hall (1999).
2. S. R. Ghorpade& B. V. Limaye, A Course in Calculus and Real Analysis – Springer

CO-PO & PSO Correlation

Course Name : Theory of Real Function (Analysis –II)													
	Program Outcomes								PSOs				
Course	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	1			1			1	1		1	1	
CO2:	1	2		1	2	2			2	1		1	1
CO3:		1				1				1			1
CO4:		1		1	1				1	1	1	1	
CO5:		1											
CO6:	1		1	2		2		2	2		1		1
CO7:	1		1	1		1			1				
CO8:		1			1			1				1	
CO9:	1		1				1			1			1
CO10:	1		1	1	1	1			1				1

Note: 1: Low 2: Moderate 3: High.

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OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B.Sc.**	**Semester :**	**III Sem**
Name of the Course:	**CC VII : Partial Differential Equation & System of Ordinary Differential Equation**	**Course Code:**	**SOS-B-MA303**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

The objective of this course is to understand basic methods for solving Partial Differential Equations of first order and second order. In the process, students will be exposed to Charpit's Method, Jacobi Method and solve wave equation, heat equation, Laplace Equation etc. They will also learn classification of Partial Differential Equations and system of ordinary differential equations.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand basic methods for solving Partial Differential Equations of first order and second order.
CO2	Understand the order, degree and various standard forms of differential equations.
CO3	Understand the order, degree and various standard forms of differential equations.
CO4	Determine solutions to first order linear differential equations.
CO5	Describe- Basic concepts and Definitions, Mathematical Problems. First- Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations.
CO6	Determine the Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.
CO7	Determine the classification of second order PDE.
CO8	Determine the Mathematical modeling of vibrating string, vibrating membrane, conduction of heat in solids, gravitational potential, conservation laws and Burger's equations.

Syllabus:

Unit 1 : Partial Differential Equations - Basic concepts and Definitions, Mathematical Problems. First- Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.

Unit 2 : Mathematical modeling of vibrating string, vibrating membrane, conduction of heat in solids, gravitational potential, conservation laws and Burger's equations, classification of second order PDE, reduction to canonical forms, equations with constant coefficients, general solution.

Unit 3 : The Cauchy problem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end. Equations with nonhomogeneous boundary conditions, Non- Homogeneous Wave Equation.

Unit 4 : Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem, Laplace and beam equation, non-homogeneous problem.

Unit 5 : Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations.

Text Books

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India.

Reference Books

1. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, 4th Ed., PHI Learning Private Limited, 2012.
2. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
3. Kendall E. Atkinson: An Introduction to Numerical Analysis

4. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th Edition, 2008
5. S. D. Conte & S. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.
6. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

CO-PO & PSO Correlation

Course Name : : Partial Differential Equation & System of Ordinary Differential Equation													
	Program Outcomes								PSOs				
Course	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	1			1	1			1	1	1	1	
CO2:	2	1				1				1	1		1
CO3:			1	1					1	1	1		
CO4:	2			1			1	1				1	1
CO5:		1	1						1		1		
CO6:	1	1			1						1		1
CO7:	1	1							1		1		
CO8:		1	1		1		1					1	

Note: 1: Low 2: Moderate 3: High.

Programme:	**B.Sc.**	**Semester :**	**III Sem**
Name of the Course:	**CC VII : Partial Differential Equation & System of Ordinary Differential Equation Lab**	**Course Code:**	**SOS-B-MA303**
Credits :		**No of Hours :**	**40**
Max Marks:	**50**		

Course Description:
The objective of this course is to understand to solve Partial differential equation and system of Ordinary differential equations numerically.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the basic command/functions use for solving PDE numerically
CO2	Plot the graph of characteristic Curves and 1st order PDE
CO3	Plot the graph of various PDE
CO4	Plot the graph of system of Ordinary differential equation

Syllabus:

List of Practical (Using any Software): Practical/Lab work to be performed on a Computer (for developing the following Numerical programs:).

(1) Solution of Cauchy problem for first order PDE.

(2) Finding the characteristics for the first order PDE.

(3) Plot the integral surfaces of a given first order PDE with initial data.

(4) Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c\frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

(i) $u(x,0) = \phi(x), u_t(x,0) = \psi(x),\ x \in R,\ t > 0$

(ii) $u(x,0) = \phi(x), u_t(x,0) = \psi(x),\ u(0,t) = 0,\ x \in (0,\infty),\ t > 0$

(iii) $u(x,0) = \phi(x), u_t(x,0) = \psi(x),\ u_x(0,t) = 0,\ x \in (0,\infty),\ t > 0$

(iv) $u(x,0) = \phi(x), u_t(x,0) = \psi(x),\ u(0,t) = 0,\ u(l,t) = 0,\ 0 < x \in l,\ t > 0$

(5) Solution of diffusion equation $\frac{\partial u}{\partial t} - k^2\frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

(i) $u(x,0) = \phi(x),\ u(0,t) = a,\ u(l,t) = b,\ 0 < x \in l,\ t > 0$

(ii) $u(x,0) = \phi(x),\ x \in R, 0 < t < T$

(iii) $u(x,0) = \phi(x),\ u(0,t) = a,\ \ x \in (0,\infty),\ t \geq 0$

Text Books

2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India.

Reference Books

7. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, 4th Ed., PHI Learning Private Limited, 2012.
8. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
9. Kendall E. Atkinson: An Introduction to Numerical Analysis
10. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th Edition, 2008
11. S. D. Conte & S. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.
12. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

CO-PO & PSO Correlation

Course Name : : Partial Differential Equation & System of Ordinary Differential Equation													
	Program Outcomes								PSOs				
Course	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	1	2		1	1			1	1	1	1	
CO2:	2	1	2	1		1				1	1		1
CO3:	1	1	1	1					1	1	1		
CO4:	2	1	2	1			1	1				1	1

Note: 1: Low 2: Moderate 3: High.

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Programme:	**B. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Numerical Methods and Scientific Computing.**	**Course Code:**	**SOS-B-MA 401**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course Handle physical problems to find an approximate solution. Use mathematical software with the accuracy one need from the computer. Students will able to understand the Algorithms, Convergence, Error and also understand the System of linear algebraic equations and their convergence analysis, Numerical differentiation, Numerical Integration. Students will learn Ordinary differential equations and evaluation of its solution

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Handle physical problems to find an approximate solution.
CO2	Use mathematical software with the accuracy one need from the computer.
CO3	Understand the Algorithms. Convergence. Errors: absolute, relative, percentage, Round off.
CO4	Evaluate root of Transcendental and polynomial equations.
CO5	Understand the System of linear algebraic equations and their convergence analysis.
CO6	Understand the Interpolation.
CO7	Understand Numerical differentiation, Numerical Integration
CO8	Learn Ordinary differential equations and evaluation of its solution

Syllabus:

Algorithms. Convergence. Errors: absolute, relative, percentage, Round off. Truncation. Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

Numerical differentiation: Methods based on interpolations, methods based on finite differences.

Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Weddle's rule, Boole's Rule. midpoint rule, Composite trapezoidal rule, composite Simpson's 1/3rd rule, Gauss quadrature formula.

Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

Text Books

3. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India.

Reference Books

13. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, 4th Ed., PHI Learning Private Limited, 2012.
14. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
15. Kendall E. Atkinson: An Introduction to Numerical Analysis
16. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th Edition, 2008
17. S. D. Conte & S. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.
18. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

CO-PO & PSO Correlation

Course Name : Numerical Methods and Scientific Computing													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:		2				1			1	1			1
CO2:				1		1				1			
CO3:		2				2			1				1
CO4:	2	2	1			1				2		1	
CO5:	1												1
CO6:	1					1				1			
CO7:		1		1									1
CO8:	2	1	1			1	1	1	1	3	1		

Note: 1: Low 2.: Moderate 3:

Programme:	**B. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Numerical Methods and Scientific Computing. Lab**	**Course Code:**	**SOS-B-MA 401**
Credits :		**No of Hours :**	**40**
Max Marks:	**50**		

Course Description:

Student will learn to use mathematical software with the accuracy one need from the computer. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of systems of linear equations and differential equations, interpolation, differentiation, evaluating integration. Students will learn how to solve the Ordinary differential equations numerically.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	To use loop and calculate the sum like 1/1 + 1/2 + 1/3 + 1/4 + ---+ 1/ N.
CO2	To find the solution of transcendental and algebraic equations
CO3	To solve the solution of system of linear equations and interpolate the data.
CO4	Solving the integration and differentiation and differential equation using any software.

Syllabus:

List of Practical (Using any Software/MATLAB/Mathematica/MAPLE etc.)

Practical/Lab work to be performed on a Computer(for developing the following Numerical programs:).

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. Enter 100 integers into an array and sort them in an ascending order.
3. Solution of transcendental and algebraic equations by
    i) Bisection method
    ii) Newton Raphson method.
    iii) Secant method
    iv) Regula Falsi method.
4. Solution of system of linear equations
    i) Gaussian elimination method
    ii) Gauss-Jacobi method
    iii) Gauss-Seidel method

5. Interpolation

    i) Lagrange Interpolation

    ii) Newton Interpolation

6. Numerical Integration

    i) Trapezoidal Rule

    ii) Simpson's one third rule

    iii) Weddle's Rule

    iv) Gauss Quadrature

7. Solution of ordinary differential equations

    i) Euler method

    ii) Modified Euler method

    iii) RungeKutta method

Note: For any of the CAS *MATLAB / Mathematica / Maple / Maxima* etc., Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expression, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Text Books

4. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India.

Reference Books

19. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, 4th Ed., PHI Learning Private Limited, 2012.
20. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
21. Kendall E. Atkinson: An Introduction to Numerical Analysis
22. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th Edition, 2008

23. S. D. Conte & S. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.
24. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

25. CO-PO & PSO Correlation

Course Name : Numerical Methods and Scientific Computing Lab													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	1	1		2	1		1	1	1			1
CO2:	1		1	2		2	1			1			
CO3:	2	1							1				1
CO4:	3		2	2	1		2	2		2		1	

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School of Science, Department of Mathematics

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B.Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Riemann Integration & Series of Functions (Analysis-III)**	**Course Code:**	**SOS-B-MA402**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**150**		

Course Description:

This course enables the students to understand Riemann integration and algebra of R-integrable functions, Fundamental theorem of integral calculus, concepts of uniform continuity, differentiation, integration and uniform convergence.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand partitions and their refinement.
CO2	Understand Integrability and theorems on integrability.
CO3	Understand the Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions.
CO4	Acquire the idea about Riemann Integrability and Riemann Integration
CO5	Determine the Riemann integrability of monotone and continuous functions.
CO6	Understand the definition and integrability of piecewise continuous and monotone functions.
CO7	Define Intermediate Value theorem for Integrals & prove the Fundamental theorems of Calculus.
CO8	Understand various theorems associated with Riemann Integration.
CO9	Develop a knowledge about Riemann Integration and applies into problems
CO10	Describe the Improper integrals; Convergence of Beta and Gamma functions.

Syllabus:

Unit 1 : Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.

Unit 2 : Improper integrals; Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions.

Unit 3 : Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test

Unit 4 : Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

Text Books

1. K.A. Ross, Elementary Analysis: The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis (3rd edition), John Wiley and Sons (Asia) Pvt. Ltd.., Singapore, 2002.

Reference Books

1. Charles G. Denlinger, Elements of Real Analysis, Jones and Bartlett (Student Edition) 2011.

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CO-PO & PSO Correlation

Course Name : Riemann Integration & Series of Functions (Analysis-III)										
	Program Outcomes						PSOs			
Cours	1	2	3	4	5	6	1	2	3	4
CO1:	1	1	1	1	1				1	1
CO2:		1		1	1	1		1	1	1
CO3:		1	1		1	1	1		1	1
CO4	1			1		1	1	1		1
CO5:		1	2	1		1	1			
CO6:										
CO7:	1	1			1			1		1
CO8:	1			1			2			
CO9:				1					3	
CO10:	1									

Note: 1: Low 2: Moderate 3: High.

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Programme:	**B. Sc. Hons.**	**Semester :**	**IV Sem**
Name of the Course:	**Linear Algebra (Algebra-III)**	**Course Code:**	**SOS-B-MA403**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**100**		

Course Description

This course covers matrix theory and linear algebra, emphasizing topics useful in other disciplines. Linear algebra is a branch of mathematics that studies systems of linear equations and the properties of matrices. The concepts of linear algebra are extremely useful in physics, economics and social sciences, natural sciences, and engineering. Due to its broad range of applications, linear algebra is one of the most widely taught subjects in college-level mathematics.

COURSE OUTCOMES

Upon completion of this course, students should be able to:

CO Number	Course Outcome
CO1	Understand the Systems of linear equations, row reduction and echelon forms
CO2	Understand Eigen values, Eigen Vectors and Characteristic Equation of a matrix.
CO3	Understand Vector spaces, subspaces, algebra of subspaces
CO4	Understand linear independence, basis and dimension, dimension of subspaces.
CO5	Understand linear transformations, null space, range, rank and nullity of a linear transformation
CO6	Understand Isomorphisms, Isomorphism theorems.
CO7	Understand Inner product spaces and norms
CO8	Understand Green's function and solutions of boundary value problems.
CO9	Understand Normal and self-adjoint operators, Orthogonal projections and Spectral Theorem. Frobeinus, Bessel's equation and Bessel's functions.

CO10	Find the change-of-basis matrix with respect to two bases of a vector space
CO11	Compute and use eigen vectors and eigen values
CO12	Understand the basic ideas of vector algebra: linear dependence and independence and spanning

Syllabus

Systems of linear equations, row reduction and echelon forms, rank of a matrix, vector equations, the matrix equation Ax = b, solution sets of linear systems, applications of linear systems, linear independence. Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of co-ordinate matrix.

Inner product spaces and norms, Gram-Schmidt orthogonalization process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Reference Books

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi, 1999.
3. S Lang, Introduction to Linear Algebra (2nd edition), Springer, 2005.
4. Linear Algebra by J.N. Sharma and A.R. Vasista, published by Krishna PrakashanMandir, Meerut- 250002.
5. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
6. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra 2nd Ed., Prentice-Hall Of India Pvt. Limited, 1971.

CO-PO & PSO Correlation

Course Name : Linear Algebra (Algebra-III)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1								2		1		1
CO2:			1							1			
CO3:							1		1		1		
CO4:		1			1		2				1	2	
CO5:	1								1				
CO6:					1					2			1
CO7:	1			1						2			2
CO8:		1			1		2				1	2	
CO9:	1								1				
CO10:					1					2			1

Note: 1: Low 2.: Moderate 3: High

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Programme:	**B.Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Real Analysis and Group Theory**	**Course Code:**	**SOS-B-MA304**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**150**		

Course Description:

This course enables the students to understand Real number system and their properties, Open and closed sets, sequences and series and Convergence and Divergence criteria for sequence and series of functions. Group theory is one of the building blocks of modern algebra. This course is to introduce students to basic concepts of group theory and examples of groups and their properties. This course will lead to future basic courses in advanced mathematics, such as Group theory-II and ring theory.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the basic properties of real number system that will used later in development of real analysis theory.
CO2	Develop the logical thinking to proof the basic results of real analysis.
CO3	Describe the basic concept of Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences.
CO4	Understand the Monotone Convergence Theorem.
CO5	Define Subsequences, Divergence Criteria, Monotone Subsequence theorem & prove the Bolzano Weierstrass Theorem for Sequences.
CO6	Understand the Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence:
CO7	Understand the Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence:
CO8	Understand the Alternating series, Leibniz test, Absolute and Conditional convergence.
CO9	Solve the problems of convergence and divergence of sequences and series.
CO10	Develop an understanding of limits in abstract way and how they are used in sequences, series.

Syllabus:

Unit 1 : Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Unit 2 : Infinite series, convergence and divergence of infinite series, Cauchy Criterion,Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Unit 3 : Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series & Maclaurin's series expansions of exponential & trigonometric functions.

Unit 4 : Group, elementary properties of groups, Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem External direct product of a finite number of groups, normal subgroups, factor groups, Group homomorphisms and isomorphism, properties of homomorphisms and isomorphisms.

Reference Books

1. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi, 1999 (IX Edition 2010).
2. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
3. S C Mallick, Mathematical Analysis

CO-PO & PSO Correlation

Course Name : Real Analysis and Group Theory										
	Program Outcomes						PSOs			
Cours	1	2	3	4	5	6	1	2	3	4
CO1:	1	1		1	1		1	1	1	1
CO2:		1	1	1	2	1			1	1
CO3:	1		1							
CO4:	1	1								
CO5:	1		1	1		1	1	1	1	1
CO6:	1	3	1	1	1	1	1	1		1
CO7:	1		1					1		
CO8:	1	1	1	2						
CO9:			1		1			1		
CO10:	1									

Note: 1: Low 2: Moderate 3: High.

Programme:	**B.Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Linear Algebra and Numerical Methods**	**Course Code:**	**SOS-B-MA404**
Credits :	**6**	**No of Hours :**	**60**
Max Marks:	**150**		

Course Description:

This is a basic course in modern algebra which deals with linear algebra and numerical methods. This course is an introductory course for solving algebraic and transcendental equation.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Solve systems of linear equations
CO2	Analyze vectors in Rn geometrically and algebraically.
CO3	Recognize the concepts of the terms span, linear independence, basis, and dimension, and apply these concepts to various vector spaces and subspaces.
CO4	Compute and use eigenvectors and eigenvalues.
CO5	To solve a system of equations.
CO6	Applications in all branches of engineering
CO7	To Find the roots of transcendental equations
CO8	To interpolate the given set of values.
CO9	Numerical solution of differential equations
CO10	Numerical solution of Integration.

Syllabus:

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Systems of linear equations, row reduction and echelon forms, rank of a matrix,

vector equations, the matrix equation Ax = b, solution sets of linear systems, applications of linear systems, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Errors, absolute, relative, percentage, Round off. Truncation. Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-falsi method, System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method.

Finite Differences and Interpolation: Forward, Backward and Central Differences, Newton forward and Backward difference interpolation formula, Lagrange and Newton's divided difference methods.

Numerical differentiation and integration: Methods based on interpolations, Newton Cotes quadrature formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Weddle's rule, Boole's Rule.

Reference Books

1. S Lang, Introduction to Linear Algebra (2nd edition), Springer, 2005.
2. Linear Algebra by J.N. Sharma and A.R. Vasista, published by Krishna PrakashanMandir, Meerut- 250002.
3. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
4. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra 2nd Ed., Prentice-Hall of India Pvt. Limited, 1971
5. B.S. Grewal, Numerical Methods
6. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India.

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OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

CO-PO & PSO Correlation

Course Name : Linear Algebra and Numerical Methods										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2
CO1:		2				1			1	1
CO2:				1		1				1
CO3:		2				2			1	
CO4:	2	2	1			1				2
CO5:										
CO6:										
CO7:	2	1	1			1	1	1	1	3
CO8:		2							2	
CO9:			1				3			2
CO10:		1						2		

Note: 1: Low 2: Moderate 3: High.